CROCODILES

Proceedings of the 13th Working Meeting of the Crocodile Specialist Group

of the Species Survival Commission of IUCN - The World Conservation Union

convened at

Santa Fe, Argentina, 11 - 17 May 1996

(Unedited and Unreviewed)

IUCN - The World Conservation Union

Rue Mauverney 28, CH-1196, Gland, Switzerland

1996

Cover photo: *Caiman latirostris* adult male (Santa Fe, Argentina)

Literature citations should read as follows:

For individual articles:

[Author]. 1996. [Article title]. pp. [numbers]. *In*: Crocodiles. Proceedings of the 13th Working Meeting of the Crocodile Specialist Group, IUCN - The World Conservation Union, Gland, Switzerlaud. ISBN 2-8317-0327-1. 516p.

For the volume:

Crocodile Specialist Group. 1996. Crocodiles. Proceedings of the 13th Working Meeting of the Crocodile Specialist Gronp, IUCN - The World Conservation Union, Gland, Switzerland.. ISBN 2-8317-0327-1: 516p.

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ISBN 2-8317-0327

Published by: IUCN/SSC Crocodile Specialist Group.

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FOREWORD

The Latin American region supports the most diverse assemblage of crocodilians, and may have the most abundant of any crocodilian species. The region has always been a major producer of skins for the international trade, and increasingly, the development of sustainable use programs is replacing the former unregulated exploitation of crocodilians. The region has immense reserves of wetland habitat, many in protected areas, and has the potential to be a region where crocodilian populations are well managed, sustainably used and secure. At the same time the Latin American region has some inherent challenges for conservation action that are well recognised. The capacity for sustainable management of all resources, and particularly crocodilians, is slowed by the relatively small number of trained personnel. The sheer logistic difficulties of vast countries with long common borders, poor communications and limited financial resources make conservation difficult. Legal and infrastructural capacity for regulation and enforcement are underdeveloped in some areas. Fortunately these challenges are being faced and met by an increasing number of young biologists and wildlife managers who are building upon their strong heritage of scholarship, national pride and vigourous development.

It was therefore a pleasure for the CSG to accept an invitation from a relatively small and recent program for the conservation and sustainable use of *Caiman latirostris* in Santa Fe province, Argentina, to hold our 13th Working Meeting. Impressed by the energy and dedication of the Projecto Yacaré team, we anticipated that the meeting would be effectively organised and stimulating. It was our particular hope that the meeting would attract the attention of many young workers in the Latin American region and provide a venue for them to showcase their work, meet each other and form bonds of friendship and cooperation that would assist their future activities. All of these expectations were met and exceeded in Santa Fe. The level of participation, the quality of presentations, the vigour of scientific exchange and the warmth of personal interactions were of the highest level. Numerous participants have told me of their satisfaction at the 13th Meeting's success. Nearly all of the papers presented at the meeting are included for publication in this Proceedings volume, as well as a number of valuable papers submitted for presentation by authors who were unable to attend. Together these papers represent another valnable contribution to crocodilian science and conservation and serve as an enduring record of this extremely successful event. Crocodilian conservation appears to be on a trajectory of increasing success in the region, fueled by the energy and enthusiasm of the CSG members there.

Professor Harry Messel, Chairman CSG.

SUMMARY OF THE MEETING

Between 13 and 17 May 1996, 112 participants from Latin America, and throughout the world assembled in Santa Fe, Argentina for the 13th Working Meeting of the Crocodile Specialist Group. The Meeting was organized and hosted by Alejandro Larriera, Projecto Yacaré and the Fundación Hábitat y Desarrollo. The Meeting received significant assistance from the Government of the Province of Santa Fe, the Municipality of Santa Fe, a number of Argentina conservation organizations and a long list of commercial sponsors. All these are listed in the Acknowledgments and we thank them again here. The energetic efforts of the Proyecto Yacaré staff, Alba Imhof, Cristina von Fink, Carlos Piña, Paula Donayo, Patricia Amavet, Pablo Sirosky, Ana Costa, and numerons other volunteers and assistants ensured the success of the meeting.

The meeting was honoured at its inauguration by the presence of the National Secretary of Natural Resources and Human Environment, Ing. Maria Julia Alsogaray; the representative of the Santa Fe Province Governor, the Production Minister Dr. Omar Perotti; the representative of the Mayor, Dr. Horacio Rosatti; and the Rector of the Universidad Nacional del Litoral, Arq. Hugo Storero. The meeting recieved wide press and media coverage. Participants heard a broad selection of presented papers covering topics of crocodilian conservation in Latin America, the biology of *Caiman crocodilus* and *Crocodylus acutus*, incubation and growth studies, disease and nutrition in captivity, field research, national program updates and alligator biology. Some of the more important papers were keynote addresses by Jeff Lang on temperature effects on incubation and sex, Bill Magnusson on the structure of field studies, Steve Busack and Sima Pandya on *Caiman* systematics and Grahame Webb on the general philosophy of crocodilian management. Field results of great interest were reports on surveys in the Colombian amazon and Brazil demonstrating substantial populations of *Melanosuchus niger*, and a series of papers on *Crocodylus acutus*. Some of these, and other presentations, totaling 52 papers, are published in this Proceedings. The Proceedings were assembled under the managing editorship of Perran Ross, and Alejandro Larriera and his staff arranged printing and distribution with funding assistance from the Government of the Province of Santa Fe.

Two workshops were conducted during the meeting. One, on application of the new IUCN Threatened species criteria, resulted in a re-evaluation of the status of all Latin American crocodilians. The other on current world trade and anticipated trends, highlighted the increasing production of crocodilian skins in sustainable use programs and focused concern on the need for market expansion to absorb the anticipated production. Full reports of these workshops appear in the Proceedings. Following the workshops a group interested in *Crocodylus acutus* studies have formed a network to communicate and coordinate their activities throughout the wide range of this species.

The meeting was notable both for the very amenable tone of the activities and for the active participation of many new and younger faces from the Latin American region. This new generation of crocodilian biologists demonstrated the quality of their work and their commitment to conservation action that augers well for the future of crocodilians in the region. As we have come to expect at CSG Working Meetings, some of the most stimulating and useful discussions were those which took place informally among participants. The CSG is particularly grateful for the sponsorship provided by Cerveceria Santa Fe and Galletitas Aguila who refreshed the strength and spirits of participants with cookies and beer each afternoon.

Following the meeting, participants dispersed to field trips to *Caiman latirostris* habitats and field study sites in Santa Fe and Corrientes province. Thanks to the generosity of the Governor of the Province of Santa Fe, many of us were able to enjoy low level flights over the marshes in his private helicopter, allowing an unequalled appreciation of the habitat and the density of caiman in the province. We must also thank our bus driver who showed great stoicism under pressure after sliding the bus into a muddy ditch, where it became immovably stuck. We also express our admiration to the Proyecto Yacare staff who had the foresight to bring sufficient wine and food in the bus to make the subsequent party very enjoyable, while we awaited rescue. Our thanks go to all who made this excellent meeting a success.

James Perran Ross, Executive Officer CSG

CROCODILE SPECIALIST GROUP

The Crocodile Specialist Group (CSG) is a worldwide network of biologists, wildlife managers, government officials, independent researchers, non-governmental organization representatives, farmers, traders, tanners, manufacturers and private companies actively involved in the conservation of crocodilians (Crocodiles, Alligators, Caimans and Gharials). The Group operates under the auspices of the Species Survival Commission of IUCN. The CSG provides a network of experts to assess conservation priorities, develop plans for research and conservation, conduct surveys, estimate populations, provide technical information and training, and to draft conservation programs and policy. CSG also assists monitoring international trade and identifying products. The CSG works closely with CITES to promote sustainable use and international trade that benefits the conservation of crocodilians. The Group is headed by its chairman, Professor Harry Messel, and maintains offices in Gainesville, FL USA. Working Meetings of the CSG are held every two years.

Participants at the 13 th CSG Working Meeting, Santa Fe, Argentina. May 1996. Arranged by country and alphabetically within country.

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THE EXPERIMENTAL RANCHING PROGRAM OF BROAD-SNOUTED CAIMAN IN SANTA FE, ARGENTINA

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Introduction

The Experimental Ranching Program of broad-snowted caiman (*Caiman latirostris*) starts in Santa Fe province on 1990, from an agreement between the Instituto Nacional de Tecnología Agropecuaria (INTA) and the Ministerio de Agricultura, Ganadería, Industria y Comercio (MAGIC). From 1992 and based on other agreement with the Mutual del Personal Civil de la Nación (MUPCN), the amount of the eggs harvest is increased and the level of the work is improved. Since its beginning the aim of the program was to determine if the Ranching technique is an usefull tool for direct conservation of caiman populations and (indirectly) conservation of the local wetlands (caiman habitats) through the economic valorization of that lands.

The philosophy of the work is very simple, the eggs are collected from the wild by the personal of the program and carried to the incubator in Santa Fe City, the hachlings are reared under controlled conditions in nurseries, and after the winter the yearlings (between 8 to 10 month old) are released into the wild in the same place where the eggs were harvested the season before. The status of the studied population is monitored by night counts and all the information is statistically analyzed.

Due to the increased amount of the harvest during this years, the program became in a permanent source of important and usefull information about the natural history of broad snouted caiman on one hand, and the captive rearing techniques on the other.

Despite the differences among species, the success of the crocodiles ranching programs all over the world seems to happen with *Caiman latirostris* too. After six years of work, with over than 3800 yearlings released into the wild, and with an eggs harvest of over than 3200 just from this year (about 2800 yearlings moore will be released next spring), we are applying now for the change of Santa Fe *C. latirostris* population from the Apendix I to Apendix II of CITES, under the 3.15 Resolution.

General Metodology

The metodology of the work was displayed extensively in the last three Crocodile Specialist Group Working Meeting, but we can make a brief summary here:

1) Eggs are harvested from the wild for the people of the project. Nests are marked for local inhabitants (mostly Cattle Ranch employers) within the forest, on the banks of narrow streams or small lakes, or arround swampy lands. Nests within swampy lands are marked by ourselves with an helicopter.

2) The transport of the eggs is carried out depending the harvest place. With horses in the cattle ranchs, with boats in a few occasions in brooks and lakes, and with the helicopter in swampy lands.

3) Incubation is carried out in the artifficial incubator at 31.5° C. and with a 95% of hummidity.

4) Hachlings are reared in concrete pools in nurseries, covered for water in a 50% of its surface. There are a basic temperature control during winter. The animals are feed three times a week with minced chicken heads, bran cereal and a vitaminic mineral mixture.

5) The yearlings are identifyed by nest and harvest year, and released into the wild at the same place of the eggs harvest the year before.

6) Monitoring is carried out with standarized nights counts in the surveyed places and the results are statistically analyzed and corrected (depending the water temperature) on the basis of our work from 1992 (Larriera et. al.).

Results

-)Eggs harvest and hatch since 1990:

YEAR	NEST HARVEST	EGGS	HACHLINGS
90/91	10	372	237
91/92	25	803	701
92/93	24	926	589
93/94	50	1936	1196
94/95	60	2211	1646
95/96	84	3120	2262
TOTALS	253	9368	6631

-) Releasings since 1990:

YEAR	RELEASED HACLINGS
1991	205
1992	655
1993	541
1994	1022
1995	1451
TOTAL	3874

-) Harvest Moment:

At the beginning of the program the harvest were carried out as late as was possible in order to reduce transportation problems. Today we are harvesting as early is possible because our investigations shows that (for differents reasons) the probability of embryo death is daily incresed in the wild. Following an example is displayed about the Hatching success depending the harvest moment in the season of year 1994 (flooding).

Harvest Moment and Hatching Success
during 1994 season

HARVEST MOMENT	HATCHING SUCCESS
Late (0 - 29 days)	39,563
Medium (30 - 59 days)	73,813

Early (60 days)	63,615

-)Monitoring

Following are displayed the results of some of the night counts carried out since 1990 in different sampling places.

YEAR	PLACE	COUNTED ANIMALS	WATER TEMPERTURE	CORRECTED VALUE
1990/91	Los Molles	8	29	13
	Lote 5	36	23	62
	Dientudo	27	25	44
	Lote 16B	2	27	3
1991/92	Los Molles	12	29	19
	Los Molles	11	25	18
	Los Molles	13	24	22
	Lote 16B	15	29	24
	Mayoraz	27	27	47
	Corralitos	4	14	19
	Corralitos	10	24	17
1992/93	Lote 5	13	22	24
	Lote 5	129	**	**
	Dientudo	116	26	197
	Lote 16B	16	22	30
	Corralitos	40	29	64
	Fisco	4	20	7
1993/94	Lote 16B	2	26	3
	Lote 5	34	28	55
	Dientudo	90	24	150
	Corralitos	135	28	218
	Fisco	0	0	0
1994/5*	Dientudo	90	24	150
	Dientudo	137	24	228
	La Colorada	110	23	189
	Fisco	48	23	82

* Extreme dry season

** No temperture data

-) Geographic caracterization and distribution area.

The distribution area of *C. latirostris* at the Santa Fe province was determined (Larriera 1993).

The differents nesting habitats were studied and it was deterimined that there are at list five different kind of nidification environment for *Caiman latirostris* in Santa Fe.

1- Floating vegetation in swampy land.
2- Ridge arround lakes or sreams.
3- Forest
4- Ridge arround artificial ponds.
5- Ridge in swampy land.

All the sampling points and nesting place were marked with GPS equipment.

Conclusions

1) Eggs harvest and rearing conditions:

The amount of eggs harvested is increased every year, the hatching success is continuously improved and mortality in captivity conditions is lower. In fact, the main mortality during rearing occur near the hatch moment, so the studies on this issue must be improved. Besides, the rain before the breeding season determining the nesting rate, and the water level during incubation determining, high mortality because flood when highs, and increse on predation levels when lows, shows that the early harvest of eggs is the recomended management alternative.

2) Status in sampling areas:

After an spectacular populational recovering the three first years, the situation looks now stabilized in the working areas. On the other hand an expansion on the distribution areas of *C. latirostris* is detected. The proportion of the marked animals (farm-released) in the field studies is 60% of the total. An explanation about it could be that ones the capacity of the environment is rised, a migration occur to bordering places, what is suggested for the recapture of farm-released animals 12 kilometers far from the releasing point. Anyway, the incidence of the hidrological situation in each particular year appear as the main thing to be considered, so in this way flood causes dispersion, dry produce concentration, and extreme dry, migrations.

3) Prospects:

A caracterization of the areas where broad snowted caiman occur, shows that the 40% of the population lives on heterogeneous environments (forest, streams, lakes, narrow rivers and artificial ponds), and the remaining 60% occur on homogeneous envirnments (inacessible swampy land). An study of the satellital images (SPOT) on the basis of the field works shows that in the 80% of the swampy lands bigger than 300 has, northern than 31° S in San Javier state, San Cristóbal state and the central portion of Vera and general Obligado states, is posible to find broad snowted caimans. The program at the moment is carried out in the 54% of the swampy land surface of San Cristóbal state (5,875 has. of 10,747 has. availables), in the 27% of the swampy land surface of San Javier state (4,813 has. of 17,809 has. availables), and did not start yet in the other studied areas (25,117 has.). This means that without consider the rest of the nort of the province, the current working area is the 19% of the available swampy land surface available.

As a general conclusion, due to the amount of the harvest, to the success in rearing, to the releasings carried out, to the populational situation, and the prospects of the program, Ranching appear as a safety management tool for *Caiman latirostris* in Santa Fe province.

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ASPECTOS GENERALES DE LA ZOOCRÍA DE CROCODYLIA EN COLOMBIA

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1-INTRODUCCION

Aunque la explotación de los *Crocodylia* en Colombia data del siglo pasado, fue tan solo en 1984 cuando se iniciaron los primeros programas experimentales reglamentados de zoocría en el país y que involucraron a 2 especies de Cocodrilos, 1 especie de Caimán y 2 subespecies también de Caimán, siendo éstas últimas "*Caiman crocodilus fuscus* y "*Caiman crocodilus crocodilus*", las subespecies que actualmente se comercializan y que en su mayoría van al mercado internacional. Las otras 3 especies "*Crocodylus acutus*" ,"*Crocodylus intermedius y Melanosuchus niger* son objeto de zoocría experimental.

A partir de 1987, Colombia entra al mercado internacional de pieles de las dos subespecies de caimanes, siendo el *Caiman crocodilus fuscus* la de mayor actividad en los programas de zoocría del país y que abarca cerca del 95% de la producción de pieles a nivel nacional.

Para finales de 1995 se registran 58 granjas de caimanes en fase comercial, ubicadas a lo largo del territorio nacional y concentrándose más del 80 % de la actividad en la zona norte del país en los departamentos del Caribe Colombiano.

Actualmente, 1996, y a través del recién formado **Ministerio del Medio Ambiente** se organizó el grupo asesor en fauna silvestre y que tiene como primera meta, realizar la evaluación técnica de la zoocría en Colombia, con el fin de unificar criterios de manejo técnico y capacitar al personal de las corporaciones regionales en materia de zoocría y manejo de fauna silvestre. Dentro de las actividades del grupo se analiza y evalúa la infraestructura de las granjas, desde el punto de vista administrativo, técnico y operativo. Y se establecen los parámetros básicos de manejo para parentales, neonatos y juveniles, así como también los sistemas de incubación y su correspondiente producción.

2-ANTECEDENTES

Uno de los trabajos recientes y más completos sobre la actividad comercial de la fauna silvestre en Colombia y que trata con especial énfasis en los Crocodylia, es la tesis de posgrado en Economía Agraria, desarrollada por O. López & Romero J. (in prensa 1995), en donde se recopiló información sobre el uso y aprovechamiento de los *Crocodylia* en el presente siglo y de donde se han extraído algunos apartes de los antecedentes del presente documento.

De acuerdo a Federico Medem (1953), el orden *Crocodylia* ha jugado un papel muy importante desde las culturas prehispánicas hasta nuestros tiempos, donde su representación se evidencia a partir de todo tipo de adornos (colgantes, collares, pectorales narigueras, ollas, etc.) , elaborados en diferentes materiales tales como el oro, cobre, arcilla, madera, hueso piedra, etc. Su uso directo se refiere a la utilización de la carne, los huevos, la grasa, los dientes y la piel.

Con el descubrimiento de América se inicia un saqueo de fauna silvestre hacia Europa, lo que dio origen a un comercio internacional. De esta situación no se escaparon los Crocodylia, pues según Medem (1981), en una de las crónicas de Fray Pedro Simón en la provincia de Mompox, en 1626 se sacrificaban anualmente más de 30.000 caimanes del Magdalena (*Crocodylus acutus*), que tenían una longitud total entre 6.1 y 7.3 metros y cuyo fin era el de obtener manteca, la cual se utilizaba para freír alimentos en grandes pailones.

Según Stevenson (1904) y Medem (1981), el mercado cóntinuo de pieles de *Crocodylia* hacia Europa se inicio aproximadamente en 1855 y se presentó como un producto de mucha importancia dada su abundancia y su frecuencia.

Para el presente siglo se cuenta con información muy puntual, que aunque es escasa, nos da una idea del comportamiento que ha tenido el comercio de pieles de *Crocodylia* en los últimos 78 años. Donde inicialmente y hasta la década de los cincuenta el comercio de pieles se centró en el

Crocodylus intermedius y *Crocodylus acutus*, afectando notablemente las poblaciones naturales hasta tal punto de quedar en la actualidad algunos individuos o pequeños grupos en peligro de extinción.

Una vez agotadas las poblaciones de *Crocodylus sp.*, comercialmente explotables, la actividad se encamino hacia la explotación de *Caiman crocodilus*, que hasta final de los años cuarenta no había sido objeto de caza masiva por considerarsele una piel de menor calidad, comparada con las pieles de *Crocodylus sp.*, las cuales eran y son consideradas "clásicas". La comercialización de pieles de *Caiman crocodilus fuscus* y de *Melanosuchus niger* se inició cerca a 1945, y diez años más tarde el recurso ya escaseaba en algunos lugares de la costa Atlántica y del Amazonas, esta situación originó el inicio de actividades masivas de caza de *Caiman crocodilus crocodilus* en los Llanos Orientales alcanzando su máximo incremento en 1970 y 1971 (Medem, 1981).

Al comienzo de la década de los 70s las especies de *Crocodylus sp* y *Melanosuchus niger* estaban catalogadas como en peligro de extinción, mientras que las subespecies de *Caiman crocodilus* se consideraron amenazadas.

Las exportaciones legales durante el período de 1951- 1980 alcanzaron a 11.649.655 pieles valor que según Medem (1981) debe tenerse como mínimo absoluto.

Actualmente en el país y desde hace 22 años aproximadamente el gobierno controla la caza de individuos silvestres y prohibe totalmente su comercialización. Solamente es posible exportar pieles o productos de *Caiman crocodilus fuscus* y *Caiman crocodilus crocodilus*, provenientes de la cría en cautiverio bajo la modalidad de "ciclo cerrado".

3-ASPECTOS TÉCNICOS DE LA ZOOCRÍA COMERCIAL DE **Caiman crocodilus**

La zoocría comercial de los *Crocodylia* en Colombia es una actividad reciente, pues las primeras labores se iniciaron a partir de 1983 y 1984 con la construcción de granjas experimentales con fines económicos y en donde se definieron los primeros parámetros técnicos de manejo para 4 especies del orden *Crocodylia*.

A nivel comercial se producen pieles y productos de *Caiman crocodilus fuscus* y *Caiman crocodilus crocodilus*, estando estas dos subespecies catalogadas en el Apéndice II del acuerdo CITES lo que significa , que su manejo debe ser controlado para que la actividad comercial no sea la causa de su desaparición, por lo que son consideradas como "**Vulnerables de extinción**".

Dentro de las especies incluidas en Apéndice II se sugieren 3 modelos de manejo en general: **Producción de ciclo cerrado, Producción en ciclo abierto y Caza comercial controlada**.

En Colombia, para todas las especies de *Crocodylia* se implementó el modelo de producción de ciclo cerrado, que aunque es especifico para especies de Apéndice 1 o en peligro de extinción como *Crocodylus ssp* y *Melanosuchus niger*, también se pude implementar para especies de Apéndice 2 .

3.1-SISTEMA DE PRODUCCIÓN:

Como se comentó anteriormente, el sistema de ciclo cerrado es el adoptado por Colombia y lo podemos dividir en los siguientes niveles de manejo:

3.1.1.-Parentales o pie de cría:

De acuerdo a la normatividad vigente, los parentales con que inician las granjas de *Caiman crocodilus*, son capturados en el medio silvestre mediante un permiso otorgado por el estado y con el compromiso de retornarlos al medio en cuotas anuales del 10%, una vez se inicie la etapa comercial, la cual es aprobada cuando el zoocriadero demuestre durante un período experimental, la suficiencia administrativa y técnica para manejar la especie en condiciones controladas y en ciclo cerrado.

3.1.1.1.- Manejo: Los encierros donde se mantienen los parentales se debe caracterizar por tener una vegetación adecuada, la cual consiste en arbolitos y arbustos que brindan sombra y aportan material foliar que será utilizado por las hembras anidantes durante el proceso de oviposición.

Todo encierro debe contar con una porción de agua de aproximadamente 1.2 metros de profundidad y en donde se realiza el cortejo reproductivo que finaliza con la fertilización de las hembras. Esta masa de agua debe corresponder a un 30% o 40% del total del área. El área seca que corresponde a un 60 a 70 % del total, debe presentar la topografía adecuada para que las hembras tengan la disponibilidad de sitio en el momento de la postura y la cual debe estar delimitada con malla o paredes de cemento lo suficientemente seguras para evitar el escape de los animales.

Con relación al área vital que requiere cada animal en los encierros, se ha estimado que un animal reproductor necesita de 25 a 45 m2 para alcanzar bajo condiciones óptimas de manejo hasta un 95% de hembras anidantes. Sin embargo, este porcentaje solamente se ha obtenido en casos muy puntuales, siendo lo más común un 55% de hembras anidantes por encierro con unos mínimos que pueden estar alrededor del 10% y unos máximos cercanos al 70%, esta última cifra sería la deseable como promedio de una granja donde se mantenga un control de parentales, con sus respectivas tasa de descartes y el reclutamiento de nuevos individuos que mantengan una producción estable.

El evento de oviposición es anual y se inicia con la construcción de un nido de hojarasca y/o material vegetal fresco y en donde se depositan de 10 a 48 huevos aproximadamente con un promedio que puede estar cercano a los 28 huevos por nido; los huevos son de color blanco, como producto de los depósitos de sales de calcio en la membrana externa la cual carece de pigmento; tienen forma elíptica, cáscara rugosa, áspera al tacto, rígida y normalmente salen recubiertos con una secreción muscilaginosa transparente.

En cuanto a la alimentación ya se conocen los requerimientos básicos para que el sistema de manejo funcione y sea productivo (proteínas, grasas, fibra, cenizas, vitaminas), faltando determinar los valores óptimos para el calcio, fósforo y elementos menores como el selenio.

Todos estos aspectos reproductivos y nutricionales están directamente relacionados con múltiples factores que afectan las actividades de zoocría y dentro de los cuales podemos citar los siguientes:

La proporción de sexos varia de 1:1-1:2-1:3 y 1-4 machos por hembra y en la actualidad no se a determinado la proporción ideal, pues se han registrado resultados mayores al 80% de hembras que realizaron posturas en encierros en donde se manejaban proporciones cercanas a 1:1 -1:2 y 1:3. Al respecto vale la pena hacer el siguiente comentario relacionado con una investigación que se lleva a cabo en la granja de Pizano S.A. (Zambrano, Bolívar, Colombia) en conjunto con la Universidad Nacional de Colombia y la Universidad Industrial de Santander:

Durante un año de muestreo y en época donde no hay oviposición (dos y tres meses después de la temporada de posturas) varias hembras disecadas, evidenciaron huevos oviductales en proceso de reabsorción, lo curioso y común fue que las hembras analizadas correspondían a especímenes provenientes del medio silvestre y aparentemente viejos. Al parecer existen individuos que por alguna razón aun no conocida, nunca se adaptan al manejo en cautiverio y por lo tanto aunque sean fértiles y ovígeras no depositaran los huevos en los encierros. Sin embargo, esta podría ser tan solo una de las causas reales. Lo anterior podría respaldar el hecho de que, en algunos encierros donde se mantienen individuos adultos nacidos en el criadero (F1), se presentan porcentajes de posturas correspondientes al 80% de las hembras existentes en el encierro. Esta situación respalda la idea de ir cambiando los animales silvestres por individuos nacidos en el zoocriadero.

Otro factor que definitivamente es importante lo constituye la calidad y cantidad de la dieta, así como la edad, el estado físico, la agresividad y el tamaño de los animales. Al respecto del tamaño de los animales se ha observado para *Caiman crocodilus fuscus,* como en algunos encierros de parentales se presenta un comportamiento dominante y agresivo de algunos machos grandes (mayores de 2 metros de longitud total) y posiblemente viejos, que compiten sexual y territorialmente con otros machos más aptos, además de competir por el alimento y no dejar comer lo suficiente a hembras potencialmente maduras, causando un stress alimenticio a estos individuos y por lo tanto afectando la productividad del encierro en materia de nidos.

3.1.2- Incubación

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Diferentes tipos de esfuerzos y planes de estudios han sido diseñados para establecer eficientemente sistemas viables de producción en granjas de *Crocodylia*. La muerte embrionaria durante la incubación es claramente el mayor problema en los programas de crocodiliocultura de propósito, tanto comercial como de conservación; un factor limitante para cualquier granja eficiente.

La investigación básica que tiene que ver con los factores físicos y biológicos que condicionan y regulan el éxito de la eclosión, se convierten en herramientas fundamentales para lograr el control técnico del proceso de incubación de huevos de *Crocodylia* y de otros grupos.

Cambios bruscos en las condiciones ambientales (temperatura, humedad relativa y saturación de oxígeno) que rodea los huevos en los sistemas de incubación controlada, son las causas más estudiadas de mortalidad embrionaria (**Ferguson**, 1985. **Rodriguez & Ulloa** 1991, 1994). Sin embargo, factores como la calidad del alimento ofrecido a parentales antes y durante la fase reproductiva, las condiciones apropiadas de hábitat y el manejo técnico en general pueden alterar la eclosión y por lo tanto verse disminuida la tasa de supervivencia embrionaria.

Desde el punto de vista nutricional el alimento de buena calidad suministrado a las hembras ovígeras, les permitirá elaborar yemas con todos los elementos indispensables para que el embrión tenga un desarrollo óptimo y por lo tanto una eclosión exitosa.

La estructuración de las **membranas que forman la cáscara** del huevo y las **membranas extraembrionarias** también depende de la calidad del alimento, y tienen como principal función el intercambio gaseoso (CO_2, O_2 y vapor de agua) y la protección del embrión. Una alimentación deficiente producirá alteraciones en estas membranas y por lo tanto cualquier anormalidad trae consecuencias letales.

En resumen, es la interacción de los siguientes factores la mayor causa de mortalidad embrionaria durante el proceso de incubación controlada:

1. Deficiencia en la estructura de las **membranas de la cáscara y extraembrionarias.**
2. Sometimiento del huevo a **cambios bruscos** de temperatura.
3. Humedad relativa que rodea los huevos mayor o menor que el óptimo (98% HR).
4. Deficiencia de oxígeno y por tanto una baja calidad del ambiente que rodea los huevos.
5. Manejo inapropiado en la recolección de huevos y durante la incubación.
6. Longevidad en las hembras anidantes.
7. Machos viejos que además de ser improductivos y territoriales compiten sexualmente con otros más jóvenes y compiten por alimento con las hembras activamente reproductivas, causando deficiencia nutricional en estas.
8. Deficiencia de vitamina E en las dieta de los parentales y por ende deficiencia en la calidades nutricionales de la yema.

Siguiendo el procedimiento operativo de las granja, los huevos deben ser recogidos de los corrales de reproducción habiendo transcurrido máximo 14 horas desde la postura, para ser trasladados y colocados en los sistemas de incubación controlada donde se les garantice el niveles de saturación de oxígeno (20.45%) en el ambiente gaseoso húmedo (HR: 98%) que rodea los huevos y con un sistema de calor o frío que mantenga estable la temperatura, ya que de esta dependerá el tiempo de incubación y la proporción de sexos de los neonatos eclosionados. Para temperaturas "bajas" entre 28.5 y 30 grados se espera una producción de hembras, mientras que para temperaturas "altas" 32 a 33.5 grados se espera producir machos, con una característica bien importante y es la que van a crecer aproximadamente un 20% más rápido que las hembras.

De acuerdo a algunos estudios realizados en los sistemas de incubación controlada se pudo apreciar que más del 55% de las muertes embrionarias ocurrían en los primeros 6 días de incubación y que una de las principales causas de este alto porcentaje estarían relacionadas con el manejo que se le da a los huevos en el momento de la recolección y posterior montaje en las cubeta de incubación. Dado que al momento de la oviposición el embrión flota libremente sobre la yema, su localización precisa depende de la posición del huevo en el nido, si el huevo es movido durante las primeras 15 horas luego de la postura el embrión se mueve hacia el punto más alto de la yema sin sufrir daños, por el contrario si el huevo es movido una vez que el embrión se ha adherido a las membranas de la cáscara (16 horas después aproximadamente), cualquier movimiento brusco puede romper las aún **incipientes membranas** que rodean al embrión y que lo unen a la cáscara ocasionando la muerte del embrión en los días siguientes de incubación al no poder realizar ningún tipo de intercambio gaseoso. De allí que la recolección de huevos después de 16 horas y los posibles efectos deletéreos de rotación o movimiento son particularmente importantes en lo que respecta a **muertes tempranas** durante el desarrollo embrionario.

En términos generales la incubación ha sido el factor más critico para todas las granjas de Crocodylia en Colombia, pues durante muchos años se desarrollaron sistemas que no suministraban las condiciones óptimas para obtener una buena incubación y por lo tanto una producción más aceptable. Sin embargo, desde hace unos años y actualmente se implementan sistemas sencillos pero muy eficientes, ya que dan como resultado eclosiones del 80 al 90% sobre la totalidad de huevos fértiles y las crías nacidas de estas incubaciones han presentado buenas tasas de crecimiento.

Los sistemas en general consisten en cuartos de paredes gruesas y forradas internamente con material sintético o madera lo que los hace térmicamente estables. Estas incubadoras están provistas de controles automáticos, electromecánicos o electrónicos, que controlan la temperatura en general y la mantiene constante de acuerdo a la programación que se realice en los controles. La humedad pude estar dada por vaporizadores o nebulizadores en algunos casos, en otros se forma un microclima a nivel de cubetas donde son colocados los huevos en un ambiente húmedo producto de la evaporación de agua o en contacto con algún material inerte como la vermiculita o material de origen vegetal similar al de los nidos o madera molida (aserrín). Todos estos sistemas requieren de una supervisión diaria y de un monitoreo técnico que mida las diferentes variables, tanto fisicas como biológicas, involucradas en el sistema y por lo tanto un control de registros que le permitan detectar alteración en el proceso y tomar los correctivos necesarios que le garanticen una buena incubación.

3.1.3 -Neonatos y Levantes:

3.1.3.1- Manejo: Una vez nacidos los neonatos deberán ser desinfectados preventivamente en la región ventral sobre la cicatriz del ombligo y permanecer dentro de la incubadora o en un ambiente similar, el tiempo necesario para que la yema sea consumido y los animales no presenten el abultamiento en la zona visceral producto de la reciente internalización del vitelo.

Este tiempo de "observación" puede variar de 12 a 36 horas, pues la situación de los individuos no es uniforme y al parecer esta determinada por el tiempo de incubación, o sea esta relacionada directamente con la temperatura de incubación.

Los individuos incubados a temperatura baja (29-30 grados) demoran hasta 85 días y por lo tanto al extenderse el período de incubación consumen todo el vitelo antes de nacer y su condición en el momento de nacer es la de un animal "flaco" y por lo tanto deben ser alimentados el mismo día de su nacimiento o ha más tardar al día siguiente.

Para el caso de los individuos incubados a temperaturas altas (32-33 grados), el tiempo de incubación puede ser de 65 a 72 días lo que implicaría que el individuo nace muy "rápido" y por lo tanto nace con mucha reserva de vitelo la cual a sido recién internalizada dando el aspecto de un neonato "barrigón" pero con mucha vitalidad. Esta reserva alimenticia le pude alcanzar para 2 a 4 días y después de este tiempo debe ser alimentado diariamente. Sin embargo, esta situación de los neonatos "barrigones", debe tratarse técnicamente y con mucha prudencia, pues si bien es cierto que estos individuos bien incubados van a corresponder a machos crecedores, también es cierto que cuando se incuba en un ambiente de humedad menor del 94%, las pérdidas por deshidratación podría estar entre un 9 a 13 % del peso inicial del huevo y lo que produciría también individuos "barrigones" pero con una tendencia bien marcada al enanismo. También se ha observado como en algunos casos y debidos a daños Iatrogénicos causados en las incubadoras, es posible inducir muerte embrionaria o nacimientos a destiempo (abortos), que traen consecuencias muy parecidas a la de los huevos deshidratados, ósea individuos "barrigones" que presentaran problemas de crecimiento.

Una vez los animales salen de la incubadora, son trasladados a encierros diseñados para tal fin, los cuales en su mayoría consisten en estanques de cemento que en su interior poseen una parte con agua y otra seca, además son cubiertas parcialmente con materiales que proporcionan sombra, esto último con el fin de crearles varias temperaturas en el ambiente artificial para que los animales se distribuyan de acuerdo a sus necesidades fisiológicas. Para animales juveniles la unidades de manejo en algunas granjas son las mismas que las de neonatos , en otros zoocriaderos se utilizan encierros en cemento o en tierra o combinado cemento-tierra y en donde siempre existirá una zona con agua y otra seca. La forma y el tamaño del encierro o estanque varia mucho, pues se construyen con pozo de agua lateral, central o en forma de laberinto y los tamaños en metros cuadrados pueden estar desde los 4 a los 1000 metros, siendo técnicamente más manejables los encierros pequeños de 12 a 100 metros cuadrados.

Relacionado con los encierros y el crecimiento y eficiencia, M. Rodriguez & Ulloa, G. (1993 documento in prensa), encontraron para Caiman crocodilus fuscus, después de 600 días de investigación en encierros de 12 m2, que los individuos crecidos en condiciones de total oscuridad y en un ambiente de temperatura más estable (27 a 38 grados en el aire y 29 a 34 grados en el agua) crecían un 25% más que los individuos testigos crecidos en encierros abiertos y en donde las temperaturas diarias pueden estar entre 20 a 39 grados en el ambiente y 24 a 35 en el agua. Además del crecimiento se registro una mortalidad mucho más baja en los encierros oscuros, pero no se pudo evidenciar diferencias en la calidad de la piel (aparentemente los osteodermos mantienen una calcificación normal).

La tendencia actual en las granjas del país es la de mantener, al menos por un año, los individuos en recintos donde la temperatura sea más estable que en el medio ambiente y es así como varios zoocriaderos están implementando este manejo. Sin embargo , esta situación puede mejorar el crecimiento de individuos siempre y cuando se manejen también las variables que tienen que ver directamente con el desarrollo y crecimiento de los individuos y que a continuación se registran.

1- Tasa de alimentación

2- Frecuencia de suministro de alimento

3- Calidad de los componentes de la dieta

4- Densidad de la población

5- Infraestructura fisica de los encierros

6- Manejo técnico de los animales

7- Sistema de incubación

8- Aspectos genéticos

3.1.3.2- Alimentación: En cuanto a la alimentación utilizada en las granjas se evidencia que además de existir una gran variedad de productos, en algunos casos no se cuenta con una fuentes fijas. Varias granjas suministra alimento que no cumple con los requerimientos nutricionales de las especies o son utilizadas cantidades inapropiadas sin ningún control técnico, las cuales no garantizan el crecimiento de los animales. Como se puede apreciar, esta es una situación crítica para algunos zoocriaderos, sin embargo, la mayoría de ellos están trabajando en la estandarización de las dietas de acuerdo a los productos que consiguen, mejorando la composición con harinas de origen animal, vitaminas , sales etc. Los productos más usados son los siguientes:

-Pescado natural y de cría

- Desechos viscerales de la actividad industrial de pesca marina

-Cabeza de camarón

-Vísceras y desechos de ganado vacuno

-Desechos viscerales de la actividad industrial avicola

-Desechos de la industria cárnica de embutidos

-Harinas de pescado, carne, sangre y de plumas

-Concentrado peletizado y extruido

- Embutido de concentrado especifico para Crocodylia

3.1.3.3- Crecimiento: En cuanto al crecimiento de los animales se observa que es muy variado para todas las granjas y que esta sujeto a todas las condiciones anteriormente citadas, donde la calidad de los parentales, la incubación, la composición de la dieta, el manejo técnico y la infraestructura de la granja, vendrían a ser los factores esencialmente responsables de la eficiencia que puedan tener los animales para crecer.

Una aproximación de crecimiento para Caiman crocodilus fuscus y que refleje la situación promedio actual de las granjas vendría ser la siguiente:

Caiman crocodilus fuscus

Edad	% de la población		
	20%	60%	20%
1 año	40 cm	65cm	75 cm
2 años	60 cm	80 cm	90 cm
3 años	80 cm	100 cm	120 cm

Vale la pena resaltar que algunas granjas, de acuerdo al manejo técnico implementado, han superado en algunos cm estos crecimientos (aprox 20%).

3.1.3.4.- Sacrificio: El sacrificio ocurre una vez que el Ministerio del Ambiente, a través de las corporaciones regionales autoricen el cupo de aprovechamiento para el año de producción , basados en varias visitas de control y en el concepto técnico de la granja que respalde la producción solicitada por el propietario.

La forma como se sacrifica en la mayoría de los zoocriaderos sigue siendo muy artesanal y en general consiste en una descerebración manual del animal, para posteriormente ser desmedulado mediante una incisión a nivel de las escamas nucales en la zona donde termina el cráneo cerca del occipucio, con el fin de quitarle movilidad al animal. Posteriormente el animal muerto y desangrado es lavado con un desinfectante durante 5 minutos en una solución de hipoclorito de sodio al 5% . para atenuar cualquier actividad bacteriana y limpiar la piel en general. Luego la piel es extraída manualmente con su respectivo corte, horn back o belly skin, de acuerdo a los compromisos comerciales que tenga el zoocriaderista, finalmente la piel es raspada para retirar los restos de grasa y carne y pasa al proceso de conservación donde básicamente se realiza una desinfección inicial para finalmente ser deshidratada mediante la utilización de abundante sal común (NaCl) y almacenadas en un medio frío (menor de 15 grados), donde permanecerán hasta el momento de su exportación. Esta labor generalmente las realizan personas especializadas en el proceso y que son contratadas por varios zoocriaderistas.

3.2- GRUPO ASESOR

El Ministerio del Medio Ambiente bajo la dirección General forestal y de vida silvestre, formó el grupo asesor que se encargará de apoyar las actividades relacionadas con el uso y aprovechamiento del recurso fauna, enfocando sus acciones hacia la estandarización de las técnicas para el manejo de los sistemas de cría en cautiverio y el desarrollo de la industria relacionada, así como el conocimiento de los procedimientos legales y jurídicos para la administración y manejo de la fauna silvestre y acuática.

También, el grupo apoyará la gestión relacionada con la evaluación, monitoreo y conservación de las poblaciones naturales de fauna silvestre, orientada a la asesoría en la elaboración y seguimiento de proyectos de investigación en fauna, así como el diseño y ejecución de programas para la preservación de especies en peligro de extinción y el aprovechamiento y manejo sostenible de otras poblaciones naturales de fauna silvestre de uso potencial.

El grupo esta integrado por 9 profesionales, de los cuales 6 han trabajado por más de 4 años asesorando varias granjas de zoocría y conocen detalladamente los avances y deficiencias del sistema de zoocría en el país y serán los responsables de enriquecer técnicamente a las granjas que se dedican a esta labor.

4-EXPORTACIONES

Como ya se registro anteriormente, las exportaciones de pieles de Crocodylia es una actividad que se viene realizando desde mediados del siglo pasado y en donde han estado involucradas, aunque no con la misma preferencia, todas las especies correspondientes al orden y que habitan a lo largo y ancho del territorio nacional.

En el presente capitulo se hará referencia a las exportaciones de pieles provenientes de los 58 zoocriaderos en fase comercial.

En 1984 se inicia el desarrollo de la zoocría en Colombia, con un comienzo lleno de dificultades, pues no se contaba con el bagaje técnico y fue preciso que apunta de error y ensayo se construyera la base inicial para sobrevivir en la actividad. Esta situación produjo algunos inconvenientes de tipo económico y legal para algunos zoocriaderistas. Sin embargo, el panorama actual y futuro desde el punto de vista técnico es mucho más halagador y promisorio, pues las investigaciones desarrolladas en materia de nutrición, incubación y manejo en general, pueden garantizar hacia el futuro una producción de pieles para exportación con buenos márgenes de rentabilidad, siempre y cuando el mercado internacional se mantenga.

De acuerdo a información del Ministerio de Medio Ambiente, la exportación de pieles y productos de "Babilla" se inició en 1988 con, tan solo, 14 pieles en total de *Caiman crocodilus fuscus* y 45.829 de *Caiman crocodilus crocodilus.* Esta última y las de 1990, para la misma subespecie, corresponden a producciones acumuladas antes del convenio CITES y por lo tanto no son producto de la zoocría.

Posteriormente la producción se fue incrementando año tras año hasta alcanzar en la actualidad (1995) la cifra aproximada de 445.021 pieles enteras y 224.148 pieles divididas en flancos, colas, tiras, barrigas y manufacturas, para un total por año de 669.169 pieles (individuos) lo que equivale a un 33.6% de todas las exportaciones acumuladas (1.992.124 pieles desde 1988 a 1995), y que nos da una referencia sobre la creciente producción de los zoocriaderos actualmente.

De las dos subespecies exportadas, el mercado internacional prefiere la piel del *C.c. fuscus* , pues su calidad es superior y por lo tanto más apetecida por los compradores extranjeros, convirtiendose esta situación en un problema grave para los zoocriaderistas del *C.c. crocodilus* y quienes no ven con "buenos ojos" el futuro de esta actividad, llegando inclusive en algunos casos a la quiebra total del zoocriadero o a la disminución de su actividad (estos zoocriaderos se ubican en la región de la Orinoquia- Llanos orientales de Colombia). En lo único que podría competir con el C.c.fuscus, sería con flancos y de individuos grandes.

Actualmente esto se refleja en los bajos niveles de producción y de exportación , por que aunque el 23 % de los zoocriaderos trabajan con *Caiman crocodilus crocodilus* , tan solo suplen aproximadamente un 4% de la producción total. Paralelo a lo anterior se registran 52.200 pieles exportadas de *C.c.crocodilus* en los años de actividad de zoocría, mientras que para *C.c.fuscus* la cifra asciende a 1.939.924 pieles totales exportadas en el mismo período. Esta situación a planteado la necesidad de modificar el sistema de ciclo cerrado para esta subespecie, por otro que permita la captura de individuos adultos mediante el otorgamiento de cupos fijos de aprovechamiento, siempre y cuando las poblaciones silvestres así lo permitan y este respaldado con un programa técnico y científico, dentro de las políticas ambientales del estado que tienen que ver con el "aprovechamiento sostenible" de nuestros recursos naturales.

Aunque no se cuenta con la información exacta, se sabe que la mayoría de las pieles son exportadas crudas y saladas y que tan solo un porcentaje pequeño es exportado en crosta o en azul-fresco-salado-. En la actualidad el tamaño comercial ha variado mucho, pues al principio de la actividad de exportación (1988-89-90-91-92-93) se vendían pieles de todas las dimensiones con un máximo de 1.25 m. y un mínimo que podría estar entre 40 y 50 cm , de longitud total, sin importar mucho el corte de extracción de la piel (honr back o belly skin), situación que era favorable para los zoocriaderistas ya que podían vender continuamente sus productos y financiar mejor los gastos de sus granjas. Sin embargo, esta situación ha cambiado, pues actualmente (Mayo 1996) y desde 1994 la mayoría de los importadores prefieren pieles de talla superior al metro y con mejor precio o una bonificación si el corte es horn back, quedando de esta manera deprimido el mercado de las pieles de animales de 8 a 18 meses y cuyas dimensiones aproximadas están entre 50 y 80 centímetros de longitud total. Económicamente esta situación es critica por los precios actuales de las pieles y cuestiona la rentabilidad que puede tener, el hecho de crecer un animal hasta 125 cm de longitud total y el tiempo que duraría este proceso, que en el mejor de los caso sería de 30 a 36 meses.

De acuerdo a los registros del Ministerio del Medio Ambiente en el país existen 8 establecimientos o industrias, autorizadas para procesar pieles de *Caiman crocodilus* y de otras especies de fauna silvestre. Estas empresas están ubicadas en los departamentos del Atlántico (3) , Bolívar (2) , Cundinamarca (2) y Antioquía (1) y en donde se producen básicamente crostas correspondientes a pieles y flancos. En una menor cantidad se producen cueros provenientes de pieles, flancos y fracciones y que suplen la pequeña demanda local ya sea para comercio interno o también para exportación. En lo que va corrido del período de zoocría (8 años), tan solo se han exportado unos 12.000 artículos de cuero o con cuero de *Caiman crocodilus*, lo que representaría aproximadamente unas 8000 pieles..

En cuanto a las comercializadoras o empresas autorizadas para comercializar pieles de Crocodylia, en el país existen 29 establecimientos los cuales se dedican a la exportación, importación, procesamiento y transformación de pieles. La mayoría se ubican en las principales ciudades y algunas están facultadas para realizar varias acciones de las anteriormente nombradas.

El lugar de destino de las exportaciones de *Caiman crocodilus* ha sido variado, pues inicialmente se tenia como buenas plazas el mercado Europeo (Francia e Italia) y el Norteamericano. Sin embargo esta situación ha ido cambiando en la medida en que han aumentado las exportaciones y los productores y comerciantes han tenido la necesidad de conocer otros mercados como el Asiático y que actualmente compra cerca del 40% del total de la producción.

5-PROYECCIONES FUTURAS DE LA FAUNA SILVESTRE

Una vez creado el Ministerio del Medio Ambiente (ley 99 de 1993), la Dirección General Forestal y de Vida Silvestre, a través de Subdirección de Fauna, inicia la elaboración de lineamientos y estrategias políticas para el desarrollo de la gestión ambiental a corto, mediano y largo plazo, relacionados con la conservación, investigación, valoración, uso y manejo de la Fauna silvestre. Todo esto enmarcado dentro de la política mundial y nacional de gestión ambiental y dentro de los principios esenciales del desarrollo sostenible.

Actualmente existe un documento preliminar, elaborado por la Subdirección de Fauna Silvestre que trata los elementos de política de la Gestión Ambiental en Materia de Fauna Silvestre y cuyos principios, objetivo y estrategias se presentaran a continuación.

5.1-PRINCIPIOS Error! Bookmark not defined.

1. Desarrollo Humano Sostenible: Manejo racional de la fauna silvestre

2. Conservación: protegerse para garantizar el mantenimiento *in situ* de las poblaciones naturales y el equilibrio de los sistemas naturales a los cuales pertenece.

3. Precaución: La planificación, el ordenamiento ambiental y la regulación del uso y aprovechamiento de la fauna silvestre obedecerá a la ampliación y profundización del conocimiento científico y tradicional sobre la misma.

4. Aprovechamiento Sostenible: La utilización y aprovechamiento de la fauna silvestre en el país obedecerá a una unidad de criterio nacional para el manejo sostenible del recurso,

5. Valoración: La gestión en fauna silvestre responderá a la valoración de la misma, a través del reconocimiento de su potencial y de la búsqueda de una ética social y humana que genere una conciencia de respeto hacia el recurso.

5.2-Error! Bookmark not defined.**OBJETIVO.**

Propender por una gestión para la conservación y manejo de la fauna silvestre, orientada a su preservación, el fomento de su uso y aprovechamiento sostenible y la potencialización de los beneficios derivados de su utilización, de tal manera que se garantice la permanencia y funcionalidad de las poblaciones naturales y la sustentación del desarrollo de nuevos modelos socioeconómicos, en concordancia con el principio fundamental del desarrollo sostenible.

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5.3-LÍNEAS DE ACCIÓN ESTRATÉGICAS

La gestión de la fauna silvestre en el país se orientará bajo cuatro líneas de acción que deberán mantenerse a largo plazo a partir de 1996, buscando propender por la conservación de la misma tanto a través de la formulación y ejecución de planes, programas y proyectos, como del desarrollo de las funciones que competen a los entes directa o indirectamente relacionados con la administración del recurso.

Error! Bookmark not defined.**5.3.1. Consolidar y ampliar la base informativa y de conocimiento sobre la estructura, dinámica y factores que inciden en las poblaciones de fauna silvestre, como fundamento para el ordenamiento y gestión del recurso**

El trabajo se orientará en principio al acopio, actualización, organización y evaluación de la información derivada de la investigación científica y de la recuperación del conocimiento tradicional, a partir de la cual se elaborará un diagnóstico preliminar del estado de avance del conocimiento sobre las poblaciones naturales.

Se revisará el estado de los trabajos que se vienen adelantando o se han adelantado, y se buscará darles una continuidad a partir de una evaluación preliminar que contempla tanto la identificación de los alcances, prioridad, importancia, deficiencias y limitantes, como de los ajustes que requieran.

Se identificarán y categorizarán las especies de particular relevancia de acuerdo a su status, potencial de uso, nivel de conocimiento e importancia ecológica y los factores que ejercen presiones negativas sobre las mismas, a nivel regional.

Se generará información que permita determinar el impacto de factores y procesos que afectan la fauna. A partir de esta información se analizarán los avances de los programas de manejo de especies en peligro, el análisis de los usos actuales de la tierra y de aquellas actividades alternas al mantenimiento de hábitats propicios para la conservación de la fauna, el análisis de las condiciones socioeconómicas, necesidades de las comunidades y demás factores relevantes a nivel regional.

Las entidades del Sistema Nacional Ambiental se encargarán de formular y coordinar programas dirigidos a la evaluación y monitoreo de las poblaciones silvestres en sus areales naturales de distribución, considerando la estandarización y homologación de metodologías con este fin.

La información derivada de tales programas será difundida a nivel regional e implementada en los procesos de ordenamiento y planificación del uso y aprovechamiento.

Error! Bookmark not defined.**5.3.2. Impulsar acciones que garanticen la permanencia y funcionalidad de la fauna silvestre en los sistemas naturales y que respondan a las necesidades de la población humana**

Con base en el diagnóstico se determinarán prioridades de investigación, se definirán metodologías generales de trabajo, procedimientos, instrumentos y mecanismos administrativos y jurídicos orientados al manejo de poblaciones naturales.

Se establecerán incentivos económicos que favorezcan el uso sustentable de la fauna silvestre y la protección de hábitats a través de un manejo apropiado.

Se formularán planes de manejo para las especies afectadas o que afectan la población y actividades humanas, priorizando sobre aquellas especies en peligro, amenazadas, endémicas, clave y "plaga".

Se definirán pautas y procedimientos para la puesta en marcha de un programa nacional de rehabilitación y reintroducción de fauna decomisada que así lo permita o su reubicación en estaciones biológicas o en los zoológicos del país y otros establecimientos, de acuerdo con sus condiciones y buscando optimizar la función que estos animales puedan cumplir. Para tal fin, se implementarán centros de paso, rehabilitación e investigación.

De igual manera, se establecerán pautas y procedimientos para adelantar programas de repoblación de las especies aprovechadas comercialmente, con base en los ejemplares mantenidos para tal fin en los zoocriaderos del país.

Se identificarán áreas de conservación estratégica y corredores biológicos sobre los cuales se implementarán planes de manejo que además de orientarse a mantener el equilibrio de las comunidades biológicas, involucren la participación activa de la población local y/o de los sectores comprometidos.

Con base en la información del diagnóstico, se establecerán los mecanismos, procedimientos, y criterios necesarios para la evaluación, control y seguimiento de las actividades de introducción y trasplante de especies.

Las políticas sectoriales y el desarrollo de actividades que generen impacto sobre las poblaciones silvestres deberán integrar los criterios, normas y procedimientos que garanticen la conservación y uso adecuado de la fauna silvestre. Se trabajará coordinadamente con autoridades aduaneras, policivas, empresas de carga y demás instituciones de control, para disminuir el tráfico ilegal de fauna silvestre.

Error! Bookmark not defined.**5.3.3. Adoptar formas alternativas de aprovechamiento de la fauna silvestre como base de nuevos modelos socioeconómicos y armonizar el uso actual con el principio fundamental del desarrollo sostenible**

Se propiciará el desarrollo de formas alternativas de uso sustentable de la fauna como recurso económico, mediante modelos de desarrollo comunitario y formas alternativas de aprovechamiento basadas tanto en cuotas de extracción teniendo en cuenta el estado de las poblaciones silvestres y la potencialidad del mercado, como en usos pasivos tales como el ecoturismo.

Así mismo, se impulsará la implementación de proyectos piloto para el desarrollo de paquetes tecnológicos dirigidos a la cria en cautiverio de especies con potencial de uso, y su transferencia a comunidades rurales.

Se establecerán proyectos para el uso y aprovechamiento de la fauna silvestre, que puedan integrarse en sistemas de producción en áreas afectadas por frentes de colonización, áreas de amortiguación del Sistema de Areas Protegidas y en el marco del Programa de sustitución de cultivos ilícitos.

Las Corporaciones Autónomas Regionales, de manera conjunta con los Municipios y en coherencia con los planes de desarrollo en cuanto a los recursos naturales, deberán revisar las condiciones de acceso a los recursos hidrobiológicos y pesqueros, estableciendo los criterios regionales que deben primar para el establecimiento de cuotas de extracción, su comercialización y transformación.

Se propenderá por la implementación de acciones que permitan mejorar la calidad e incrementar el valor agregado de productos y servicios derivados del uso de la fauna silvestre. Así mismo, se apoyará el establecimiento de líneas de crédito y facilidades de comercialización de dichos bienes.

Con el apoyo de organismos como el SENA, UMATAS y CARs, entre otros, se implementarán programas de asistencia técnica dirigidas a la implementación de alternativas de uso y aprovechamiento sostenible de la fauna silvestre.

En aguas continentales, se deberá examinar la potencialidad del área cubierta por embalses, para generar proyectos de acuicultura, lo que puede disminuir la presión sobre los recursos pesqueros y lograr su concurso en la producción regional y nacional de recursos hidrobiológicos.

Error! Bookmark not defined.5.3.4. Avanzar en la valoración de la fauna silvestre a partir de su caracterización en términos ecológicos, económicos, científicos, sociales y culturales

Se propenderá por la caracterización del valor de la fauna en términos ecológicos, económicos, científicos, sociales y culturales, a fin de que se incluya en su verdadera dimensión en las cuentas ambientales del país.

Con el fin de contar con instrumentos económicos y financieros para la sostenibilidad de proyectos de conservación de poblaciones silvestres, se formularán e implementarán mecanismos de captación e internalización de beneficios derivados de su aprovechamiento.

En cuanto a la zoocría específicamente, el grupo asesor del Ministerio del Medio Ambiente seguirá trabajando en evaluación técnica de las granjas de fauna silvestre y unificara criterios generales de manejo, así como también planteara recomendaciones individuales para cada especie y para cada establecimiento, con el fin de enriquecer técnicamente esta actividad.

Otra función que desarrollara el grupo, será el de monitorear las investigaciones básicas referentes al mejoramiento de los sistemas de uso y aprovechamiento de fauna silvestre, donde se incluyen los zoocriaderos y las poblaciones naturales, con el propósito de darle un manejo racional y sostenible .

También se dará inicio a los programas de repoblación una ves se cuente con la evaluación de las poblaciones naturales y la metodología necesaria para mantener un monitoreo continuo y poder evaluar en un momento derterminado el estatus poblacional de las especies en cuestión enmarcado dentro de un "**plan especifico de manejo**". Con relación a lo anterior desde 1994 se inicio el primer censo de las poblaciones naturales de Crocodylia en todo el territorio nacional y en el presente año

(1996) se lleva a cabo el segundo muestreo de dicha actividad. Los resultados del primer año de labores serán presentados en la presente reunión donde se espera la participación de los asistentes con críticas constructivas que faciliten y enriquezcan esta labor.

ESTADO, DISTRIBUCION, SISTEMATICA Y CONSERVACION DE LOS CROCODYLIA COLOMBIANOS.

CENSO 1994 -1995

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RESUMEN

Durante la estación seca de finales de 1994 y hasta Marzo de 1995, se efectuo el conteo de ejemplares de las diversas especies del orden Crocodylia, en desarrollo de la primera fase del proyecto "Estado, distribución, sistemática y conservación de los Crocodylia de Colombia". La interpretación de esta informacion se hace de acuerdo con los conceptos planteados en el proyecto original del Gobierno Colombiano.

Los resultados obtenidos, tienen la enorme importancia de constituir la línea base cuantitativa del estado de las poblaciones de crocodílidos existentes en los sistemas hídricos evaluados. A partir de esta, los programas de monitoreo, permitirán establecer las tendencias de la dinámica de las poblaciones naturales; a partir de las cuales se podrán entónces plantear e implementar o complementar medidas y programas de conservación y manejo de este valioso e importante recurso natural.

La característica común entre las poblaciones de crocodíleos evaluadas durante 1994 - 1995 es la fragmentacion. De todas las especies se encuentran a lo sumo pequeños grupos de ejemplares aislados, muy esparcidos (baja densidad); son comunes los individuos solitarios. En muy contados puntos de muestreo se encontraron núcleos numerosos de animales con una adecuada estructura demográfica.

Un caso inesperadamente crítico lo constituyen las bajas y muy dispersas poblaciones de ***Caiman crocodilus fuscus***.

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PRESENTACION

Durante la estación seca de finales de 1994 y hasta Marzo de 1995, tres equipos de trabajo se dieron a la labor de efectuar el conteo de ejemplares de las diversas especies del orden Crocodylia, en desarrollo de la primera fase del proyecto "Estado, distribución, sistemática y conservación de los Crocodylia de Colombia", presentado en su debido momento por INDERENA a las autoridades de la Convención CITES. Proyecto estructurado por el INDERENA (y ahora el Ministerio del Medio Ambiente), junto con la asociación que agremia a las granjas de Crocodílidos (AZOOCOL) y la secretaria CITES.

No sobra resaltar la importancia que tienen los resultados obtenidos, los cuales constituyen la línea de base cuantitativa del estado de las poblaciones de crocodílidos existentes en los sistemas hídricos evaluados. A partir de esta, los programas de monitoreo, permitirán establecer las tendencias de la dinámica de las poblaciones naturales; a partir de las cuales se podrán plantear e implementar o complementar medidas y programas de conservación y manejo de este valioso e importante recurso natural.

1.- LOS CROCODYLIA EN COLOMBIA

Crocodylus acutus y ***C. intermedius*** fueron muy abundantes hasta 1928, año en el cual comenzó la caza comercial de pieles. Esta se prolongó hasta mediados de los años 50, cuando las dos especies alcanzaron los niveles de extinción comercial.

Los procesos de empobrecimiento de las poblaciones tanto de ***Melanosuchus niger*** como de las diferentes subespecies de ***Caiman crocodilus*** comenzaron hacia mediados de los años 50 cuando sus especies se convirtieron en la fuente de materia prima que reemplazo a la de los ***Crocodylus*** ya muy escasos.

Las anteriores situaciones se dieron principalmente por que hasta el año 1941 las leyes Colombianas permitían la caza indiscriminada de "babillas y caimanes".

2.5.- METODOLOGIA DE DETERMINACION DE LA DISTRIBUCION, LA ABUNDANCIA Y LA ESTRUCTURA DEMOGRAFICA.

La metodología seguida, la cual se origina en el taller dictado por el CSG en Zambrano, Bolívar (1994), cumplió las siguientes fases :

2.5.1.- **Cuantificación inicial del areal de distribución.** Con base en cartografía de escalas 1:1500000 y 1:500000 se determinó la extensión del territorio Colombiano ubicado por debajo de la cota de 500 m.s.n.m., nivel promedio del limite altitudinal de distribución de los crocodílidos. A partir de este registro cartográfico del país, se determinaron cinco grandes Areas Hidrológicas: Caribe, Pacífico, Magdalena - Cauca, Amazonía y Orinoquia. (Villamizar, 1993, 1994).

2.5.2.- **Selección de áreas de muestreo.** De acuerdo con la extensión de la subcuenca, el régimen hidrológico y las características del hábitat. Debido a la inaccequibilidad que algunos sitios presentan, muchos de los escogidos muestran gran deterioro, reducción e intervensión de su hábitat, lo que afect a la presencia o no de ejemplares de Crocodylia.

2.5.3.- **Conteos de campo.** La metodología básica fue el inventario por conteo nocturno para determinación de índices de abundancia, en áreas previamente seleccionadas. Dada la magnitud de este proyecto y las condiciones logisticas, la metodología utilizada para las especies en via de extinción (a excepción de *C. intermedius*) fue la misma, lo cual no es muy conveniente.

2.5.4.- **Determinación de la estructura de la población censada.** Con base en la distribución de los individuos en clases de tamaños, de acuerdo con la normalización de la metodología efectuada por el Ministerio del Medio Ambiente (Martínez, 1994), basada en la propuesta por Ayarzagüena y Velazco (1992).

3.- AREAS CENSADAS EN 1994 - 1995.

Durante el período seco de finales de 1994 y el primer semestre de 1995 se realizaron los conteos en puntos seleccionados pertenecientes a las diferentes áreas de acuerdo con la distribución que aparece en la tabla 3. (Martínez, 1995; Naranjo, 1995, y Bonilla y Barahona, 1995).

4.- RESULTADOS DEL CENSO 1994 -1995.

La superficie de los cuerpos de agua censados en cada cuenca, registrados en la tabla 4, corresponden a las áreas en agua efectivamente muestreadas.

Como puede apreciarse, durante esta fase de campo se contaron los ejemplares encontrados en 54468.87 hectáreas de superficie acuática. Estas representan cerca del 2% de la superficie del recurso hídrico en Colombia (Marín, 1992).

4.1.- INDIVIDUOS CENSADOS Y ESTIMACION DE LA DENSIDAD.

Siguiendo los criterios establecidos en la definición metodológica, en la tabla 5 se presentan tanto el índice relativo de abundancia (Densidad), como los valores absolutos del numero de individuos observados y contabilizados en cada una de las subcuencas muestreadas.

Cómo puede apreciarse en la tabla 5, la densidad calculada para la población global evaluada es de 0.0676 individuos por hectárea de cuerpo de agua, lo que equivale a encontrar un ejemplar por cada 14 hectáreas de superficie acuática. Este valor debe considerarse únicamente de manera muy general atendiendo al criterio establecido de considerar como discretas a las poblaciones de cada sistema hidrográfico, y por lo cual se consideran como representativos los valores de densidad calculados para cada subcuenca.

4.2.-DISTRIBUCIÓN POR ESPECIES DE LOS EJEMPLARES CENSADOS.

La distribución por especies de los 3668 ejemplares avistados se consigna en la tabla 6.

De acuerdo con la información recogida el 85.1% de los ejemplares contabilizados pertenecen a ***Caiman crocodilus***.

Los resultados también muestran como ***Paleosuchus trigonatus*** es numéricamente mas abundante que ***P. palpebrosus***.

4.3.- ESTADO DE LAS POBLACIONES.

4.3.1.- Crocodylus acutus.

De esta especie solo se visualizo un ejemplar (Río Bogotá) en las 39654.7 Has. de agua muestreadas dentro del areal de distribución de ésta especie. Sin embargo se encontraron evidencias de la presencia de ejemplares en 31 sitios del área hidrográfica Magdalena- Cauca.

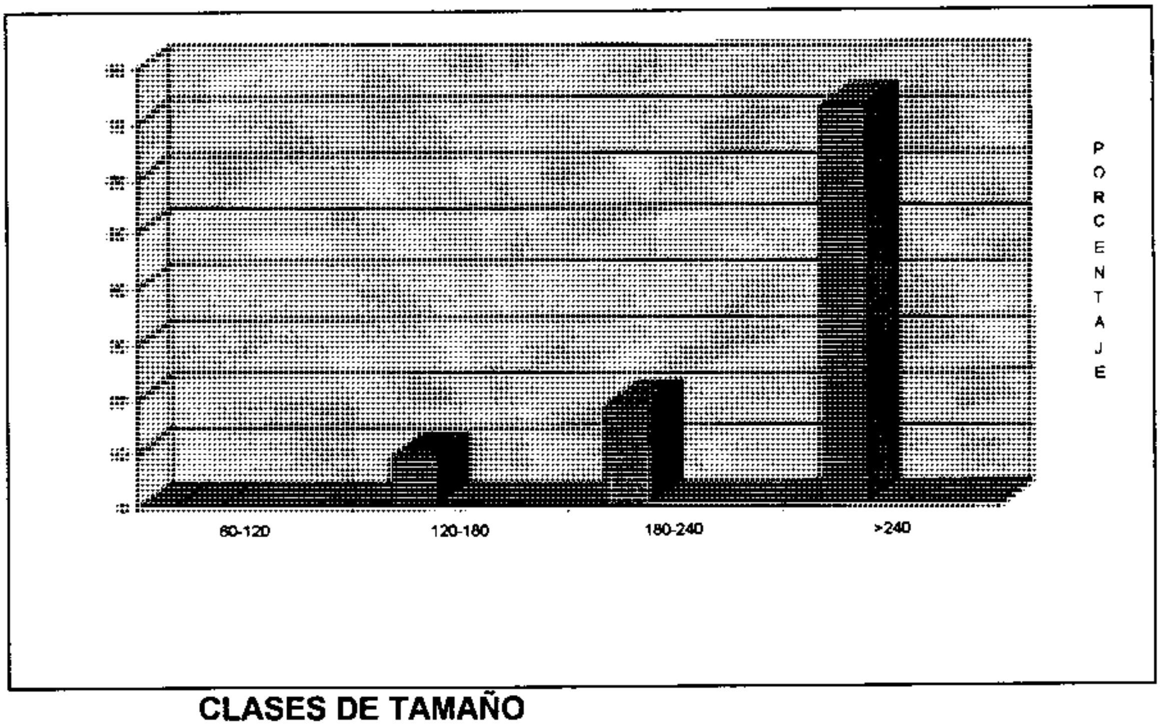
También se tuvo conocimiento de la presencia de ejemplares en los ríos Truandó y Chintadó de la cuenca del Atrato y en el estero Teran del río Mira. (Pacífico).
Adicionalmente una pequeña población de esta especie, localizada en Bahía Pórtete (Guajira), fue evaluada por Abadía (1995) quien encontró 2 a 11 individuos.

Los resultados indican entonces que las poblaciones de ***C. acutus*** aun existentes están muy fragmentadas, siendo frecuentes los individuos aislados; existe la posibilidad de que estas se hallen restringidas, en lugares inaccesibles.

4.3.2.- Crocodylus intermedius.

El presente censo, realizado en los ríos Ele y Cravo Norte de la cuenca del Casanare, permitió localizar 28 ejemplares en un transecto de 35.4 Km. Esta cifra indica una densidad de 0.79 ind/Km. Es importante aclarar que a diferencia de la metodología seguida para ***C. acutus***, en el caso del Caimán Llanero el área de muestreo fue seleccionada por que anteriores trabajos de campo (Clavijo y Lugo, com. personal) habían detectado la existencia de este núcleo de animales.

El histograma de distribución por clases de tamaño, que permite determinar la estructura de la población así como su estado (Velázco y Ayarzagüena, 1992), aparece en la gráfica 1. Es notoria la predominancia de ejemplares adultos, y la ausencia de ejemplares juveniles (60 a 120 cm de longitud total), lo que indica que la población no se encuentra demográficamente equilibrada.



GRAFICA 1.- Distribución en clases de tamaño de la población de *Crocodylus intermedius* en los ríos Ele-Cravo Norte (Cuenca del Casanare). Censo 1994-1995.

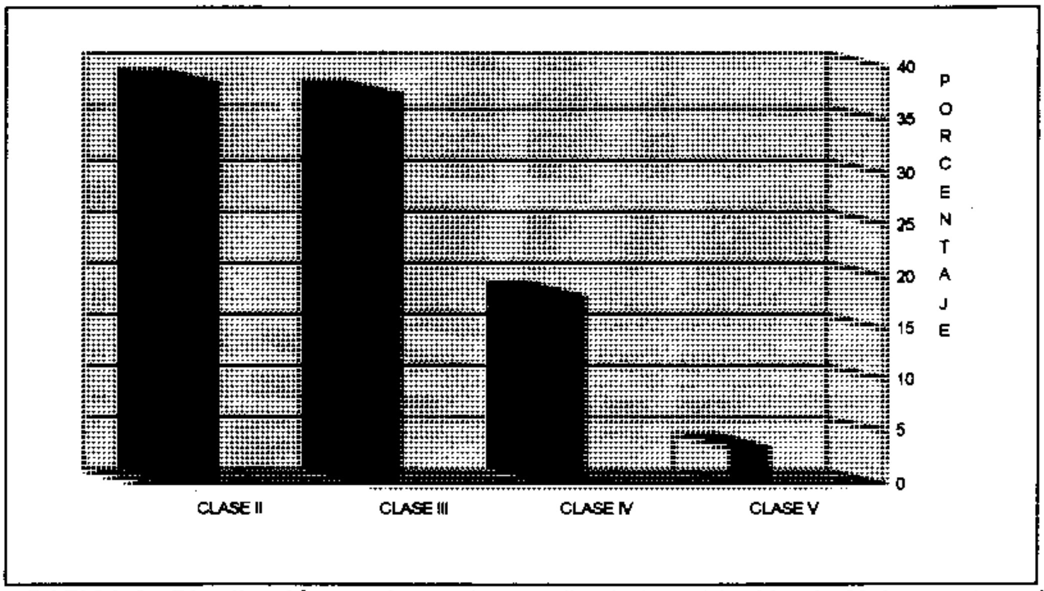
Aunque el área de muestreo seleccionada para evaluar a ***Crocodylus intermedius*** es relativamente pequeña con respecto a la totalidad del hábitat disponible, es poco probable que se encuentren poblaciones de esta especie mucho mas grandes que la del río Ele. Lugo (com. personal) ha recorrido muchos de los puntos en los que Medem había registrado la presencia de caimanes llaneros, sin encontrar ningún animal.

4.3.3.- Melanosuchus niger.

Durante el censo 1994-95 fueron contados 271 ejemplares de ***M.niger***.

Como la tabla 7 lo indica, los núcleos con mayores valores tanto absolutos como relativos se hallan en las tres lagunas del Putumayo evaluadas. En estas se concentra el 76.7% de los caimanes negros censados. También en el lago Garzacocha del Amazonas se encuentra un núcleo de alta densidad.

El histograma de la gráfica 2., se puede interpretar como una estructura demográfica equilibrada o por lo menos con fuerte tendencia hacia el equilibrio entre clases.



GRAFICA 2.- Distribución en clases de tamaño de la población de *Melanosuchus niger* **en la cuenca del Putumayo. Censo 1994-1995**

De ***Melanosuchus*** se hallaron otras poblaciones con números relativamente altos (Yarinas, Sunicocha, Tarapoto y Garzacocha) que merecen no solo el establecimiento de monitoreos, junto con La Apaya, sino el establecimiento de planes específicos de manejo. El objetivo principal de estos debería considerar la reestructuración de las poblaciones desde el punto de vista demográfico.

4.3.4.- Caiman crocodilus fuscus.

Durante el censo 1994-1995, Martínez (1995) y Naranjo (1995) encontraron 930 ejemplares en 38699.3 hectáreas de 89 sitios de muestreo evaluados.

En la Tabla 8 se presentan los valores absolutos y de densidad encontrados.

TABLA 8.- Número total y densidad de Caiman crocodilus fuscus. Censo de áreas hidrográficas Magdalena-Cauca y Caribe. 1994-1995.

PUNTO DE MUESTREO	INDIVIDUOS OBSERVADOS	DENSIDAD ind/Ha.
Represa de Betania	53	0.0121
Represa El Juncal	16	0.17
Jagüey Campo Alegre	12	25
Represa La Sucia	4	0.07
Represa Río Prado	15	0.0042
Violanta	54	1.256
La Sierpe	0	0
La Balastrera	5	10
Jagüey Gamba	20	8
El Burro	4	0.67
Canal vertedero	1	6.67
Jagüey Tamalo	34	52.3
Río Bogotá	0	0
Río Bache	0	0
Jagüey Providencia I	1	285
Jagüey Providencia II	0	0
Jagüey La Zapuna	0	0
Jagüey La Guaca	1	0.043
Ciénaga La Culebra	18	6
Ciénaga Alto Bonito	10	0.67
Ciénaga Florencia	13	37.1
Ciénaga Costa Rica	17	8.5
Ciénaga Porvenir I	22	44
Ciénaga Porvenir II	0	0
Ciénaga Porvenir III	10	20
Ciénaga El Cerro II	2	200

Caño Lejio	8	1.465
Caño Tolones	0	0
Caño El Converso	13	5.42
Río La Miel	3	0.0143
Caño Dentones	1	2.5
Quebrada La Soñadora	1	0.56
Caño La Culebra	2	12.5
Río Corconá	8	100
Ciénaga La Panda	2	0.019
Pozo El Caimán	7	23.33
La Ilusión	10	0.286
Ciénaga Man	34	0.778
Ciénaga Intermedia	4	0.0267
Ciénaga Corozal	2	0.022
Ciénaga Buenos Aires	22	0.6
Río Man	2	0.02
Ciénaga Trementino	2	0.032
Ciénaga La Cruz	7	0.00625
Ciénaga Gamboa	4	0.00766
Ciénaga Ayapel	8	0.026
Ciénaga Sábalos	2	0.0286
Caño Fístola	1	0.078
Caño Madre Vieja	0	0
Caño Rastrojo	12	0.381
Ciénaga Hoyo Grande	0	0
Ciénaga La Hormiga	2	0.33
Ciénaga La Caimanera	11	0.037
Ciénaga Zapatosa	10	0.00067
Caño Iguana	0	0
Ciénaga Guarumal	0	0
Ciénaga Andrés Martínez	0	0
Caño Inésica	1	0.018
Río Cesar	2	0.021
Arroyo Hondo	5	0.16
Brazo de Mompos	5	0.0056
Brazo Papayal	0	0
Río Magdalena (En Banco-Papayal)	0	0
Ciénaga Chilloa	41	0.0051
Ciénaga Palomeque	11	0.0144
Ciénaga Palenquillo	9	0.029

Ciénaga Carabalí	14	0.053
Caño Carabalí	1	0.0243
Ciénaga María La Baja	0	0
Caño Correa	11	0.0803
Canal Del Dique	3	0.0091
Ciénaga Aguas Claras	31	0.0257
Ciénaga Zarzal	3	0.0083
Ciénaga Matuya	17	0.03
Ciénaga Capote	9	0.00254
Ciénaga Tupe	2	0.00445
Ciénaga Malena	10	0.000497
Ciénaga La Luisa	9	0.0545
Ciénaga La Ceiba	2	0.00288
Caño El Chuchal	0	0
TOTAL	676	
Río Atrato	16	
Río Truandó	70	
Canal Esteban	19	
Río Chintado	20	
Quebrada Taparal	2	
Ciénaga La Honda	28	
Ciénaga La Rica	13	
Ciénaga Tumaradó	35	
Ciénaga La Grande	51	
TOTAL	254	0.1057

Como puede apreciarse ***C. c. fuscus***. presenta valores de densidad muy variables; estos oscilan entre 0.0 ind/ha hasta 200 ind/ha.

En el 99.93% de la superficie censada la densidad oscila entre 0 y 1.46 ind/ha. Los valores mas altos de densidad, para esta porción del área, se encuentran en los cuerpos de agua de la cuenca del Magdalena Medio, el Cauca y el Alto Magdalena.

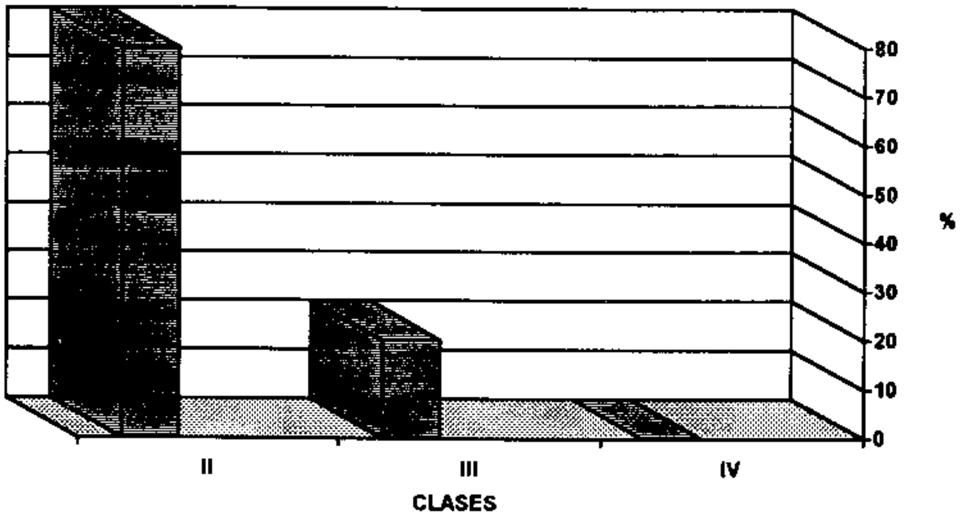
Son comparativamente mas bajas las densidades observadas en las cuencas del Bajo Magdalena y El Canal del Dique.

La población total para las 36419.3 hectáreas evaluadas en el área Magdalena Cauca es de 676 ejemplares.

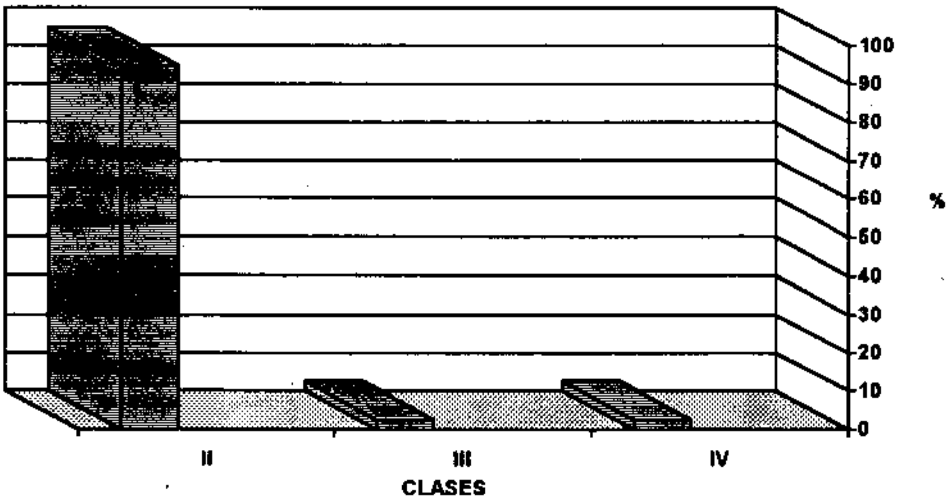
En la cuenca del Atrato, en 2280 hectáreas muestreadas, se encontraron 254 ejemplares de ***C. c. fuscus*** lo cual representa una densidad 2.2 veces superior a la estimada para Magdalena Cauca.

Los histogramas de distribución de las poblaciones de la especie en clases de tamaño, (Gráficas 3 a 5) indican que todas las poblaciones presentes en todas las áreas hidrográficas estudiadas se hallan en desequilibrio.

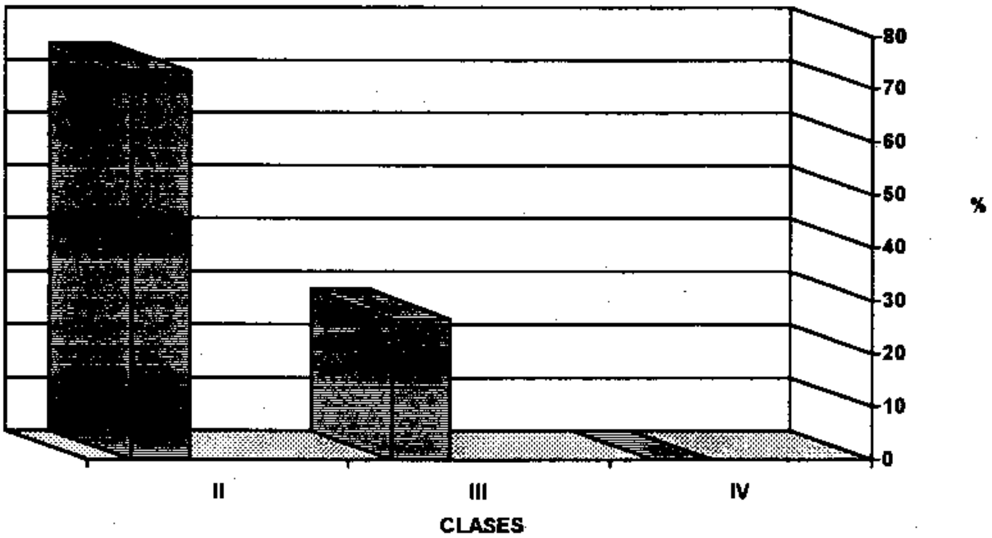
Es de especial importancia el caso de la cuenca del Alto Magdalena donde la población encontrada se puede catalogar de muy explotada, pero donde además de los fenómenos de caza ilegal es notoria la perdida de hábitat como causa de las bajas densidad y abundancia.



GRAFICA 3.- Distribución en clases de tamaño de la población de *C.c. fuscus* **en la cuenca del Alto Magdalena (n=219; solo ojos 41%). Censo 1994-1995**



GRAFICA 4.- Distribución en clases de tamaño de la población de *C.c. fuscus* en la cuenca del Medio Magdalena (n=141; solo ojos =22%). Censo 1994-1995.



GRAFICA 5.- Distribución en clases de tamaño de la población de *C.c. fuscus* en el Canal del Dique (Cuenca de la Costa) (n=112; solo ojos=15%). Censo 1994-1995.

4.3.5.- Caiman crocodilus crocodilus.

Bonilla y Barahona (1995) y Naranjo (1995) contaron durante el censo de 1994-95 un total de 2133 ejemplares de esta especie en 4727 hectáreas de las cuencas del Casanare y Guaviare -Inírida y 8156.1 hectáreas de cuerpos de agua en el Amazonas.

En la tabla 9 se registran los valores absolutos de animales contados así como la densidad calculada para los diferentes sitios de muestreo.

Los lugares en que las poblaciones de ***C.c.crocodilus*** están mas concentradas manteniendo números apreciables de individuos corresponden a los ríos Ele - Cravo Norte de la cuenca del Casanare y el Lago El Muñeco en la del Río Apaporis.

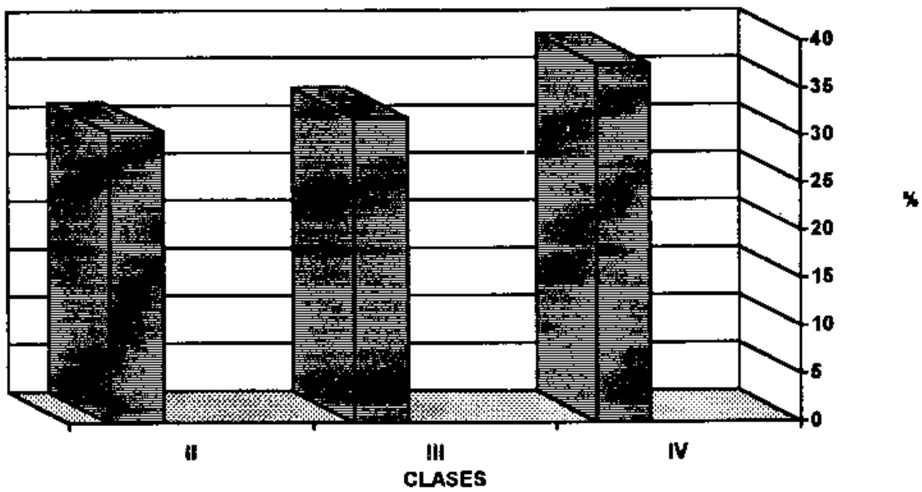
TABLA 9.- Número total y densidad de *Caiman crocodilus crocodilus.* **Censo en áreas hidrográficas del Orinoco y Amazonas. 1994-1995.**

PUNTOS DE MUESTREO	INDIVIDUOS OBSERVADOS	DENSIDAD
Río Ele-Cravo Norte	627	3.820
Río Guaviare-Inirida	506	0.172
Río Inírida	279	
Río Putumayo	82	0.035
Río Curilla	30	0.220
Río Caucara	32	0.120
Quebrada La Paya	14	0.140
Laguna La Paya	14	0.096
Cocha Yarinas	2	0.030
Esteracocha	21	0.129
Sunichocha	93	0.500
Río Caqueta	147	0.450
Río Bumelo	20	0.220
Río Caguán	25	0.400
Lago El Mosco	91	2.600
Río Amazonas	9	0.014
Quebrada Pichuna	3	0.050
Quebrada Matamata	5	0.086
Río Atacuarí	7	0.120

Río Loretayacu	22	0.040
Río Amacayacu	3	0.010
Río Borahuazu	12	0.053
El Soco	32	1.030
Islas Colombia	24	0.510
Pozo Cacharama	14	1.270
Lago Tarapoto	6	0.064
Lago Garzachocha	13	0.400
TOTAL	2133	

En la cuenca del Río Putumayo la densidad de ***C. c. crocodilus*** es de 0.0854 ind /ha.

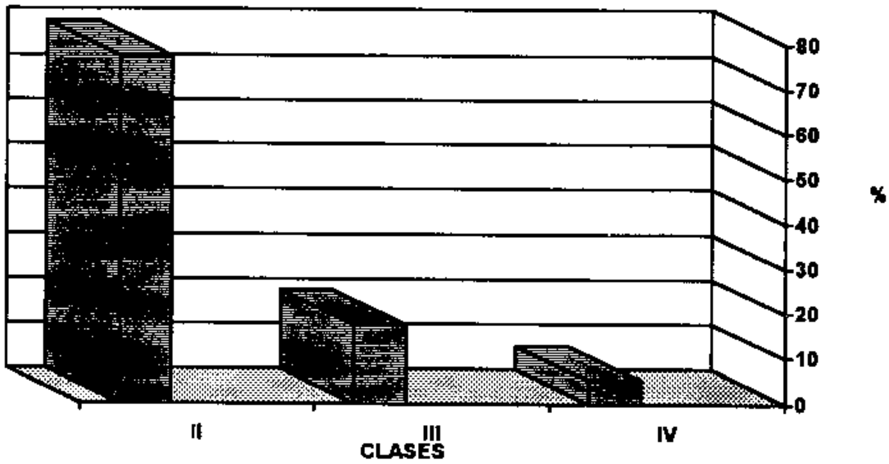
El histograma de distribución de ***C. c. crocodilus*** para la cuenca del Casanare indica que la población no ha sido explotada por caza ilegal. Sin embargo no es clara la condición de equilibrio ya que se presenta un poco usual 35% de individuos de la clase IV. (Gráfica 6).



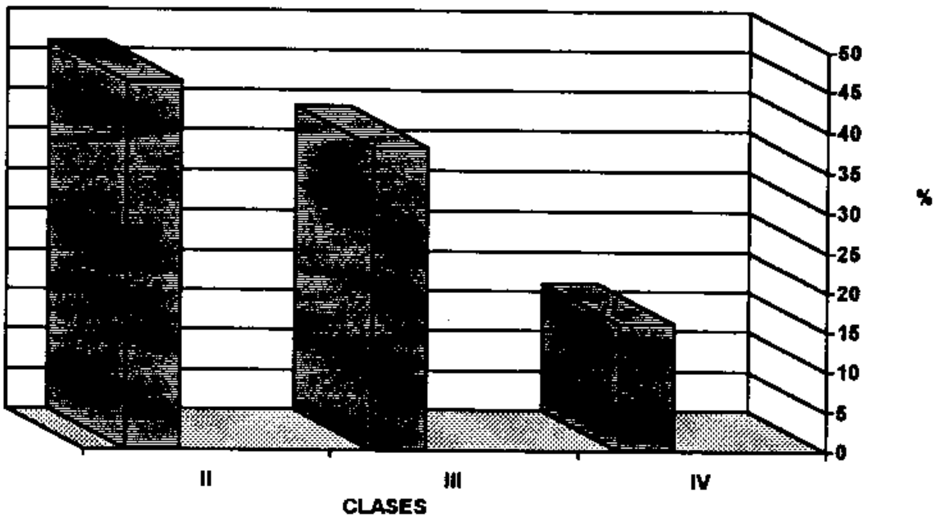
GRAFICA 6.- Distribución en clases de tamaño de la población de *C.c. crocodilus* **en los ríos Ele-Cravo Norte de la Cuenca del Casanare (n=627; solo ojos 74%). Censo 1994-1995.**

Los histogramas de distribución por clases de tamaño de los cuerpos de agua muestreados en las cuencas de los ríos Guaviare, Inírida, Putumayo, Alto Caqueta, Apaporis, Caguán y Amazonas indican que las poblaciones han sido explotadas (Gráfica 7).

En los sistemas hídricos del Caqueta y Putumayo las poblaciones aunque explotadas presentan una mejor situación en cuanto a su estructura demográfica, con una buena perspectiva de llegar al equilibrio.



GRAFICA 7.- Distribución en clases de tamaño de la población de *C.c. crocodilus* en las cuencas de los Ríos Guaviare-Inírida (n=125; solo ojos =69%). Censo 1994-1995.



GRAFICA 8.- Distribución en clases de tamaño de la población de *C.c. crocodilus* en la cuenca Río Caqueta (n=185; solo ojos =35.2%). Censo 1994-1995.

C. c. crocodilus es la subespecie mas abundante en Colombia. Aunque la población estudiada en el Casanare presenta adecuados valores de abundancia y densidad así como una buena distribución demográfica, es claro que las restantes poblaciones distan de presentar condiciones tan deseables.

4.3.6.- Caiman crocodilus chiapasius

En el presente estudio se circunscribe esta subespecie al Area Hidrográfica del Pacífico.

Durante el censo 1994-95 Naranjo (1995) encontró 78 ejemplares de esta subespecie en 1459.9 hectáreas de cuerpos de agua muestreados en las cuencas de los ríos San Juan, Patía y Mira. (Tabla 10)

TABLA 10.- Número total y densidad de Caiman crocodilus chiapasius. Censo en el Area Hidrográfica del Pacífico 1994-1995.

PUNTOS DE MUESTREO	INDIVIDUOS OBSERVADOS	DENSIDAD
Laguna Chimbusa	9	0.160
Laguna El Trueno	4	0.130
Laguna de Píri	32	0.510
Estero de Teran	0	0.000
Estero Chontal	8	0.330
Estero Guabal	1	0.004
Estero Sangumba	5	0.001
Estero Iguanero	7	0.026
Río Calima	1	0.004
Quebrada La Isla	5	0.016
Pozo Palestina	1	0.004
Estero San Nicolas	5	0.019
Estero La Paila	0	0.000
Estero Majagual	0	0.000
Río Mungidó	0	0.000
Río Togoroná	0	0.000
TOTAL	78	

Tal como se aprecia, el 41% de los individuos encontrados ocupan la Laguna El Píri en la cuenca del Patía, en la cual cada ejemplar ocupa dos hectáreas de cuerpo de agua.

El restante 59% de los ejemplares contados se encuentran en 10 cuerpos de agua, en números que van de 1 a 9 ejemplares con una densidad media de 0.069 ind/ha (Rango de 0.001 a 0.16). Esta indica que se encuentra un ejemplar por cada catorce hectáreas de superficie acuática.

4.3.7.- Paleosuchus palpebrosus.

Durante el censo 1994-95, Naranjo (1995) encontró 41 ejemplares de ***P. palpebrosus*** en cinco ríos del Area hidrográfica del Amazonas. Bonilla y Barahona (1995) no registran ningún ejemplar de esta especie en los ríos Ele-Cravo Norte, aunque Medem indica su existencia en Caño Limón de la cuenca del Casanare. La distribución de los ejemplares aparece en la tabla 11, en la que se expresa la densidad calculada (ind/km.).

TABLA 11.- Número total y densidad de Paleosuchus palpebrosus. Censo en el Area Hidrográfica del Orinoco y Amazonas. 1994-1995.

PUNTOS DE MUESTREO	INDIVIDUOS OBSERVADOS	DENSIDAD ind/Km.
Río Putumayo	6	0.510
Río Caqueta	9	0.550
Lago El Muñeco	18	0.340
Río Loretoyacu	6	0.160
Río Amacayacu	2	0.080
TOTAL	41	

En la cuenca del Putumayo ***P.palpebrosus*** constituye el 5.5% de la población, encontrándose un ejemplar por cada 10 Km. de río muestreado.

En la cuenca del Alto Caqueta ***P.palpebrosus*** constituye el 4.8% de la población.

Se encuentra un ejemplar por cada 1.8 Km. en el Caqueta, o por cada 2.9 km. en el Apaporis (Lago El Muñeco).

En la cuenca del Amazonas ***P.palpebrosus*** se hallo en los ríos Loretoyacu y Amacayacu.

Considerando que ***P.palpebrosus*** no es normalmente objeto de caza comercial, ocasionalmente de subsistencia, y dada la relativa baja densidad de la especie no se discutirá la estructura demográfica de las poblaciones censadas.

5.3.8.- Paleosuchus trigonatus.

Naranjo(1995) hallo 186 ejemplares de ***P.trigonatus*** durante el censo 1994-95, cuya distribución aparece en la tabla 12, junto con el estimativo de densidad.

TABLA 12.- Número total y densidad de Paleosuchus trigonatus. Censo en el Area Hidrográfica del Amazonas. 1994-1995.

PUNTOS DE MUESTREO	INDIVIDUOS OBSERVADOS	DENSIDAD ind/Km.
Río Caucaya	25	3.60
Río Caqueta	25	1.50
Río Bernardo	14	0.48
Río Apaporis	80	1.50
Caparú	3	0.61
El Muñeco	38	0.73
Quebrada Matamata	1	0.34
TOTAL	186	

En la cuenca del Putumayo la especie esta presente en el río Caucaya. En este río tiene una alta densidad, encontrándose 3.6 ejemplares en cada kilometro evaluado.

P. trigonatus esta ausente en el Caguán, tal como lo había registrado Medem (1981). La especie, de otro lado, constituye el 100% de la población de crocodílidos censados en el Apaporis y en el Caparú.

Finalmente en la cuenca del Amazonas solo se encontró en la quebrada Matamata un ejemplar de la especie.

6.- CONCLUSIONES Y RECOMENDACIONES.

La característica común entre las poblaciones de crocodíleos evaluadas durante 1994 - 1995 es la fragmentación. De todas las especies se encuentran a lo sumo pequeños grupos de ejemplares aislados, muy esparcidos; son comunes los individuos solitarios. En muy contados puntos de muestreo se encontraron núcleos numerosos de animales con una adecuada estructura demográfica.

Es recomendable continuar monitoreando el núcleo de ***C. intermedius*** a fin de detectar su tendencia demográfica. También es recomendable el desarrollar búsquedas similares a la realizada con ***C. intermedius*** para ***C. acutus.***

Tanto para ***C. acutus*** como para ***C. intermedius*** es conveniente el fortalecimiento de los centros de reproducción en condiciones controladas ya existentes o el montaje de nuevos. En este sentido las granjas que operan actualmente a nivel experimental se podrían incluir dentro del esquema de producción. El principal objetivo al estructurar esta estrategia es el de contar con poblaciones numérica y genéticamente adecuadas para iniciar programas de reintroducción en lugares donde las condiciones ambientales, sociales y económicas lo permitan.

La destrucción del hábitat o su reducción es un fenómeno que claramente explica la ausencia de ejemplares en áreas determinadas, unido a la cacería de subsistencia, la caza ilegal y de alguna manera la cacería de fomento.
Con la continuidad de los programas de monitoreo de estas y otras poblaciones se podrá determinar con precisión la tendencia demográfica de éstas. La información que de éstos se obtenga permitirá planificar de manera adecuada las políticas y programas a seguir para cada especie y para cada población.

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SEMARNAP

INSTITUTO NACIONAL DE ECOLOGIA

DIRECCION GENERAL DE VIDA SILVESTRE.

PLAN NACIONAL PARA LA CONSERVACION, INVESTIGACION, MANEJO Y USO SUSTENTABLE DE LOS COCODRILOS Y EL CAIMAN.

MEXICO, 1996.

ABSTRACT

Noways, the need the actual distribution and abundance of wild populations and to make a sustainable use of crocodiles and alligators in Mexico have made the Ministry of Environment, Natural Resources and Fisheries (Secretaria de Medio Ambiente, Recursos Naturales y Pesca, SEMARNAP), trough the National Institute of Ecology (Instituto Nacional de Ecologia, INE) to establish coordinated efforts among federal an state instutions, academic institutions, non-govemmental organizations and private foundations, as well as international foundations, to design and implement a strategy that can allow and make sure to have a rational exploitation of crocodiles and alligators as a renowable resource, and this could translate into a better life the human communities that are intimately related to this resource.

In this way, it was structured the National Plan for Conservation, Research, Mamagement and Sustainable Use of Crocodile and Alligator, which has as a primary goal to develop such a strategy and to involve all interested people from those orgazations (federal, state, municipal offices from the government, academic institutions, nom-governmental organizations, fishers cooperatives, landowners and fiels workers, producers, etc.) in this project, and make sure their participation takes place in the corresponding realm of anyone; henece this Plan takes short , medium and large term goals into account, having as a frame for action foir big programs: The Resource, The Habitat, The Users and Sustainable Use. At this time 16 offices, academic institutions and civil organizations participate in this Plan, with 37 researchers including particular producers and two cooperative societies.

Ammong the efforts of this Plan, it has been developed also the control and monitoring mechanisms of the Productive Units (Criaderos), as well as the prototpe of a project for a Mexican Official Norm (NOM) that is going to establish the specifications and procedures to follow in order to register, control and monitornig this productive units. Also, it is elaborating an up to date Directory of institutions and researchers that actually work with the resource, and has been created the National Association for the Conservation and Research for Crocodiles (a Civil Association).

RESUMEN

Actualmente, la necesidad de conocer la distribución y abundancia real de las poblaciones silvestres y la de realizar un uso sustentable de los cocodrilos y caimán en México, han llevado a la Secretaría de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP) a través del Instituto Nacional de Ecología a establecer esfuerzos coordinados entre Instituciones Federales y Estatales, Académicas, ONG's e iniciativa privada, así como con instancias internacionales; para diseñar e implementar una estrategia que permita y asegure realizar un aprovechamiento racional de los cocodrilos y caimán como un recurso natural renovable y que esto se vea reflejado en mejor nivel de vida de las comunidades que se encuentran íntimamente relacionadas con el recurso.

De esta manera se estructuró el "Plan Nacional para la Conservación, Investigación, Manejo y Uso Sustentable de los Cocodrilos y el Caimán", el cual contempla como objetivo principal el desarrollar una estrategia que involucre a todos los interesados en estos organismos (oficinas federales, estatales y municipales de gobierno, Instituciones académicas, ONG's, grupos de pescadores, ejidatarios y campesinos, pequeños propietarios y productores) y que su participación sea en el ámbito que a cada uno corresponda por lo cual el Plan contempla metas al corto, medano y largo plazo, teniendo como marco de acción cuatro grandes programas El recurso, El hábitat, Los usuarios y Uso Sustentable. Actualmente participan en este Plan 16 dependencias e instituciones académicas y civiles, 37 investigadores incluyendo a productores particulares y dos sociedades cooperativas.

Dentro de los esfuerzos de este Plan de han desarrollado también los mecanismos de control y seguimiento de las Unidades de Producción (Criaderos) así como el anteproyecto de Norma Oficial mexicana que establece las especificaciones y procedimientos para el registro, control y seguimiento de las unidades de producción, además se esta elaborando un directorio actualizado de instituciones e investigadores que trabajan con el recurso y se creó la Asociación Nacional para la Conservación é Investigación de los Cocodrilos, A.C.

Introducción

Durante las últimas dos décadas, el interés hacia los cocodrilos y el caimán en México se ha visto incrementado considerablemente por dos razones fundamentales: la conservación de las especies y el aprovechamiento sustentable del recurso.

En el pasado la explotación de diversas especies de cocodrilos representó una actividad económica relevante en algunas regiones del mundo. Sin embargo, debido a la extracción desmedida a la que se vieron sujetos, 18 de las 21 especies hoy en día se encuentran amenazadas.

México no fue la excepción, y es en los años cincuentas que se inician los primeros esfuerzos de conservación para sus especies ***Crocodylus moreletii***, ***Crocodylus acutus*** y ***Caiman crocodilus fuscus***. A la fecha podemos ver los primeros resultados de estos esfuerzos, ya que con la construcción de granjas, estos organismos se han reproducido exitosamente.

Si bien es cierto que a la fecha se desconoce el estado que guardan las poblaciones silvestres en la mayoría de los Estados donde habitan estos reptiles, también es cierto que existe en la actualidad un esfuerzo científico importante para generar este tipo de información en diferentes regiones del país (Jalisco, Chiapas, Tabasco, Yucatán y Quintana Roo, entre otros).

Por otra parte, al igual que en otros países, la recuperación de las poblaciones silvestres y la factibilidad de desarrollar una importante actividad económica alrededor de los cocodrilos, se plantea como una demanda inaplazable para desarrollar una estrategia de Conservación, Manejo, Aprovechamiento e Investigación de Cocodrilos y Caimán en México .

Internacionalmente las especies de cocodrilos mexicanos se encuentran ubicadas en el apéndice I y II de la Convención sobre el Comercio Internacional de Especies Amenazadas de Flora y Fauna Silvestres (CITES), y en el libro rojo de la UICN, son considerados como en peligro de extinción.

En la actualidad, la necesidad de conocer la distribución y abundancia real de sus poblaciones y la necesidad de llevar a cabo un uso sustentable del recurso en México, ha llevado a la Secretaría del Medio Ambiente Recursos Naturales y Pesca (SEMARNAP) a establecer esfuerzos coordinados entre las instituciones federales y estatales, con instituciones académicas, ONG'S e iniciativa privada, así como instancias internacionales, para diseñar e implementar una estrategia que permita y asegure la conservación, la investigación, el manejo y el uso sustentable de los cocodrilos y el caimán en México.

Como parte de esta estrategia, a la vez de aprovechar el esfuerzo y la experiencia acumulada de los últimos cuarenta años, se ha creado en el sureste mexicano un Centro de Investigación para la Conservación de Especies Amenazadas (CICEA). En dicho Centro se desarrolla una parte de la investigación básica y aplicada sobre diversos aspectos de los cocodrilos que habitan en nuestro país.

Hoy gracias a la suma de voluntades políticas, esfuerzos académicos e interés por el valor de estas especies, se presenta el **Plan para la Conservación, Manejo, Investigación y Uso sustentable de los Cocodrilos y el Caimán**.

Antecedentes

Hace algunos años, México contaba con una fuente de ingresos de relativa importancia, principalmente para los habitantes de los estados costeros incluyendo ambos litorales, ésto era por la explotación de piel de cocodrilo. Al igual que en otras regiones del mundo esta actividad decayó debido al descenso de las poblaciones silvestres.

Ante esta situación el Gobierno Federal declara en veda permanente al recurso y pone en marcha distintos programas de conservación y reproducción de cocodrilos en Campeche, Tabasco, Chiapas, Oaxaca, asimismo, Gobiernos de los Estados, como Colima también se incorporan a dicha estrategia.

De manera adicional los Gobiernos Federal, Estatal y Municipal (en algunos casos) han decretado varias áreas naturales protegidas, como una importante superficie del habitat para estos organismos como parte componente de la Biodiversidad en México.

A finales de la década de los 60's y principios de los 70's, el Instituto Mexicano para la Conservación de los Recursos Naturales (IMERNAR), en conjunto con el apoyo del Fondo Mundial para la Vida Silvestre (WWF) apoyan el desarrollo de dos investigaciones a nivel nacional con repercución en los cocodrilianos mexicanos, estas obras : "Biología e Importancia Económica de los Cocodrilos Mexicanos", de Manuel Guzmán Arroyo, y "Los Crocodylia de México-estudio comparativo" del Profesor Miguel Alvarez del Toro, han y siguen siendo textos básicos de consulta para los interesados en este grupo de Reptiles.

Por otra parte, en el entendido que la conservación debe estar vinculada con las medidas destinadas a satisfacer los requisitos económicos de la sociedad a corto plazo, y que sólo el desarrollo es capaz de romper el círculo vicioso de la pobreza que causa el deterioro ecológico, el cual a su vez causa más pobreza; el Gobierno Federal a mediados de la década de los 80's estimula el establecimiento de Criaderos Intensivos de Cocodrilos, como una alternativa para generar fuentes de empleo y divisas en las regiones que estén interesadas en desarrollar esta actividad. Una vez implementados los criaderos, la Federación se ha encargado de generar una normatividad de vigilancia, control y seguimiento de dichas iniciativas, con el fin de asegurar un adecuado aprovechamiento y uso sustentable del recurso.

También los esfuerzos internacionales como el del Grupo de Especialistas de Cocodrilos de la Unión Internacional para la Conservación de la Naturaleza (UICN), han permitido que la Federación cuente con una normatividad clara y con los procedimientos de vigilancia necesarios para la conservación de los cocodrilos y el caimán en México.

Tomando como referencia la situación actual que guardan las especies de cocodrilos y caimanes en México a lo largo de cuarenta años de trabajo, El Instituto Nacional de Ecología, a través de su Dirección General de Vida Silvestre, se ha dado a la tarea de implementar el **Plan Nacional para la Conservación, Investigación, Manejo y Uso Sustentable de los Cocodrilos y el Caimán.**

Problemática

Los cocodrilos, han existido desde hace 200 millones de años, mucho más tiempo que los mamíferos, pero ahora éstos están desapareciendo en cantidades alarmantes. De las 21 especies de cocodrilos, 18 están amenazadas de extinción disminuyendo considerablemente sus poblaciones silvestres.

Algunas especies, como el aligator americano ***Alligator mississippiensis***, parecen estar fuera de peligro debido a medidas estrictas de conservación, algunas otras sobreviven principalmente en parques nacionales, áreas de reserva, o en estaciones de reproducción. Esto es cierto para los cocodrilos de hocico delgado de Africa y Asia, el cocodrilo de agua salada de Australia y Sureste de Asia, el caimán negro y el cocodrilo del Orinoco en Sudamérica, el lagarto chino, el cocodrilo de Siam y otras especies.

La destrucción del habitat es uno de los principales factores para la disminución de los cocodrilos, cada año un mayor número de áreas de reproducción son transformadas, tales como los pantanos y ciénegas, los ríos, estuarios y la vegetación ribereña. Hay que añadir la captura ilegal de las comunidades rurales nativas, así como también los cazadores profesionales. Una gran cantidad de estos animales están siendo capturados debido a su alto valor en el mercado.

La cacería excesiva tiene un efecto devastador en las poblaciones de cocodrilos porque su distribución de edades se asemeja a una pirámide: un número pequeño de animales reproductores domina a un gran número de juveniles y crías, donde la mayoría de éstos nunca alcanza a sobrevivir hasta la madurez sexual.

La recuperación de las poblaciones silvestres de cocodrilos es muy lenta, ya que para la mayoría de las especies; las hembras alcanzan la madurez sexual en promedio a los 8 años de edad.

Importancia:
Económica

Actualmente existe un amplio mercado para los productos obtenidos a partir de cocodrilos, debido a que poseen pieles gruesas y durables, tienen una gran demanda en la industria peletera internacional para la elaboración de zapatos, bolsas, cinturones, portafolios y billeteras, entre otros productos. En menor escala, la carne de estos reptiles se utiliza como alimento y en algunos países es considerada un platillo muy apreciado.

Para tener una visión clara de la demanda internacional de este recurso se puede señalar que la producción mundial de pieles de Cocodrilos durante 1993 asciló en las 844,007 unidades (pieles enteras) destacando como países productores Colombia, Estados Unidos, Venezuela y Zimbawe.

Existe un interés creciente en la crianza de cocodrilianos por lo que países como Argentina están dando un fuerte impulso a la actividad, La industria del Lagarto americano ***Alligator mississippiensis*** representa en los Estados Unidos un ingreso de alrededor de 30 millones de dólares por la venta de pieles y subproductos.

También cabe destacar que las granjas de cocodrilianos tienen importantes ingresos vía turismo ya que representan un gran atractivo turístico y son visitadas por muchas personas.

En el ámbito nacional que los peleteros mexicanos importarón en 1995; 15,958 pieles de cocodrilianos esperando que para 1996 el consumo se incremente sustancialmente pues la tendencia así lo indica.

Dentro de otros subproductos provenientes de los cocodrilianos y que pueden ser aprovechados están los dientes que son utilizados para elaborar collares y dijes. Las glándulas de almizcle de algunas especies tienen potencial para utilizarse en forma de resinoides en la industria de la perfumería. Existe además una gran demanda de crías de cocodrilos para el comercio de mascotas.

Desde 1970 alrededor de 1.5 millones de pieles de cocodrilos han entrado al comercio internacional anualmente, de éstos, alrededor del 75% han sido de ***Caiman crocodilus***, de estas pieles un número significativo entra al comercio en forma ilegal.

Ecológica

Desde este punto de vista, los cocodrilos desempeñan un papel de suma importancia para el equilibrio de los ecosistemas donde habitan. Como depredadores intervienen en el control de las poblaciones de otros animales. Incorporan nutrientes al medio acuático a través de la heces producidas por la digestión de animales terrestres; además mantienen abiertos canales que comunican a los cuerpos de agua. En las zonas pantanosas construyen fosas circulares que constituyen el único refugio de la fauna acuática durante la época de sequía.

Cultural

Entre las antiguas culturas mexicanas, los aztecas consumían los huevos y la carne de Acuetzpalin y le atribuían a las vísceras propiedades medicinales. Los mayas continuamente asociaron a Itzam Can Ain (monstruo cocodrilo de la tierra) con símbolos de fertilidad del agua y la tierra, seguramente tenían un profundo conocimiento del papel ecológico de este recurso. Actualmente algunos grupos indígenas como los lacandones consumen la carne y los huevos de este reptil, preparan las pieles con una mezcla a base de corteza de caoba y mangle, además conocen con detalle su historia natural. Por otra parte, en Oaxaca consideran al caimán como el protector del grupo, por lo cual lo respetan y lo veneran.

Científica

Actualmente existen un sinnúmero de estudios realizados en todas las especies del orden como son: el conocimiento del *status* y distribución de los cocodrilianos; taxonomía, paleontología, ecología, dinámica poblacional, ecología en nidaciones; biología, aspectos reproductivos, determinación de sexo por temperatura; etología, comportamiento social , selección termal; bioquímica y fisiología *in vivo*, osmoregulación, cambios de temperatura sobre las frecuencias cardíaca y respiratoria; aplicaciones biomédicas; manejo y aprovechamiento en cautiverio y vida silvestre; filogenia y sistemática: lepidosis, musculatura, morfología, coevolución, zoogeografía y fisiología, citogenética, análisis inmunológicos de proteínas, digestión de endonucleasas en restricción de ADN mitocondrial y ribosomal y genética de poblaciones, entre otros.

A nivel mundial, todas las investigaciones realizadas en los cocodrilos y afines, tienen como metas la conservación de las especies y su hábitat, procurando la continuidad a través del tiempo dentro de sus rangos de distribución actual, incluyendo el aprovechamiento y uso sustentable y la problemática hombre-cocodrilianos, lo cual engloba la importancia para los científicos realizar una gran cantidad de investigaciones en diferentes áreas.

En las especies de cocodrilianos presentes en México existen trabajos, notas y comentarios en diferentes áreas como son *status* y distribución, dinámica de poblaciones, biología reproductiva, fisiología, genética y zootecnia, en vida silvestre y en cautiverio. Estos trabajos se han realizado por investigadores mexicanos y extranjeros.

De las tres especies en México el cocodrilo de pantano *Crocodylus moreletii* es la especie mejor estudiada, para el que existe el mayor numero de investigaciones a diferencia de las otras dos especies. Además de la importancia por la calidad de la piel y el éxito para reproducirlo en cautiverio, lo que parece haber influido en esto. El *C. acutus*, es el segundo en trabajos realizados y por último el ***Caiman crocodylus fuscus*** para el cual existe menos información.

EL PLAN PARA LA CONSERVACION, INVESTIGACION, MANEJO Y USO SUSTENTABLE DE LOS COCODRILOS Y EL CAIMAN SE CONTEMPLA COMO :

Objetivo General

Desarrollar una estrategia de Conservación, Investigación, Manejo y Uso sustentable para los Cocodrilos y el Caimán, que involucre a los diferentes sectores de la Sociedad.

Objetivos Particulares

Continuar los estudios sobre distribución y hábitat de los cocodrilos en las costas del Pacífico, Golfo y Caribe Mexicano y de Caimán en la Costa del Pacífico.

Capacitar recursos humanos a nivel técnico y profesional, para el estudio, conservación, manejo y uso sustentable de los cocodrilos y el caimán en México.

Determinar el estado actual de las poblaciones silvestres de los cocodrilos y el caimán en cada uno de las regiones de la República Mexicana en que se encuentren estos organismos de manera natural.

Identificar los habitats y/o poblaciones en estado crítico para las tres especies y proponer refugios, santuarios y manejo como medidas de protección a las mismas.

Preparar y difundir un amplio programa de educación ambiental hacia todos los sectores de la sociedad relacionados con las especies de cocodrilos y caimanes en el país.

Establecer los convenios y gestiones a nivel internacional que garanticen el uso sustentable del recurso.

Vincular instituciones científicas nacionales e internacionales , así como a la iniciativa privada y sector oficial a los programas y proyectos que desarrolle el Plan.

Iniciar un programa de recuperación de las poblaciones silvestres en su lugar de origen.

Organizar y normar un programa de reproducción en cautiverio del recurso para nuestro pais.

Organizar y normar un programa de manejo de las poblaciones silvestres.

Sentar las bases para iniciar en el mediano plazo el uso sustentable del recurso en México.

Revizar la Legislación Ambiental vigente y proponer las modificaciones para el aprovechamiento y conservación de los Cocodrilos y el Caimán en su medio natural.

Involucrar a las comunidades en los programas y proyectos del Plan para lograr su desarrollo sustentable del recurso.

Dar los lineamientos a seguir y respaldo a los Planes Estatales de Conservación, Investigación, Manejo y Uso Sustentable de los Cocodrilos y el Caimán.

Desarrollo y Alcances del Plan

México, además de una gran diversidad de recursos naturales, posee también una gran variedad de culturas y maneras de ver las cosas. Desde este punto de vista la problemática en torno de los cocodrilos y caimanes es también influenciada por más de un factor donde se puede mencionar entre otros al origen étnico, las creencias religiosas y el nivel socioeconómico de cada región.

Es por esto que el Plan Nacional para la Conservación, Investigación y Uso Sustentable de los Cocodrilos y el Caimán, deberá ser un instrumento dinámico que se adecue a las características de cada uno de los estados de la República. El **Plan** , prevé tres fases de desarrollo: a corto, mediano y largo plazo.

Asimismo contempla la implementación de acciones simultáneas que son complementarias entre sí y que conforme a sus avances irán proporcionando las bases para iniciar las acciones subsecuentes en el desarrollo de las fases de mediano y largo plazo.

Algunas de sus acciones ya presentan un avance substancial y en algunos casos se cuenta con resultados concretos, como ejemplo de ésto, es el conocimiento de la biología de las especies, los programas de reproducción en cautiverio, normatividad y protección del habitat, entre otros.

Además de la conservación y de la generación del conocimiento científico, con el Plan se prevee el aprovechamiento de los organismos confinados que se han reproducido con éxito por años, así como la infraestructura instalada, gubernamental y privada, para realizar un aprovechamiento comercial en el corto plazo y preparar las regulaciones y metodología que permitan en el futuro el uso sustentable de las poblaciones silvestres.

En el futuro la aplicación del paquete tecnológico del cultivo de estos animales, promoverá en algunos de los estados de la República, el uso de tierras no aptas para actividades agropecuarias y el desarrollo de una importante actividad económica alrededor de los cocodrilos y el caimán.

Todas estas acciones están contempladas y conforman 4 grandes programas:

PROGRAMA	SUBPROGRAMAS	PROYECTOS	METAS
El Recurso	Banco de Información Ecología	Estudios Básicos Estudios Autoecológicos Estudios Sinecológicos	Definición de métodos de monitoreo y modelos matemáticos. Determinar el estado actual de las poblaciones: a) Manejo productivo b) Necesidades de conservación **in situ.**
El Hábitat	Investigación Sobre Hábitats	Investigación Cuantitativa y Cualitativa	Areas de Conservación Areas de Manejo.
Los Usuarios	1.- Integración de las Comunidades Locales. 2.- Productores no Comunitarios.	- Investigación sobre extensionismo e integración. - Capacitación al personal - Información y difución económica y ecológica.	- Establecimiento de granjas con comunidades. - Coinvestigadores integración y apoyo comunitario.

PROGRAMA	SUBPROGRAMAS	PROYECTOS	METAS
Uso Sustentable	1.- Producción 2.- Manejo de poblaciones silvestres.	1.- Registro, formento y certificación: - Cosechas - Granjas - Industrias Diseño e implementación de acciones de manejo productivo de poblaciones.	Determinación de cuotas anuales de volúmenes de extracción y registro de la producción. Manejo y monitoreo de las poblaciones
		2.- Delimitación,diseño y establecimiento de ANP.	- Recuperación de poblaciones. - Restauración de hábitats. - Formación de recursos humanos. -Programas de manejo en ANP.
		3.- Zootecnia Evaluación y diseño de la zootecnia del recurso.	- Manual de zootecnia en criaderos. - Manual de zootecnia en engordas.
		4.- Economía Investigación sobre aspectos económicos.	1.- Economía: - Comercio interior y exterior estudios de factibilidad comercial y mercadeo. 2.- Comercio exterior 3.- Mercado.
		5.- Legal Revisión y propuestas de adecuación de legislación. Convenios (Coordinación interinstitucional	1.- Normatividad sobre hábitats. 2.- Normatividad sobre cocodrilos. 3.- Normatividad sobre unidades de producción. 4.- Normatividad sobre comercio y mercado. 5.-Normatividad sobre marcaje.
		6.- Difusión del Plan	
		7.- Educación Ambiental Proyecto de educación ambiental en comunidades. Proyecto de educación ambiental en el País.	Integración de los diferentes sectores en la conservación, entendimiento y manejo de los cocodrilos.
		8.- Evaluación Evaluación y seguimiento permanente del Plan.	Retroalimentación de la estructura del Plan para sus posibles modificaciones.

Aspectos Legales

México, preocupado por sus recursos naturales eleva a rango constitucional la protección y conservación de los recursos naturales como lo indica en sus artículos 27, 28 y 32. El dominio sobre éstos es inalienable e imprescriptible y la explotación, el uso o el aprovechamiento de los recursos naturales, por los particulares o por sociedades constituidas conforme a las leyes, no podrá realizarce sino mediante concesiones, otorgadas por los organismos gubernamentales correspondientes, de acuerdo a las reglas y condiciones que establezcan las leyes.

Por tales motivos en el año de 1951 se publicó la Ley Federal de Caza, en donde se da protección a la fauna silvestre y especificamente en lo relacionado al aprovechamiento cinegético y así en su capítulo II, artículos 4,5,6 y 8, y en su capítulo III se marca la necesidad de establecer las zonas de las reservas nacionales y asimismo determinar las vedas temporales o indefinidas para la repoblación, propagación o refugio de la fauna silvestre y principalmente para todas aquellas especies que se encuentren en peligro de extinción. En su capítulo VII nos indica la necesidad de solicitar los permisos correspondientes para llevar a cabo el aprovechamiento cinegético, para la curtiduria, tenería y taxidermia y tener un control de éstos.

Debido a que no existía una Ley que diera protección, conservación y marcara los tipos de aprovechamiento posibles para la flora y fauna silvestres en el año de 1988 se publicó la Ley General del Equilibrio Ecológico y Protección al Ambiente, en la cual se marca la protección, conservación y aprovechamiento racional de los recursos naturales, en su título II, capítulo III, artículo 79, 80, 81, 82, 83, 84, 85, 86 y 87; establece los criterios para la protección y aprovechamiento de la flora y fauna silvestre.

Con base en su artículo 36 se publica en el Diario Oficial de la Federación el día 17 de mayo de 1991, la Norma Técnica Ecológica NTE-PA-CRN-001/91 que determina las especies de flora y fauna silvestres, terrestres y acuáticas, raras, endémicas, amenazadas, en peligro de extinción y sujetas a protección especial, siendo la primera norma en listar las especies en peligro de extinción, posteriormente en el año 1994 se publica la Norma Oficial Mexicana NOM-059-ECOL-1994, que determina las especies y subespecies de flora y fauna silvestres, terrestres y acuáticas en peligro de extinción, amenazadas, raras y las sujetas a protección especial y que establece especificaciones para su protección. Anteriormente, no se otorgaban permisos para un aprovechamiento de dichas especies, con esta NOM-059-ECOL-1994 se permite el aprovechamiento del medio natural solamente para obtener el material parental para la formación de Unidades de Producción.

También se cuenta con dos acuerdos para la protección y aprovechamiento de los recursos naturales como es el caso del Acuerdo por el cual se Establece el Calendario Cinegético y el Acuerdo por el que se Establece el Calendario para la Captura, Transporte y Aprovechamiento racional de Aves Canoras y de Ornato, los cuales son revisados y actualizados cada año, en donde participan la iniciativa privada, organismos no gubernamentales, organizadores cinegéticos, asociaciones civiles, entre otras; tanto a nivel estatal como nacional.

Ante la necesidad de controlar el tráfico y comercio ilegal que se ha venido dando con nuestra flora y fauna silvestre, México se adhiere en el año de 1992 a la Convención sobre el Comercio Internacional de Fauna y Flora Silvestres (CITES).

Asimismo, preocupado por la conservación de los recursos naturales, México forma parte de Convenios internacionales, como es el caso de la Convención Internacional de Lucha contra la Desertificación , con la cual se intercambian experiencias con otros paises en la materia; con el Convenio Relativo a los Humedales de Importancia Internacional, con este convenio se tienen apoyos financieros para la elaboración de estudios técnicos de Conservación de los humedales en nuestro país; con el Fondo para el Medio Ambiente Global, se cuenta con apoyo financiero para la protección de las áreas naturales protegidas de alta prioridad, con el Comité Tripartita (Canadá - Estados Unidos - México) se manejan financiamientos para la elaboración de estrategias de restauración y protección de humedales; con el U.S. Fish and Wildlife Service se brinda apoyo financiero para la conservación, manejo y aprovechamiento de la biodiversidad.

Por otro lado, ha adquirido compromisos de cooperación bilateral y multilateral en materia de conservación de los recursos naturales, como es el caso de la Convención de la Biodiversidad con la cual se tienen programas de conservación, información y aprovechamiento de la biodiversidad, en coordinación con la Comisión Nacional para el Conocimiento y Uso de la Biodiversidad.

Legislación Nacional

Desde 1910, se encuentran antecedentes legales en los que se nota la preocupación del legislador por la conservación del recurso que se ve amenazado por la extensiva e irracional captura de que es objeto.

La Ley de Aguas del 13 de diciembre de 1910 autoriza al titular del Poder Ejecutivo para expedir un reglamento sobre pesca y explotación de recursos acuáticos. Con base en ella, el 24 de diciembre de 1923 se expide un acuerdo de la Secretaría de Agricultura y Fomento que establece "que la explotación inmoderada que se ha hecho de las distintas especies de lagartos que existen en el país, ha dado por resultado que disminuya considerablemente el número de animales y que de seguir así sin tasa alguna esa explotación pronto vendría la extinción de las especies, lo que sería un mal irreparable que se debe evitar"

La primera medida que se adoptó, en consecuencia, fue decretar la veda parcial, permitiendo la caza del lagarto sólo entre el 1o. de marzo y el 30 de septiembre de cada año y evitando que la actividad se realizara entre el 1o. de octubre y el último de febrero.

Posteriormente se decretó la veda total en Tamaulipas (1954); en 1955 en Oaxaca; Veracruz y Yucatán impusieron la veda del recurso en 1961 y en 1970 se decretó la veda en toda la República Mexicana.

En el curso de este proceso hubo otras disposiciones orientadas a estimular la protección y reproducción del lagarto, aún cuando el desarrollo urbano e industrial del país redujeron considerablemente el medio ambiente propicio a los cocodrilos.

De 1940 a 1945 funcionó una estación repobladora del lagarto en Laguna Verde, Veracruz, y otra más en la Barra de Suchiate, Chiapas.

En 1968, se integra el Programa de Estudio de los Cocodrilos Mexicanos, en el cual participan el Instituto Nacional de Investigaciones Biológico-Pesqueras y el Instituto Mexicano de Recursos Naturales Renovables, S. C. mediante un convenio. Sin Embargo, esta última institución se retira del programa en el último trimestre de 1969.

A partir de esa fecha, el programa se desarrolla en conjunto por el Departamento de Vertebrados de Aguas Continentales y el de Piscicultura, dependencia del Instituto Nacional de Investigaciones Biológico-Pesqueras. Este programa es suspendido en septiembre de 1971.

En razón de ello, el Gobierno de Tabasco y la Comisión del Grijalva deciden proteger la especie mediante la instalación de un criadero de lagartos, cuyo objetivo principal es preservar la especie.

A este intento han proseguido otros con mayor o menor éxito, pero en forma aislada. La Secretaría de Medio Ambiente Recursos Naturales y Pesca ha establecido y opera granjas en Campeche, Nayarit y Oaxaca.

Legislación Internacional

La reglamentación internacional del comercio de pieles y productos procedentes de animales silvestres tiene importacia, toda vez que implica facilidades o impedimentos para la venta de los productos.

En el caso particular de los cocodrilos, al igual que para la mayoría de los animales silvestres, el comercio internacional se rige por los reglamentos de la CITES (Convención Sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres), con sede en Ginebra, Suiza de la cual son significativos 130 países.

Dicho comercio internacional de la flora y fauna silvestres, importa anualmente millones de dólares, y es una de las causas de la masiva desaparición de númerosas especies de animales y plantas a nivel mundial.

El constante monitoreo del comercio internacional que se realiza por medio de esta Convención, permite conocer estatutos de las especies de flora y fauna silvestres a nivel mundial, y basados en los records de comercio de cada país parte lleva; es posible evaluar las poblaciones de estas especies y controlar el comercio que se haga con ellas. Ya que se tienen antecedentes sobre las cantidades de las diferentes especies que se comercian en forma legal cada año, quien o quienes las exportan, quienes las importan y las que las re-exportan.

No se debe olvidar que la estrategia mundial para la conservación y la comisión mundial sobre el medio ambiente y el desarrollo han indicado que un desarrollo sostenible es escencial para el futuro de la humanidad y que la conservación de la gran variedad del mundo natural es fundamental para este desarrollo. Dicho desarrollo significa uso, y uso es comercio, y por lo tanto, la CITES, como organismo regulador del comercio de especies silvestres, es un factor importante en el proceso del desarrollo sostenible.

Gran parte de los países miembros tienen mercados potenciales, para la adquisición de pieles, productos y subproductos, como Estados Unidos, Alemania, Suiza, Inglaterra o Canadá, y otros que son productores de pieles de cocodrilos, como República de Colombia, Papúa, Nueva Guinea, Egipto, Australia, Nueva Zelanda, Venezuela y Brasil entre otros.

Autorizaciones y Concesiones

En apego al artículo 87 de la Ley General del Equilibrio Ecológico y Protección al Ambiente, la Dirección General de Aprovechamiento Ecológico de los Recursos Naturales perteneciente al Instituto Nacional de Ecología, es la encargada de otorgar las autorizaciones para la creación de criaderos de fauna silvestre, para lo cual es necesario cumplir con ciertos requisitos legales, administrativos y técnicos. Así mismo es la encargada de las concesiones de pie de cría a dichas Unidades de Producción, por lo que el solicitante deberá de presentar un estudio poblacional de la especie solicitada para reproducción controlada e indicar las posibles áreas de extracción de los ejemplares, métodos de captura y el número de ejemplares deseados, con la finalidad de realizar una evaluación y dictamen técnico que permitirá determinar si es posible o no la extracción de dichos ejemplares, y por otro lado determinar el número de ejemplares que pueden ser extraidos, quedando éstos en custodia en el criadero Propiedad de la Nación.

Reporte de Granjas e Inspecciones.

El Instituto Nacional de Ecológia a través de la Dirección General de Aprovechamiento Ecológico de los Recursos Naturales encargado de vigilar, conservar y otorgar el aprovechamiento sustentable de los recursos naturales en nuestro país y como Autoridad Administrativa y Científica de la CITES, lleva a cabo programas de inspección y verificación de las Unidades de Producción y Posesión de Flora y Fauna Silvestre, con la finalidad de otorgar las Constancias de Registro CITES de fauna silvestre en posesión, para el caso que nos ocupa, se presentan las oficios de comisión y de verificación en apego a la normatividad ambiental vigente, con la finalidad de llevar a cabo la verificación sin ningún problema legal, durante la visita de verificación la primera parte consiste en constatar que las instalaciones y las medidas de seguridad sean las adecuadas para las especies de cocodrilos, si existiera alguna falla al sistema se le notifica en el momento y posteriormente se les reafirma por medio de un oficio, después se lleva a cabo, el inventario del material parental (pie de cría), en donde se verifica el número de reproductores, marcas, proporción de sexos y las bajas de ejemplares, de igual forma se constata las diferentes categorías de edad que tenga el criadero, y por último se revisan a las crías y se marcan e inventarian los nuevos ejemplares y se observa el estado de salud que guardan.

Las visitas de verificación se llevan a cabo después de la época de eclosión y durante esta se le solicita al responsable técnico nos indique cuantos huevos se recolectaron, cuantos huevos fueron viables; así como la mortalidad de ejemplares que tuvieron en el año. Además el criadero remite semestralmente un informe detallado de las actividades y a final de año envía los avances en la ejecución del proyecto, composición nutricional y su programa sanitario.

En el caso de que un criadero de cocodrilos desee hacer el aprovechamiento comercial, se lleva a cabo la visita al área de sacrificio para verificar que las instalaciones sean las adecuadas y existan los controles sanitarios que marca la Secretaría de Salud y la Secretaría de Agricultura, Ganadería y Desarrollo Rural

El Criadero deberá tener todos los permisos y autorizaciones necesarias para llevar a cabo el sacrificio de los ejemplares y notificar también que partes serán utilizadas para la comercialización y cuales incineradas.

El Criadero notificará a la autoridad correspondiente durante el evento, la fecha de sacrificio y deberá remitir el número de marca y talla de los ejemplares que serán sacrificados, para que ésta esté presente.

Antes del sacrificio se verificarán que las marcas de los ejemplares seleccionados coincidan con las remitidas, después de la separación de la piel del cuerpo, se procederá a colocar la marca universal para pieles de cocodrilos según la notificación No. 8.14 y así mismo se constatará que el salado de las pieles hasta su almacenaje en los conservadores, así como de los demás productos utilizados para su comercialización.

Mecanismos para llevar a cabo la Exportación de Pieles de Cocodrilos.

Para llevar a cabo la exportación de ejemplares, productos y subproductos de cocodrilos, primeramente se lleva a cabo una visita de verificación para constatar que los organismos a sacrificar sean separados del hato, para verificar el número de la marca de cada uno de éstos.

Posteriormente, durante el sacrificio se observa que la marca sea la misma del ejemplar separado, al cual se le coloca la marca universal para identificar pieles de cocodrilos.

Por último el criadero solicita los permisos para la exportación ó venta nacional, indicando el número de marcas otorgadas a cada una de las pieles. En el caso de una exportación se otorga un Certificado CITES, en donde se indica el número de pieles y de marcas, el cual es verificado por las autoridades aduanales y también por la Procuraduría Federal de Protección al Medio Ambiente (PROFEPA) y en ventas nacionales se realiza una visita de verificación para constatar que no existan en sus bodegas pieles , en el caso de que se encuentren pieles sin la documentación legal, se remitirá a la PROFEPA, para levantar las sanciones administrativas correspondientes, y sí se llegasen a tener en su poder pieles, se verificarán los saldos en nuestros expedientes con los encontrados en las bodegas de la industria peletera y posteriormente, se otorgará la autorización y se les dará un seguimiento verificativo constante al destinatario.

Inspección y Vigilancia

México, por su posición geográfica que lo coloca junto al mayor mercado de Flora y Fauna Silvestre; los Estados Unidos de Norteamérica y por lo extenso de su línea fronteriza, ha sido considerado como la mejor vía para ingresar legal e ilegalmente especies, productos y subproductos de vida silvestre nacional que por su gran diversidad y endemismos las hace muy atractivas para el mercado de mascotas, colecciones, investigaciones, etc. y de especies exóticas provenientes de diferentes partes del continente y el mundo.

Promover participación y responsabilidad de la sociedad en la formulación y aplicación de la política ecológica, así como acciones de información, difusión y vigilancia del cumplimiento de la normatividad ambiental.

Y realizar la vigilancia de viveros, criaderos y lugares en los cuales se lleve a cabo el manejo reproductivo, exhibición, comercialización y transportación de flora y fauna silvestre, sus productos y subproductos.

Por lo tanto se tiene un nuevo concepto de lo que es la inspección y vigilancia donde se maneja la protección integral de los recursos naturales del país y su aprovechamiento sustentable con una participación importante y necesita de los sectores relacionados muy estrechamente con los recursos.

Es por esto, que la PROFEPA opera actualmente con el objetivo principal de: establecer un programa permanente de inspección y vigilancia, apoyado por instituciones públicas y privadas, que garantice la conservación, fomento y aprovechamiento de las especies de flora y fauna silvestre; en donde los cocodrilos juegan un papel importante para algunos de los ecosistemas nacionales incluyendo las áreas naturales protegidas.

Respecto al grupo de los cocodrilos se contemplan acciones que permitan disminuir al máximo el comercio ilegal, llevar un seguimiento de los diferentes centros de reproducción establecidos, así como el hacer la verificación y certificación de las especies, productos y subproductos que de ellos salgan y sancionar a aquellos que no cumplan con las autorizaciones que les haya otorgado la autoridad competente para el caso.

Participantes

Actualmente este Plan en México, ha sumado los estudios y experiencias profesionales adquiridas por especialistas, investigadores, productores y grupos de pescadores así como de Instituciones con prestigio académico públicas y privadas interesadas en la conservación y aprovechamiento de los Recursos Naturales de México.

Dependencias Oficiales, Institutciones Académicas y Asociaciones Civiles

Secretaría de Medio Ambiente, Recursos Naturales y Pesca
Instituto Nacional de Ecología
Procuraduría Federal de Protección al Ambiente
Instituto de Ecología, A.C.
Universidad Juárez Autónoma de Tabasco
Centro de Ecología, UNAM.
Instituto de Biología, U.N.A.M.
Secretaría de Desarrollo, Gobierno del Estado de Tabasco.
Fundación Cuitzmala. A.C.
Instituto de Recursos Bióticos de Tabasco, A.C.
Instituto de Historia Natural de Chiapas.
Marea Azul A.C.

Manejo de Recursos Silvestres, S.C.
Yum-Balam A.C.
Amigos de Sian ka'an, A.C.
Zoológico Miguel Alvarez del Toro

Criaderos Oficiales

El Fénix	Campeche
Laguna de Chacahua	Oaxaca
San Blas	Nayarit

Criaderos Particulares	**Estado**	**Registro**
Dr. Julio César Pastrana Caso	Chiapas	DFYFS-CR-IN-0048-CHIS
Cocodrilos Mexicanos, S.A. de C.V	Sinaloa	DFYFS-CR-IN-0069-SIN
Banana Safari-Chula Zoo	Chiapas	DGCERN-CR-IN-0011-CHIS
Criadero de Caimanes "El Palomo	Chiapas	DFYFS-CR-IN-0054-CHIS
Industrias Moreletii	Tabasco	DFYFS-CR-IN-0016-TAB
Secretaría de Desarrollo de Tabasco	Tabasco	DGCERN-CR-IN-0047-TAB
CICEA	Tabasaco	DFYFS-CR-IN-0023-TAB
Laguna de Alcozahuc	Colima	DFYFS-CR-IN-0065-COL
La Trinidad	Tabasco	DGCERN-CR-IN-0020-TAB
Croco-Cun	Q. Roo	DFYFS-CR-IN-0115-Q.ROO

Crocodilian Status in Ecuador on the Rio Curaray

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Recent surveys in Ecuador along the Rio Napo, Yasuni, Largartococha, and Cuyabeno, generated data which indicated that black caiman Melanosuchus niger and spectacled caiman Caiman crododilus occur in densities compared to viable crocodilian populations in other parts of the world (Asanza 1992), (Hines and Rice 1994). Similar surveys conducted along the Rio Pastaza found that, although the spectacled caiman and dwarf caiman Paleosuchus sp. were present, the black caiman were not present on the Pastaza in Ecuador.

The region between the Napo and Pastaza which includes the Rio Nashino, Cononaco and Curaray had not been surveyed, but was thought to contain viable caiman populations.

The primary objective of this survey was to determine the status and distribution of black caiman and associated caiman species on the Rio Curaray and Cononaco in Ecuador, and to evaluate this area as a source of black caiman eggs or hatchlings for a ranching program.

METHODS

Supplies and equipment were shipped by air to Loracachi Military Base which is located on the lower Rio Curaray in Ecuador. Two survey crews departed from Lorocachi by motor canoe; one going upstream to Amarunchocha approximately .5 canoe/day above Pavacachi, the other downstream to the Peruvian border. Originally plans were to access the Rio Cononaco at its confluence with the Curaray which entailed a brief crossing of the Peruvian border. This was deemed imprudent by our military escort and therefore not allowed. We surveyed lagoons (both isolated from the river and connected), navigable tributaries and segments of the main river (Curaray). Each survey crew consisted of two military guides, an interpreter and one biologist familiar with crocodile survey techniques. Equipment for each crew consisted of a cargo canoe (15m), a small portable canoe, fuel and supplies. Locations of survey routes were established with the use of a global positioning system. Standardized nighlight survey techniques were utilized (Woodward and Marion 1978). Water and air temperature, water depth (lagoons), weather, habitat, and time were recorded for each survey. Crocodilians were recorded by species and size which was estimated for black and spectacled caiman; unknowns were apportioned by species in the same ratio as the knowns except when unidentified animals appeared to be large (>2m) then, they were assumed to be black caiman.

DESCRIPTION OF AREA

The Rio Curaray in the Oriente region of Ecuador is a winding, silt laden river, subject to considerable variations in flow rate. During the dry season it is contained within high clay bluffs with sandbars evident on most inside bends of the river. Bordering rainforests had little evidence of agriculture or other human disturbance except in areas near military hases. When river levels were low, most lagoons were not accessible by boat from the river; then, small dugout canoes were transported over land to lagoons. The lagoons averaged 150-400 ha in size (typically averaged <1m deep) and were, in most cases, long and narrow (50m wide) open water lakes bordered by rain forests.

RESULTS

Thirteen lagoons and 8 river routes were surveyed along 160km of the Rio Curaray or its tributaries between S. 1 32 81.7 W. 76 30 39.8 above Parvacachi (Fig. 1) to the Peruvian border from August 24 to September 4, 1994. Survey routes were established on 22km in lagoons and 50km in streams. Three species; the black caiman, spectacled caiman and dwarf caiman Paleosuchus trigonatus were found to occur on the Rio Curaray. Identification of P. trigonatus was based on photographs of captured individuals which probably should be validated from collected individuals. The spectacled caiman was found in both riverine and lagoon habitat (riverine $\bar{x}$: 1.73 animals/km, lagoon mean: 3.85/km), the black caiman was most ahundant in lagoons (lagoons $\bar{x}$:4.34/km, riverine mean: .63/km), while the dwarf caiman was only found in the rivers ($\bar{x}$: 1.16/km).

In lagoons water temperatures, taken from 6:45 PM to 10:15 PM, ranged from 26C to 33C ($\bar{x}$28.9C). Air temperatures taken at the same time ranged from 24C to 33C ($\bar{x}$ 26.4C). Overall, lagoon water temperatures averaged 2.5C warmer than the air, conversely, water temperatures in the river averaged 2C cooler. Lagoon water temperatures averaged 3.1C warmer than the river.

In lagoons caiman densities ranged from 4.4 - 13.8/km (Table I). Black caiman occurred in 12 of 13 lagoons while spectacled caiman were present in 10 of 13. Black caiman were most abundant in 6 (46%) and were the only species found in 2. Spectacled caiman were most abundant in 7 (53%) and the only species present in one. In lagoons shared by spectacled and black caiman, habitat partitioning was apparent.

In riverine hahitat, crocodilian density was 3.4/km compared to 8.19/km in lagoons. Mean densities were 1.73/km, 1.16/km And 0.63/km for spectacled caiman, dwarf caiman and black caiman respectively. On river surveys spectacled caiman were present on all 8 routes and most abundant on 5, dwarf caiman occurred on 7 and most abundant on 2, while black caiman were found on 4 and most abundant on 1 (Table 2).

Occurrence by species

Surveys in riverine habitat indicated that dwarf caiman was second in abundance to spectacled caiman, and were most often observed on the bank at the water's edge apparently night basking out of the water in warmer air. Water turbidity apparently wasn't a factor in where they were observed because they were located in the Ashmabuay area, a clear water tributary, as well as the higher turbid main river. We did not observe them during lagoon surveys.

A mean density of 4.34/km (range 12.43 - 1.04) black caiman were observed during all lagoon surveys (Table 1), but were observed at 5.17/km in the 12 lagoons where they were found. This compares to $\bar{x}$.63/km for the 8 river routes surveyed. Size distribution ranged from 28.9% <.6m to 18.6% > 1.8m for both river and lagoon routes (Table 3). Small black caiman (<.6m) were found in both lagoon and river habitats.

Spectacled caiman were observed in 10 of 13 lagoons surveyed and on all river survey routes. Densities ranged from 0-8.40/km $\bar{x}$3.85 in lagoons and 0.30-5.80/km $\bar{x}$1.73 on river routes (Table 1-2). Size distribution was 47% <.6m 32% .6-1.2m and 19.7% > 1.2m (Table 4).

Discussion

Black caiman densities in Ecuador north of the Rio Pastaza were comparable to densities found earlier in the Napo region. Our highest black caiman counts on the Curaray were at Shitico (12.4/0 - black caiman/spectacled caiman). This compares to 14.7/.36 black caiman/spectacled caiman at Imuya on the Rio Napo (Hines and Rice 1994). Asanza (1992) found a ratio of 17.6/5.9 black caiman/spectacled caiman at Zancudococha and Imuya on the Napo. Mean black caiman densities were 4.34 and 4.65 for the Rio Curaray and Napo-Lagarto respectively (Hines and Rice 1994 and this survey).

It has been suggested that ratios of black caiman to spectacled caiman are influenced by intraspecific relationships between the species, especially where commercial hunting has reduced black caiman populations. In this case, spectacled caiman are reported to play a role in slowing natural recovery of black caiman (Magnusson 1982, Brazantis et al. 1988). It is probable that multiple variables affect this inter-specific competition, however, we have no definitive data on what these variables might be. While over-hunting of black caiman and subsequent competition by spectacled caiman may influence black caiman recovery in some circumstances, it would be erroneous to assume that dominance by spectacled caiman is always indicative of over-exploitation of black caiman. Interestingly, the ratio of black caiman to spectacled caiman on the Rio Napo and Curaray were similar in spite of the fact that past hunting pressure on the two river systems was probably different.

Unlike on the Napo, it is improbable that commercial hunting for black caiman has been important on the Curaray. During the time of our surveys we did observe that caiman were taken opportunistically for meat by military personnel near military posts and by Indians along the river. However, our limited observations indicated that local people had little hunting tradition that was directed toward black caiman, but rather an attitude of awe and fear toward them. In fact, observations throughout the Amazon region of Ecuador indicate that spectacled caiman are highly preferred over black caiman by indigenous hunters for food. If in fact limited exploitation of black caiman has occurred on the Curaray we found little evidence of their numbers having been seriously reduced, or were they unusually wary, an additional indication of their not being hunted. Also all size classes of black caiman were represented with a high frequency of large animals present (Fig. 1), a further indication of little hunting pressure.

Spectacled caiman and black caiman occurred simpatically in lagoons and to a lesser extent in riverine habitat, however, habitat partitioning appeared to occur in lagoons. Usually, spectacled caiman occurred in shallower portions of shared lagoons. Dwarf caiman were only observed in riverine habitat, but at densities comparable to spectacled caiman. Dwarf caiman were most frequently observed during hours shortly after dark on the river bank apparently basking. This behavior, we believed, was the result of their preference for the warmer air temperature as compared to the river water temperature.

Surveys indicated that size class distribution of black caiman on the Curaray and Napo differed (Fig. 1). Observable size classes may have been influenced by differing water levels on the two rivers during surveys. We targeted survey dates to coincide with the dry season and its resulting low water levels, however, the dynamic nature of the river systems in the Amazon region of Ecuador may cause highly variable local water levels with resulting effects on surveys. Relatively lower water levels on the Curaray during our surveys may have influenced habitat selection and thus distribution of caiman. As river levels recede many lagoons become shallower and isolated from the main river. This results in elevated lagoon water temperature compared to the river. We found a range of nearly 5°c difference between water temperature in some lagoons and the river. Additionally, as water levels recede fish become more concentrated as an available food source. We observed tracks, in some cases ≥25 cm, on trails leading between lagoons and the main river indicating that black caiman may have been influenced to move between lagoons and the river to feed and thermoregulate. Large animals were also observed during river surveys which were probably black caiman. The matter of caiman observe ability in lagoons and riverine habitat as it is affected by varying water levels need further quantification.

Our surveys on the Rio Curaray indicated that a viable population of black, spectacled and dwarf caiman were present. Additional study of the dynamics of all three species is important to provide a basis for improved managment of these important resources.

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Figure 1. Size distribution of Melanosuchus niger based on surveys in the Rio Napo and Curaray regions of Ecuador

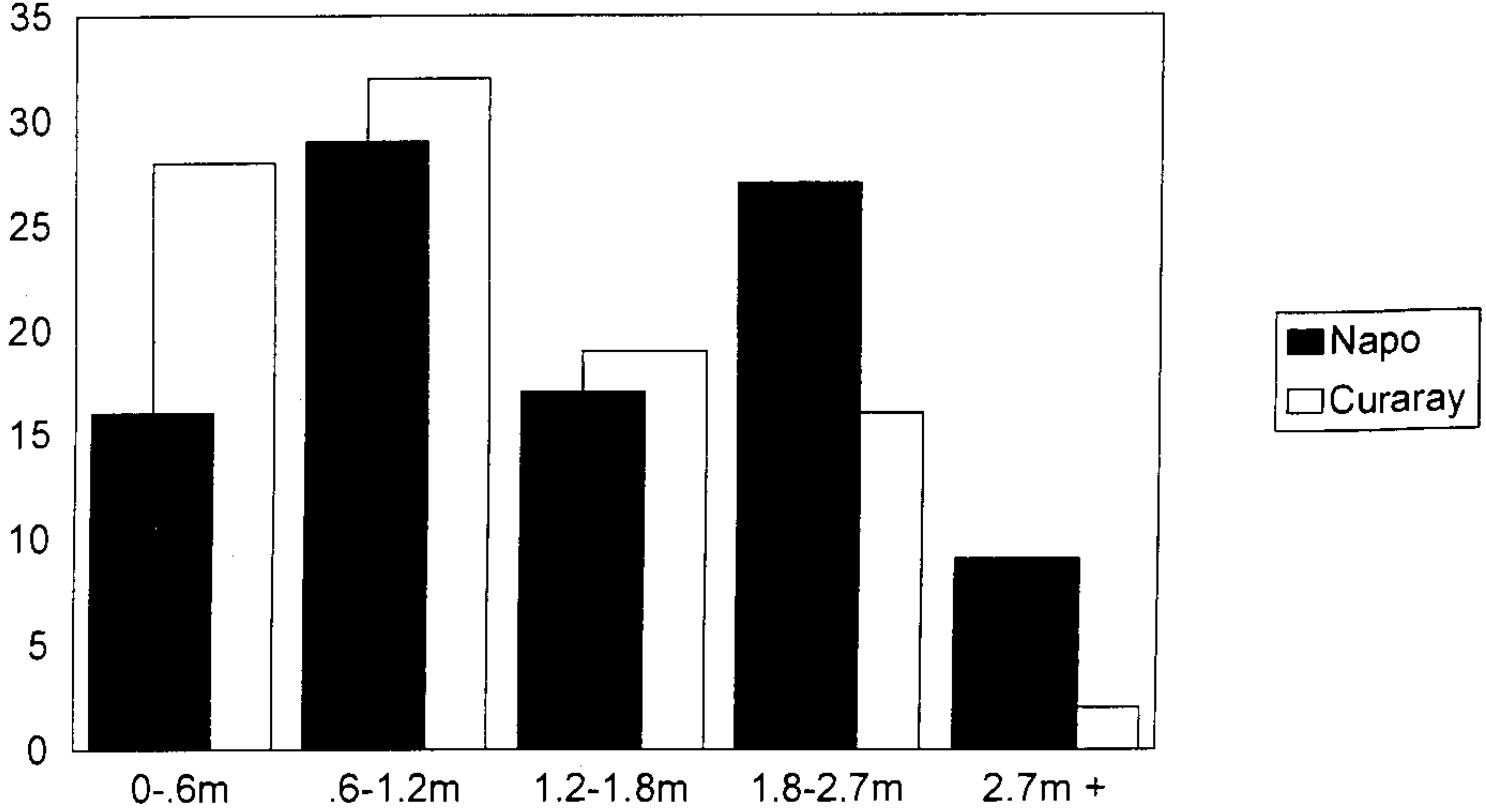

Table 1

Crocodilian Densities in lagoons along the Rio Curaray

ROUTE	SURVEY LENGTH km	CROCODILIANS /km	M.niger /km	C.crocodilus /km
Patoama	1.609	4.97	4.97	0.00
Shitico	1.609	12.43	12.43	0.00
Mitamo	1.609	9.30	8.07	1.23
Chibilaco	1.609	4.35	3.72	.63
Amaruncocha	.66	4.54	3.03	1.51
Unknown	1.21	6.60	6.60	0.00
Piranacocha	1.609	11.80	5.60	6.20
Guinacocha*	1.8	8.30	3.88	4.42
Guinacocha*	.80	8.75	3.75	5.00
Dantacocha	4.80	8.7	1.04	7.66
Shuiar	2.4	6.25	2.90	3.35
Unknown	1.3	13.84	6.15	7.69
Anguilacocha	1.06	8.40	0.00	8.40
TOTAL km	22.80			
mean/km		8.19	4.34	3.85

*Different lagoons

Table 2

Crocodilian River Route Densities in the Rio Curaray and one Tributary

ROUTE	SURVEY LENGTH km	C.crocodilus /km	M.niger /km	P.trigonatus /km
Curaray 1	4.8	5.80	0	0.83
Curaray 2	4.8	1.45	0.51	2.08
Curaray 3	4.8	1.25	1.66	0.83
Ashmahuayacu	16.9	0.71	0	0.88
Curaray 4	4.8	1.25	1.04	0.00
Curaray 5	4.8	4.30	2.80	2.08
Curaray 6	4.8	1.66	0.00	1.04
Curaray 6	4.9	0.39	0.00	2.20
TOTAL km	50.6			
mean/km		1.73	0.63	1.16

Table 3

Size Class Distribution of <u>Melanosuchus</u> <u>niger</u> along the Rio Curaray

(Size in Meters)

ROUTE	TOTAL M.niger	0.2-0.6	0.6-1.2	1.2-1.8	1.8-2.7	2.7+
Chibilaco	6	0	1	3	1	1
Unknown	6	3	3	0	0	0
Piranacocha	6	0	0	3	3	0
Dantacocha	2	0	0	2	0	0
Unknown #2	4	0	3	1	0	0
Guinacocha	2	0	2	0	0	0
Shuiar	5	0	5	0	0	0
Guinacocha II	6	0	2	2	2	0
Patoamo	8	4	1	0	3	0
Shitiaco	16	1	6	5	4	0
Mitamo	13	4	7	1	1	0
Amarunchocha	2	0	1	0	1	0
TOTAL RIVER ROUTES	21	16	1	2	1	1
TOTALS PERCENTAGES	97	28 28.9	32 33	19 19.6	16 16.5	2 2.1

Table 4

Size Class Distribution of Caiman crocodilus along the Rio Curaray

ROUTE	TOTAL C.crocodilus	-0.6	0.6-1.2	1.2-1.8	1.8+
Chibilaco		1	0	0	0
Unknown		0	0	0	0
Prianacocha		0	5	1	0
Dantacocha		0	11	3	0
Unknown #2		2	4	0	0
Guinacocha		0	1	2	1
Shuiar		38	4	0	0
Guinacocha #2		5	0	1	0
Patoamo		0	0	0	0
Shitiaco		0	0	0	0
Mitamo		0	1	2	0
Amaruncocha		0	0	1	0
Anguilacocha		3	1	2	0
TOTAL RIVER ROUTES		17	17	15	0
TOTALS PERCENTAGES		65 47	44 32	27 19	1 .7

PROGRAMA DE INVESTIGACIÓN
Melanosuchus niger

ESTUDIOS ETNOECOLÓGICOS, EVALUACIÓN DEL ESTATUS POBLACIONAL, BIOLOGÍA REPRODUCTIVA Y NICHO TRÓFICO DE LOS CROCODYLIA

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JOSE MARTÍN RIOS SILVA
NELSON PINILLA**

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I. INTRODUCCIÓN

En esta parte de la Amazonía están presentes cuatro especies: *Melanosuchus niger, Caiman crocodilus, Paleosuchus palpebrosus* y *P. trigonatus.*

En Colombia antiguamente la especie Melanosuchus niger fue muy abundante en el río Amazonas desde Leticia hasta el río Atacuarí, limite con el Perú, así como en sus afluentes mayores; sin embargo según observaciones de los biólogos del INDERENA, Hernando CHIRIVI Jorge HERNANDEZ, la especie fue registrado casi extinta para la zona (Medem, 1981). Los registros de Pachón (1982) muestran la cantidad de pieles comercializadas en tres años consecutivos; en 1970 fueron 6333, en 1971 bajaron a 767 y en 1972 llegaron a 1012; apartir de ese año no se reportan más exportaciones.

CARACTERIZACIÓN DE LA COMUNIDAD

Los comunidades que habitan la ribera colombiano del río amazonas están conformadas por sucesivas oleadas de indígenas Tikunas desplazadas de sus territorios ancestrales desde el comienzo de la conquisto hasta la actualidad. Estas comunidades poseen un complejo sistema de manejo ambiental que desde hace muchos siglos se han ido adaptanda para el uso y aprovechamiento sostenible de la Hylea amazónica; socialmente están divididos en Nasones de gente Alada o con plumas a gente terrestre creando los clanes de filiación, donde esta prohibido el matrimonio entre personas del misma noson. La actividad más característica la representa el cultivo de chagra en mingas, la pesca y la cacería; hombres y mujeres trabajan en la artesanía.

Debido a lo anterior y el gran patencial biológico y económica de todas las especies de crocodilidae presentes en la zona, se ha iniciodo el programa de investigación que busca aportar conocimiento sobre la ecología y biología, en especial de *Melanosuchus niger*, así mismo para diseñar e implementar una estrategia de manejo acorde con lo dimensión ambiental de los comunidades indígenas de la región..

II. ETNOECOLOGIA

INTRODUCCIÓN

A partir del conocimiento tradicional ancestral que aún hoy conservan las comunidades y logrando un entendimiento integrado de los espacios que se utilizan a

[1] * Transversal 13 A, N°. 119- 95 Of. 104, Bogotá, Colombia Sur América.
** Solo Ectno Ecología.

diario, en las chagras, la selva, la casas, el río. Se integran otras conocimientos que abordon el temo a nivel práctica y teórico, como son la antropología, sociología, etnografía, historia, geografía, botánica, zoología y ecología, todo lo anterior es denominodo etnoecología, ya que considera la dimensión de integridad de los diferentes componentes de la naturaleza. El dominio de lo etnoecología no es solo conocimiento, sino el comportamiento que este genera , reconociendo que el estudio de los sistemas cognoscitivos no se puede estudiar separadamente de la práctica (Sanabria, 1991; Toledo 1990; Prada y Pinilla 1994).

METODOLOGÍA

I. FASE

Entre julio y junio de 1993, se visitaron 19 comunidades indígenas ubicadas a lo largo del río Amazonas; estas fueron: San Juon de Atacuarí, Bocas de Atacuarí, Naranjales, Cocharedonda, Santaren, San Juan del Socó, San Francisco, Puerto Nariño, San Martín de Amacayacu, Palmeras, Mocagua, Macedonia, Vergel, Zaragoza, Santa Sofía, Arara, Nazaret y la isla de Ronda.

En dichos lugores se recopilo información acerca de la presencia de *Melanosuchus niger* con base en un encuesta de 33 preguntas, tales como: Conoce el Caiman negro?, Consume huevos?, Donde lo ha visto? etc.

II. FASE

Habiendo reconocida el vasto conocimiento de las comunidades, se inicia un proceso de concertación y planteamiento de alternativas viables de desarrollo, involucrando a algunos miembros conocedores de la comunidod como coinvestigadores, se tiene presente el enorme beneficio que esto representa, al permancer ellos de manera permanente en el área de estudio. Todo este proceso de investigación debe ser precedido por una fase de concertación en metodologías para la recolección y toma de datos.

RESULTADOS

SIGNIFICADO CULTURAL

En la cultura Tikuna el Caiman negro es la hija mayor de Yewae (Madre aguo), es por eso que las personas que matan al Caiman por odio, mueren y se convierten en caimón o bufeo.

CONCEPCIONES TIKUNAS

-Características y manejo

El Caiman *(M. niger o C. crocodilus)* es cazado especialmente cuando esta escaso el pescado, se busca en playas, lagunas, madres viejas, donde se mantiene. Cuando el Caiman esta con huevos es bastante agresivo y rápido; el sonido que se da al frotarse dos huevos es como el de dos piedras o ladrillos, ése sonido hace que el animal corra enfurecido hacia el nido.

-Usos locales

Como alimento se consume su carne, es muy blanca, suave y nutritiva con un exquisito sabor. En animales pequeños se come moqueado (Ahumoda) o en sancocho. Los animoles grondes no son consumidos por el carácter fibroso de su carne. Los huevos se preparan de forma normal.

La manteca (grasa, Lípidas) del Caimon negro es tomada y se utiliza para personas que sufren de asma (No solo es mencionodo en las comunidades, también en Leticia se escucha, uso y vende).

El diente del Caiman raspado en té y tomándolo cada quince minutos es usado contra la mordedura de culebras venenosas.

-Historias, anécdotas y ataques al hombre.
Varias personas mencionaron que el tigre se come al caimán y lo hace de diferentes formas; una de ellas es moviendo la cola dentro del agua, el Caiman negro se confunde y va a la orilla, en ese momento el tigre da un zarpazo y luego le muerde la nuca.

Se mencionan muchas personas que cayeron en las fauces del caimán negro, la mayor parte tuvieron características en común; eran niños y/o sucedió mientras se estaban bañando en la orilla del río. Estos ataques se han reducido casi a cero por la situación actual de las poblaciones de *M. niger.*

RELACIÓN Y SIGNIFICADO ACTUAL
En varias comunidades se trabaja muy bien la madera, especialmente el Palo de sangre y se tallon caimanes con uno fidelidad tol que en lo mayoría de los artesanías es posible identificar la especie. También los cráneos algunas veces son lavados y limpiados para ser vendidos, regalados o como adornos.

Actualmente en la mayor parte de las comunidades son concebidos como animales peligrosos, que en un tiempo pasado fueron muy abundantes, pero que la caza para vender su piel los diezmo y ohora solo se le caza en algunas épocas para comer. La perdida de mística está muy relacionada al proceso de evangelización

ÁREAS DE PRESENCIA Y MANEJO
En las comunidades de San Juan de Atacuarí y Boyahuazú se encuentran más cercanas de lagos, quebrados, cochas, etc. de las poblaciones de *M. niger* más importantes.

III. CENSO

METODOLOGÍA

SELECCIÓN DE ÁREAS
En 1993 con base esn la información etnoecológica, se planearon salidas a los lugares más frecuentes arrojados por la encuesta y de más fácil acceso.

En 1994 y 1995 los censos hon sido nocturnos, con un faro explorador y/o linterna de cabeza. El censo se desarrollo, siguiendo los parámetros establecidas en el primer taller sobre censos de crocodylidae (Zambrano, Bolívar; Min. Ambiente y Azoocol 1994). Se utilizo bote de aluminio de cinco metros de largo y un motor fuera de bordo 15HP. El tiempo de los recorrido entre las 20:00 y 03:00 horas. La extensión de los recorridos estuvieron entre 0.3 a 19.2 Km. a lo largo de los márgenes de los cuerpos de agua. Al realizar los acercamientos se calculo a cada espécimen la longitud hocico-cloaca (HCC).

PROCESO DE DATOS

Los en 1995 los ejemplares se agruparon en clases de longitud HCC con intervalos de 10 cm La clase 25 cm.

ANÁLISIS DE DATOS

Los *M. niger* observados en julio de 1993 fueron así: tres (3) adultos en el día, desde la orilla de un lago. Trece (13) individuos entre juveniles y subadultos en tres transectos en bote nocturnos, además se encontraron huellas en una playita del río Amazonas.

En julio de 1995, se realizaron censos nocturnos en cinco cuerpos de agua diferentes. Se recorrieron 45.6 km. entre las localidades. Se localizaron 214 ejemplares distribuidos: 63 C. crocodilus, 94 M. niger, 3 P. palpebrosus y 54 ejemplares no identificados.

La densidad para M. niger osciló desde 0.28 hasta 53.3. La mayor densidad fue obtenida en el Lago Gonzalillo con un perímetro menor a un (1) km. (Tabla 1). La densidad total corresponde a 4.7 individuos /km.

No	Localidad	No de individuos	Kilometros	Densidad
1	R.A. Quebrada el Tigre	4	2.4	1.70
2	R.A. Quebrada Yacarite	36	19.2	1.90
3	R.B. Lago Redondo y Garzacocha	5	17.9	0.28
4	R.B. Lago Gonzalillo	16	0.3	53.30
5	R.L. Lago Tarapoto	33	5.8	5.70
	TOTAL	94	45.6	2.06

Tabla No 1. Datos de *Melanosuchus niger*. Localidad, No de individuos, longitud de los monitoreos (Km) y Densidad de individuos por kilometro.

DISCUSIÓN

La evaluación de las poblaciones de crocodiliae que se presenta no constituye un censo poblacional completo, sino una indicación de las estructuras de las poblaciones en las diferentes localidades.

Melanosuchus niger

En 1993 se localizaron 16 ejemplares entre juveniles y subadultos de M niger, Costaño y Ríos 1994 localizaron 47 ejemplares de los cuales 28 eran neonatos, en un recorrido de 136.5 km.

Los datos anteriores son mínimos al compararse con los obtenidos en 1995 donde contabilizaron 94 ejemplares en un recorrido de 45.6 km.

La mayor frecuencia de aparición de la especie se ubicó en las clases de longitud HCC 55, 65 y 45 cm con un número de individuos de 24, 20 y 14 respectivamente. Durante esto fase no se observaron neonatos.(

Castaño y Rías en 1994 obtuvieron una densidad de M. niger en 136.5 km. recorridos de 0.34 individuos/km., en 1995 la densidad fue de 2.06 individuos/km. en un recorrido de 45.6 km.

DIETA

METODOLOGÍA

En julio de 1995, durante y pasada la faena del censo se realizaron las capturas respectivos de los especímenes con lazada, gancho para serpientes y a mano (Webb y Messel, 1977; Chabreck, 1963).

Al dia siguiente se les realizo la biometria y se les removieron los contenidos estomacales de 24C. crocodilus, 18M. nigery 3 P. palpebrosus, mediante las metodologías de Toylor et al (1977) con algunas evaluaciones y modificaciones sugeridas por Fitzgerald (1989).

Los contenidos fueron previamente descrito a nivel taxonómico y luega colectadas en bolsas plásticas con solución de alcahol al 70% y formol al 10% dependiendo del grado de descomposición de las presas. Cada contenido se peso utilizando una balanza O-Hauss con una precisión de 0.1 g. y clasificó entre las presas y las respectivos especies de caimán.

Los tipos de presa se agruparon taxonómicamente de menor a mayor categaría: Invertebrodos terrestres, cangrejos, Moluscos, Peces y vertebrados terrestres. A cada tipo de alimento se le determino la frecuencia de oparición en porcentaje (%FA), el peso total en porcentoje (%PT).

RESULTADOS

Los resultados del análisis de los contenidos estomacales tres, cuatro y diez ejemplares ubicados en las clases de tamaño de Longitud HCC de 40-49.9, 50-59.9- y > 60 respectivamente.

En lo clase 40-49.9 cm aparece como alimento dominante los cangrejos con una frecuencia de aparición del 66.66% y un 45.26% de peso total. En segundo lugar están los peces con una frecuencia igual (66.66%), pero un valor de peso del 40.08%. Los Coleóptero y Caracoles (Pomacea) presentaron un frecuencia de aparición de 33.33% y un volor de peso totol de 7.12 y 1.89 respectivamente.

Los individuos de clase 50-59.9 cm de longitud HCC, los peces son el alimento dominonte con una frecuencia del 75 % y un peso total de 55.69%; después le siguen los cangrejos y los Coleoptera con una frecuencia y porcentaje del peso total de 25 y 50 % y 13.26 y 2.91% respectivamente.

Para los > 60 cm de Long HCC, los peces constituyen claramente la base de la dieta con una frecuencia de aparición del 60% y un peso total del 89.65%. Con valores de peso inferiores siguen apareciendo los coleópteros (1.73%) y algunos vertebrados no identificados (3.19% de peso total).

El 22.2% se encontraban con el estomago vacío.

DISCUSIÓN

-Relación entre la presa y tallo del caimán

La principal presa de los juveniles consistió básicamente en su totalidad de invertebrados, especialmente Diplopodo y Ortoptera. Los peces fueron para los adultos la principal presa. En el presente estudio no se encontraron camarones.

Cantidad de presa consumida

La cantidad de contenido estomacal, en promedio fue 7.58 gr. que representa el % del peso total del animal.

La cantidad de presa debe estar más relacionada con la oferta y variedades de presas en el medio y/o necesidad de alimentarse. La presencia de material vegetal en los contenidos estomacales fue muy frecuente , pero esto no se consideró entre los renglones alimenticios, ya que esta es consumida cuando los animales atrapan las presas.

REPRODUCCION

Se han recopilado una buena cantidad etnoecológica referente a reproducción (comportamientos reproductivos, época de cortejo, postura y eclosión, localización de nidos, predadores, etc.)

Se esta a la espera de la financiación para iniciar los estudios en la biología de la reproducción, buscando encontrar patrones fijos de acción en cada una de las fases del comportamiento reproductivo.

OTROS

En el momento se están adelantando una serie de investigaciones en Patología, a raíz de unos cuerpos extraños encontrados en la piel M. niger y Caiman crocodilus; se han tomado muestras de sangre con el fin de evaluar la presencia de posibles parásitos en la sangre.

CONCLUSIONES

-En 1993 se reportó que Melanosuchus niger, NO ESTA EXTINTO DE LA REGIÓN y parece encontrarse en un periodo de recuperación.

-Son grandes los requerimientos en información desde cualquier óptica, biológica, ecológica, etnoecológica, etológica, etc.; los resultados hasta ahora obtenidas son apenas datos preliminares que deben y necesitan ser ampliados para al mayor conocimiento de las especies en su manejo para repoblamiento, programas ecoturísticos, rancheo, zoocría, etc.

-Es invaluable el conocimiento que las comunidades y en especial los conocedores tradicionales tienen sobre las especies, hecha que ayuda a establecer un modelo altemativo de desarrollo para los asentamientos indígenas y la región.

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Growth in *Melanosuchus niger* and *Caiman crocodilus crocodilus* at Zancudococha and Cuyabeno, Ecuadorian Amazon.

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Introduction. Crocodilians undergo a spectacular size change during their life. Abercrombie (1987) states that *Alligator mississipiensis* can achieve 7000% his hatchling weight as an adult. *Melanosuchus niger* and *Caiman crocodilus* show a similar trend.

As we can imply from that sort of changes, many aspects of their natural history and ecology are closely related to their size: type of prey (Magnusson *et al.* 1987, Asanza 1991), competition groups (Vallejo 1995), mortality (Woodward *et al.* 1987), only to name a few.

Thereby, it is very helpful to know the growth rates of the animals in order to understand the population dynamics of the species, and to have insight to some important management and conservation subjects. For example, Rebêlo and Magnusson (1983) present a most interesting hypothesis to explain the diminishing in *M. niger* populations when they are exposed to sever hunting pressure, while *C. crocodilus* tolerate it much better.

Based on hunted skins sizes and some data on growth of both species, they suggest that *M. niger* spends 2 to 3 years at a size range that hunters prefer, before sexual maturity, which it achieves between 1.8 and 2.0 m. in total length (Rêbelo and Magnusson 1983, Ross and Magnusson 1989, Herron 1991), while *C. crocodilus* will be at that range for far less time. This will make it harder for *M. niger* populations to recruit new reproductive individuals under hunting pressure than it is for *C. crocodilus* ones.

Herron (1991), based on growth data from a sample of both species, extended that hypothetical time span to 4.5 to 6 years for *M. niger*.

The results of our study suggest that that period could be even longer.

Methods. From August 1992 to January 1995, 105 different individuals of *C. crocodilus* and 146 of *M. niger* were captured, marked, measured and released in three black water lagoons of Ecuadorian Amazon: Cuyabeno, Zancudococha and Imuya). Because many animals had incomplete tails, the snout-vent length (SVL) of every animal was measured. Then, a lineal regression was calculated between the snout-vent length and the total length of all those animals with complete tail:

for *M. niger*, ETL = (SVL + 1.4886) / 0.4876 r= 1,

and for *C. crocodilus*, ETL = (SVL + 0.7793) / 0.5063 r= 1.

This regressions were applied to every snout-vent length for calculating the expected total length (ETL), with which analysis were made.

In order to reduce measuring error, only recaptures with 90 or more days of interval where included in the analysis. These were 8 recaptures for *C. crocodilus* and 23 for *M. niger* (96% of the data for *M. niger* comes from Zancudococha, locality in which this species is dominant in a 9:1 proportion over *C. crocodilus*).

For normalizing growth to cm of expected total length increment/year, no difference on growth throughout the year was assumed.

Results and discussion. Growth variation among individuals was large in the two species.

C. crocodilus presented growth rates between 3.59 and 34.33 cm/year (always ETL), with an average growth of 13.61 cm/year. Notice that the extreme values were found on individuals of the same initial length (104.54 and 104.25 cm respectively) and sex: males (table I).

For *M. niger* normalized growth rates were between 1.72 and 25.13 cm/year, with an average of 12.44 cm/year (table II). That is, slower than that assumed by Rêbelo and Magnusson (1983) (35.5 cm/year), and than the one found by Herron (1991) ($\overline{x}$=17.2 cm/year). That will mean, making the same assumptions as in the above mentioned studies, that the period that *M. niger* spends in hunter's preferred size without been sexually mature extends from 6.5 to near 9 years.

This would explain the devastating impact that hunting has had for *M. niger* populations throughout it's distribution range, and the almost complete supplantation of this species by *C. crocodilus* in the more hunting-exposed localities.

It will also make us search for the reason of the little or none recuperation of *M. niger* populations in areas newly occupied by *C. crocodilus* (Asanza 1985, Ron 1995), despite more than twenty years of protection, not only in the competition of resources between these two species, but also in the slow growth of *M. niger*, and the long time it needs for recruiting reproductive individuals.

And, of course, this warns us of the fragility of the few remaining populations of the larger Amazon predator.

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Data Provided by Research on Crocodilians in the Field

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Many years ago, Clarence Abercrombie and I planned to produce a general model of crocodilian population dynamics. We never brought the project to fruition but, since then, I have been trying to collect data from studies on crocodilian population dynamics that could be used to construct such a model.

In 1992, I questioned the utility of techniques generally used in studies of crocodilians (Magnusson, 1993). Since then, other papers criticizing and/or showing the limitations of field studies for management have been published (Abercrombie & Verdade, 1995; Magnusson, 1994a, b,1995; Magnusson & Mourão, 1995). Ross (1995) emphaticized the need for adaptive management and Thorbjarnarson (1996) suggested the production of a simple manual for the adaptive management of crocodilians.

In this paper, I cannot give answers, but it is important that we consider the restrictions within which we are working. Collecting data to plug into population models may not be very efficient. Abercrombie & Verdade (1995) very elegantly showed that it is difficult to make predictions based on computer models and that even deterministic models may show caotic behavior. Add to this stochastic effects caused by weather and other environmental fluctuations (e.g. Caughley & Sinclair, 1994: Fig. 6.6), and our predictive abilities fall below those of the seat-of-the-pants predictions that "the number will probably be about the same as last year" or "the population decline will probably continue".

Modelling genetic effects based on mean demographic parameters may be even more difficult. Studies of birds indicate that life-time reproductive success varies greatly and that a few individuals may contribute most of the genetic variation to the next generation (Newton, 1995).

It may not even be easy to decide what population size we consider to be within the "normal" range. We can take some lessons from fisheries biology where each generation of fisheries biologists starts working from a new baseline, often in ignorance of the true historical levels (Pauly, 1995).

Also, we have to honest when we list the reasons we want to protect the species. It is not a good idea to only say that the species is a "keystone" predator or only that it is a valuable economic resource. Will we be willing to let it go extinct if a competent biologist can show that it is not a keystone species or if the crocodilian skin market collapses?

When the species is being managed for economic gains, we have to be more careful. Economics is even less predictable than the population dynamics. It has been called the voo-doo science. For many species, intrinsically low rates of population increase mean that the most economically sensible management is to reduce the stock to economic extinction and invest the money elsewhere (Caughley & Sinclair, 1994). This can also be true for species with high intrinsic rates of increase when market prices or government regulations are unpredictable. Fortunately, the potential rate of increase of most populations of crocodilians is probably high enough to make other options viable (but not necessarily optimum for all segments of society). Some options that are safe biologically may not be safe economically (Magnusson & Mourão, 1995).

At this point, I will assume that all readers believe that crocodilians should be subject to adaptive management. If you do not agree, go back and read the basic references cited above. Adaptive management sounds great but those two simple words hide a multitude of very difficult decisions. (Hilborn & Ludwig, 1993) At the very least, we have to be able to answer the questions marked in bold below.

(1) What are we managing for?

Do you want to maintain the species within its present distribution, re-establish it in its former range, maintain population densities above some predetermined level, increase the population at some predetermined rate, maintain the population size structure, sustainably remove a segment of the population for economic use, maintain the species' "role" in the ecosystem, avoid human/crocodilian conflicts, or something else? If your answer is "all of the above", go back and do some basic reading. Many or most of these objectives are mutually exclusive and, as Caughley & Sinclair (1994: Ch.1) point out, very often based on value rather than technical judgements.

(2) When will we intervene?

Management is expensive. You do not want to spend money fixing things if they would fix themselves naturally next year. Curtailing harvests imposes costs on the producer and reduces the credibility of the management authority. However, failure to intervene may mean the loss of the species or reduction in the value of the resource. Will our measure of failure be based on population parameters, catch per unit effort, economic returns, public opinion, ecosystem function, or some other indicator? In general, qualitative failure criteria have little utility for management (Caughley & Sinclair, 1994:Ch.1).

(3) Who will pay?

This probably depends on what we are managing for. The minimum cost is the monitoring of the population to determine when intervention is necessary. In the ideal world, the user pays. In the real world of politics and conservation, the economic gains usually accrue to a few and the costs are borne by many. When the intervention implies habitat protection or reconstruction, the costs may be very high. There is no point in decreeing intervention if it is not viable.

Do you still want to do adaptive management? I hope so. But, deciding what data we need to collect is not going to be easy and, if those data do not help us with the three questions given above, it will be of little use for management. Only a lot of hard dicussion between crocodilian biologists in various parts of the world will reveal how many of the answers are general and how many will apply only to a restricted range of species.

Acknowledgments: Accomodation at the meeting was provided by the organizing committee and the plane ticket was donated by Suheil Neves. Many of the ideas expressed here were developed by Clarence Abercrombie, Peter Bayliss, Guilherme Mourão, John Thorbjarnarson and the late Graeme Caughley. I hope that you will attribute any errors to them. Should some useful information have inadvertently slipped in, I am willing to take the glory.

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MONITORING WILD POPULATIONS OF SPECTACLED CAIMAN (*Caiman crocodilus*) IN SOUTHERN GUARICO AREA

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RESUMEN

Las poblaciones naturales de baba son aprovechadas en Venezuela bajo control del MARNR desde 1983. En 1991-92 se incluyó a Guárico, con una cosecha total de 37.322 animales machos adultos. Sin embargo, a partir de 1992 se suspendió el Programa en esta región debido a la baja proporción registrada de machos adultos. El presente estudio se dirigió a establecer el status poblacional luego de 4 años de veda ininterrumpida. El área de estudio abarcó 50 fincas (251.115 ha) en la zona sur de Guárico (8% del área total del estado), donde se hicieron censos nocturnos entre febrero y marzo de 1995 (verano), con fuentes portátiles de luz. Se censaron 221 cuerpos de agua, totalizando 25.859 individuos: 24.3% machos adultos (IV), 42.9% adultos (III) y 32.8% subadultos (II), con una densidad de 0.102 ind/ha. Las poblaciones más abundantes se localizaron en Cazorla y Camaguán, con valores bajos en Paso de Caballo, Parmana y Guayabal. No se encontraron diferencias (P<0.05) entre unidades y subunidades geomorfológicas ni tipos de cuerpo de agua. Los habitats asociados a bosques y matorrales mostraron mayor número de individuos que las sabanas abiertas. Las clases de tamaño II y III mostraron mayores abundancias en caños rodeados de bosques o matorrales y menores en préstamos y lagunas ubicados en sabanas abiertas. Se constató una fuerte presión de cacería ilegal en la región dirigida hacia huevos y neonatos, por la reducción de las clases II y III respecto a censos anteriores. Se recomienda desarrollar alternativas de manejo diferenciales para cada localidad que incluyan protección de nidos y neonatos a través del establecimiento de zoocriaderos con fines de conservación y repoblación.

INTRODUCTION

Wild populations of baba are subject of a harvesting program in Venezuela, under government control and surveillance by the Servicio Autónomo de Fauna PROFAUNA. This program started in 1983 in the states of Apure, Barinas, Cojedes and Portuguesa. During 1991 and 1992, Guarico state was included in the program with a harvest of 17649 and 19673 large male adults animals, respectively. The program was suspended in this region since 1992, due to the low values (less than 7%) of large male individuals (Class IV in classification of Ayarzagüena 1983) reported the by MARNR-CITES Project (Velasco & Ayarzagüena 1995), which recommended further detailed studies before re-starting harvests, to determine if there were a recovering of the wild populations. The objective of the present work is to determine the status and size-structure of the wild populations in southern Guarico state, the ecological characterization and management strategies for the region after 4 years of banned harvests.

STUDY AREA

Southwestern Guarico was defined as ecological region from the point of view of baba populations by Velasco & Ayarzagüena (1995). Its main geographical and ecological features were characterized by Arteaga (1989) and Berroterán (1992). A polygon formed by the line Corozo Pando-Espino on north, the Portuguesa river on west, the Apurito River on south and the Zuata river on east was defined as study area. Within this polygon, 50 farms were chosen considering its area and ability for the species management, covering a surface of 288420 ha which represents 3.87% of the total area of the Guarico state and 6.53% of the area defined as ecological region. This area is almost four times larger than the area observed by Velasco & Ayarzagüena (1995) during 1992.

METHODS

Six localities were established for field work (Paso de Caballo, Cazorla, Guayabal, Camaguán, Cabruta and Parmana, Map 1), during February 23 and March 25, 1995 (dry season). Waterbodies were classified as *caños* (drainage streams), *tapas* (small dikes), lagoons, *préstamos* (small man-made lagoons), channels and *morichales* (small streams), and accordingly to its surrounding vegetation (savanna, brush, forest or its combination).

Each waterbody was observed during daylight to establish the size-structure of the population accordingly to Ayarzagüena (1983) classification: Class I (hatchlings), Class II (juveniles), Class III (male and female adults) and Class IV (large male adults > 1.80 m). After that, a night-light count (Woodward & Marion 1977) was carried out to obtain abundance data of the population.

The locations of censuses by its geographical coordinates were positioned in geomorphological units established by PROA (1984) in the study area. Data were processed with analysis of variance, using as numerical variables the total number of counted babas and proportion in percent of each size class; the classification variables were: geomorphological units and subunits, type of waterbody, dominant vegetation and locality.

RESULTS

General characteristics of the study area

The geomorphological units (landscapes) identified in the study area were plains, tables and river valleys, with the following characteristics for each locality:

Cabruta	• Eolic plains, sand hills, valleys, undulating relief • Alluvial fluvial-deltaic flooding plains • Large lagoons surrounded by forests and shrubs
Parmana	• Tables, hills, valleys, undulating relief • Small lagoons surrounded by savanna
Paso de Caballo Cazorla Camaguán	• Alluvial fluvial-deltaic flooding plains • Poor drained soils • Large and small lagoons surrounded by forests, shrubs and savanna • Drainage streams

Number of Individuals and Densities

Table 1 shows the data of size structure and total density per hectare of each locality. A total of 221 waterbodies were observed, from which approximately a half were natural lagoons, with 25859 animals counted. The localities of Cazorla and Camaguán shows the maximum counts (10822 and 9549 individuals). The proportion for each size-class revealed a global amount of almost 25% for large male adults, which is very influenced by the values reached in Cazorla, Camaguán and Cabruta, for a density value of 0.192 ind/ha for this size-class. The total density of the population in the region was 0.09 ind/ha.

Table 1. Summary of results for each locality

Region	Area (ha)	Class II (%)	Class III (%)	Class IV (%)	Total (No. ind)	Density (Baba/ha)
Cabruta	37305	10.6	29.3	60.1	1196	0.03
Camaguán	20063	22.0	50.6	24.7	9549	0.48
Cazorla	100987	35.6	39.4	24.9	10822	0.11
Guayabal	31250	66.6	22.5	10.9	701	0.02
Parmana	24265	63.3	24.2	8.5	422	0.02
Paso Caballo	74550	44.9	39.5	15.6	3169	0.04
Total	288420	32.8	43.7	24.3	25859	0.09

The ANOVA demonstrated that the total of counted animals does not show significant differences between geomorphological units and subunits, type of plains and localities. Also, there was no difference among types of waterbodies. In contrast, there was significant differences between the surrounding vegetation of the waterbodies, with the savanna formations showing the lowest average number of babas (37.4 individuals), while the forest and brush reaches highest (65.8 and 86.5 individuals, respectively). These two plant formations showed no significant difference between them. This results are coincident with reports of several authors (Muñoz 1988, Oubuter & Nanhoe 1988, Gorzula et al. 1988, Colomine 1993), indicating preference of the species for habitats surrounded by forest or brush vegetation.

Size Classes

The proportion of Class IV (large male adults), with 24.3% of the total counted population, showed no significant differences among geomorphological units or sub-units, type of waterbodies or surrounding vegetation. However, a significant difference was detected between localities, with higher results for Cabruta, Camaguán and Cazorla respect to Paso de Caballo, Guayabal and Parmana.

In contrast, the remaining two size-classes (II and III, juvenile and male-female adults), which comprises 32.8% and 43.7% of all censed animals, had significant differences for the type of waterbodies: the *préstamos* showed the lowest average (II=7.8 and III=4.6 ind.), while the *caños* reached the highest values (II=87.8 and III=130.8); the lagoons showed intermediate values (II=29.8 and III=20.8). Also, this fraction of the population showed significant differences between the surrounding vegetation types, with higher values in forested areas (II=75.5 and III=128.1 ind.) and brushes (II=48.6 and III=33.3); the lowest values were observed in waterbodies surrounded by open savannas, which is coincident with previous reports (Colomine 1993).

Discussion

The study area showed favorable habitats for the species, specially in its southwestern corner. The drainage streams (*caños*) that retains water during the prolonged dry season, surrounded by forests and shrubs, seems to be the most preferred habitat for all size-classes, particularly for subadults (Class II) which showed the highest averages in these environments.

The global density (0.09 ind/ha) resulted slightly lesser than the estimated density in 1992 of 0.13 ind/ha (Velasco & Ayarzagüena 1995). This figure is an evidence of the slow recovering of these populations since the hunting ban. The highest density was reported for Camaguán (0.48 ind/ha), which is comparable to another Llanos regions (i.e. Apure, Velasco & Ayarzagüena 1995), reflecting specially favorable conditions in this locality. There are abundance of alluvial flooding plains and permanent waterbodies with surrounding forests (Arteaga 1989). The other sampled zones, with the exception of Cazorla, showed low values of density, total number of counted animals and large male adults proportion.

Besides this difference among localities, it is important to remark that the proportions of juveniles and small adults altogether amounts up to 75%, while the proportion of large male adults was approximately 25%. In contrast, the proportions reported by Velasco & Ayarzagüena (1995) were 93% of II-III Classes and only 7% for IV Class. Probably, a strong illegal hunting on small animals and egg collection for human consumption or trading to farms is related with this change on the size-class proportions, reducing the recruitment rate inside the wild populations (Ojasti 1989). Herron (1991) observed similar effects on populations of *C. crocodilus* and *Melanosuchus niger* after uncontrolled hunting.

CONCLUSION

The hunting prohibition alone in Guarico region have not produced the expected recovering of populations. The southern part of this wide zone is plenty of favorable habitats for a successful establishment of wild populations, but the illegal hunting pressure, specially on the early stages, is affecting their reproductive potential.

It is recommended a full census of nests and to keep annual monitoring of wild populations, together with a conservationist management program of species and habitat protection, that includes a special project of environmental education for the inhabiting people.

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POPULATION EVALUATION OF THE SPECTACLE CAIMAN (*Caiman crocodilus*) IN THE ORINOCO DELTA

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RESUMEN

El Delta del Orinoco esta conformado por aguas provenientes de la cuenca del río Orinoco, en una superficie de aproximadamente 3.650.158 ha de llanos deltaicos y con una vegetación predominantemente del tipo bosque seco tropical. Se encuentra dividido en bajo delta (área mas cercana al mar), medio delta y alto delta (fin del rio Orinoco). El área de estudio se ubica en el medio y alto delta, con una superficie aproximada de 544.777 ha, equivalente al 14,92% del área total. Se realizaron dos censos, uno en la época de máximas aguas en el medio y alto delta, cubriendo una superficie de 44.421 ha de canos, lagunas y ríos, en el cual se utilizo factores de estimación en la abundancia de la población, y otro censo en el periodo de mínimas aguas solo en el alto delta, para evaluar la estimación realizada. Se determino en ambos estudios la estructura de tamaños de la población de babas, así como su abundancia. Durante máximas aguas se estimo una abundancia promedio de 0,91 ind/ha de terreno bruta en toda el área muestreada, con un 41% de los individuos de clase II, 41% para la clase III y 18% en la clase IV. En mínimas aguas para el alto delta la abundancia encontrada es de 2,61 ind/ha y una estructura de tamaños de 35% en la clase II, 46% para la clase III y 18% en la clase IV.

Introduction

In Venezuela there exist five crocodile species; the spectacle caiman (*Caiman crocodilus*), the Orinoco crocodile (*Crocodylus intermedius*), the Coast crocodile (*Crocodylus acutus*), the black caiman (*Paleosuchus palpebrosus*) and the morichal caiman (*Paleosuchus trigonatus*).

The Orinoco crocodile (*Crocodylus intermedius*) is one of the 12 species under greatest peril and threaten for extinction (IUCN, 1990), while the Coast crocodile (*Crocodylus acutus*) is considered a vulnerable species. On the other hand there is no population information about the *Paleosuchus* species (IUCN/SSC/CSG).

The spectacle caiman (*Caiman crocodilus*) is the species with the greatest distribution in Venezuela. Its population status has been well studied (Seijas, 1986 and Velasco and Ayarzagüena, 1995), being an species under a commercial management program in the flooded llanos region of the country, since 1983. One of the distribution areas of the species is the Orinoco Delta, where there was done a population study (Estevez and Gorzula, 1988) in order to determine the harvest capacity of the population.

The objective of the present work was to determine the abundance and population structure of the spectacle caiman in the Orinoco Delta, as well as to determine the harvest capacity of the region.

Study Area

The Orinoco Delta is sedimentary and gets water from the Orinoco river system as well as part of the Amazonas. It has 3.650.158 ha of delta llanos and dry tropical forest with a net of rivers, springs and lagoons. The water level depends on the Orinoco river heights, as well as the tides oscillations.

The study area was of 544.777 ha. It represents 14,92% of the delta and covers the regions of the Alto y Medio delta.

Methodology

First stage (flooding period peak))

The work was started in 1992. The first census was developed between August-September 1992 with an area covered of 44.421 ha, 8,2% of the total study area, with four teams integrated by one professional and two local helpers each one.

Spectacle caiman abundance and population structure was determine using the same methodology described by Velasco and Ayarzagüena (1995) for the spectacle caiman population study in the flooded llanos, based on night census.

It is important to point out that as in some opportunities it was impossible to count all the individuals, there was needed to use a correction factor. It oscillate between 2 and 10, depending on the habitat conditions (Velasco et al., 1996).

Second Stage (dry period peak))

Two teams, integrated by the same persons, did a second census during March-April 1993. An area of 4.717 ha, 10,62% of the total, was covered. Each team has a motor boat, 12-15 feet with a 40 HP motor, boats with paddles (curiaras), horses, spot-lights, counters, maps 1:100.000, field notebooks and other camping materials.

During this census no correction factors were used as one of the objectives of it was to determine how good the population estimation were. Size structure was determined based on the information obtained from all the individuals counted by night. It was possible due to the reduced water area as a result of the dry season.

Results

First stage (flooding period peak))

There were sensed 128 water surface, distributed as follows: 106 in the Alto Delta (29.105,6 ha) and 22 in the Medio Delta (15.315,4 ha). Table 1 is a summary of the abundance and density results per region. The Alto Delta region shows a higher spectacle caiman population in relation to the Medio Delta. It could be the result of more salty waters in the Medio Delta, due to the proximity of the Orinoco river mouth to the Atlantic Ocean.

Table 1. Densities and number of babas in Alto and Medio Delta.

Region	Area Survey (ha)	Population Observed (# ind.)	Population Estimated (# ind.)	Density Observed (ind/ha)	Density Estimated (ind/ha)
Alto Delta	29.105,60	8.229	34.631	0,28	1,19
Medio Delta	15.315,40	1.703	5.860	0,11	0,38
Total	44.421,00	9.932	40.491	0,22	0,91

Table 2 is a summary of the size structure results per region. The Alto Delta shows a truncated pyramidal structure at size class II and the Medio Delta shows the typical pyramidal form reported for the flooded llanos.

The difference between the two size structures could be a consequence of different habitat characteristics between the regions. The Medio Delta is considered as a transition zone between the Alto and Bajo Delta. In it the tide effect alternate with the river heights, depending on the season.

Table 2. Size Class in Alto and Medio Delta.

Region	% Class II	% Class III	% Class IV
Alto Delta	42	41	18
Medio Delta	36	42	22
Total	41	41	18

Second Stage (dry period peak)

During 1992 census it was covered 4.717 ha, 16,82 % of the Alto Delta study area. 76 water surface were sensed using correction factors.

Table 3. Abundance, Density y Size class in maximal dry season in Alto Delta.

Region	Area Censada (ha)	Population Observed (# ind.)	Density Observed (# ind./ha)	Class II (%)	Class III (%)	Class IV (%)
Alto Delta	4.717	12297	2,61	35	46	19

Table 3 shows an increase in the population abundance and density, as well as in the size structure of the population. These could obey to the differences in the area covered by water between the seasons. In the Alto Delta the first census was done during the highest flooding period, around 90% of the study area was covered by water. Therefore individuals were spread in the area. The second census was done during the peak dry season with reduced water area, so the individuals were concentrated in those.

Conclusions

The comparison between the census done during peak of flooding and peak of dry season, made us to think in the goodness of the correction factors used, since there was not shown an overestimation of the population abundance.

The population density of 2,62 Ind./ha is in the density interval obtained by Estevez and Gorzula (1988) for the Orinoco delta, between 2.0 - 2.8 Ind./ha. However, needs to be pointed out that there exist fundamental differences between these studies, in area covered, correction factors, and number of individual classified by size.

A sustainable harvest estimation for the Orinoco Delta could be between 10% and 20% of the individuals Class IV. It is equivalent to a harvest which could oscillate between 12.500-25.000 individuals.

An experimental commercial management program has been implemented in the region since 1993. It to determine the harvest effort and involve the Indian and rural communities of the region. In 1993, after the first census, 274 individuals were taken through this program, 911 individuals in 1994 and 2.853 in the 1995.

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SURVEYING NESTS OF SPECTACLED CAIMAN (*Caiman crocodilus*) IN ECOLOGICAL AREAS OF VENEZUELAN LLANOS

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RESUMEN

Desde 1987 se establecieron zoocriaderos de baba con fines de repoblación en los Llanos venezolanos,, bajo la regulación del Servicio Autónomo PROFAUNA-MARNR. Entre 1991-94 se otorgaron licencias para extraer en total 388.150 huevos. El presente trabajo se realizó en octubre de 1994 (final de lluvias), para estimar la cantidad de nidos (en paréntesis) en cinco regiones ecológicas definidas por PROFAUNA: Bajo Apure (BA:877), Alto Apure (AA:420), Cajón de Arauca (CA:394), Llanos Boscosos (LB:184) y Guárico (G:29). De 1905 nidos en 242.404 hectáreas censadas, 57,9% se encontraron en bosques o matorrales, 34,5% en sabanas abiertas y 7,6% en terraplenes. La densidad mas alta se obtuvo en CA=0,23 y la mas baja en AA=0,03 nidos/ha. Un 81,1% de los nidos se encontraron llenos y en buen estado, pero esta característica varió entre las regiones, relacionada con el nivel de inundación. La mayoría de los nidos estaban construidos con material vegetal diverso y tierra. En la sabana abierta los nidos se encontraron mas cercanos a las zonas de inundación e inclusive flotantes. Hay diferencias ($P<0,05$) en alto y ancho de los nidos entre las regiones, dependiendo del material usado; los nidos mas altos se ubicaron en CA=46,8 cm y los mas bajo en G=36,1 cm. Las dimensiones internas no mostraron diferencias entre las regiones; la profundidad de la cámara osciló entre 10 y 23 cm. El número de huevos por nido mostró el menor promedio en LB=26,6 y el mayor en BA=32,4, con baja proporción de huevos infértiles por nido (6,8) y máximo de 100 huevos en un nido de tres cámaras. Se concluye que las zonas boscosas contienen mayor cantidad de nidos que las sabanas abiertas, al disponer de hábitats mas favorables para la nidificación. Se recomienda un manejo diferencial para cada región, tomando en cuenta la densidad de nidos y la extensión de bosques y sabanas.

INTRODUCTION

Few scientific works have been done regarding nesting habits of baba. Rivero-Blanco (1973, 1974), Staton & Dixon (1975), Medem (1981), Ayarzagüena (1983) and Joanen & Mc Nease (1989), reported general information on ecology, physiology of nesting and early development of this species, but the abundance and geographical distribution of nests, as well as its possibilities of management in breeding farms, are still not well documented in Venezuela.

Since 1987, several farm owners that had been harvesting wild populations of baba as commercial resource under legal control (Velasco et al. 1995), initiated captive breeding activities and egg incubation with reintroduction purposes of animals aging two years for natural population increasing. Lately, on June 15, 1990, the Servicio Autónomo de Fauna (PROFAUNA), authorized the establishment and functioning of farming activities with commercial proposes, controlling it with the Resolution No. 79 (GORV, 1990).

One of the technical basis of the program is described in the article 14 of this Resolution, which expressed that farm owners must present a technical report prepared by a biologist accredited by PROFAUNA, with nest censuses performed one year before the nest collection. Permission was given for a maximum of 50% of the reported nests, depending upon the capacity of the farm and the number of observed nests in each ranch that supply eggs to the farm under contract. Since 1991 to September 1994, 121 licenses for commercial hunting were conceded for a total of 388.150 eggs; also, the collection of 10.487 hatchling during 1991 and 1992, were permitted.

The main objective of the present work was to perform nest censuses to estimate the number of nests per ecological areas and to propose an index of nest/hectare.

STUDY AREA

The field work was carried out in the ecological regions described by Velasco y Ayarzagüena (1995) for flooding Llanos of Venezuela. Approximately 182.420 ha in Apure Lowlands (AL), Apure Highlands (AH), Arauca Basin (AB), Forested Llanos (FL) and Guarico (G) were censed.

METHODOLOGY

Data from 1905 observed nest were taken in 11 farms, differentiating the predominant plant formation (forest or savanna) and estimating canopy height, shadow covering over the nest and condition of the nest (full or empty nests, and ecclosioned, predated, harvested or old nests).

External dimensions of each nest were measured (height and width in two directions), and also the distance to the nearest waterbody and flooding level of the surrounding ground. The materials used for nest building were identified under the following categories: grasses, litter, branches and ground or sand.

Based upon a random number table, about 10% of the counted nests were opened to count and classify the eggs based upon their fertility. Inner dimensions of the chamber (depth, height and width in two directions) were taken.

Data processing were done by analysis of variance with a signification level of 5%, using the following numerical variables: external dimensions of nests (height and width), flood depth of the surrounding ground, shadow covering on the nest, distance from the nest to the nearest waterbody, canopy height, inner dimensions of the chamber (depth, beight and width) and number of fertile and infertile eggs per nest. The classification variables were: ecological regions, plant formation, nest materials, nest condition.

Data were expressed on cartographic sheets (scale=1:25.000), to evaluate the total censed area of each farm, and the forest and savanna areas to determine the nest density in each case.

RESULTS AND DISCUSSION IN EACH ECOLOGICAL REGION

Tables 1, 2 and 3 shows the results of censed area, number of nests and densities, per plant formation and ecological region. Table 4 presented averages of numerical variables per ecological region.

1. Arauca Basin

Data from 473.75 ha (162.5 ha of savanna and 311.25 of forests) and 111 nests were recorded, were more abundant in forests (79) than in savannas (32), from which 56 were full and 55 were harvested, predated or empty, with a density of 0.234 nest/ha. The average of eggs per nest was 31, all of them fertile Canopy height and shadow coverage on nests resulted maximum in this region. Flood level were very low and the nests located relatively far away from the waterbodies; only 29 nests were located on flooding areas (17 in forests and 12 in savannas). External nest dimensions resulted with maximum values in this region, with highest nests located in savannas. More frequent nest materials were litter, branches and ground.

2. Apure Highlands

From a total of 420 observed nests, 265 were full and only 61 empty, ecclosionated or predated nests. Average of eggs/nest resulted the lower compared with other regions (27.85), with high infertility (6.79). External dimensions of nests were similar to Low Apure and Guarico regions (Table 4). Nests were located mainly in savannas and forests, but an important proportion were observed on dikes and brushes. Canopy height and shadow covering over the nests resulted lower than in other regions with the exception of Guarico, reflecting the dominance of the savannas in this region (95%). The flooding levels resulted relatively high, associated with the frequency of dikes and dams, but the nests were generally away from the waterbodies. The most frequent building material of nests were grasses (almost 54%).

3. Apure Lowlands

An area of 1068.75 ha of forests and 6480.5 of savanna were observed, but high amount of nests were censed in forests (539), with 338 in savannas, most of them (94%) filled with the highest average of egg/nest (32.39) and fertility (32.05). External dimensions were relatively low, compared with Arauca Basin and Apure Highlands (Table 4). Most of the nests were built with litter, branches and ground. The canopy height was moderately, but with a good shadow covering and high flooding level of the surrounding ground.

4. Forested Llanos

Forests occupied an area of 1081.25 ha and savannas only 767.5 ha, but almost the same amount of nests were observed in both formations (Table 2), most of them filled. The canopy height resulted relatively low, with shadow covering of about 46%. There was no nests in flooded areas, but they were frequently located near the waterbodies and in open savannas. External dimensions were similar to other regions, but nests mainly built by grasses even in forests, containing the lowest average of eggs (26.6) and lowest fertility (26.5).

5. Guarico

All the nests were observed on dikes and dams of only one farm, most of them empty or predated. Frequently, the nests were built of grasses and aquatic plants, located in open places, without shadow coverage and in flooding zones or close to the water. External dimensions resulted relatively lower than in other regions, but the number of egg/nest and fertility had similarity with other regions.

Densities

Nest densities were calculated on the basis of the censed savanna or forest area in each region, obtained from cartographic sheets (Table 3). Higher density was found in the Arauca Basin followed by Apure Lowlands, Forested Llanos, Guarico and Apure Highlands. This result is obviously influenced by the amount of hectares censed in each case. Apure highlands and lowlands received more attention, due to its higher amount of farms involved in the Program of harvesting and farming babas. Generally, the forests shows high density of nests than the savannas, except in the case of the Forested Llanos region. The farms on this region have wide deforested zones, which can influence the results.

CONCLUSION

Forest are preferred by babas for nesting, but they also use savannas and other environments. We strongly recommend the protection of forested areas as nesting habitats.

The permission for eggs extraction must consider the density values as an index. The probable number of eggs in a farm is obtained multiplying densities for the number of hectares of savanna and forest. Taken into account the number of eggs per nest in each region, the probable number of eggs in a farm can be calculated with the following relationship:

(Forest Density × Forest Area) + (Savanna Density × Savanna Area) = Number of Nests

Number of Nests × Average of nest in each region = Number of eggs

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Table 1: Censed area (ha) by region and plant formation

Region	Forest	Savanna	Total
Apure Highlands	535,25	11.255,1	11.790,31
Apure Lowlands	1.068,75	6.480,5	7.549,25
Arauca Basin	311,25	162,5	473,75
Forested Llanos	1.081,25	767,5	1.848,75
Guarico		425,0	425,00
Total	2.996,50	19.090,6	

Table 2: Censed nests by region and plant formation

Region	Forest	Savanna	Total
Apure Highlands	127	232	359
Apure Lowlands	539	338	877
Arauca Basin	79	32	111
Forested Llanos	89	75	164
Guarico		29	29
Total	834	706	

Table 3: Densities of nests by region and plant formation

Region	Forest	Savanna	Total
Apure Highlands	0,237	0,021	0,030
Apure Lowlands	0,504	0,052	0,116
Arauca Basin	0,254	0,197	0,234
Forested Llanos	0,082	0,098	0,089
Guarico		0,068	0,068

TABLE 1: Averages and significance of numerical variables in each ecological region (number of cases in brackets).

VARIABLE	SIG	Apure Highlands	Arauca Basin	Apure Lowlands	Guarico	Forest Llanos
Canopy Height (m)	*	9,73 ± 0,75 (175)	13,08 ± 0,81 (103)	8,31 ± 0,56 (200)		7,23 ± 1,29 (11)
Shadow coverage (%)	*	43,62 ± 2,50 (242)	76,38 ± 3,29 (105)	65,57 ± 1,25 (541)	15,00 ± 7,91 (9)	46,53 ± 10,19 (13)
Flood level (cm)	*	22,61 ± 5,89 (155)	1,34 ± 0,71 (29)	0,23 ± 0,02 (67)	42,61 ± 10,71 (26)	0,00 ± 0,00 (1)
Distance to water (m)	*	15,55 ± 2,14 (346)	39,20 ± 6,75 (111)	7,54 ± 0,37 (872)	0,56 ± 0,17 (29)	3,11 ± 0,52 (51)
Nest Height (cm)	*	38,79 ± 0,79 (326)	46,84 ± 1,53 (109)	37,99 ± 0,55 (431)	36,13 ± 1,45 (52)	37,10 ± 2,14 (29)
Nest Width (1) (cm)	*	102,28 ± 1,77 (327)	116,86 ± 3,07 (109)	101,54 ± 1,48 (431)	93,44 ± 5,15 (29)	82,11 ± 2,98 (52)
Nest Width (2) (cm)	*	91,66 ± 1,52 (207)	116,43 ± 6,74 (23)	111,77 ± 2,53 (315)	91,71 ± 3,39 (28)	100,00 ± 0,00 (1)
Eggs/nest	*	27,81 ± 0,96 (88)	31,72 ± 0,40 (289)	32,39 ± 0,40 (349)	31,00 ± 0,00 (1)	26,61 ± 0,44 (137)
Fertile eggs/nest	*	27,85 ± 0,94 (82)	31,72 ± 0,40 (289)	32,05 ± 0,40 (348)	31,00 ± 0,00 (1)	26,54 ± 0,44 (137)
Infertile eggs/nest		6,79 ± 2,41 (14)	2,00 ± 0,00 (1)	4,35 ± 1,06 (14)		0,80 ± 0,49 (5)
Chamber depth (cm)		12,40 ± 1,17 (20)		13,33 ± 1,84 (31)	10,00 ± 0,00 (1)	23,00 ± 2,09 (5)
Chamber height (cm)		15,50 ± 1,42 (12)	23,33 ±10,68 (3)	19,36 ±1,15 (57)	15,00 ± 0,00 (1)	
Chamber width (cm)		30,09 ± 6,40 (11)		24,09 ± 1,89 (46)		

COLONIZACION Y OCUPACION TERRITORIAL DE LAGUNAS ARTIFICIALES POR *Caiman crocodilus fuscus* (Cope, 1868) CROCODYLIA : ALLIGATORIDAE.

JAIME DE LA OSSA VELASQUEZ[*]

ABSTRACT .

The main objetive of this study is to get to know how artificial lagoons are colonized by wild popupation of babilla *Caiman crocodilus fuscus,* during the dry season of the year. Artificial ponds are generally used as drinking fountains for the cattle and total number and extension of these lagoons are representative of the Colombian north coast.

RESUMEN .

El presente estudio tiene como objetivo, conocer como las poblaciones silvestres de babilla *Caiman crocodilus fuscus,* colonizan y ocupan lagunas artificiales durante la época seca del año. Estas lagunas son construidas y comúnmente usadas como fuentes de agua para el ganado vacuno, su número y extensión total es representativo para la región Costa norte de Colombia.

Palabras claves : *Caiman crocodilus fuscus*, Babilla, Colonización, migración, ocupación, Laguna, Costa norte, Colombia.

INTRODUCCION .

La evaluación del potencial que posee la Costa norte Colombiana, en cuanto se refiere a las poblaciones silvestres de Babilla *Caiman crocodilus fuscus,* no es todavía conocida aun cuando los datos de captura legalizada, obtenida mediante la caza de fomento para el establecimiento de los Zoocriaderos y los informes que eventualmente se tienen sobre contrabando son relativamente altos, en el medio natural es evidente la existencia y mantenimiento de poblaciones silvestres de número considerable.

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Ahora bien, una parte de esta población ocupa lagunas artificiales , denominadas localmente " Jagüeyes ". Todas las fincas o haciendas del Departamento de Sucre, dedicadas a la ganadería y ubicadas en la subregión Golfo de Morrosquillo o llanura aluvial costera , poseen las citadas lagunas como una solución para abrevar el ganado vacuno y satisfacer las necesidades primarias de agua .

Se calcula que existe una laguna artificial o " Jagüey " por cada 50 hectáreas de terreno dedicado al sector pecuario, en esta zona del Departamento de Sucre, con un espejo de agua que oscila entre 2.000 y 8.000 metros cuadrados, ubicando la media en 6.000 metros cuadrados de área. Por otro lado, en casi todas estas lagunas se han sembrado peces, principalmente Bocachico ***Prochilodus reticulatus magdalenae*** , Sábalo ***Tarpon atlanticus*** , Tilapia ***Oreochromis niloticus***. Lo cual ha incrementado la productividad de estos ecosistemas.

La zona de estudio se ubicó en un predio particular de 500 hectáreas, situado en el Corregimiento de Puerto Viejo, Municipio de Santiago de Tolú, Departamento de Sucre, Costa Norte Colombiana. Si se tiene en cuenta la extensión total de la llanura aluvial costera referida y las de formaciones ecológicas que posee se puede pensar que los datos y conclusiones obtenidas tienen un caracter puntual, no obstante son una muestra de alto valor para lograr el conocimiento poblacional que de esta especie se requiere, al tiempo que se reconoce la capacidad colonizadora y los mecanismos de adaptación, aspectos que en gran medida han ayudado a la supervivencia natural de ***Caiman crocodilus fuscus***.

MATERIALES Y METODOS.

Para llevar a cabo este estudio, se tomaron dos (2) Lagunas artificiales o " Jagüeyes ", distantes el uno del otro aproximadamente 2 kilómetros, sin ninguna conexión de cauces entre ellos. Durante tres (3) años consecutivos : 1990 , 1991 y 1992., hacia el mes de Marzo , que corresponde al periodo de mayor sequía, se procedió a la evaluación de las poblaciones de ***Caiman crocodilus fuscus*** , allí existentes.

Cada año, durante tres (3) días consecutivos se realizaron conteos visuales, con un horario distribuido, así : 08:00 , 10:00 , 14:00 , 18:00 , 20 :00 y 24:00 horas . Durante el periodo diurno a simple vista y durante la noche con el uso de lámparas de pilas, cada conteo ocupó un espacio de 30 minutos aproximadamente. El cuarto día, inmediatamente posterior a los conteos descritos, usando una red de pesca que cubría al menos el 20 % del área de cada estanque, se procedió durante el periodo diurno y por espacio de 8 horas a extraer la mayor parte posible de ejemplares de ***Caiman crocodilus fuscus***, en promedio se hicieron 10 pasadas de la red, tratando de arrastrar en el fondo del estanque. Después de la extracción se realizó un conteo visual de control, siguiendo la misma metodología descrita anteriormente.

Todas las Babillas extraídas se clasificaron por talla y sexo, los individuos catalogados como inmaduros y de talla menor a 1.10 metros de longitud total, fueron marcados eliminando escamas simples de la cresta caudal, usando las tres (3) primeras escamas para señalar el año del muestreo y las dos (2) subsiguientes, es decir la cuarta y la quinta escama, para indicar la laguna en donde se les había capturado. Por su lado, los individuos mayores a 1.11 metros de Longitud total y clasificados como maduros, fueron retirados y se les mantuvo aislados en encierros ambientados, al finalizar el estudio fueron devueltos a su lugar de captura, durante la época de lluvias.

RESULTADOS :

LAGUNA # 1:

Extensión : 1.1 Has
Profundidad Media : 1.5 mts

FECHA	[illegible]				[illegible]				[illegible]			
HORA	[illegible]	[illegible]	[illegible]	X	[illegible]	[illegible]	[illegible]	X	[illegible]	[illegible]	[illegible]	X
[illegible]	[illegible]	[illegible]	4	[illegible]	5	[illegible]	5	[illegible]	1	[illegible]	2	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2	[illegible]	[illegible]	[illegible]	2	[illegible]	2	[illegible]	2	[illegible]	[illegible]	[illegible]
X [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
X [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Tabla # 1: Conteos visuales registrados en la Laguna # 1.

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]	1	1	1
[illegible]	[illegible]	[illegible]	[illegible]

Tabla # 2: **Relación promedio entre los conteos diurnos y los conteos nocturnos para la laguna # 1.**

FECHA	[illegible]			[illegible]			[illegible]		
TALLA	H	M	T	[illegible]	M	T	H	M	T
[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]
[illegible]	3	[illegible]	4	[illegible]	[illegible]	[illegible]	3	[illegible]	[illegible]
[illegible]	3	1	4	[illegible]	[illegible]	[illegible]	2	1	2
[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	[illegible]	[illegible]
[illegible]	2	[illegible]	4	[illegible]	[illegible]	[illegible]	2	1	[illegible]
[illegible]	1	[illegible]	2	[illegible]	[illegible]	[illegible]	1	1	[illegible]
[illegible]	0	[illegible]	1	[illegible]	[illegible]	[illegible]	1	1	2
TOTAL	11	[illegible]	[illegible]	[illegible]	7	[illegible]	12	[illegible]	33

Tabla # 3: Capturas discriminadas por talla y sexo realizadas en la Laguna # 1.

FECHA			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Relación
Diurno:Nocturno 1:4.4 1:4.4 1:4.5

Tabla # 4: Datos de los muestreos visuales de control, realizados posteriormente a la captura, en la Laguna # 1.

** Los individuos con talla 30/50 no fueron sexados.

AÑO	1990			1991			1992		
ESTADO	#	%	Rel.	#	%	Rel.	#	%	Rel.
MADUROS	7	[illegible]	1	[illegible]	[illegible]	[illegible]	8	[illegible]	1
INMADUROS	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25	[illegible]	4
TOTAL	[illegible]	[illegible]	1 a 7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1 a 4

Tabla # 5: Relación entre individuos maduros e individuos inmaduros acorde con la captura, en la Laguna # 1.

SEXO	H	M	H a M
AÑO			
1990	[illegible]	[illegible]	[illegible]
1991	[illegible]	[illegible]	[illegible]
1992	[illegible]	[illegible]	[illegible]
PROMEDIO	11,22	[illegible]	[illegible]

Tabla # 6: Relación hallada entre sexos, según la captura en la Laguna # 1.

AÑO	1991			1992		
TALLA	H	M	T	H	M	T
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1	[illegible]	2	[illegible]	1	[illegible]
[illegible]	1	[illegible]	[illegible]	[illegible]	1	[illegible]
[illegible]	1	[illegible]	[illegible]	[illegible]	2	[illegible]
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]

Tabla # 7: Recapturas logradas en la Laguna # 1.

LAGUNA # 2.

Extensión : 0.9 Has.
Profundidad Media : 1.3 mts.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Tabla # 8: Conteos visuales registrados en la Laguna # 2.

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Tabla # 9: Relación promedio entre los conteos diurnos y los conteos nocturnos para la laguna # 2.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Tabla # 10: Capturas discriminadas por talla y sexo realizadas en la Laguna # 2.

[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Relación Diurno:Nocturno	**1:3.53**	**1:1.25**	**1:2.51**

Tabla # 11: Datos de los muestreos visuales de control, realizados posteriormente a la captura, en la Laguna # 2.

[illegible]	[illegible]			[illegible]			[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Tabla # 12: Relación entre individuos maduros e individuos inmaduros acorde con la captura, en la Laguna # 2.

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Tabla # 13: Relación hallada entre sexos, según la captura en la Laguna # 2.

[illegible]	[illegible]			1992		
[illegible]	H	M	T	H	M	T
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Tabla # 14: Recapturas logradas en la Laguna # 2.

DISCUSION :

Se manifiesta la existencia de una ocupación territorial de lagunas artificiales por parte de ***Caiman crocodilus fuscus***, los mecanismos seguidos son claramente observados en el periodo de lluvias, época durante la cual debido a la formación de cauces temporales como producto de la escorrentía , las virtuales vías de traslado son más accesibles y seguras tanto para Babilla como para otras muchas especies , tales como : Peces y Tortugas .

Durante la época de sequia se observa una alta concentración de Babillas (Godshalk, 1976 ; Ayarzaguena , l980 y Gorzula , 1984). El fenómeno de concentración poblacional obedece en primera instancia a una oferta limitada de hábitats y a una relativa concentración del alimento disponible en el ecosistema ; específicamente y haciendo énfasis en este estudio, los suelos cuyo carácter arcilloso, los hacen demasiado endurecidos y requebrajables en la época de sequia son una limitante para la estivación, lo cual tiene ingerencia en la ocupación de los lugares con agua disponibles y la detección de una alta densidad poblacional. No obstante se observan migraciones individuales durante la época de sequia, causadas posiblemente por delimitaciones territoriales intraespecificas y/o despliegues agresivos de diversa índole entre individuos adultos, lo cual obliga a una migración hacia otras lagunas o cuerpos de agua , sin que esto implique una mejoría en la oferta del espacio disponible. Los cambios estacionales tienen una muy marcada influencia en el comportamiento poblacional de Babilla. (Gorzula , l984)

Aún cuando la información colectada en este trabajo, apenas cubre una pequeña muestra de la Costa Norte Colombiana, se estima que matemáticamente y con ajuste a los resultados, la ecuación válida y aplicable al caso, seria :

$\mathbf{P = \Sigma\ [\ (N + D\ )\ /\ 3\ ]\ 3.85.}$ Lo que equivale a multiplicar la sumatoria de los promedios de los avistamientos totales realizados por el factor **l.2833.**

Aplicando este factor se tiene :

LOCALIZACION	POBLACION	CAPTURA	DIFERENCIA	%	DENSIDAD*
LAGUNA # 1					
[illegible]	[illegible]	[illegible]	2.2	[illegible]	52.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.3	[illegible]	[illegible]
LAGUNA # 2					
[illegible]	[illegible]	[illegible]	0.5	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.2	[illegible]	[illegible]

* **Densidad Ind / Ha.**

Tabla # 17: Cálculo y comparación entre la densidad hallada y las capturas logradas en este estudio, con la aplicación del factor matemático propuesto.

Según el factor propuesto el valor de la densidad que puede calcularse en este estudio, tiene un margen de error que alcanza un máximo del 11 %, lo cual es compensable y ajustable si se tiene en cuenta que existe después de la captura un conteo de control, que siempre da valores positivos. Por otro lado la experiencia indica que los censos de fauna silvestre en medio natural y en especial para los Crocodylia , tienen estimativos de densidad calculada más bajos que lo que se logra obtener en las posibles capturas.

La relación existente entre los conteos diurnos y los conteos nocturnos, presentan una amplia diferencia entre ellos, son mucho mayores los valores obtenidos en los conteos nocturnos y tienen la tendencia a incrementarse significativamente con la hora y a medida que los animales se acostumbran al observador y a la intensidad de la luz usada; para ambas lagunas la relación entre los conteos diurnos : conteos nocturnos, es de 1 : 3.5 en promedio.

La relación existente entre individuos maduros e individuos inmaduros da para la Laguna # 1 un valor de 1: 6.0 y para la Laguna # 2 un valor de 1: 5.4, lo cual es muy similar en ambos ecosistemas. Los resultados de recaptura tanto para la Laguna # 1 como para la Laguna # 2, son muy similares. Se evidencia una tendencia en los individuos inmaduros de menor talla a permanecer en su hábitat, este es un mecanismo que brinda mayores posibilidades de subsistencia; quedaría por esclarecer que sucede con aquellos individuos de mayor talla o cercanos a la madurez.

Desde una perspectiva de conservación, estos ecosistemas son importantes ya que la tendencia en la zona de sabanas, por el desarrollo tecnológico agropecuario que se va logrando, tiende a incrementar el numero de represas artificiales, con el fin de obtener una mayor producción y a la vez evitar tener que desplazar el ganado vacuno durante las épocas de sequías , esto sumado a la creciente destrucción de hábitats naturales aumentaran el valor ecológico de los jagüeyes como refugio de fauna silvestre.

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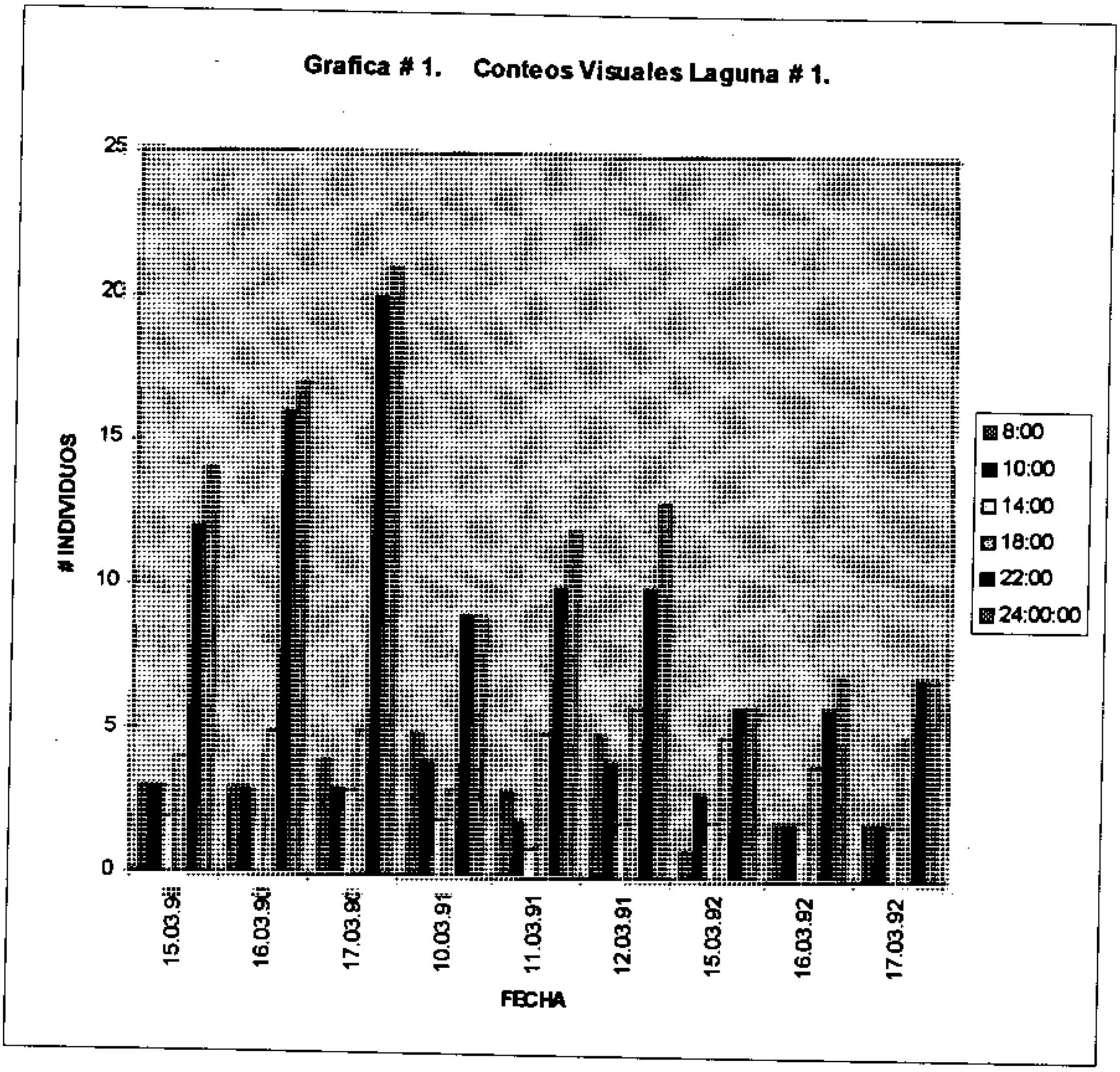
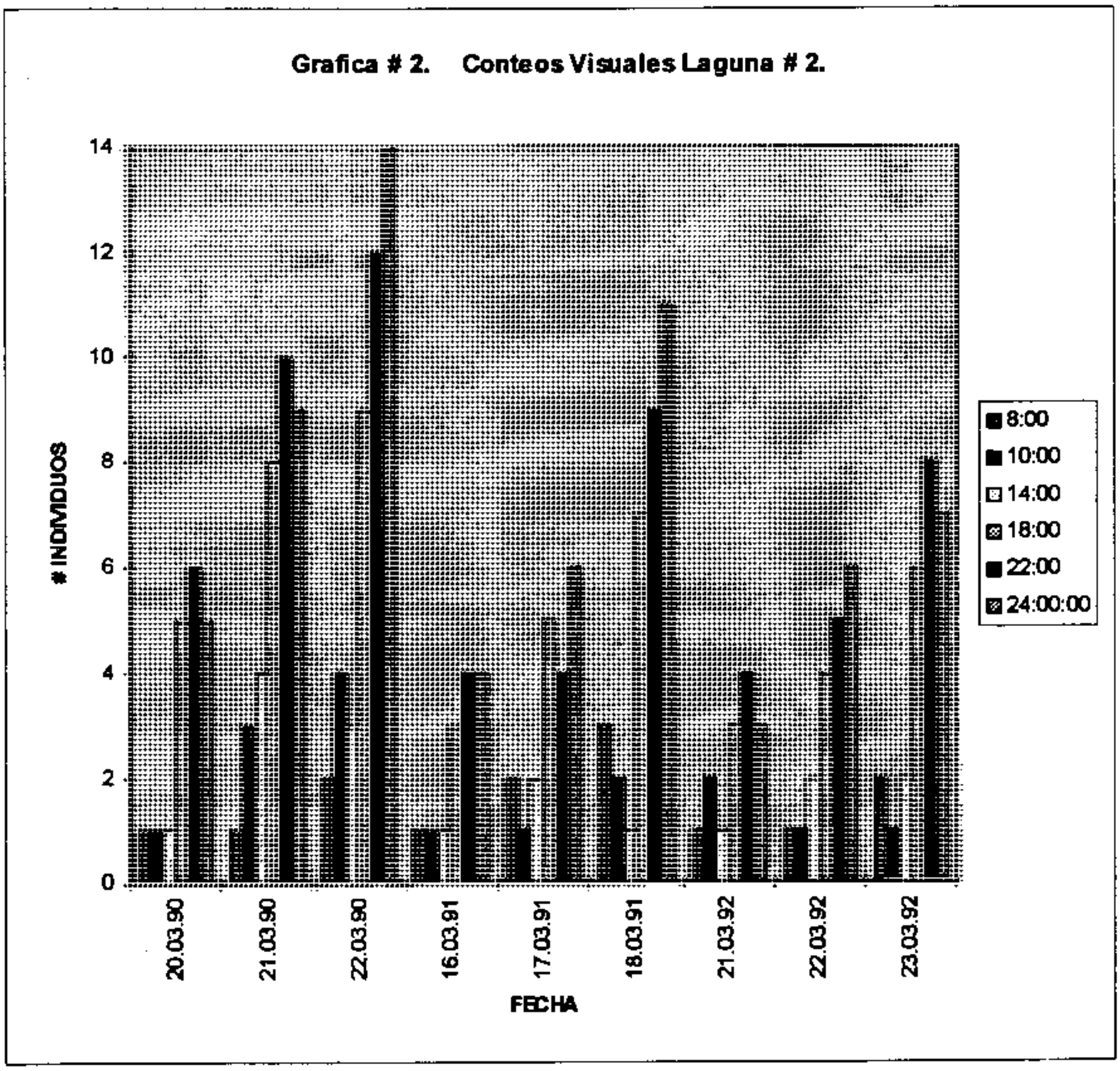
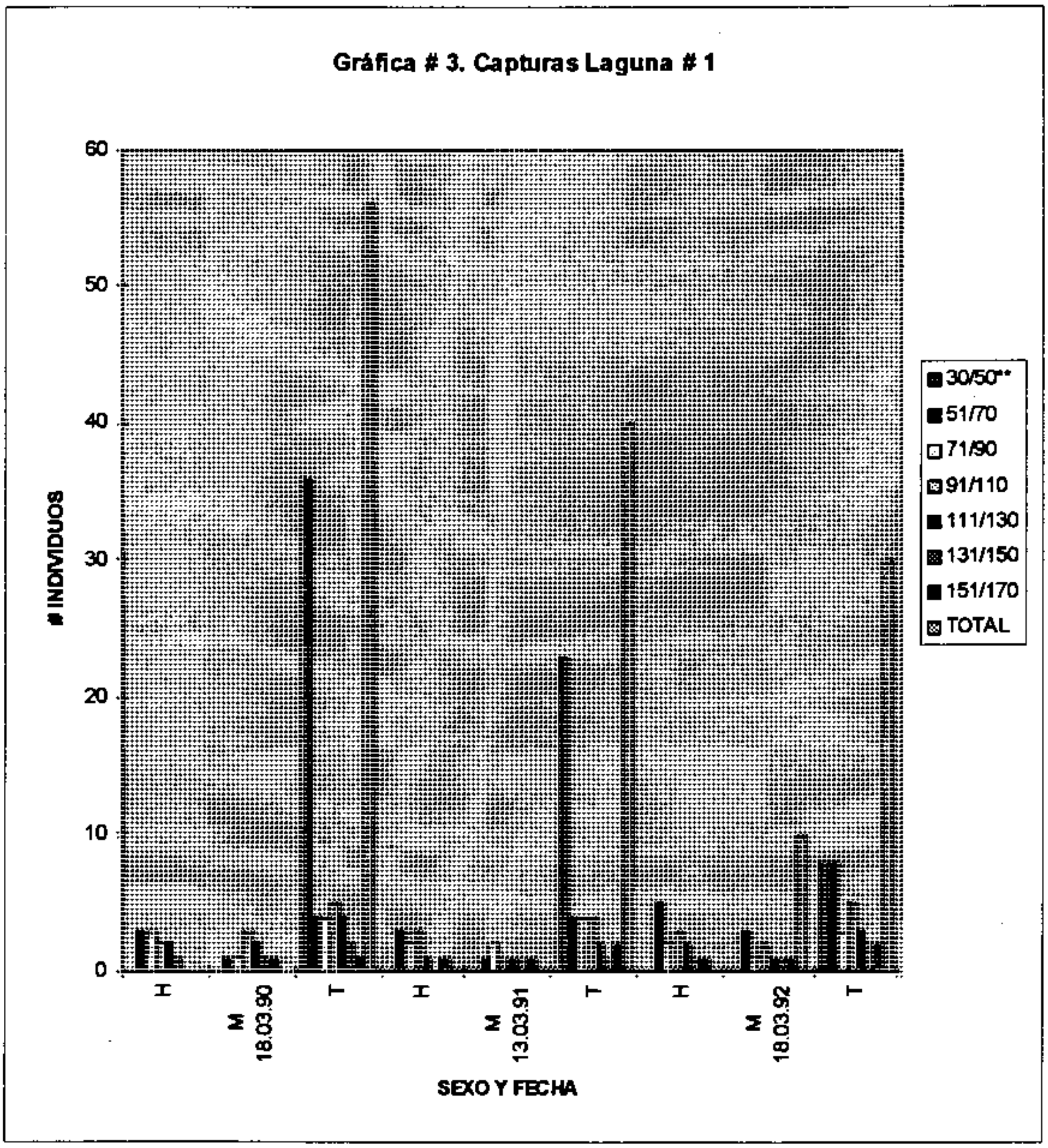
ANEXOS.

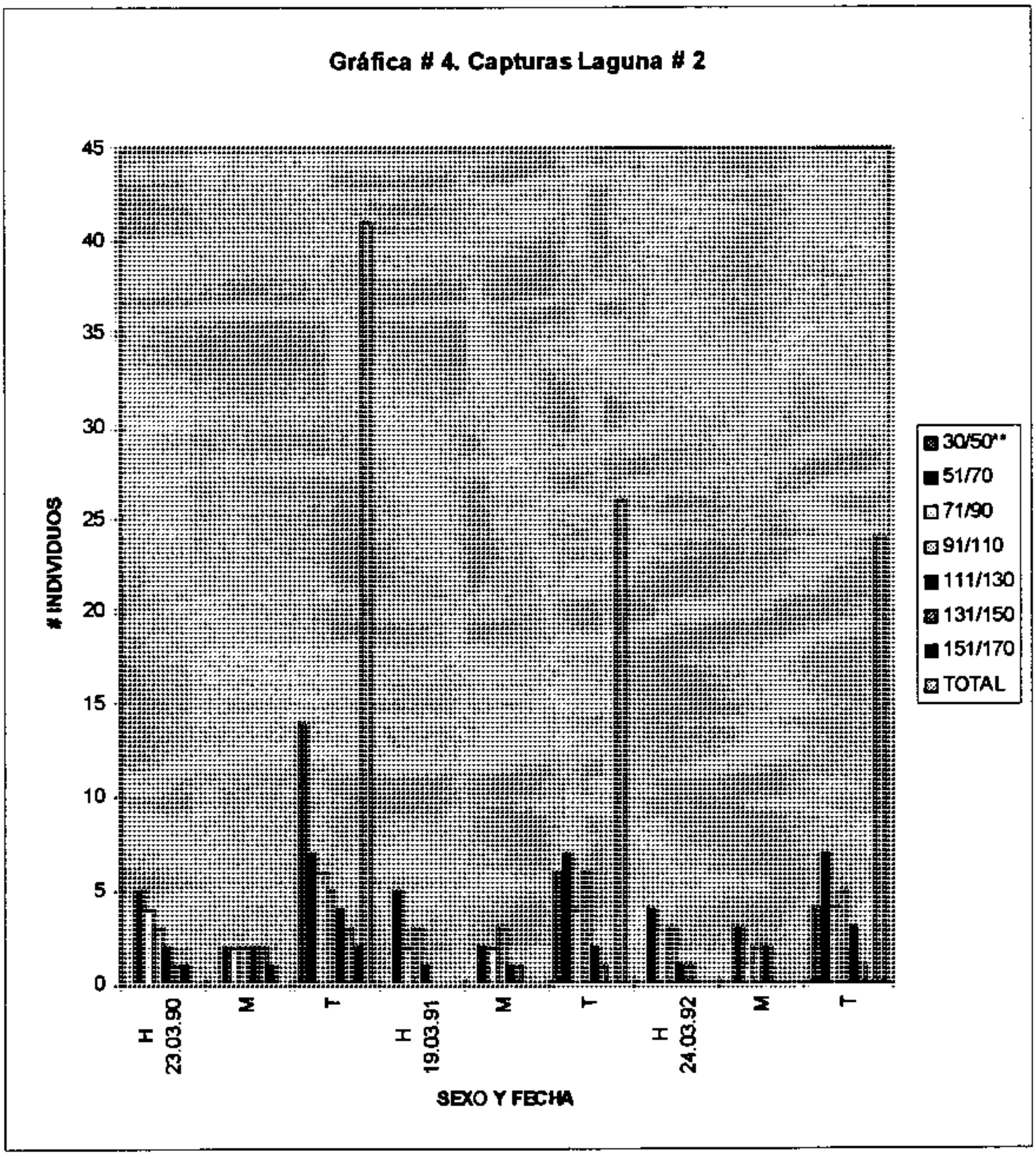


Grafica # 1. Conteos Visuales Laguna # 1.
0
5
10
15
20
25
INDIVIDUOS
15.03.90
16.03.90
17.03.90
10.03.91
11.03.91
12.03.91
15.03.92
16.03.92
17.03.92
FECHA
8:00
10:00
14:00
18:00
22:00
24:00:00


Grafica # 2. Conteos Visuales Laguna # 2.
14
12
10
8
6
4
2
0
INDIVIDUOS
20.03.90
21.03.90
22.03.90
16.03.91
17.03.91
18.03.91
21.03.92
22.03.92
23.03.92
FECHA
8:00
10:00
14:00
18:00
22:00
24:00:00



Gráfica # 3. Capturas Laguna # 1
60
50
40
30
20
10
0
INDIVIDUOS
30/50**
51/70
71/90
91/110
111/130
131/150
151/170
TOTAL
H
M
18.03.90
T
H
M
13.03.91
T
H
M
18.03.92
T
SEXO Y FECHA



Gráfica # 4. Capturas Laguna # 2
45
40
35
30
25
20
15
10
5
0
INDIVIDUOS
H 23.03.90
M
T
H 19.03.91
M
T
H 24.03.92
M
T
SEXO Y FECHA
30/50**
51/70
71/90
91/110
111/130
131/150
151/170
TOTAL

Conservation and Sustainable Use of the Yacare Caiman, *Caiman yacare*, in Bolivia

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Abstract Bolivia has traditionally supplied a large percentage of caiman hides to the international market. Hunting was undertaken with little control and quotas were set without population data. In 1986, a Presidential Decree halted all commercial wildlife exploitation. Provisions allow for future commercialization of species following appropriate study. The yacare caiman, *Caiman yacare*, is capable of being managed as a valuable, renewable resource.

A conservation program, which includes a controlled harvest plan, is being developed for Bolivia. It will attempt to produce a sustained yield of hides from wild populations, using the successful program in Venezuela as a model. Conservation of the caiman for a regulated harvest would produce multiple benefits for Bolivia at both the individual and national levels. Although the yacare caiman populations in Bolivia have shown vigorous recovery under the ban, a recent increase in illegal hunting underscores the need to develop a working program.

Most of the caiman populations and suitable habitat are contained within large cattle ranches and legal Indian Territories of the Departments of Beni and Santa Cruz, and therefore these lands occupy an important position in any management scheme for Bolivia. The present project is developing an experimental pilot harvest plan for limited production which is projected to begin in 1996.

Keywords: caiman, sustainable use, Bolivia, Indigenous, cattle ranches, *Caiman yacare*

Problem Statement - Bolivia has great potential for developing sustained use programs for its crocodilian species. Until recently, these resources were being exploited with little regard for potential use in the future and were consumed at such a high rate that local caiman populations were severely reduced. A Presidential Decree has brought the legal trade to a halt but continued poaching is a problem. A comprehensive management plan is required to protect these valuable components of tropical wetland ecosystems. Experience with caiman conservation in other countries has shown that the economic value can be used as an incentive for species protection and provide support for sustainable use on a long-term basis. Support from local rural inhabitants can be enthusiastically enlisted when they receive tangible benefits. Generation of substantial income is possible if management policies are focused on the conservation of wild caiman populations and incorporate sustainable use concepts .

The yacare caiman, *Caiman yacare*, has considerable potential to provide a continuous, ecologically-sound production of hides in Bolivia. This project will work with Indigenous communities within legal Indigenous Territories, and private landholders in the conservation and harvest of yacare caiman. These lands contain the largest areas of suitable habitat for caiman and most of the remaining populations. Thus, any national management plan will have to rely primarily on the caiman populations that exist on private and communal lands. The project has begun by conducting essential population surveys on a small group of selected properties. Using this baseline data, an experimental pilot harvest will be planned and executed. If the results prove successful, the information produced will be used to slowly and carefully expand the harvest and to develop a comprehensive national plan for this species.

The project will explore the effectiveness of locally-based caiman conservation under two different types of land tenure. The lands on large cattle ranches and Indian Territories provide both large areas of suitable habitat for the yacare caiman and good potential for protection. Most Indigenous Territories in Bolivia have been declared within the last five years and resource rights have only recently been defined. The two Territories selected for this experimental harvest program total over two million hectares and include excellent habitat. Local residents maintain traditional lifestyles of swidden agriculture and moderate subsistence hunting. Resource use and management is integral within their cultures, Sustainable use of the caiman has potential to provide employment and communal income for the benefit of Territory inhabitants. Local Indigenous leaders were contacted and informed of the projects concepts and goals. They were very interested and felt certain that community members would be eager to be involved.

Cattle ranchers throughout the tropics have received a bad reputation due to widespread deforestation for pasture development. However, this has not been the pattern in most of Bolivia, where the lowland savannas are a naturally occurring ecosystem. On these great open grasslands ranchers have been able to pursue their occupation with minimal disturbance to the area.

A Venezuelan conservation program serves as a core model. It was developed over the last 15 years and has proved very successful. Management of the common caiman, *Caiman c. crocodilus*, a subspecies closely related to the yacare caiman, has produced sustainable populations on private lands under very similar conditions of climate, habitat and land tenure. A sound management plan has evolved which uses cattle ranches for the conservation of caiman populations and harvesting of adult animals. Surveys are undertaken annually by trained personnel registered with the government on ranches where harvesting is requested. Quotas are assigned in accordance with the caiman population survey results. Only large male caiman over 1.8 m are harvested and CITES control tags are fastened to the hides. Although 150,000 skins were produced in the 1988 season in Venezuela, subsequent surveys show population declines and the recent harvests have been reduced. This demonstrates the flexibility of the program and appropriate adaptive management response to maintain sustainable caiman populations.

The system of private "stewardship" of the caiman has proven to be an effective conservation strategy. The Venezuelan cattle ranchers now view the caiman as an economic asset. Many of these ranchers were previously indifferent to widespread caiman poaching that occurred on their land but now regard these animals as part of their livestock inventory. The cooperation and active participation of the ranchers is essential for the plan's continued success. These factors, coupled with an effective regulation of the taking, processing and transport of skins, has been the core of Venezuelan policy. The high level of control of the caiman hide production in Venezuela has led to the development of a legitimate industry based on a long-term, sustained yield program.

This project proposes development of a similar system for *Caiman yacare* in Bolivia. This requires the protection of the breeding populations and their habitat. The necessary habitat is present on the Indigenous Territories and large ranches, but recent poaching is eroding the population base needed to form a sustainable, high-yield system. The landholders often ignore poaching, or, if involved, have no concept of sustained yield possibilities for caiman. With a different perspective, they could learn to utilize the caiman as a regulated, renewable resource.

Using the Indigenous Territories is a departure from the Venezuelan model. Land is held communally as well as the resource rights. The widely scattered settlements provide protection for wildlife from poachers and outside intruders. Caiman have recuperated from previous depredations of the 1970s and 1980s when hunting took place there before Indigenous control. The caiman are currently numerous and do not interfere with any subsistence activity. Leaders have expressed interest and feel the community members will be willing to be involved.

Most ranchers already have the conceptual framework from their management of cattle. Routine management of their livestock require the foundations of animal husbandry. Adequate numbers of cattle must be retained to insure production for the following year. In contrast to domestic animal production, the continuous reduction of caiman populations decreases any potential future benefits and makes recovery of the populations more difficult. The resulting decline in caiman numbers has been observed in Bolivia, Brazil, Peru, and Colombia in spite of laws regulating the hide trade. Venezuela stands alone among the South American nations in having produced a working, harvest program of wild caimans. This is due, in a large part, to the local involvement and successful integration of cattle ranches into the conservation and utilization schemes. A review of the historical setting will put the current situation in Bolivia in the proper perspective.

Background - Yacare caiman in Bolivia are facing an uncertain future. King and Videz Roca (1989) estimated that, during the 1980s, up to 400,000 hides annually were being taken from Bolivia. The current ban on hunting has great effect in reducing this number as local markets have closed. Hides were traditionally smuggled out, mostly to Paraguay (Hemley and Caldwell 1986, King and Videz Roca 1989) and this is still continuing, although at a very reduced level. The hide hunting previously reduced the average size of hides as the older animals were extirpated and populations were threatened in some areas (Glastra 1983, Medem 1983, Cintra 1989, Brazaitis 1989, Crawshaw 1991). King and Videz Roca (1989) measured a sample of 16,000 tanned hides in Bolivia and found 65% under the legal size limit.

Five caiman species are found in Bolivia but only *C. yacare* is economically important at this time. The black caiman, *Melanosuchus niger*, is the largest and has the most valuable hide. Bolivian populations of this species are so reduced that it is now economically extinct (Medem 1983, King and Videz Roca 1989). The Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES) includes *Melanosuchus* on the endangered list, Appendix 1, which prohibits any commercial trade. Small quantities of black caiman have been found in recent confiscated hide shipments. These skin are frequently in chaleco or flank form, indicating that novice hunters are entering the illegal trade. Reduced ventral osteoderms in this species allows the whole belly and tail to be utilized

The broad-snouted caiman, *Caiman latirostris*, is also a species with superior hide quality. It is now is nearly extinct in Bolivia (King and Videz Roca 1989) and is also listed on Appendix I. This species never was traded in Bolivia in large quantities. The two *Paleosuchus* species are quite small and they are rarely taken as the skin is heavily ossified and unsuitable for most leather products.

The caiman has a long history of exploitation in Bolivia. Various Amerindian groups are known to have hunted caiman for food and skins (Cardús 1886, Church 1912, Arce 1954, Denevan 1966, Holmberg 1969), but the current importance of caimans has only been recently quantified for the Sirionó Indians (Stearman and Redford 1992). Caimans have a place in the popular folklore and various products are ascribed certain medicinal properties (Oblitas 1971, Smith 1981). The current economic value of the yacare caiman is primarily derived from the skin, but the meat is delicious and has potential markets (Eregueta and Pacheco 1990). However, non-Indigenous Bolivians have no tradition of utilizing caiman as a food source and this has contributed to conservation of the species since the ban on hide trade. Substantial additional income from the Venezuelan harvest is generated from national sale of salted caiman meat (Thorbjarnarson 1991) and suggests that the meat from Bolivia could also be sold. Markets should be explored to increase the total potential of the program. Sale of fresh or frozen meat on the international market has even greater economic prospects.

The present mismanagement of the caiman resource in Bolivia is very destructive, but this can be reversed. The Bolivian Government receives no legal income from the illegal hide trade of *Caiman. yacare* which occurs within national borders. The low prices paid to Bolivian hunters for the salted or crusted hides represents a very meager income. In 1994 and 1995, I was told that hides were sold to Paraguayan dealers for an average of less than US $2. This was in anticipation of a harvest program there which never materialized. Previously, Paraguayan dealers often become the "official" exporter, shipping many of the Bolivian hides to Singapore and Europe. The recipient nation, where skins are usually finish-tanned and the final products are produced and sold, reaps the largest profits. At the same time, constant illegal hunting pressure in the supply country often results in the reduction of the breeding stock. This certainly would have great effects on future population levels and undermine conservation efforts for the caiman. Recent action by the Paraguayan government has greatly reduced the amount of hide traffic from Bolivia. We hope this vigilance continues with rigor.

The conditions seen today in Bolivia are part of a process that has been continuing for decades in South America. As the world market for hides depleted the more valuable species, the hunters turned increasingly to the smaller, less valuable caimans (King and Brazaitis 1971). The caiman species, found only in the Neotropics, have previously been protected by two main factors. First, most species do not attain much more than two meters in length compared with four to six meters for true crocodiles. Secondly, all caimans have bony ossicles, known as "buttons", in much of the hide that make it unsuitable for many leather products (Fuchs et al, 1989). These osteoderms are especially pronounced in the dorsal and ventral skin and, as a result, only the soft flanks are usually taken. Today, caiman hides comprise about 75% of the world market in crocodilian skins, as the more valuable species are not available in sufficient quantities (Fitzgerald 1988).

Traditionally, crocodilian resources have been exploited for short-term benefits to international businessmen. Local people have rarely benefited and often fall into debt peonage as patrons extend credit to hunters in the form of ammunition, batteries and staples required for trips in the field. This results is extremely low prices paid to the hunter. Previous traffic in raw hides also meant that further steps in processing occured outside the producing country, eliminating any other potential income there.

It also appears that key elements of complicated wetland ecosystems have been removed with negative effects for wildlife populations. Fittkau (1970, 1973) indicated that caimans are a major accelerator in nutrient processing and very important in maintenance of fish stocks and general ecology of Amazon wetlands. He presented data suggesting that where caiman have been eliminated, the diversity of fishes declines, and as a result fewer fish are caught for human consumption. My experiences in Venezuela (Godshalk 1978) inteviewing fishermen and old caiman hunters, though anecdotal, lend credence to these ideas. Other sources address this topic and support this view (Chirivi-Gallego 1973, Medem 1981, 1983). Although detailed studies are few, indications are that caiman are an important element in the ecosystems where they are found.

As the global deterioration of crocodilian species became apparent, the international conservation community responded by taking steps to control the trade. CITES has been very influential in slowing the illegal international traffic of crocodilian hides (Jenkins 1987). Countries must now compile annual reports documenting both exports and imports of hides. Tagging of skins in the country of origin, use of required export permits, and analysis of annual reports have reduced illegal trade significantly (Jelden 1990). These factors, plus increasing availability of legal hides, both from captive-raised and wild-harvested animals, make the illegal trade both more difficult and less profitable (King 1989).

Caiman hunting in Bolivia began in the fifties. A Bolivian law, passed in 1961, established size limits and hunting seasons to protect the wild populations (Brockmann 1986). It also prohibited the export of raw skins for two intended effects: 1) effective control could be established over the small number of tanneries capable of tanning the hides to international standards and 2) revenue increases would result if hide processing was conducted in-country. Unfortunately, the law was never enforced. Hunting occurred year-round, and raw skins of all sizes were exported. Bolivia became a CITES signatory in 1974 and issued export permits for *Caiman. yacare* under the regulations until 1988.

The Bolivian Wildlife Department established an export quota of 50,000 hides per year for 1986 and 1987. However, Ministry officials illegally sold the CITES export permits to hide dealers in Paraguay for personal gain. The Paraguayans used these permits to export illegal hides, many of which were smuggled from Bolivia. Meanwhile, anticipating the promised CITES permits for the legal export quotas, Bolivian tanners had purchased large quantities of hides from local hunters. Since the permits had been already been sold, they could not export their legal stock (King and Videz Roca 1989). Due to previously ineffective control of the commerce by the Bolivian authorities, in November, 1987 issuance of legal permits was suspended and a Presidential decree halted all wildlife commercialization (Marconi and Andrade 1992). In 1990, this decree was extended indefinitely. Petition for lifting the ban for experimental programs can be made by the wildlife authorities on a species specific basis.

Bolivia needs to formulate a national management plan in order to conserve its crocodilians, but lacks most of the required resources. Suspending legal trade for a brief period is a temporary move and has allowed some populations to recuperate. It does little to stem the flow of illegal hides, however. Historically, very few studies of *Caiman. yacare* have been undertaken in Bolivia and few relevant data exist. It is in Bolivia's best interest to manage this resource with care. Harvesting of a related species, *Caiman c. crocodilus*, occurs in Venezuela with an annual take of 30,000 to 100,000 hides, each valued at approximately US $50 to US $60 (Gorzula 1987), although this depend on current international market conditions. The overall economic value of the 1987 Venezuelan harvest was in excess of US $9 million in terms of employment, support services, hide values, meat sales, etc. Revenues per hectare to landowners at that time were very comparable to proceeds from cattle ranching (Thorbjarnarson 1991). Ranchers need only to protect the reproducing stocks and insure that permanent water is available to provide dry season habitat.

This low input scheme has also been quite productive for capybaras, *Hydrochaeris hydrochaeris*, in Venezuela, which provides additional income on many ranches (Ojasti 1991). Cattle, caiman, and capybaras combine to increase the net value of the land production without conflict. With careful management and conservative harvest quotas, the populations of both caiman and capybaras maintain good annual production. On one large ranch in Apure State (95,000 ha), the annual operating expenses were frequently met with the proceeds from the capybara harvest. Little capital or effort is required as the animals are not penned. In Bolivia, capybaras are routinely shot as vermin because ranchers believe a local myth that they carry parasites and disease that affect cattle and thus a potential resource is being wasted.

To conserve the caiman for future use, they must be managed for a sustainable yield. The necessary foundation is protection of the habitat and the caiman populations that are found within the Indigenous Territories and private ranches in the lowland states - Beni, Pando, Santa Cruz and northern La Paz (Unzueta 1975, see map 1). Communal and private landholders could play a large role in caiman conservation and supplement their annual earnings with little capital input. By protecting a resource of sizable value, these landholders could realize a sustainable annual harvest of hides as determined by existing populations and habitat. Potential value to the rural inhabitants from caiman would be an incentive to conserve both habitat and reproductive populations (Magnusson 1984).

Objectives - The underlying goal of this project is to plan the conservation of yacare caiman and conduct a controlled experimental harvest. This involves coordination of many people and institutions. The plan will research the harvest effects and assess prospective sustainability. We will investigate the effectiveness of caiman conservation under the two types of land tenure systems. The following objectives are required to meet this goal:

1) Conduct standardized, repeatable caiman population surveys

2) Integrate communities and communal lands within legal Indigenous Territories into a community-based conservation and sustainable harvest plan.

3) Integrate private ranchers in a private landholder-based conservation and sustainable harvest plan.

4) Research institutional support.

5) Investigate the infrastructure for tagging, transport and processing of hides

6) Explore tannery support for conservation and legal hide use

7) Produce a document with analysis and recommendations for use by the Bolivian Government in development of a national management program for *Caiman yacare*.

Methods The experimental harvest will be conducted on a very limited number of properties. Quotas will be assigned according to the results of the population surveys. In Venezuela, about 7% of the population is harvested. Only adults of a 90 cm minimum snout-vent length are taken, assuring an all-male harvest (Thorbjarnarson 1991). Repeating surveys each year monitors the populations and sustainability of the program. The specific details will be worked out to fulfill the project objectives, following results of the ongoing surveys.

1) Caiman surveys - Detailed population surveys were initiated in 1995 to identify the properties to be included in the pilot harvest program. These field studies will be continued in 1996, with spotlighting at night and establishment of GPS coordinates for repeatable surveys. The system has been standardized by Messel *et. al* (1981) and has been used by many other researchers (King *et. al* 1994). This will produce pre-harvest baseline data for the current caiman populations. Both total number counts and size-class distributions will be investigated. These data will be compared with subsequent post-harvest surveys on the same properties. The results will be used to formulate harvest quotas and monitor population trends.

2) Indigenous Communities - The Bolivian government has recognized several Indigenous groups by granting them legal territories. This gives them most use rights for the natural resources within their boundaries. I spoke with representatives of two major Territories and traveled to various communities. They understand the necessity of sustainable use for future security and are eager to develop programs with their people. Two Beni-based NGOs that work with Indigenous projects are very interested in this proposal and want to be involved. The Director of the national Office of Indigenous Affairs has also pledged her support and wants close involvement in one of the first Indigenous projects based on conservation and sustainable use of natural resources.

The two Indigenous Territories selected have healthy caiman populations. Caiman are not traditionally hunted for food by native people and the areas have little intrusion from outsiders. Access into the areas can be controlled for poaching control and the resident communities are enthusiastic to begin. In 1994 we conducted a planning workshop that was attended by Indian leaders, local NGOs and both national and local govt. officials from the Wildlife and Indian Affairs offices, all pledging support. In 1995 we surveyed areas in the Territorio Indígena Parque Nacional Isiboro-Sécure (see map 2) and spoke with inhabitants of numerous communities.

The proposed system would credit hunters for payment for each skin produced. These skins would later be sold in auction by the local community to the tanners. The natural resources are communal property and the majority of benefits would return to the community. After payment to hunters, the remaining funds are available for the community benefit as they see fit. Local leaders are anxious for involvement in the program and want to begin training their people for caiman surveys and management

3) Ranchers - Much of caiman habitat in the Beni Department is held on the vast cattle ranches of the natural savannas. Many ranches are over 50,000 ha. and, due to the extensive systems of management, exhibit little degradation from human influence (Jones 1980). Some large ranches in eastern Santa Cruz Department also have appropriate habitat and caiman populations. The prospect of financial benefits from caiman is not new. Many ranchers were involved during the legal and illegal hide trading periods leading up to a few years ago. We have spoken before the local Cattleman's Association of the two Departments, and with officials and ranchers individually, and enthusiasm for the project is high. Some have warned that cattlemen are slow to accept something new and unproved, but they usually add that using an example (i.e. an effective, functioning pilot program) ranchers will be quick to adopt the plan.

Ranchers often maintain small settlements scattered on their property which can be effective in poaching control. Employment during the harvest will extend to outside help. Proceeds will induce landholders to actively promote caiman conservation on their property. We hope this will result in a sustainable system that will increase the overall income per hectare and provide local employment. An analysis by Thorbjarnarson (1991) showed how caiman benefits/ha. can approach that of beef cattle where good habitat exists. These activities are complementary in nature, not competitive. It also brings returns from areas that are not productive in traditional ranch management.

4) Institutional Support - The government wildlife resources are very limited in the Beni and Santa Cruz Departments. The Department of Wildlife has only recently been removed from its historic home under Forestry (Ministry of Agriculture) and placed in the new Ministry of Environment and Sustainable Use. This has proved problematic though while it now has a certain autonomy, there is less fiscal stability. There are scant funds for personnel and less for equipment. Field presence is virtually non-existent through most of the area.

This program endeavors to provide institutional support in two ways. We will provide the materials and begin necessary training to build a core of survey technicians needed for the annual population counts. This helps capacitate field personnel and gives them higher visibility in the rural areas. It also instills a feeling of personal achievement and a greater pride in service. More importantly, a value-added service charge can be applied to each hide that will provide funds toward the maintenance of the caiman conservation program. This will ensure that the program can generate some or all of their own operating funds and not rely on general funds for support. We are also trying to include university students in our work to instill interest and assure a future cadre of researchers in the field.

We have met with the highest wildlife officials of the Beni and Santa Cruz and they pledged their support. The Department governments have been decentralized, which translates into greater freedom of action. They see opportunities in sustainable wildlife use but have few resources to carry them out. The proposed program is designed to develop and expand the management capabilities of local wildlife authorities.

5) Infrastructure - A reliable system must be erected to control the tagging, transport and processing of the hides. An integrated, multi-institutional approach was adopted by the Venezuelan program to reduce problems of graft. A similar system is being explored in this project. We have established good contact and support from the National Direction of Biodiversity Conservation and their national wildlife office in La Paz, the focus for official cooperation at the national level. The pilot program has a base of production primarily in the Beni Department, but also includes properties in Santa Cruz Department, tanneries in the Cochabamba, Beni and Santa Cruz Departments. Initial contacts have been made to the Army for security during hide transport. Inter-institutional coordination is necessary as the hides need to be tagged and transported across interior political boundaries, and final products will later be shipped internationally.

6) Tanners - The tanning industry in Bolivia is well respected on an international level. For this reason, permission was granted recently to import American alligator hides from the US for tanning. Tannery officials complain that the current national ban on use of caiman hides has only hurt the legitimate businesses with a resulting loss of jobs and income, while the illegal trade continues. Under Bolivian statutes, caiman hides must be tanned before export. The poachers and smugglers are not easily controlled and continue sending raw hides to buyers outside Bolivia.

I met with officials from the four existing tanneries which made up the association of government-licensed caiman tanners, ASICUSA. They are very interested in participating in a legal program that would ensure a sustainable flow of prime material. They understand the close scrutiny of international trade controls of CITES and the requirements for strict accountability. They expressed the need for a program that is well defined and allows them to function in an extortion-free environment. The common misconception is that the caiman hide business is extremely lucrative and bribes have been previously required at every level to conduct a legal business. The tanners are very interested in participating in a well-defined system that can achieve continuity over a long period.

The pilot program will result in high-value, legal hides that will be sanctioned by CITES. Rather than use the traditional salt and sun dry field preparation after skinning, a new, inexpensive and mandatory system of brine storage will be introduced. This will result in a higher quality hide. Compared to illegal hides, which are generally of low quality and are increasingly harder to traffic, the tanned, legal skins should command a much greater price on the market. Involvement of companies that produce finished articles, instead of shipping tanned skins abroad, would help multiply the overall economic and employment benefits of the program for Bolivia, and solidify a larger support base for the conservation program.

7) Harvest Analysis - A national management plan for *Caiman yacare* in Bolivia is needed. Results from the pilot harvest will provide some of the necessary information to develop a plan on a national scale. If the harvest proves successful, care must be taken not to increase the scale of the program beyond the level of the administrative capacity. This means that the number of properties involved and quantity of hides produced must increase slowly. Continuous communication with wildlife personnel and officials of tanneries authorized to process caiman hides is necessary to keep the project within realistic boundaries. Based on these results, a set of recommendations for the Bolivian Government will be drafted.

Significance - The successful Venezuelan model has demonstrated that a workable solution to caiman management problems can be achieved with the collaboration of the private ranches. The amazing recuperative potential of crocodilians has been demonstrated by the quick return of the American alligator (*Alligator mississippiensis*) in Florida and Louisiana (Hines 1990, Joanen and McNease 1990), and the caiman in Venezuela (Gorzula 1987). This has underscored not only the need for sound management plans, but also the potential for use of economic rewards as incentives for conservation. It has been shown with other crocodilian species that their value as a revenue-producing commodity has prompted effective implementation of recovery plans (Nichols 1987, Bolton 1990).

Historically, raw caiman skins were sold cheaply to the consumer nation where most of the profit was produced. By retaining more steps in the manufacturing process within the producer country, many benefits can be realized by local people. Higher profits and increased employment are achieved, as well as a more efficient use of the national resources. Stable employment of workers for the hide production can be assured and tanneries can have a guaranteed source of raw materials. By providing information to the producers on the best way to flay and cure the hides, and by limiting the harvest to large, adult caiman, higher prices can be earned for each individual hide. If the in-country production process continues to include the manufacture and sale of the finished goods, even higher profits can be realized and further employment offered locally. This is in sharp contrast to the present situation in Bolivia where smuggled skins, with very low value to hunters, produce little national income. Further, a renewable resource is being wasted with no long-term benefit to Bolivia. This project is designed to reverse this current trend by producing a sound management plan.

A sustainable use program for caiman can have widespread conservation effects. It can increase the value of many areas now considered marginal and help counter pressures for conversion to agriculture. Indigenous groups form some of the poorest of rural inhabitants and this program will provide income generation without degrading the environment. Sustainable wildlife use has important potential for improving the life of local residents when managed under sound ecological foundations.

The private sector can have similar benefits also. Numerous ranches were previously bolstered by a government subsidized meat purchase program linked to the immense government mining sector. After a brief period of 24,000% hyperinflation in 1985, the government sold its major mining interests and the massive meat purchases ceased, along with the airlift of beef from remote ranches (Hudson & Hanratty 1989). Now costs are much higher to reach the markets and ranchers are especially interested in supplemental incomes that don't interfere or compete with their ranching.

Caiman conservation requires habitat protection. As a top predator in their ecosystem, caiman act as an "umbrella" species and many other species benefit from the protection. This applies to the important watersheds and associated biodiversity and elements such as water quality and icthiofauna. Bolivia, a typically beef consuming nation, has vast lowland fish resources that are barely exploited. Damage to these resources must be factored in as an opportunity cost when considering effects from large-scale agriculture and attendant problems of habitat destruction, siltation and chemical pollution.

Conservation benefits can be competitive with less sustainable ventures such as large-scale agriculture. A large ranch in Venezuela where I worked provides a good example. It is involved in a similar harvest program for capybara, a common savanna mammal. Proceeds generated just from this species are able to compensate for the annual operating expenses for the main activity of cattle ranching. The ranch is also involved in the caiman harvest, runs a captive crocodile breeding facility, a biological station, and has recently begun a successful ecotourism venture. Aggregates of "conservation units" like this could have great positive effect on landscapes and biodiversity, as well as contributing to the well-being of local inhabitants.

South American countries have all seen the need for management of their wildlife hut very few effective policies have been implemented that attain the desired results. The more-developed, industrialized countries have recently taken the initiative by using CITES to control the consumer end of the trade and force reduction of unsustainable products. Now, the less-developed, producing countries must exert greater control over their own resources if they seek sustainable development. International attention has heen focused on Bolivia as a result of its past natural resource mismanagement and current state of inaction. In 1986-87, CITIES funded an expensive, general country survey of crocodilians which suggested that the Government of Bolivia should act soon to save declining caiman populations through a sustainable use program(King and Videz Roca 1989). CITES has also funded the current project in an effort to continue this process. Information from this study will form the basis for initiating a national program that uses sustainable use concepts for managing caiman.

Acknowledgments - I would like to thank the CITES Secretariat, in particular Dr. Obdulio Menghi, for providing funds for this project, to Dr. F. Wayne King a Project Director and my academic advisor, the University of Florida for logistic support, The Tropical Conservation and Development Program, Program for Studies in Tropical Conservation, Tinker Foundation, and Ernest L. Godshalk for financial support, to Dante Videz, Ingrid Fernandez S. and many others for their help in the field, and to Lic. Alexandra Sanchez de Losada and Eliana Flores from the Ministry of the Environment. There are many other too numerous to name here, the ranchers, Indigenous people, guides, pilots whose help and kind assistance made our first field season possible. A special thanks to my wonderful wife, Vicki, who endured our separation during this study with good spirit.

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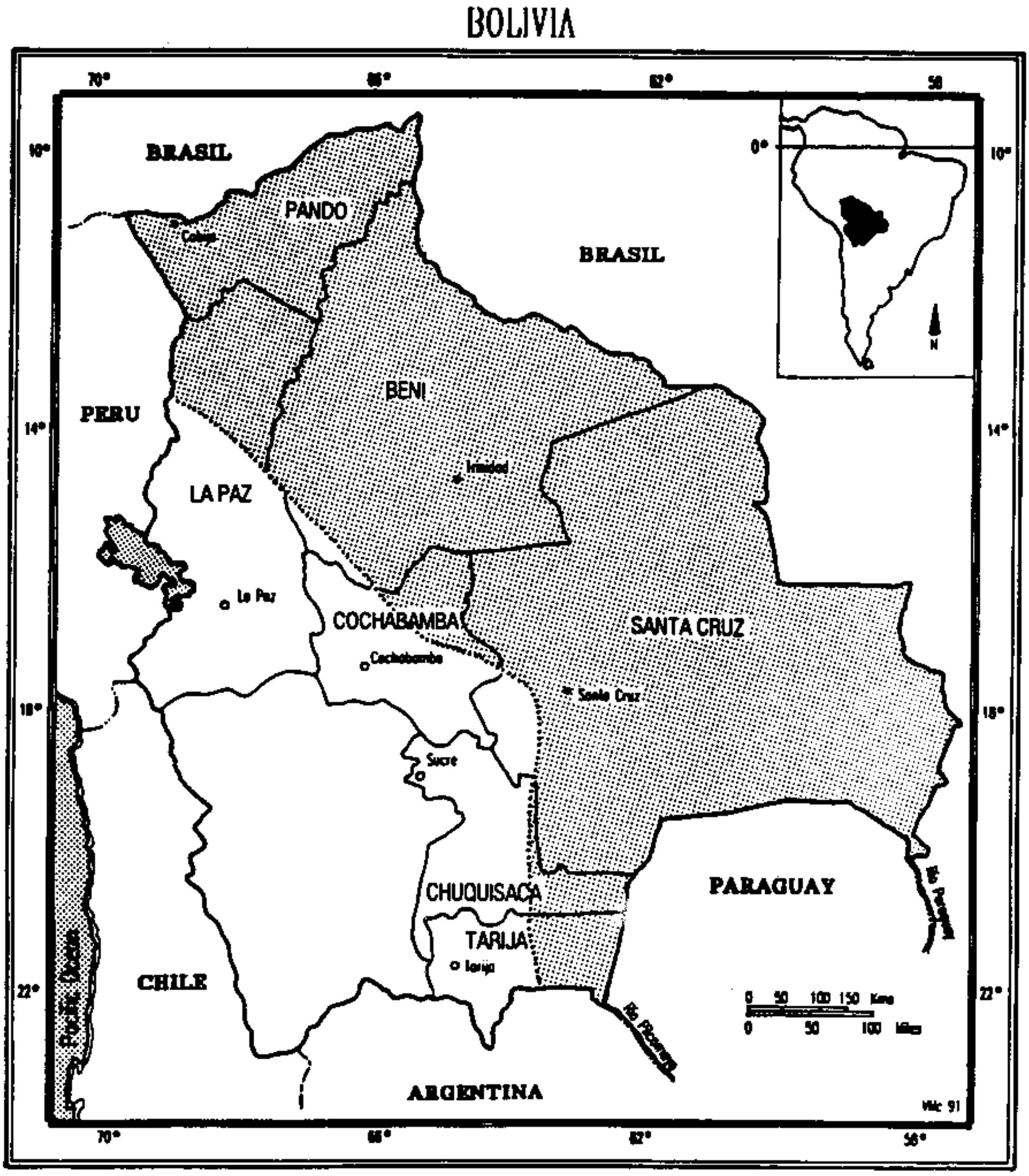
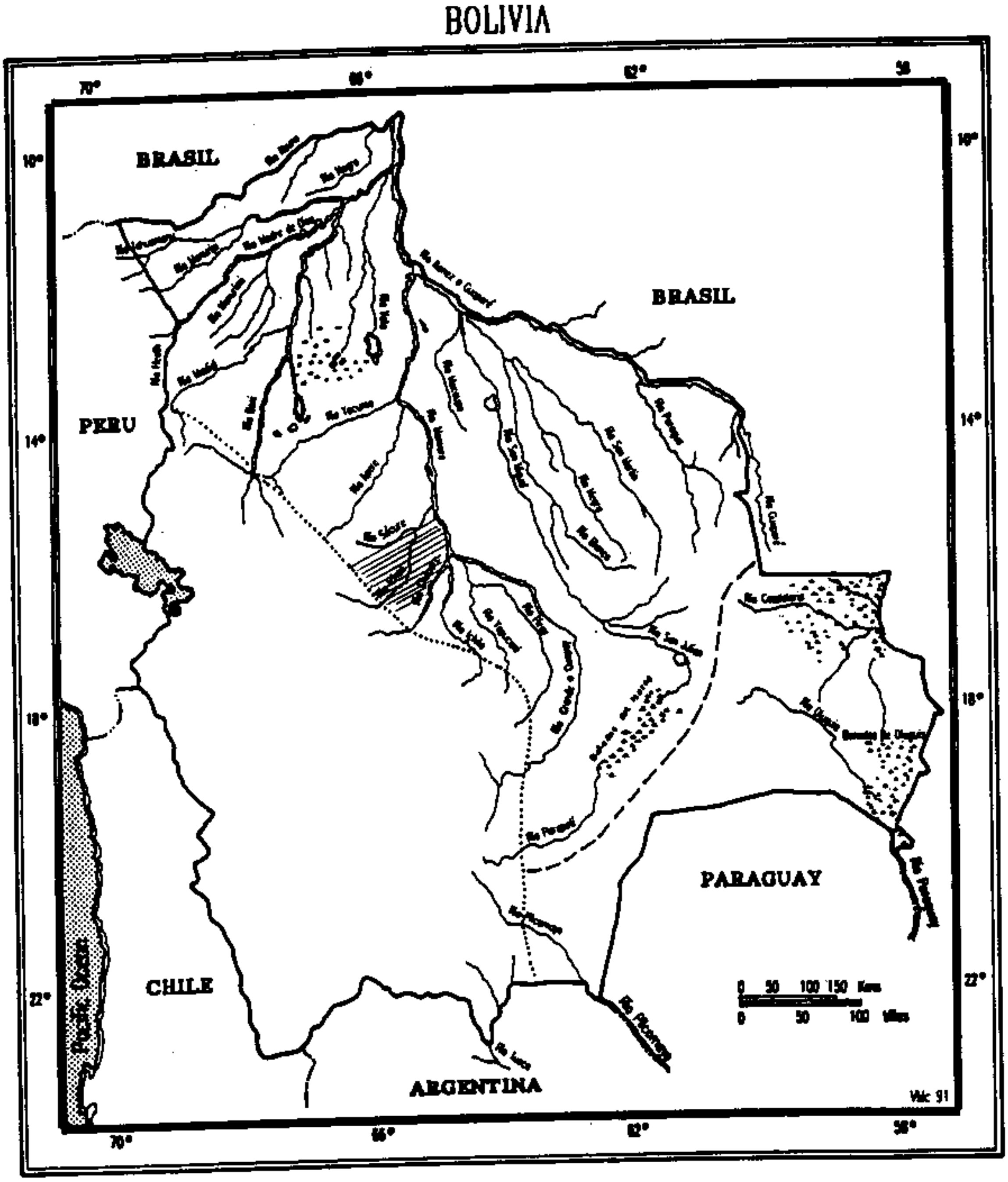


Map 1. The Departmental boundaries encompassing the lowland areas of Bolivia (shaded), with Departmental Capitals. Dotted line represents 500 m altitude contour.



Map 2 - Hydrographic network for the Bolivian lowlands. Dashed line represents division of Amazon (north) and Parguay-La Plata (south) River basins. Dotted line represents 500 m contour. Hatched lines represent Teritorio Indígena Parque Nacional Isiboro-Sécure.

CAIMAN SITUATION IN CHIAPAS, MEXICO.

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Chiapas is a privileged state at a national and international level because of its geographical location, topography, being close to the equatorial axis and its relations with the Gulf of Mexico and the Pacific ocean; all these factors favor a great diversity of ecosystems. Chiapas has the three Mexican crocodilian species: *Crocodylus acutus* , basically located in the Pacific coast, *C. moreletii* predominantly in the Gulf coast, and *Caiman crocodilus fuscus* in the south of Mexico. Chiapas and Oaxaca states are the northern limit of its continental distribution. *Caiman crocodilus fuscus* is located in a physiographic province called "Pacific coast plain" in Chiapas, with an extension of 280 Km parallel to the littoral. It begins since Mar Muerto in Oaxaca and it crosses the 13 coastal municipios (=districts) of Chiapas: Arriaga, Tonala, Pijijiapan, Mapastepec, Acapetahua, Escuintla, Acacoyagua, Villa Comaltitlan, Huixtla, Huehuetan, Mazatan, Tapachula and Ciudad Hidalgo, to the Suchiate river at the frontier with Guatemala (I.H.N. 1995). In those locations, the caiman has different aquatic natural ecosystems: estuary, lagoons, slow course rivers, flooding savannas (Alvarez 1974) and anthropogenic ecosystems, reservoirs, jageyes and aquaculture facilities.

The caiman prefers sweet rather than saline waters. In Chiapas it does share the habitat with *Crocodylus acutus* whom dominates the area, but when it is extirpated, the caiman then occupies the scenery. During the dry months of the year, it is possible to see big conglomerates of caimans in the water bodies which are dried (Alvarez 1974, Gorzula & Seijas 1989); these water bodies are known in the region as "Pampas". In Chiapas the caiman is protected in the La Encrucijada Biosphere Reserve decreed in 1995 (D.O.F. 1995) where Professor Alvarez del Toro carried out important observations about the natural history of the specie since 50s and 60s. This reserve count on 144 868 hectares of total surface. Its found in Pijijiapan, Mapastepec, Acapetahua, Villa Comaltitlan, Huixtla, Huehuetan, Mazatan and Tapachula districts. The aquatic ecosystems in the reserve occupy 71 151 hectares of the protected area without counting lagoon systems (I.H.N. 1995). In this wide surface can be said that the caiman could be protected and used in a sustainable way since the decree of the area foresees the resources utilization by the settlers who live in the buffer areas. The Natural History Institute (I.H.N.) has made observations about the abundance of caimans in La Encrucijada Biosphere Reserve and in Brisas del Mar estuary of Tapachula district, and a monitoring of the population flux in Estero Prieto of Puerto Arista in Tonala district, in this site has been made nocturnal monthly countings during a year.

In Chiapas exists four facilities focused to the breeding, research, exhibition and sustainable use in captivity of *Caiman crocodilus fuscus*, these are:

1. Miguel Alvarez del Toro Regional Zoo. Here was obtained the first reproduction of the species in 1966 and it has been continued during several years (Alvarez 1969, Sigler 1994b). This zoo functions as a state gathering center and as a wildlife reubication center (Sigler 1994a).

2. Technical fishery secondary school of Paredon in Tonala district. This place keeps a group of breeding animals in its facilities, their objectives are education and exhibition (Sigler 1995).

3. Intensive breeding center of caimans El Palomo in Tapachula district. With the experience of three generations working around legal wild caiman use and currently establishment of the first breeding center with an integral use of this resource in Mexico (Lopez 1995, Sigler 1995).

4. Banana Safari and Chula Zoo in Tapachula district. It exhibits a group of caimans and in a near future it will realize their integral use (Manuel Muqiz pers.comm.).

Current studies about illegal trade of crocodilians in Mexico point out that *Caiman crocodilus fuscus* is sold in considerable amounts as stuffed animals and their sizes goes from 0.23 to 1.25 m. of total length and in a minor scale manufactured products of animals from 1.50 to 1.75 m. of total length (Lazcano unprinted). There are abundant and healthy populations of the specie in the region and can be considered as a species of big potential use.

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Conservación y manejo de *Crocodylus acutus* en la Cuenca Baja del Río Yaracuy, Venezuela.

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Resumen

Con el objetivo de fomentar la conservación y el manejo de la población de Caimanes de la Costa (*Crocodylus acutus*) en la Cuenca Baja del Río Yaracuy, FUDENA con el apoyo de la empresa VENEPAL, ha adelantado investigaciones sobre el estado poblacional de la especie y evaluado una serie de alteraciones que ha sufrido este río en los últimos años. Producto de ello se estableció como estrategia de conservación y manejo la instalación de un zoocriadero o centro de cría en cautiverio para programas de repoblamiento, y la declaratoria de un área bajo régimen de administración especial que conlleve a la protección del hábitat natural de la especie, lo cual forma parte de las recomendaciones finales realizadas por Seijas y Chávez (1991). El área de estudio es la zona del río Yaracuy entre el puente La Hoya y su desembocadura en el Golfo Triste, la cual se ha denominado cuenca baja. De acuerdo al estudio realizado por Seijas y Chávez (1991) esta sección tiene cerca de 24,43 m y fue sectorizada en ocho segmento de longitud variable. Se realizaron recorridos diurnos y nocturnos en la referida sección del Río Yaracuy, para evaluar la situación del mismo y realizar censos, respectivamente. La detección nocturna tanto de caimanes como de babillas (*Caiman crocodilus fuscus*) se realizó usando faros y linternas. Una vez detectado un ejemplar, se estimó su Longitud Total (LT) desde la punta del hocico hasta el extremo de la cola, en base a clases de tamaño establecidas por Seijas (1988). Entre los resultados de estas investigaciones se tiene que durante 1995 se agudizaron una serie de problemas: deforestación y quema de vegetación de la orilla Este, desviación del cauce a altura del Puente La Hoya, y mal dragado del canal del río. En términos de abundancia poblacional y estructura de tamaños, los resultados indican una reducción en un 40 % de la población de Caimanes de la Costa registrada hace 5 años. Igualmente se registró una disminución significativa en la abundancia de Babillas.

Conservation and management of *Crocodylus acutus* in the Low Basin of the Yaracuy River, Venezuela.

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SUMMARY

For the conservation and the management of the population of American Crocodile (*Crocodylus acutus*) in the low basin of the Yaracuy River, FUDENA with the support of the company VENEPAL, it has advanced investigations on the population status of the species and evaluated the alterations that affect this river in recent years. Product of this was the establishment of a captive breeding center for restocking programs, and the proposal of a wildlife refuge for the protection of the natural habitat of the species in this area, something which is one of the final recommendations made by Seijas and Chávez (1991). The study area is the low basin of the Yaracuy river between Puente La Hoya and its mouth in Golfo Triste. This section is about 24.43 km and it was divided into eight variable length segments. To determine the population status were conducted daytime and nocturnal surveys in the referred section. Spotlight and headlamp were used for nocturnal censuses of crocodiles and spectacled caymans (*Caiman crocodilus fuscus*). Once detected it was estimated its Total Length (TL) according to the size classes established by Seijas (1988). Deforestation, deviation of the river and wrong dredging were determined. In terms of population abundance and size structure, the results indicate a 40% reduction of the crocodile population. A decrease in the abundance of spectacled caymans was detected.

1. INTRODUCTION

The population status of the American Crocodile in Venezuela was described by Seijas (1986b), in 14 localities along the coastal zone as critical but not irreversible. In a review, Seijas (1990) indicated that the status had improved in 10 years, based on studies conducted in the same localities and new reports. Seijas (1986, 1988) and Seijas and Chávez (1991) reported for the Yaracuy river a maximun abundance of 3.50 ind/km in 1984; 2.62 ind/km in 1987; and 6.35 ind/km in 1989. In 1991, a survey determined an abundance index of 4.82 ind/km (Arteaga, 1993). Based on these data it was estimated that the population abundance of the species in the river had increased gradually, with a relative abundance of hatchlings (< 60 cm TL). This might indicate the possibility that this is an important reproduction area for the species (Arteaga, 1993).

The objective of the present report is to present the results of the investigations conducted in 1995 with the support of the company VENEPAL, in the low basin of the Yaracuy River.

2. AREA

The area is the low basin of the Yaracuy river between Puente la Hoya and Boca Yaracuy, its mouth in Golfo Triste (Figure 1). This section is about 24.43 Km and it was divided into eight variable length segments by Seijas and Chávez (1991):

SEGMENT	Km
Boca Yaracuy - Puente Ferrocarril	1.07
Puente- Limoncito	5.32
Limoncito - Casa EFASA	3.67
EFASA - Cables Alta Tensión	7.30
C.A.T.- Puente La Hoya	7.07
Total	24.43

3. MATERIALS AND METHODS

In this study were used two outboard engines of 15 and 30 HP, and aluminum boats of 14 and 16 feet. For the nocturnal censuses were used spotlight and headlamps. Total Length (TL) of crocodiles and spectacled caymans were estimated based on the size classes established by Seijas (1988):

Class I: < 60 cm TL
Class II: 60 to < 120 cm TL
Class III: 120 to < 180 cm TL
Class IV: 180 to < 240 cm TL
Class V: > 240 cm TL

Population Abundance Indexes (PAI) in terms of the total number of individuals (> 60 cm TL) by kilometer surveyed (ind/km). The high mortality commonly reported for the Size Class I, is the reason why they were not included for calculating such index. The observed animals whose sizes could not be estimated, were classified as individuals Without Data (WD) and were used for calculating the indexes. The animals that could not be identified were reported as No Identified (NI).

4. RESULTS

4.1. RIVER ALTERATIONS

Deforestation

The 4th of April of 1995 a deforestation was detected in one shore of the Yaracuy river at the Limoncito-Casa EFASA segment. A wide fringe of gallery forest was cut and burned, without keeping the 50 mts that imposes the Venezuelan legislation. Possibly such disturbance will have a negative influence on the reproduction of the species, because it affects nesting areas reported by Seijas and Chávez (1991).

Deviation of river course

The deviation of the river course near Puente La Hoya (Figure 1) affected about 50 % of the section of the river studied, an approximated 14 km. This deviation affected directly the crocodile population and other species of the fauna associated with this area of the river.

Dredging

During the study a dredge had been working in the section of the river between Limoncito and Casa EFASA. It was observed that the dredge was destroying the rivershores, eliminating the beaches and homogenizing this ecosystem. This disturbance produced negative effects on the population of crocodiles inhabiting this section. Seijas and Chávez (1991) indicated that the dredging alters the natural habitat of the species in this sector, since the speed of the river increases with the characteristics of the shores, this probably causes an increase in hatchling dispersion and predation.

4.2 Population censuses

From April to November of 1995 were conducted four studies in the referred section of the river. Table No. 1 presents the results of the censuses by sector and size classes, and it also indicates the water level.

Abundance indexes

The first census was carried out the 05 of April of 1995, with a low water level. A total of 105 crocodiles plus 2 NI were counted. Out of this total, 21 crocodiles (20%) were < 60 cm TL, possibly juveniles hatched in 1994, and 84 crocodiles > 60 cm TL. The PAI was 4.82 ind/km.

For the second census (03 of August of 1995) the section of the river between Puente La Hoya and Casa EFASA started to dry out, and downstream the water reentering the original rivercourse from the adjacent plains. With a high water level in the river, only 41 crocodiles were observed and 1 NI. A larger number of spectacled caymans (10) were detected, most likely from these adjacent plains. Out of this total of 41 crocodiles, 8 (19.5%) were < 60 cm TL, and 33 (80.5%) were > 60 cm TL. The PAI was 2.52 ind/km.

In the third and fourth censuses (30 of August 1995 and 10 of November of 1995) only the segment between Boca de Yaracuy and a point located 300 m from Casa EFASA, exactly at Primer Caño, could be surveyed (Figure 1). Upstream from this point the river had dried out, being Primer Caño a collector of the water that reentering from the flooded plains. In the third census the level of the river decreased almost 1 m and were counted 83 crocodiles and 1 NI, 11 animals (13%) were < 60 cm TL, and 72 animals (87%) were >60 cm TL. The PAI was high, 7.13 ind/km, which is usual when the water levels are low. In the fourth census 43 crocodiles were counted, all > 60 cm TL and PAI was 4.26 ind/km.

Differences in PAI were caused by variations in water levels. However, in general the PAI could be compared with estimates of previous studies in this segment of about 24 km, between Boca de Yaracuy and Puente La Hoya.

In 1991, it was estimated a PAI of 4.82 ind/km (Arteaga, 1993) and in 1989 of 6.35 ind/km (Seijas and Chávez, 1991), which confirms that the population abundance is relatively stable. Nevertheless, the dessication of the segment of river between Puente La Hoya and Casa EFASA caused the crocodiles to concentrate, which could be observed in the third census with low water level, where PAI was 7.13 ind/km.

Size Structure

With regard to the size structure of the population studied, the adjustment proposed by Seijas and Chávez (1991) was applied, considering the segment between Casa EFASA and Boca Yaracuy. This adjustment is based on the methodology of Messel *et al* (1981), that considers the maximum number of crocodiles seen for each size category and in any of the night surveys, as the best estimate for that particular category. Table 2 presents this adjustment.

According to this methodology, the size structure presented in Graphics 1 and 2 are quite contrasting. Comparing both graphics, notable differences in the number of crocodiles by size classes were observed, which indicates a reduction for each size class and specially for the Class I. Certainly, this is one of the consequences of the deforestation and deviation of the river occurred this year, that presumably affects the nesting.

However, this results are similar to those reported by Thorbjarnarson (1989), predominantly juveniles (ind. <121 cm TL 56.3%; and ind.<90 cm TL 74,3%) and low percentages of subadults (18.7% and 10.7%, for animals between 121-183 cm and 90-180 cm TL) and adults (12 to 25%, >180 cm TL).

5. POSSIBLE DISTURBANCE IMPACTS

Besides the possible impact on nesting of the deforestation and deviation of the river, the direct and indirect impacts of the dredge has not been evaluated. Considering the PAI, apparently crocodiles are concentrating in the segment between the Casa EFASA and Boca Yaracuy, precisely where this machine is operating.

Using the data of Seijas and Chávez (1991) and the data from this study, a preliminary evaluation of the status of the species in the low basin of the river can be performed, taking into consideration the referred disturbances. Seijas and Chávez (1991) estimated 148 crocodiles >60 cm TL, and this study estimated 88 crocodiles >60 cm TL, which only represents 60% of the first number reported. In other words, 40% of the population has not been accounted for in this last study. Nevertheless, further research is required in order to establish the real impact of these disturbances on the nesting, abundance and population structure.

6. CAPTIVE BREEDING AND PROTECTION OF THE NATURAL HABITAT

The establishment of a captive breeding center in VENEPAL is justified by the high reproductive potential of the adjacent Yaracuy river. It is important to monitor the activity of the dredge in the river, to seek mechanisms that lessen its impact on the crocodiles and associated wildlife. The captive breeding center would serve for the relocation of perishable nests along the river.

Finally, to consolidate the recovery of the species, it should be procure the declaration of an officially protected area that guarantees the viability of this population of the species, preserving its natural habitat. There are precedents in the country regarding the establishment of protected areas for the conservation of endangered crocodiles and its natural habitat. The Caño Guaritico Wildlife Refuge and the Cinaruco-Capanaparo National Park, were declared officially for the protection of the Orinoco Crocodile (*Crocodylus intermedius*) (Arteaga, 1993a).

In the Yaracuy river, Seijas and Chávez (1991) recommended the creation of a Wildlife Reserve. However, it would be more adequate the declaration of a Wildlife Sanctuary, accompanied with a Protection Zone, because of its small area. In this area, a relatively undisturbed swamp forest is found (according to Beard, 1944; quoted by Seijas and Chávez, 1991), the only remnant in all of the coastal north region of Venezuela.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the following persons and institutions: Glenda Medina and Diego Díaz, former and present Executive Director of FUDENA, and Genaro Solé, Samuel Narciso, Elias León, Juán Quaro, who assist us in the field work. To Dr. Julio Ortega, Milke Zubeldia and Ali Rojas of VENEPAL, for their assistance and collaboration. Special thanks to Gustavo Hernández, for his assistance both in the field and in the translation and comments of this paper. Finally the authors recognize and are very grateful to VARIG Airlines and WWF-USA for their support and funding, which made possible to present this paper.

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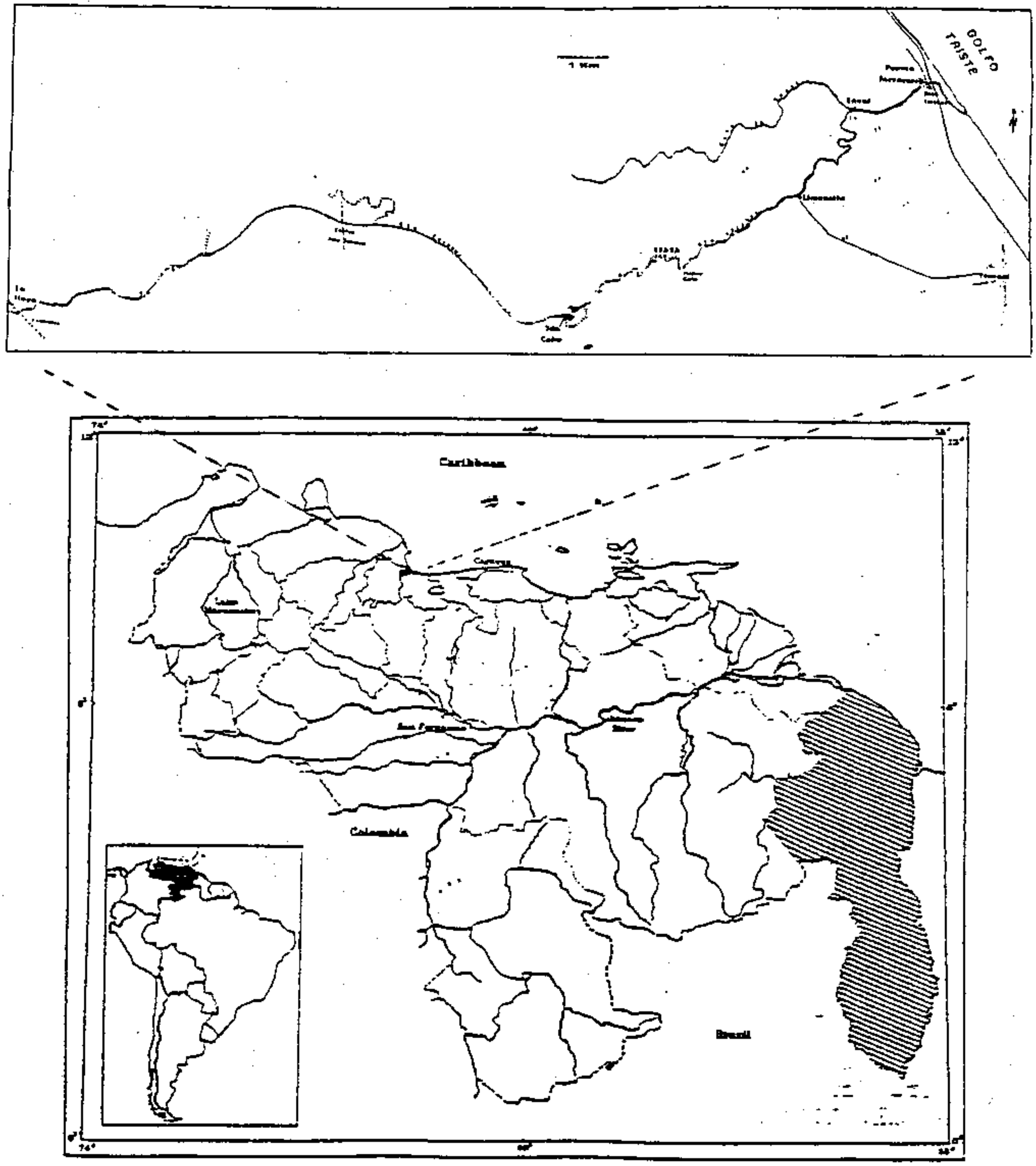


Figure 1: Area in low Basin of the Yaracuy river.

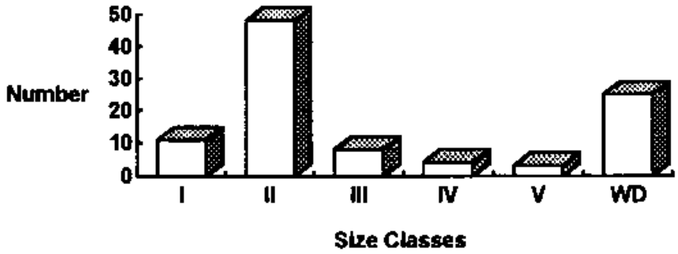
Table 1: Summary of censuses conducted in the Yaracuy river. Class I: < 60 cm TL; II: 60 < 120 cm TL; III: 120 < 180 cm TL; IV: 180 < 240 cm TL; V: ≥ 240 cm TL; WD: Without Data; NI: No Iden. PAI: Population Abundance Index, (only crocodiles ≥ 60 cm TL y WD).

DATE (Water level)	Segment	SIZE CLASSES I	II	III	IV	V	SD	SUBTOTAL (NI)
05/April/95	Boca-Puente							
(~150)	*Crocodiles*	0	5	0	0	1	2	8 (1)
	Puente-Limoncito							
	Crocodiles	6	17	1	0	0	2	26 (3)
	Limoncito- EFASA							
	Crocodiles	5	19	2	1	0	5	32
	EFASA-Cables A.T.							
	Crocodiles	10	21	3	0	0	5	39
TOTALS	*Crocodiles*	21	62	6	1	1	14	105 (4)
Distance	17.4 km							PAI= 4.82 ind/km
03/Aug/95	Boca-Puente							
(273)	*Crocodiles*	0	2	5	0	0	0	7 (1)
	Puente-Limoncito							
	Crocodiles	2	0	1	1	0	1	5
	Caymans		1					1
	Limoncito-EFASA							
	Crocodiles	0	9	0	1	0	5	15
	Caymans		5					5
	EFASA-3 km							
	Crocodiles	6	4	0	2	0	2	14
	Caymans		2				2	4
TOTALS	*Crocodiles*	8	15	6	4	0	8	41 (1)
	Coymans		8				[illegible]	10
Distance	13.1 km							PAI= 2.52 ind/km
30/Aug/95	Boca-Puente							
(182)	*Crocodiles*	0	7	2	0	0	1	10 (1)
	Caymans				1			1
	Puente-Limoncito							
	Crocodiles	5	15	0	2	1	13	36
	Limoncito-EFASA							
	Crocodiles	6	17	1	2	1	10	37
TOTALS	*Crocodiles*	11	39	3	4	2	24	83 (1)
	Caymans				1			1
Distance	10.1 km							PAI= 7.13 ind/km
10/Nov/95	Boca-Puente							
(220)	*Crocodiles*	0	12	1	0	0	0	13
	Caymans		3					3
	Puente-Limoncito							
	Crocodiles	0	10	1	2	0	2	15
	Caymans	0	1	0	0			1
	Limoncito-EFASA							
	Crocodiles	0	8	0	0	0	7	15
	Caymans	2	0	0	0	0	[illegible]	2
TOTALS	*Crocodiles*	0	30	2	2	0	9	43
	Caymans	2	4					6
Distance	10.1 km							PAI= 4.26 ind/km

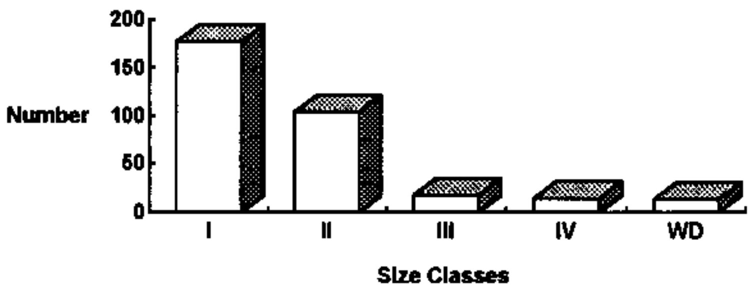
Table 2: Adjusted Size Structure of the population of *Crocodylus acutus* in the Low Basin of the Yaracuy river. Class I: < 60 cm TL; II: 60 < 120 cm TL; III: 120 < 180 cm TL; IV: 180 < 240 cm TL; V: ≥ 240 cm TL; WD: Without Data: NI: No Identified.

		SIZE CLASSES						
Segment		I	II	III	IV	V	WD	Subtotal (NI)
Boca-Puente								
	Crocodiles	0	12	5	0	1	2	20 (1)
	Caymans	0	3	0	1			4
Puente-Limoncito								
	Crocodiles	6	17	1	2	1	13	34 (3)
	Caymans	0	1	0	0			1
Limoncito- EFASA								
	Crocodiles	5	19	2	2	1	10	34
	Caymans	2	5	0	0			5
Boca-EFASA								
	Crocodiles	11	48	8	4	3	25	88
	Caymans	2	9	0	1			10

Graph. 1 : Adjusted Size Structure of a population of American crocodiles between Boca-EFASA, Yaracuy river.



Graph. 2 : Adjusted Size Structure of a population of American crocodiles between Boca-Puente La Hoya, Yaracuy river, data from Seijas and Chávez (1991)



CONSERVATION OF THE AMERICAN CROCODILE *Crocodylus acutus* IN CAÑON DEL SUMIDERO NATIONAL PARK, CHIAPAS, MEXICO.

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INTRODUCTION. Sumidero Canyon is an impressive natural beauty from Chiapas state. It is a geological fault among the earth plaques, that opened their entrails approximately 200 million years ago when even formed part of the sea bottom that in that edge covered the Yucatan Peninsule. Moreover of the beauty of the scenario that protect, the ecosystems located at the Sumidero Canyon keeps populations of spider monkeys, white tailed deer, armadillo, collared peccary, paca, kinkajou, margay, yaguaroundi, coatimundi and racoon (Galvez 1990), several kinds of herons, raptors, migratory birds, great curassaw, black iguana, green iguana, boa, rattle snake, and others snakes and the only protected population of the American Crocodile *Crocodylus acutus* in the Grijalva river basin in Chiapas.

The terrain characteristics avoid that human being -main predator of the modern age- affected the animal kinds that inhabited there. Our eyes just can admire the beauty since the cliffs and were not so much people whom navigated the Grijalva river and its dangerous rapids and coming out to count it. Some explorers commented the abundance of crocodiles that occur at The Sumidero Canyon; they saw them almost in every sandy beach present across the river which increased or decreased its volume following a natural cycle of dry season and rain season. We know females nested in those beaches and their hatchlings born before the flood (Alvarez 1974). The Sumidero Canyon was decreed as a national park on December 4th 1980, counts on 21 789 has and surrounds more than 50 km of the Grijalva river shore, one of the most copious in the country, also counts on different ecosystems outstanding riparian forest 360 m.a.s.l., tropical deciduous forest, evergreen seasonal forest, evergreen clouded forest at more than 1 700 m.a.s.l., and unnamable cliffs plenty of plants. Because of the nearness with Tuxtla Gutierrez city, the Sumidero canyon was a well studied area by Professor Alvarez del Toro, director of the Instituto de Historia Natural (I.H.N.). When the construction of the Chicoasen hydroelectric dam in 1980, the I.H.N. participated in the flora and fauna rescue that could died before the increased volume that inundated the Canyon with registered elevations of three meters per day in different sites. The dam is the main supplier of energy to the nation and even to the exportation to neighbor countries. In recent years, Miguel Alvarez del Toro Zoo (ZOOMAT), belonging to the I.H.N., has done some visits to this park in order to relocate fauna donated to the zoo and to appreciate some aspects of the populations of fauna that still occur in the place. In 1995, I.H.N. initiated a project called '*Crocodylus acutus* Situation at Sumidero Canyon national park' with the objectives of knowing the total of crocodilians that occurs there, the areas that requires protection due to their importance as nesting areas and hatchling growing bays, the problems that confront the group and the benefits that represent to the cooperatives of touristic boats which operates in the place.

MATERIAL AND METHODS. The study area is located between the 16 4000 parallels and 16 5700 of north latitude and between 93 01 and 93 07 of west length (Galvez 1990); it is delimited between the places known as Silent cave and Belisario Dominguez bridge inside the national park, with an approximately length of 10 km. of Grijalva river at an altitude of 360 m.a.s.l. The river has stretches that varies from 30 to 130 meters wide. The shores are constituted by different kinds of vegetation; also has rocky walls, cleared areas, sandy beaches and rocky beaches. It has been included the Sabinal river mouth since the pollution and sewages it maintains seven adults animals which varies in size, ranging from 2.5 to 4.5 m of total length in no more than 100 meters.

Monthly diurnal and nocturnal visits were carried out. At the first ones, the river was reviewed as well as its shores looking for crocodiles at basking or visiting sandy areas for nesting proposes. When the nests were located, the basic measures were took such as: date, location, distance to the water, deep, circumference, incubation chamber temperature as well as environment temperature. From each detected nest at the begging of the incubation (less than three days) were collected 10 eggs (leaving the rest of the eggs in the site), were identified and measured, transported in polyurethane containers with nest material to ZOOMAT and were incubated artificially under controlled conditions. During the nocturnal visits the mayor area of crocodiles activity was ubicated and delimited. The countings begun one hour after sunset in a plane floor aluminum boat four meters long with an eight horsepower outboard motor and a pair of spotlights counting the animals eyes by reflection. Also temperature and water level were measured at the beginning and at the end of the census. The site of capture was registered at the moment; cloacal, water and air temperature were recorded with a Bravo contact thermometer. Total length, Snout - vent, head length and wide, postoccipital, nuchal, dorsal, doble crest, single crest and lateral caudal scales were measured in each crocodile. The captured animals were marked by cutting the scales of the double and single crests, and were released in the same site. Both , the hatchlings born by artificial incubation and the captured ones were transferred to ZOOMAT and were kept under stable conditions of temperature. They were marked, fed every other day and monthly measured at weight and total length. When they were one or two years old they were released in the areas with better aquatic vegetation coverin the park.

RESULTS 16 visits were realized since March 31st 1995 and finished on March 18th 1996, 128 observations hours were recorded from which 65 were nocturnal. Were counted since 14 to 38 animals without include 1995 neonates or crocodiles released by ZOOMAT. The dates of mayor countings were May 18th and September 6th 1995. 52.63% of the counted population is conformed by adults (2m. or more); 13.15% sub-adults (1.5-1.99 m.); 5.27% four years old (1.2-1.5 m.); 15.8% two years old and 13.15% one year old. In other samplings, five different specimens from 1992 class (three years old) were counted but they were not seen in the biggest sample from May 18th 1995 which was the one who we analyzed. 40 wild crocodiles were captured, measured, sexed and marked from the following classes: 23 (1995), 9 (1994), 6 (1993), 1 (1992) and 1 (1991), and released in the same place. Was very notorious that from the total of all captured animals 37 were males and 3 females. Some adults crocodiles permitted a good approach but we dont have experience enough to manage animals bigger than 3 meters. Territoriality was observed in adults, sub adults and some juveniles because they were found in the same places each sampling. Five active different nests were found. Three were found in 1995 and three in 1996; one of them had repetition in both years. One nesting zone was common for three females in the same year, the maxim distance among the nests was 15m. and the less 7.5m. (table 1). Laying date was from middle March to early April. Natural eclosion was from middle May to early June. In 1995, we collected 7 fertile eggs and incubated artificially at ZOOMAT; from these, 6 males hatchlings were obtained with normal characteristics and similar sizes to their brothers left at the natural nest, the artificially incubated ones, born 4-6 days later. In 1996, 28 fertile eggs were collected from 3 different nests and we expect their exclusion at early June, according to the growth of the bands, the embryos develop correctly, the temperature was maintained constantly between 29.5 to 30.5 C during the first 45 days for increasing the female proportion (Thorbjarnarson pers. comm.). Data of the collected eggs for artificial incubation and obtained hatchlings in this procedure are shown in table 2. Thirty-five wild neonates were collected: 2 in

1993, 7 in 1994 and 21 in 1995 to keep them for one or more years at ZOOMAT; all of them were males. Their growth was constant but lower in 1994 and similar in 1995 to the shown by those born in captivity (Sigler in press.). In 1995, 9 crocodiles were released, they belonged to the 93 and 94 classes and were captured at borning in the study area and in 1996 25 from 95 class will be released. From the 23 hatchling born in captivity from ZOOMAT parents , 11 were released in 1995 (Sigler 1994) and 10 will be released in 1996. From the 18 recaptured crocs, 15 of them were kept one year in captivity and released by ZOOMAT and the rest were wild animals. In March 1995, the zoo was notified about the presence of a dead crocodile in the Sabinal river, due to the moldering changes it could not be necropsied, however, her skeleton was conserved and prepared for scientific collection. This 2.94m. adult female was about to laying because were found more than 30 eggs, and in spite of our attempts to incubate them were not possible due to their softy shell. During our visits, informal interviews were made with fishermen and boatmen from the touristic cooperative, founding that the reproductive season and nesting sites were unknown, but exist knowledge about eclosion time. They also reported the presence of some small crocodiles extracted from the park and kept in captivity in some houses from the surroundings. They have not had big problems with those animals by using the illegal trammel nets. The author appreciated in the Sabinal river mouth a fisherman who crossed the river swimming in front of three adults crocodiles and surprisingly was not attacked, this man argued that he never has any problem with crocodiles and these animals are able to avoid the trammel nets when they touched them with the top of the snout and retroceded.

DISCUSSION It is probable that population fluctuates around 80 animals, because the river shores offer a very big vegetal floating coverture were some crocodiles could not be seen during the samplings. Some crocodiles progress in the recognition of the spotlight at posterior captures, this effect has made difficult our last samples, however is possible it can be useful avoiding human predators. When the rainy season is present (July-September) the dam is carried down to 5m. less of the normal level, this fact makes the animals be lack of hides during the samplings, but also before their predators. It is possible that some hatchlings move to places beyond the Silence cave dragged by the strong flow of the river in the rainy season and they be ubicated in the dam, area still not monitored. The nesting sites availability is reduced because the river has not adecuated beaches for the crocodile reproduction, the almost 25 km of the Sumidero Canyon are coffered by the rocky walls and because that the crocodiles came out the Canyon and are located mainly at the beginning of the park and at the end of the dam, these are places with high human pressure both the animals as well as the habitats they occupy and indispensable they need.

CONCLUSIONS It is important to carry out for one more year this study to evaluate the survival of the released animals which attempt to be acceptable. During 1996, the feeding habits evaluation will start. We consider important to manage the wild nests to orientated their production towards the obtention of females and in this way nivelate the sex ratio in juveniles. This National Park in considered a good place for releasing hatchlings born in captivity at ZOOMAT and due to the nearness with our facilities, we can give them a periodical monitoring. In the near future is contemplated studying the population across the Grijalva river, detecting the better populations and suggesting to the settlers of each area, measures for living together and for touristic approachment of the crocodiles.

ACKNOWLEDGEMENTS This study would not be possible without the enthusiastic support of IDEA WILD project 040 that donated the outboard motor and made the difference. Special thanks are given to the sapo-iguana team in collaborating with every work visit.

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Head-starting and Translocation of Juvenile *Crocodylus acutus* in Lago Enriquillo, Dominican Republic

by

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ABSTRACT

Since 1992 the Dominican Republic is carrying out a conservation project in Lago Enriquillo, a hypersaline inland lake, where the country's only Crocodylus acutus population is surviving. The population had declined from 300-600 adults in the early 1980s to some 200 in 1992, mainly due to illegal killings. The Dominican Wildlife Department (DVS), in charge of animal and plant conservation, developed an action plan to secure the crocodiles' survival and well-being. An inter-institutional executive council was formed to plan and supervise the plan's activities.

Because of the delicate state of the Crocodylus acutus population the council decided in 1993 to take eggs to the Santo Domingo Zoo for a headstart program. In April and May 178 eggs and 53 hatchlings were taken to the zoo. A total of about 130 neonates were in the zoo by the end of 1993. Most of them died in 1995 due to severe internal problems in the zoo.

In 1994 it was decided to translocate the hatchlings from the nesting beaches on the islands to freshwater habitat along mainland shores, in order to improve survival rates. 255 hatchlings were translocated, after being marked. In Los Borbollones area some 20 % were recaptured. Since post-hatching care is an important phenomenon in Lago Enriquillo crocodiles, we are not sure if mortality was reduced significantly by our translocation activities.

Growth rates in the juveniles were 30 to 35 mm per month. Mean weight gain in the first year was 63 g / month, in the second year about 200 g / month.

RESUMEN

Desde el 1992 la República Dominicana está llevando a cabo un proyecto de conservación en el Lago Enriquillo, un lago hipersalino en el interior, donde la única población del cocodrilo americano (Crocodylus acutus) del país sobrevive. Esta población ha declinado de 300 - 600 adultos en los años 80 a unos 200 en el 1992, sobro todo por matanzas ilegales. El Departamento de Vida Silvestre, responsable para la conservación de animales y plantas, desarrolló un plan de acción para asegurar la sobrevivencia y el bienestar de los cocodrilos. Un consejo ejecutivo, de forma inter-institucional, fue formado para planificar y supervisar las actividades del plan de acción.

Por el estado delicado de la población de Crocodylus acutus en el lago, el concejo decidió en 1993 de llevar huevos al Jardín Zoológico de Santo Domingo para iniciar un programa de crianza en cautiverio. En abril y mayo 178 huevos y 53 neonatos fueron llevados al zoológico. Un total de unos 130 neonatos estaban en el zoológico a finales de 1993. La mayoría de ellos murió en el 1995, por fuertes problemas internos de la institución.

En 1994 fue decidido trasladar los neonatos desde sus playas de anidamiento en las islas hacia los sitios de agua dulce en las orillas del lago, con fines de aumentar la taza de sobrevivencia. Unos 255 neonatos fueron trasladados, después de haber sido marcados. En el área de Los Borbollones un 20 % de ellos fueron recapturados. El cuidado que las cocodrilas les dan a sus crías parece ser un fenómenon muy importante en el Lago Enriquillo. Así no estamos seguro, si la mortalidad ha sido reducida significativamente por las actividades de traslado.

Las tazas de crecimiento de los juveniles eran 30 - 35 mm por mes. El promedio del aumento de peso era 63 g por mes en el primer y 200 g por mes en el segundo año.

INTRODUCTION

The American crocodile *(Crocodylus acutus)* was once abundant along much of the Hispaniolan coastline (Descourtilz 1809, Moreau de St. Mery 1797). Today, in Haiti there are only small populations along the coast and in Etang (Lake) Saumatre (Thorbjarnarson 1988); and in the Dominican Republic *C. acutus* has only persisted in Lago Enriquillo (SEA/DVS 1993).

Lago Enriquillo is situated in the Neiba valley in the southwestern part of the Dominican Republic, bordered by two 2000 m mountain ranges. It has a water surface of about 200 km^2, a length of 35 km, a width of 11 km and a maximum depth of 22 m (Araguás et.al, 1993). There is one big island, Isla Cabritos and two small islands, La Islita and La Barbarita. At the moment Lago Enriquillo has a salinity of 80 ppt (1996) and lies 40 m below sea level. The lake is a remnant of a marine channel that once divided Hispaniola into two paleo-islands (Mann et.al 1984, Inchaustegui et.al 1978). The climate is semi-arid: annual precipitation ranges between 470 and 780 mm and evaporation is estimated to exceed 2000 mm. Mean air and lake water temperatures are approximately 30° C. Water level, lake surface, and salinity vary significantly from year to year.

In the early 1980s the crocodile population of Lago Enriquillo was considered to be the biggest and densest for the entire species, estimating an adult population between 300 and 600 individuals (Inchaustegui and Bautista pers. comm.). Between 70 and 112 nests were found in the years 1977 through 1984 (Inchaustegui in SEA/DVS 1993).

Surveys carried out in 1990/91 by the Departamento de Vida Silvestre (Dept. of Wildlife) revealed alarmingly low numbers of nests and of crocodiles seen. In 1992 Vida Silvestre started the project "Study and Protection of the American crocodile". Surveys during the first months showed that the situation of the crocodiles was even worse than expected. Few adults were seen along the coast. Despite intense searching only four nests were located. Thereafter evidence of crocodile killings; bones, including smashed skulls, human tracks, wooden poles and crocodile traps were found in many places (SEA/ DVS 1993, Schubert and Santana 1996).

A "Surveillance Plan" was established and implemented for the whole lake. An "Action Plan for the Conservation of the American Crocodile" was worked out. It includes five programs: 1. Surveillance, 2. Investigation, 3. Reproduction, 4. Public Relations and 5. Resource Management. An interinstitutional "Executive Council" was created to plan and supervise the activities. Members of this council are representatives of the National Park Directorate (DNP), the Wildlife Department (DVS) and the Santo Domingo Zoo (ZOODOM). Grupo Jaragua (a national NGO) and the German Service for Development (DED) are included as consultants. The action plan is in its fourth year of implementation. Human impacts on the crocodiles have been reduced and public awareness improved significantly; the crocodile population is increasing slowly. More than 200 adults are now estimated for the lake area.

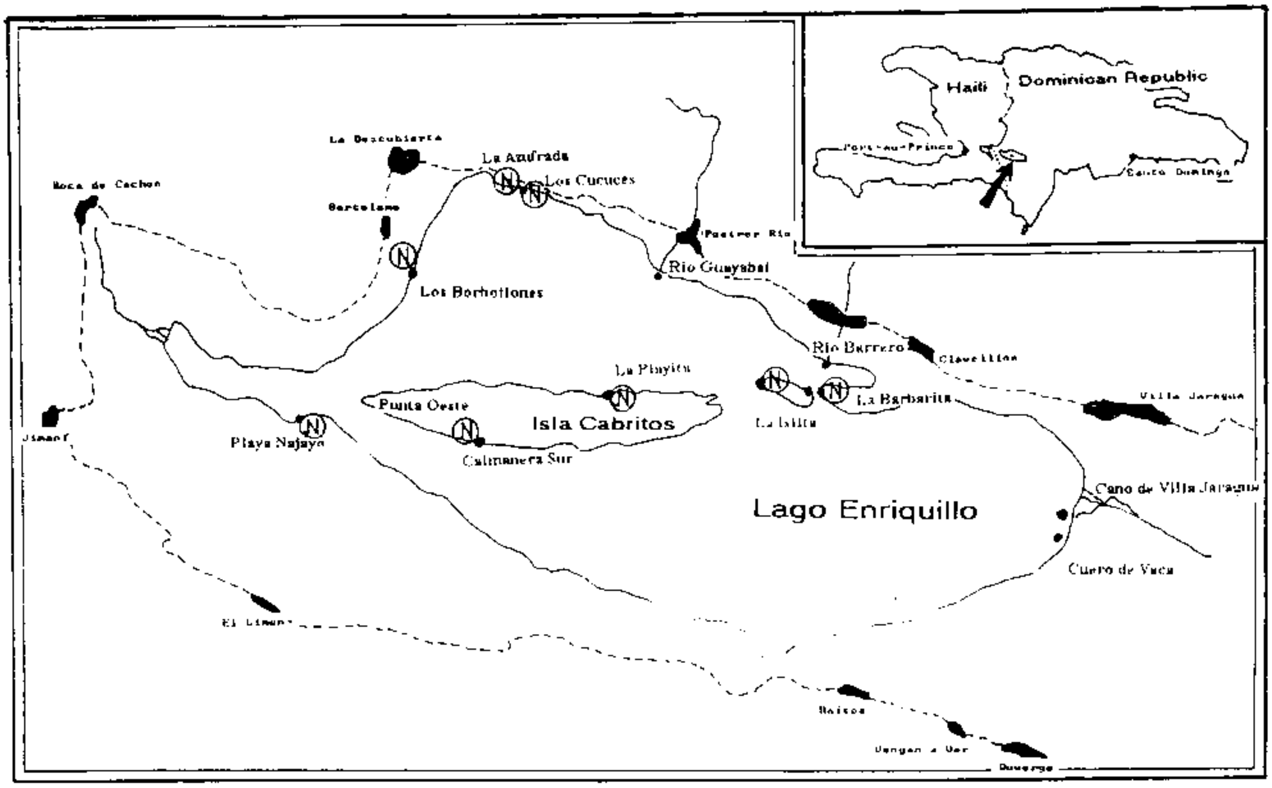

Fig. 1: Map of Lago Enriquillo. N: major nesting sites

METHODS

Since 1993 all major nesting beaches have been patrolled every two to three days during the egg-laying period (January through March). Nests were opened, and the eggs were counted, measured and weighed, then put back in exactly the same position from where they were removed. In 1993, eight nests were reopened and the eggs were collected and taken to the Santo Domingo Zoo, after having incubated two thirds of their required time (a mean of 60 days). Once they arrived at the zoo, they were measured and weighed and checked for overall shell appearance. Then they were handed over to the zoo personnel. They were kept in an incubation room until they hatched.

Since 1993 was a good year for the crocodiles, in terms of reproduction and stabilization of the population, the "Executive Council" decided for 1994, not to take eggs or neonates to the zoo, but to evacuate them from nesting beaches, especially on the islands, to freshwater habitat on the mainland. In April and May 1994 255 neonates found on their nesting beaches were captured and taken to the mainland, where they were measured, weighed and individually marked by cutting the tail scutes according to a prearranged code. They were released in freshwater habitats along the northern and northwestern shore on the same day or a day later in four different localities.

At the same time we started a capture - recapture program with neonates and juveniles. In May and June 1994 this program focused on the neonates that hatched in the Azufrada area. They were either caught the day after hatching or some days later. After a break of three months, the capture - recapture program continued in September. Juveniles from 1993 and 1994 were caught, measured, weighed, sexed, marked and released immediately. Their position was mapped on small-scale maps (scale 1:20,000 m and 1:10,000 m).

RESULTS AND DISCUSSION

Nesting. In Lago Enriquillo nesting activities generally begin in January or February. Most females frequently visit the beaches to select their future nesting site. All nests are hole nests, excavated in the sand. Mean number of eggs is 22 per nest. The smallest nest recorded had nine eggs, the biggest 36. Clutch size does not vary significantly between years or between nesting beaches.

According to Fig. 2, the number of nests varied greatly between 1990 and 1996. Due to severe human impacts only four nests were found in 1992. In 1993 and 94 the number of nests went up to 36 and 48 respectively, then dropped again in 1995 to only 14 nests (SEA/DVS 1994b and 1995b). This year we have located 30 nests so far, and we estimate a total of at least 40 nests for 1996.

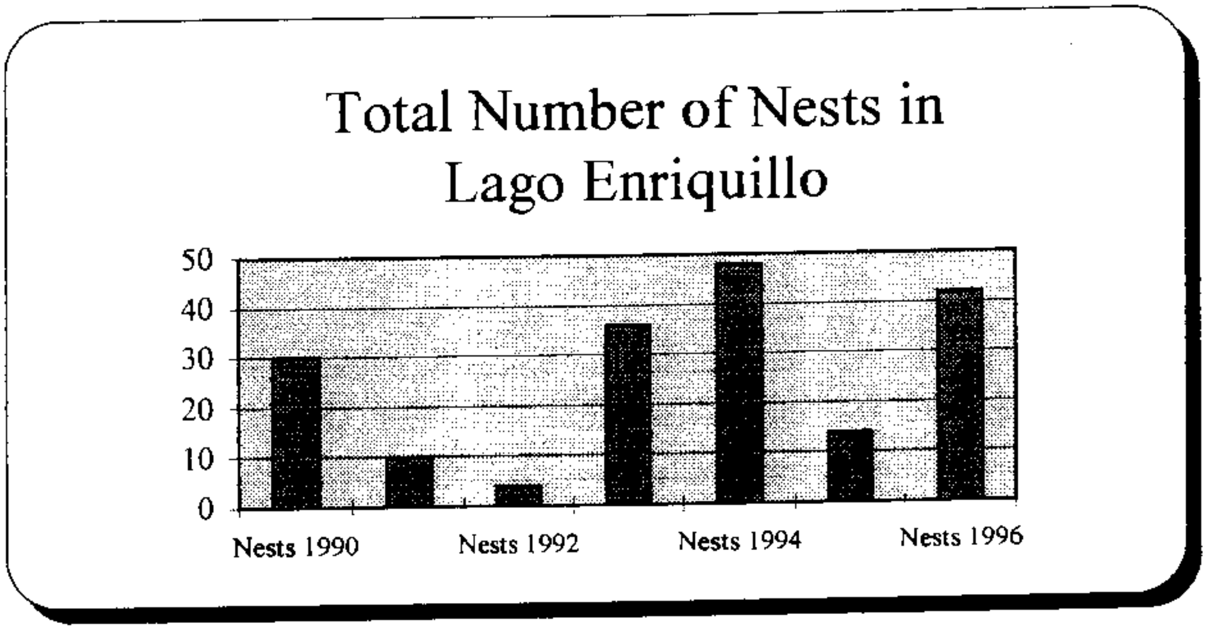

Fig. 2: Number of nest in the years 1990 through 1996. The 1996 number is estimated, based on 30 nest found after laying.

Nesting beaches. Some 32 km or 30% of Lago Enriquillo's coastline are sandy beaches. However less than 5 km are used for nesting. There are seven major nesting beaches in Lago Enriquillo, five of them of high importance with more than three nests per year and two of lesser importance. In two further beaches nesting was recorded on only one occasion. Four nesting beaches are situated on the islands. In the last five years a little more than half of the nests were found on island beaches. From these beaches the neonates have to cross up to ten km of the hypersaline lake to get to freshwater habitat on the mainland.

We assume that mainly human disturbances are the reason why Lago Enriquillo crocodiles tend to choose the islands for nesting. Killings of crocodiles and egg-robbing were common before conservation measures were taken. On the islands, especially on Isla Cabritos, human access is very limited.

Due to the very low reproduction success in 1992, the Executive Council decided to take eggs to the Santo Domingo Zoo for artificial incubation in a head-starting program. In April and May 1993 eight nests (22% of total) with 178 eggs plus 53 already hatched neonates were taken to the zoo. At the end of 1993 the zoo had some 130 juvenile *Crocodylus acutus* in captivity. The head-starting program failed completely. In 1995 a change of the zoo director led to severe internal problems, causing the death of many zoo animals (see also last CSG Newsletter). More than half of the crocodiles died and the rest are probably in a very delicate state of health.

In April and May 1994 255 neonates found on their nesting beaches were taken to the mainland, only 42 neonates were left on the beach where they had hatched. Visiting the same beach a day later we found that they had disappeared. In 1995 it was agreed not to evacuate any neonates, however, due to a misunderstanding by the park rangers 53 neonates were captured and taken to the mainland. Only 9 stayed on the nesting beaches. We estimate a total of 250 crocodiles hatched for 1995.

In May and June 1994 the capture and recapture rates showed that neonates were moving west towards an area with dense cattail stands and a high abundance of freshwater. They were using small freshwater ponds along the coast to hide during the daytime. On several occasions an adult crocodile, presumably the mother, was seen in the lake next to the little ponds. On one occasion the mother was even in the pond, hiding in the mud: one of us almost stepped on her.

Between September 1994 and March 1995 a stretch of about 4 km of coastline of major importance for the juveniles was patrolled monthly, ten juveniles or more were caught during each visit, all juveniles seen were registered and their position was mapped. The same activity was repeated between September 1995 and January 96. However, this time it was much more difficult to catch the juveniles, due to increased wariness. Only a mean of two animals per patrol was obtained.

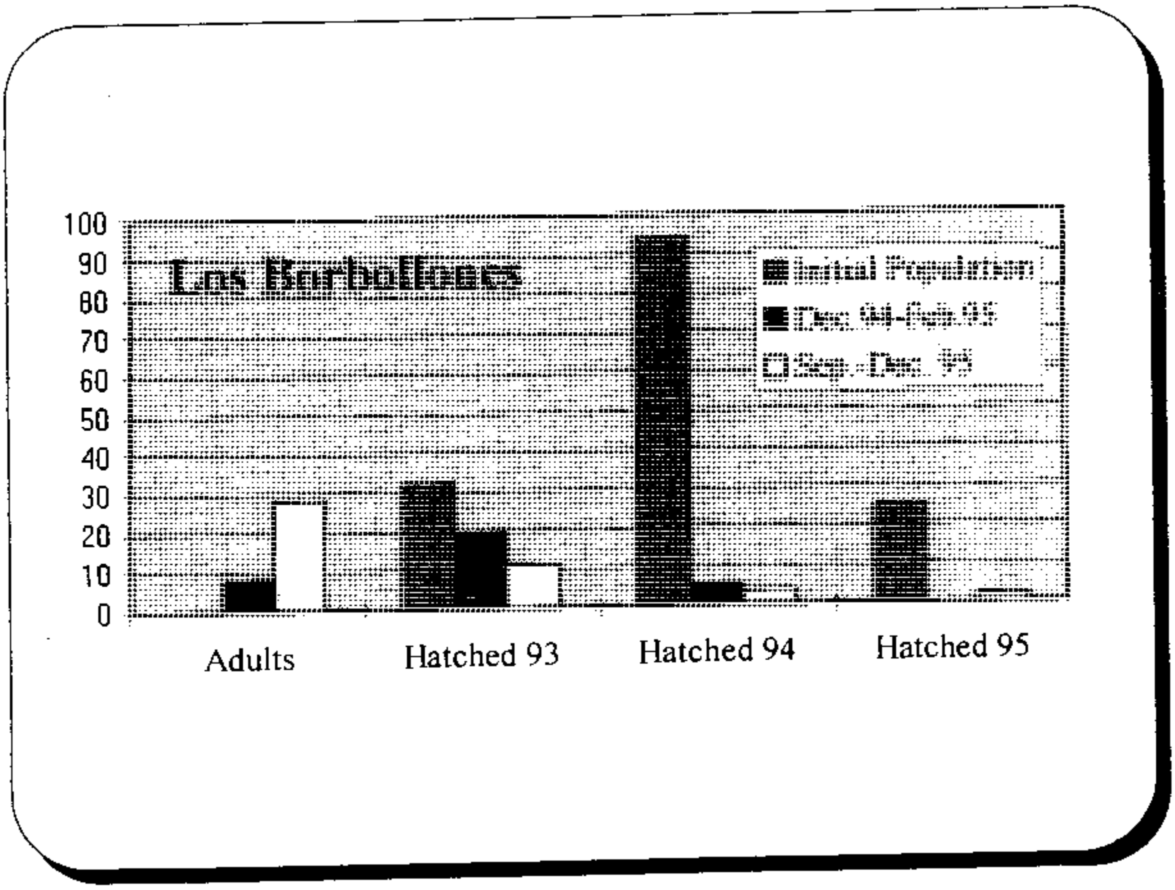

Fig. 3: Abundance of different year-classes in Los Borbollones.

Los Borbollones is one of the areas patrolled regularly. On a stretch of 1 km there are many freshwater springs that drain into the lake. Los Borbollones is an important site for adults who presumably stay here for some days to osmoregulate and, to a lesser degree, to nest (a mean of two nests per year). The streams that drain the springs and the brackish water along the shore form important habitat for neonates and juveniles. Fig. 3 shows the initial amount of neonates in Los Borbollones for each year class, as well as its abundance in Dec. '94 through Feb. '95 and for Sept. '95 through Jan. '96. While the 1993 born crocodiles diminished slowly, numbers for 1994 and 95 decreased drastically within the first months. The principal cause for this decrease is probably a very high mortality rate, rather than a high rate of migration. Even though juveniles were recorded to migrate distances of up to 3.6 km within two weeks, most of them stay in the same locality for many months. A 1993 juvenile, radio-tracked since January 1996 apparently has a rather small home range (less than 2 km of coast line).

However, it is important to point out that only a fraction of the juveniles are seen. In April and May 1994 some 82 marked neonates were released in the Borbollones area. Between September 1994 and March 1996 we captured 24 of them, corresponding to 19.5%. Another eight unmarked juveniles of the 94 age class were captured, so the relation marked : unmarked was 2 : 1. The unmarked animals came either from one of the two Borbollones nests or were brought to the area from other nesting beaches by their mother.

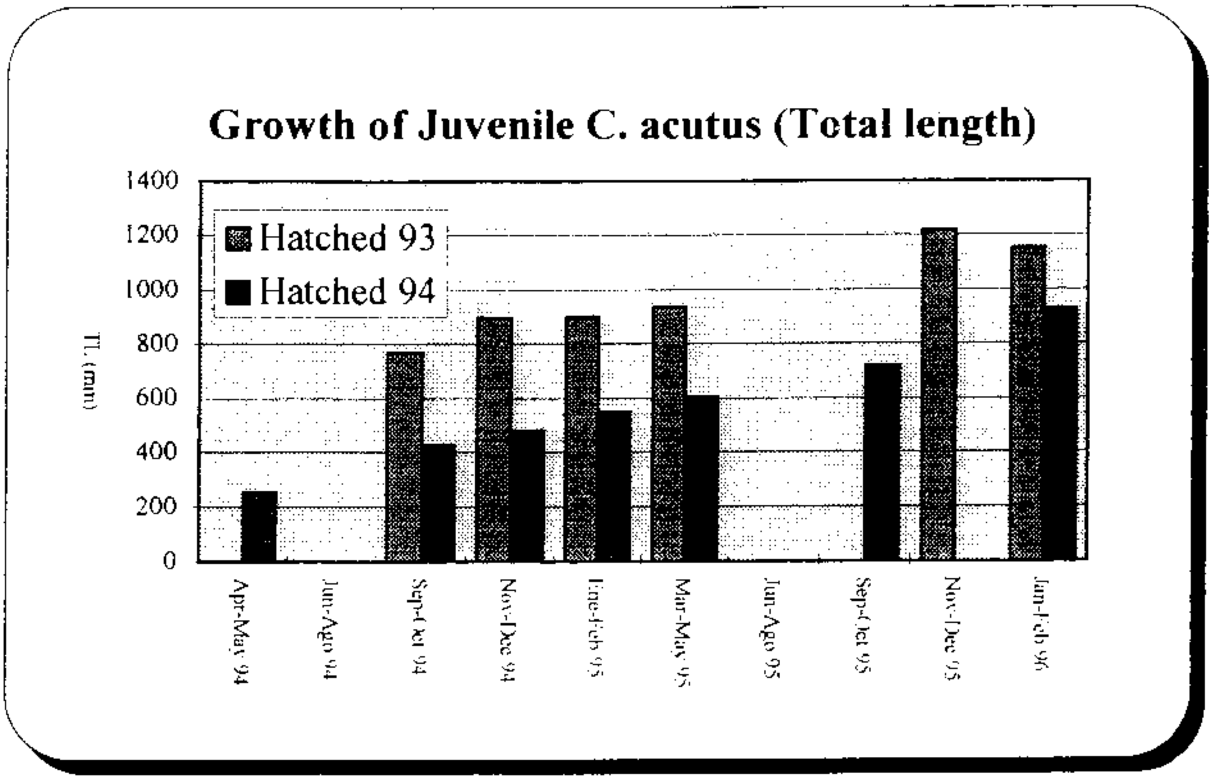

Fig. 4: Growth of C. acutus juveniles in mm per month (total length)

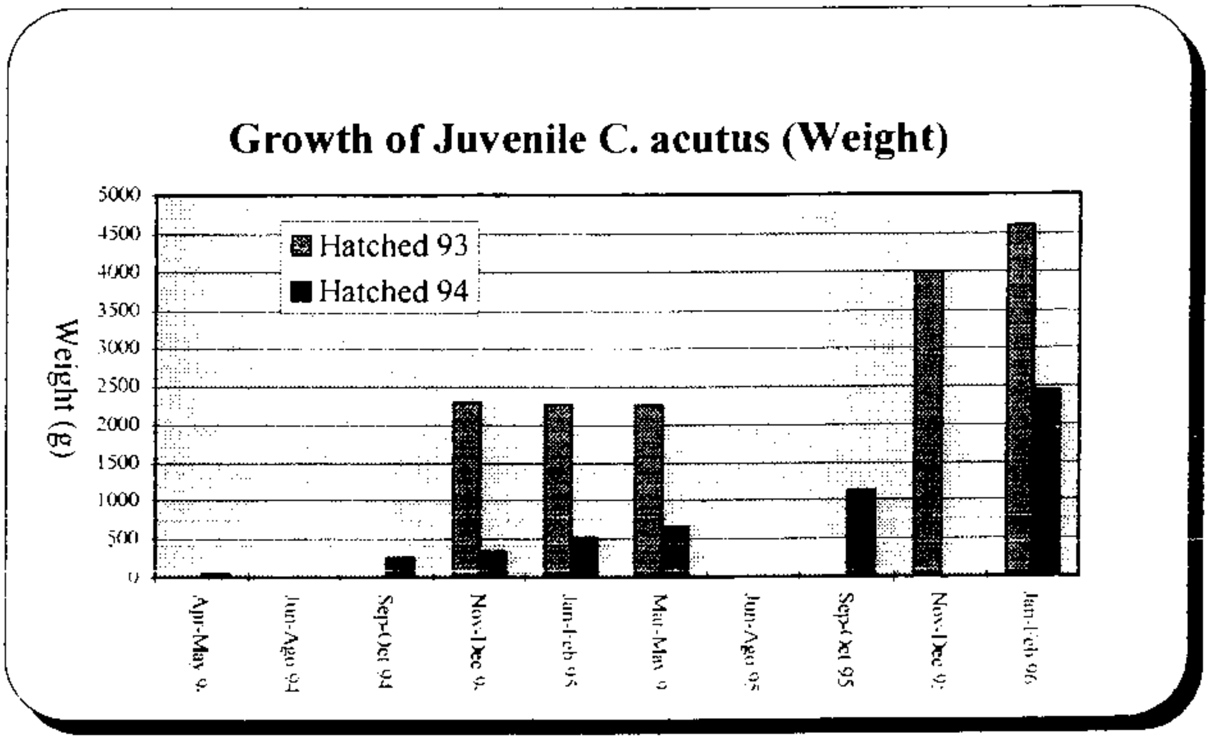

Fig. 4: Growth of C. *acutus* juveniles in grams (g) per month

Growth. Figures 4 and 5 show the mean total length and weight of juveniles hatched in 1993 and 94. In their first year, the total body length of both age classes increased by 30 to 35 mm per month. First-year neonates gained 63 g monthly, while second-year neonates gained almost 200 g per month. The 1993 hatchlings showed some cutback in their growth between November 94 and May 95. Their mean length and weight stagnated. Some individuals even lost weight (150 and 220 g per month). This stagnation might have been related to a rapidly lowering lake level and drying out of freshwater swamps next to the lake after August 1994. However the lake keeps shrinking but the juveniles are growing and gaining weight again.

The juveniles that were raised in the Santo Domingo Zoo (head-starting) were measured May 15 of 1995, when they were exactly two years old. Their mean total length was 532 (64) mm, corresponding to a growth rate of 11.5 mm per year or one third of the growth rate in Lago Enriquillo. They had a mean weight of 428 (171) g. This means they had gained weight by 15.5 g per month or one quarter that of Lago Enriquillo. We processed 103 juveniles, just before the severe problems in the zoo started. Originally some 130 neonates, forming part of the head-starting program were registered in the zoo at the end of 1993.

CONCLUSIONS

The head-starting program had failed for reasons that could not have been foreseen nor was there a chance for the conservation community to influence the proceedings. Fortunately the Lago Enriquillo *Crocodylus acutus* population was not as depleted as it seemed in 1992/93.

The success of translocating hatchlings from nesting beaches to freshwater habitat has not been thoroughly evaluated yet. We are not sure if first year mortality was reduced significantly by translocating the neonates. Post-hatching care in the Lago Enriquillo *Crocodylus acutus* population might be more important than was previously credited.

On different occasions we saw crocodiles with up to six hatchling in their mouths swimming along the shore or even taking off from a nesting beach on the island. We have evidence that a mother removes neonates and hatching eggs from the nest and takes them to the lakeshore, where she hides them under rocks, in shallow pools or in the foam that is produced by wave action. Then she takes them to freshwater habitat. At least twice we saw female crocodiles staying next to their hatchlings for more than two months. This phenomenon was also recorded on video. In 1995 we observed the mother of one of the nests whose neonates were evacuated to check on its nest almost every night for over a month, before finally giving up.

ACKNOWLEDGMENTS

We would like to thank the Departamento de Vida Silvestre of the Secretary of Agriculture and the National Park Directorate, especially their directors and all involved wildlife inspectors and park rangers for the great effort to establish and maintain the conservation activities concerning the Lago Enriquillo crocodile population. We also would like to thank the ex staff members of the Santo Domingo Zoo. The US Peace Corps and the German Service for Development (DED) provided technical help, the latter also gave very important financial support. Additional project activities are supported by the Swiss Development Agency HELVETAS and by the Wildlife Conservation Society. The IUCN Crocodile Specialist Group has always been concerned about the situation of the crocodiles in Lago Enriquillo.

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Population Dynamics and Conservation Strategies for Crocodylus acutus in Bahía Portete, Colombia.

Gerardo Abadía

Bahía Portete is located in the northern most part of Colombia, in the Guajira Peninsula on the Atlantic coast. Portete is a fairly small bay with consistent salinity values of 40 ppth., typified by a shallow coral reef formation on its West side, and a mangrove ecosystem South and East, which is home to a wild Crocodylus acutus population.

Since 1981, the construction of a big sea port for the exportation of coal has been under way and finally started operation in 1985. In addition to the sea port, there are two other human settlements: Puerto Nuevo and Puerto Portete both of which provide a place to unload merchandise coming from Aruba and Panama in small ships, as well as a place to live for an increasing community of fishermen.

Crocodylus acutus was formerly very abundant throughout its distribution range covering southern U.S.A., Mexico, Guatemala, El Salvador, Belize, Honduras, Nicaragua, Costa Rica, Panama, Jamaica, Haiti, Dominican Republic, Colombia, Venezuela, Ecuador and Peru (Powwel, 1971). However due to the value of their hides, commercial hunting has wiped out most of the world's crocodile populations.

Crocodylus acutus was common in Colombia along the Magdalena Basin and on both the Atlantic and Pacific coasts, but due to commercial and local hunting, habitat destruction, irrigation projects for both agriculture and ranching and the fear of people, crocodile numbers have declined to a minimum (Medem, 1981). Crocodylus acutus is protected in Colombia by Resolución No. 573 of July 24th, 1969.

Crocodylus acutus in Bahía Portete is an isolated wild crocodile population with no migration or recruitment rates and therefore offers ideal conditions for the study of the population dynamics of the species. The fact that there are very few crocodiles left and their important role within the food-chain (Fittkau, 1970; Craighead, 1967; Fittkau, 1973; Kushland, 1974) makes it worth the effort for their conservation.

MATERIALS AND METHODS

A population estimate is not a census. Censi are very seldom carried out because they are time-consuming and expensive. Population estimates are based on direct observation of the animals during the day at their basking sites or during night counts. Usually an index as an account related to the animals presence (such as tracks, sand bank slides, nests, droppings or vocalizations) is also used (Davis and Winstead, 1987).

The Crocodylus acutus population in Bahía Portete has been monitored since November 1981.

Between 1979 and 1981 this population was subject to extensive commercial hunting. The total number of animals taken could not be determined. Two or three crocodiles were shot each night and their hides sold on the black market. By 1982 the commercial hunting ceased due to the low number of remaining crocodiles.

Between November 1992 and January 1993 a new study of the crocodile population was carried out in Bahía Portete. In total 8.8 kms. of beach and mangroves were inspected on foot and 25 hours of nocturnal surveys were completed by boat over a transect of 22 kms which was repeated six times. A Nauticol inflatable boat with an Evinrude Super 25 outboard engine was used whenever possible, and an Indian canoe was used when navigation became too difficult. An AUTOMAR Long Range Mod. 453 lamp and a 100 Watts DENJI lamp were used during night counts along with two Winchester headlights. Later, in 1996, a Frezzolini 30 Volt Spot Lite lamp and a 500,000 CP Cordless Lectronic Science Inc. lamp were both added as basic equipment during night counts. A temperature-compensated Reichert-Jung refractometer was used to determine water salinity.

RESULTS

In 1992, night surveys revealed between 2 and 11 (mean 7) individuals in the 22 kms transect with only 2 individuals over six feet total length. Counts of tracks and sand bank slides indicated similar numbers and range of sizes in the area. Extrapolation of the survey data suggests a population of around 140 individuals with the great majority in size classes of one to six feet total length.

Ogden (1978) and Chabreck (1966) have both used the number of nests to estimate total populations of Crocodylus acutus and Alligator mississippiensis. When using their formula for six nests found in Bahía Portete, the total crocodile population ranges between 120 and 150 individuals.

In 1996, 90 hours have been accumulated in close contact with the crocodile populations of Bahía Portete and Caño Lagarto. Data collected so far suggests that the population shows stability but lacks apparent increase.

Hunt (1990), Messel and Vorlicek (1987) and Webb and Smith (1987) have all reported aggressive behavior of adults towards juveniles and sub-adults which are forced to leave the place where they were born. Adult Crocodylus acutus in Bahía Portete occupy the breeding grounds within the network of channels and lagoons deep inside the mangroves, whereas the smaller size classes are displaced to the margins of the mangroves and more open areas, where they are frequently caught in fishermen's nets. In addition to this, since 1993 smaller size crocodiles living near Puerto Portete have been forced to move further west (Gregoria Fonseca per. com.) as they are being hunted by local fishermen, all of whom carry a harpoon in their boats.

THE HUMAN FACTOR

The construction of the sea port for the exportation of coal meant the arrival of a great number of local Wayuu Indians hoping they would be hired by the coal company. This eventually created a very poor suburb when they decided to stay despite the harsh local conditions and a lack of work opportunities. These people have since turned to the sea as their only source of food, creating an over-exploitation of marine resources and imposing a serious threat upon the crocodile population.

In 1992, there was little interest among local people for crocodile hunting or egg consuming. However, a few hides were taken and sold in the market.

Although Wayuu Indians are not particularly fond of crocodile meat, they are eager to eat adult crocodile meat as a source of protein if other food is scarce. They find hatchling and juvenile flesh disgusting.

Since 1992, an increasing number of juveniles have been drowned when tangled in fishermen's nets. These crocodiles are never skinned but their carcasses are found minus both the skull and the tail. The meat from the tail is eaten whereas the skull is used for witch-craft. To avoid being misused in witch-craft, Indians will bury all crocodile skulls making it extremely difficult to collect skulls for scientific purposes. There is a strong belief that the strength and power of the crocodile can be obtained if the skull is ground, toasted and eaten. If buried close to the water-hole of an enemy, it will eventually render the water-hole useless. Crocodile skulls are also thought to heal wounds if their ashes are rubbed against the injured tissues. Crocodile fat is used against intestinal worms and is also considered to stimulate sexual arousal in men.

On the other hand it is of increasing concern that at present the channel leading to the breeding grounds has been well trimmed with machetes by the Indians to make access to the breeding stock very easy, whereas the channel used to be inaccessible and its navigation burdensome. Two adult crocodiles measuring 275 cms and 180 cms have already been taken away from the breeding site and slaughtered for their hides. Crocodile hides are sold for a nonsensical 25,000 pesos (US $ 25). Within a population with only six nesting females, killing one of these means cutting reproductive potential by 17%. The total number of nests in Bahía Portete for 1996 has not yet been completed and remains unknown.

NOTES ON REPRODUCTION

Crocodylus acutus in Bahía Portete will start nesting in late April or early May. Females will build four or five nests prior to egg laying. Clutch size will range from 19 to 41 eggs. No sand beaches in Bahía Portete are suitable for crocodile nesting, therefore females will nest in rocky beaches under desert vegetation. The roots of cactus and shrubs will keep the rocks and pebbles tightly packed and prevent the nest chamber from collapsing. The added benefit of building a nest under tight bushes is that the eggs are protected from over-heating. Females will not lay their eggs in the same spot every year but they will definitely nest in the same area and stick to their territory year round.

A couple of weeks prior to egg laying, females will come out to the breeding grounds and completely cover the beach with crocodile tracks and fake nests.

Not only is human predation of nests common in Bahía Portete, which accounts for 30% average egg loss, but so is predation by wild foxes and raccoons, Procyon lotor and Procyon cancrivorus. To cut down on such egg losses a strong smelling disinfectant solution is poured over the nests to confuse the sense of smell of the predators.

CROCODILE BEHAVIOR

It has often been said that larger, older crocodiles are much more wary than younger animals. Robert Bustard demonstrated the crocodiles' ability to learn and avoid being recaptured (Bustard, 1968). In Bahía Portete a 3 foot long crocodile was swept away from the mangroves by the sea currents and ended up by the sea port. This animal cannot be approached whereas adult crocodiles at the breeding site have gotten used to human presence, will respond to the sound of a whistle and have been hand fed.

CONSERVATION

A conservation strategy for Bahía Portete needs to give the live crocodile an economic value greater than a dead crocodile. It is basically two men and their families who are well acquainted with crocodile hunting and they can easily be converted from poachers to conservationists if they are paid more for preserving the crocodile population rather than killing the animals. If any of these Indians sell a crocodile hide for US $25, but spend US $5 in salt and transportation, in addition to his time and effort, his net profit is US $20 for each animal. If he were paid this US $20 for ensuring the yearly survival of each adult crocodile under his care, he would not only save himself a lot of trouble, but he would assure a yearly income on the basis of preserving natural resources. A continued monitoring of the crocodile population is then mandatory and so is protection of vital nesting areas, not only during the nesting season but year-round since these are home for the brood stock which will remain in their territories.

ACKNOWLEDGMENTS

This work was supported by a contract with INTERCOR-CARBOCOL (TEC.IA.024.92) in 1992 and a grant from Fondo FEN Colombia and the McArthur Foundation in 1996. I am also indebted to Dr. Felipe Guhl and Dr. Henry Von Prahl (†) from Universidad de los Andes for their earlier support to the project back in 1981.

I wish to thank Pilar Vásquez, Jorge Velásquez and Ricardo Melendro from INTERCOR as well as Angel Guarnizo and Eduardo Guerrero from Fondo FEN. Miguel Paz and Carlos Díaz have both assisted me in the field.

I wish to take this opportunity as well to thank Dr. Wayne King and Dr. James Perran Ross from the University of Florida, Hernando Zambrano from the Ministerio del Medio Ambiente and Arturo Liévano from Azoocol for their concern and support and finally, I also wish to thank Mr. Alastair Turton for his personal cooperation and tolerance in the course of my latest work.

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Preliminary Assessment of the Status of the American Crocodile (Crocodylus acutus) in the Coastal Zone of Belize.

Steven G. Platt [1] and John Thorbjarnarson [2]

ABSTRACT

The status of the American crocodile (Crocodylus acutus) in Belize remains poorly known. Commercial over-exploitation decimated populations prior to protection in 1981, and recent survey data are lacking. Spotlight surveys were conducted in 1994 and 1995, of Turneffe Atoll, Maps Cay, and northern Ambergris Cay. A total of 187.8 km were surveyed and 86 crocodiles observed (0.45 crocodiles/km). These results indicate significant crocodile populations are present at all three localities. Evidence of nesting was found at three sites in the Turneffe Atoll and on a spoilbank near Maps Cay. Raccoons (Procyon lotor) are a major nest predator. Suitable nesting beaches are limited, and while some illegal killing is occurring, the greatest threat to the continued viability of crocodile populations appears to be development of these beaches. The distribution and status of the American crocodile on the mainland, where it occurs sympatrically with Morelet's crocodile (C. moreletii) remain largely unknown. As part of a comprehensive coastal zone management plan, a survey of the entire coastal zone is planned for 1996-97 to determine present population status and identify critical habitat.

INTRODUCTION

The American crocodile (Crocodylus acutus) is one of two species of crocodiles which occur in Belize. The American crocodile is a medium to large crocodile found in coastal habitats and offshore islands, while Morelet's crocodile (C. moreletii) is a somewhat smaller species inhabiting inland freshwater wetlands. Both species are currently listed as endangered under the United States Endangered Species Act and are on Appendix I of CITES (Convention on Trade in Endangered Species of Flora and Fauna) treaty (Thorbjarnarson, 1992). Surveys of the American crocodile in Belize have been accorded high priority by the IUCN/SSC Crocodile Specialist Group (Thorbjarnarson, 1992).

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Commercial crocodile hunting began in Belize during the late 1930's and 1940's, as the importance of forest products in the local economy declined (Hope and Abercrombie, 1986). Subsequent over-harvesting led to depletion of both C. acutus and C. moreletii populations (Charnock-Wilson, 1970). Crocodile skins were sold to buyers in villages and larger towns, and after progressing through a chain of middlemen, exported to Europe for processing (Abercrombie et al., 1982; Hope and Abercrombie, 1986). Unfortunately quantitative survey data from this period are lacking, and the practice of categorizing both spotted cat and crocodile skins as simply "hides and skins" in government trade statistics makes it difficult to determine past levels of exploitation (Frost, 1974; Abercrombie et al., 1982; Hope and Abercrombie, 1986). Furthermore, a considerable number of crocodiles were shot by sport hunters and members of the British garrison, and an unknown number of skins were exported illegally (Charnock-Wilson, 1970).

By the 1960's both C. acutus and C. moreletii were nearly extirpated from Belize (Charnock-Wilson,1970). Neill and Allen (1961) reported the collection of a single juvenile C. acutus from a mangrove swamp in Belize City and considered the species rare. Powell (1971) concluded American crocodiles were present on some offshore cays (islands), but extinct on the mainland, and King et al. (1982) noted some island populations had also been eliminated. C. acutus was afforded legal protection under the Wildlife Protection Act of 1981 (Marin, 1981).

The current status of the American crocodile remains poorly known and survey data are lacking. The largest remaining population in Belize may occur in the Turneffe Atoll (Thorbjarnarson, 1992). C. acutus is also present on Cay Caulker (Meerman, 1993), and in mainland coastal lagoons of Shipstern Nature Reserve (Meerman, 1992; Ouboter, 1992). Additional reports by fishermen and others indicate American crocodiles occur widely on offshore islands throughout the coastal zone of Belize. Distributional records are summarized in Table 1. Perkins (1983) estimated a country-wide population as high as 10,000 to 20,000 animals, but these numbers must be considered somewhat speculative. The objective of this project was to obtain preliminary data on the status of the American crocodile, and provide conservation recommendations based on these findings.

STUDY AREA

The coastal zone of Belize includes three atolls, over 200 offshore islands, and extensive mainland swamps. The Belize barrier reef extends the entire length of the 325 km coastline from Ambergris Cay in the north to the Gulf of Honduras in the south, and is separated from the mainland by a narrow stretch of shallow water known as the inner channel. Both mainland and offshore coastal habitats are dominated by red mangrove (Rhizophora mangle), with black mangrove (Avicennia germinans) swamps occurring in some hypersaline areas. Elevated beach ridges are dominated by beach thicket and cay forest associations (Minty et al., 1995). Crocodile surveys were conducted at three localities in the coastal zone: Turneffe Atoll, the Bacalar Chico region of northern Ambergris Cay, and Maps Cay (Figure 1).

1. Turneffe Atoll - This atoll, located approximately 30 km southeast of Belize City, is the largest of three coral atolls found on the barrier reef of Belize, and one of only four atolls in the western hemisphere. Turneffe Atoll is approximately 50 km long and 16 km wide with an estimated surface area of 533 km^2. The atoll consists of a chain of islands partially enclosing three shallow lagoons: Southern Lagoon, Central Lagoon, and Northern or Vincent's Lagoon. A near continuous beach ridge extends along the windward side of the atoll (Figure 2). Maximum elevation is about 1.5 m above sea level (Perkins, 1983).

With the exception of three tourist resorts most of the atoll remains undeveloped. Turneffe Island Lodge is located at the southern end of the atoll on Cay Bokel, and Blackbird Cay Resort and Turneffe Flats Lodge are located at the southern and northern ends, respectively, of Blackbird Cay. Coral Cay Conservation/University College of Belize have established a research center on Calabash Cay. Small fishing camps are scattered throughout the atoll. The atoll is under increasing pressure for development and the construction of several additional tourist facilities has been proposed. A draft development plan was recently compiled to address conflicting land-use issues (Turneffe Island Development Committee, 1995).

2. Bacalar Chico National Park (proposed) - The Bacalar Chico region of northern Ambergris Cay has recently been proposed as a National Park. This area encompasses significant terrestrial, mangrove, and marine habitats (Dotherow, 1995). Elevated ridges surround a system of open water lagoons and red mangrove swamps.

Some residential development has occurred on beach ridges along the windward side of the cay (Figure 3).

3. Maps Cay - A cluster of low-lying, offshore mangrove cays within the inner channel, approximately 7 km east of Belize City. An elevated beach ridge extends along the windward shore of the cay where a small tourist lodge and several fishing camps are located. A network of deep lagoons are found in the interior of the cay, and a spoilbank extends ca. 50 m along a dredged channel on the leeward side of the cay.

METHODS

Spotlight surveys were used as an index of crocodile densities (Bayliss, 1987). This technique is used in crocodile surveys worldwide and other methods of population estimation have confirmed its validity. Spotlight surveys were conducted from a motorboat propelled slowly along the shoreline, using a handheld Q-beam spotlight (250,000 candlepower) and auxiliary 12-volt headlights. Areas not accessible to motorboats were surveyed by canoe. Crocodiles were located by noting eyeshine reflections in lightbeams and classified according to their estimated total length (TL) as juveniles (TL < 90 cm), subadults (TL = 90 - 150 cm), or adults (TL > 150 cm). Crocodiles that could not be approached close enough to estimate total length were classified as "eyeshine only". Distance travelled in each survey was calculated with a cartometer using maps and aerial photographs provided by Coral Cay Conservation. Crocodile densities were calculated as the number of crocodiles observed per kilometer of survey route, allowing quantitative comparison with other survey data. Maps of survey routes were deposited with the Coastal Zone Management Unit, Department of Fisheries, Belize City, Belize.

Daylight reconnaissance was conducted along some proposed routes to determine feasibility, locate possible hazards, and search for nesting habitat. Potential nesting habitat was identified by noting the presence of indicator plant species such as paurotis palms (Paurotis wrightii) and coconut palms (Cocos nucifera). These plants are restricted to well-drained beach ridges, and these habitats were searched for the presence of nest mounds, excavations, eggshells and fragments, and unhatched eggs. Eggshells and unhatched eggs were counted to estimate clutch size. In areas where nests were found, physical characteristics of the site were noted. Coordinates of nesting beaches in Turneffe

Atoll were obtained with a Sony Pixis IPS-360 Global Positioning System (GPS). Fishermen were interviewed when encountered and questioned about the presence of crocodiles and possible nesting areas.

RESULTS AND DISCUSSION

Population Surveys

Turneffe Atoll

Fieldwork was conducted from 22 May to 2 June, 26 to 30 June, and 1 October to 6 October 1994, and 15 to 22 June 1995. Due to the difficulties of maneuvering boats over the reef after nightfall, most areas surveyed were on the leeward side of islands, and in sheltered creeks and lagoons. Most crocodiles were observed in shallow water along red mangrove shorelines sheltered from prevailing easterly winds. Survey results are presented in Table 2. In general, populations of low to moderate density were found in Turneffe Atoll. A total of 67 crocodiles were observed and 132.2 km were surveyed. A mean of 0.50 crocodiles/km of survey route was calculated from all surveys. However, relatively high densities of crocodiles were found at the southern and northern ends of Calabash Cay (3.0 and 2.0 crocodiles/km respectively), and along the windward shore of Blackbird Cay (2.8 crocodiles/km). Moderate densities of crocodiles were noted in Soldier Bight-Blackbird Cay (0.71 crocodiles/ km), Northern Lagoon (0.70 crocodiles/km), and along the leeward side of the atoll from Northern Lagoon to Crikozeen Creek (0.83 crocodiles/km). Low densities (0.08 - 0.46 crocodiles/km) were found in most other areas.

Crocodiles observed at the southern end of Calabash Cay were in a network of small mangrove creeks and lagoons, and in the vicinity of a fishing camp. These animals may have been attracted by fish remains discarded from the camp. An unusual congregation of subadult crocodiles was noted along an exposed beach on the windward shore of Blackbird Cay. Crocodiles usually prefer sheltered waters free from wave action (Thorbjarnarson, 1989) and the presence of these animals was surprising. The gradually sloping gradient of this beach probably offers good foraging habitat, and the barrier reef affords protection from significant wave action. Thorbjarnarson (1989) stated intermediate size classes (TL = 1.0 - 2.0 m) may be more frequently found in these marginal habitats. Most crocodiles observed along the leeward side of the atoll were foraging in turtlegrass (Thalassia testudinum) which forms dense beds in shallow water and supports large schools of fish and aquatic invertebrates.

The size-class distribution of crocodiles recorded in the Turneffe Atoll is presented in Table 4. Juveniles (5.9%) are probably under-represented as they probably avoid open water and remain among flooded mangroves where they are less visible during spotlight counts. Subadults (41.7%) were the size class most frequently observed and were encountered in most areas surveyed. Adults (23.8%) and "eyeshine only" (28.3%) comprised the remainder. The largest concentration of adult crocodiles was noted in the vicinity of Blackbird and Northern Cays and may reflect the proximity of nesting habitat. Crocodiles tend to become increasingly wary with age and many of the eyeshines recorded likely represent adult crocodiles which submerged before they could be approached close enough for size-class identification. The percentage of adult crocodiles observed in the Turneffe Atoll is comparable to population data from the Everglades, Florida, USA (24.5%) and Turkey Point, Florida, USA (25.0%), but higher than Etang Saumatre, Haiti (15.7%). However, size-class limits vary somewhat making comparisons difficult (Thorbjarnarson, 1989).

Bacalar Chico

Fieldwork was conducted from 27 June to 1 July 1995. Survey results are presented in Table 3. A total of eight crocodiles were observed and 42.7 km surveyed. A mean of 0.18 crocodiles/km of survey route was calculated from all surveys. However, all crocodiles were encountered in mangrove swamps, creeks, and lagoons, and none were observed along the windward or leeward shoreline of Ambergris Cay. If these shorelines are excluded, the result is a mean of 0.39 crocodiles/km of survey route, comparable to low-density populations noted in some areas of Turneffe Atoll.

The size-class distribution of crocodiles recorded in Bacalar Chico is presented in Table 4. Juveniles comprised 50% of all sightings, subadults 25%, and adults and "eyeshine only" each 12.5%. Because of the small number of crocodiles observed, these results should be interpreted with caution.

Maps Cay

A single spotlight survey was conducted on 21 July 1994. Eleven crocodiles were observed along 12.9 km of shoreline (0.85 crocodiles/km). The size-class distribution is presented in Table 4. All crocodiles were observed along an exposed shoreline on the windward side of the cay, and because of shallow inshore waters, most could not be approached closely enough to determine size.

Coastal Mainland

Determination of the status and distribution of the American crocodile in mainland coastal habitats is complicated by the presence of C. moreletii. These two species are morphologically very similar, identification is difficult in the field, and often requires capturing crocodiles (Platt,1996). Ouboter (1992) and Meerman (1992) found both species present in mainland lagoons in Shipstern Nature Reserve. The skull of an American crocodile that drowned in a fishing net in Southern Lagoon was examined in 1994. Drag marks and tracks of what was probably an American crocodile were also observed south of Southern Lagoon, leading from a brackish swamp, over the beach, and into the open ocean. Zisman (1989) listed American crocodiles as present in both Northern and Southern Lagoons, but the source of these records is unknown. Further surveys of mainland coastal lagoons are warranted.

Crocodiles with characteristics of both C. moreletii and C. acutus have been reported from coastal regions of Belize (Schmidt, 1924; Abercrombie et al., 1980), and an animal we collected in Kates Lagoon exhibited a C. acutus-like dorsal scale pattern. These animals typically exhibit a reduced number of dorsal scales in each transverse row, and reduced or absent caudal irregularities. Ross and Mayer (1983) suggest hybridization may occur between the two species, and Ross and Ross (1974) found C. moreletii traits in C. acutus only where the two species are sympatric. The situation regarding hybridization remains unresolved and must await application of molecular genetic techniques.

Nesting

Turneffe Atoll

Three nesting areas were located during this survey. The first site is located on the leeward side of Blackbird Cay 1 km south of Turneffe Flats Resort (N 17° 25' 33.1", W

87° 49' 24.0") on an elevated sandy ridge approximately 20 m long. The vegetation corresponds to the broken palmetto thicket association which occurs on drained peat and organic sand (Minty et al., 1995). In 1994 two nests were located. One nest was a large mound of sand (ca. 30 cm high) and the other a hole nest. In 1995 a hole nest that appeared to have been opened by raccoons (Procyon lotor) and three eggshells were found. Additional nesting habitat was found in this vicinity, and Greg Smith (pers. comm.) reported finding a nest closer to Turneffe Flats Resort several years ago. However, an intensive search of this area failed to locate further evidence of recent nesting activity.

The second and most extensive nesting site is located on Northern Cay ca. 8.3 km north of Turneffe Flats Resort (17° 29' 35.3" N, 87° 47' 06.9"W). This site (corresponding to Site 17/26 of Minty et al., 1995) is an elevated beach ridge on the windward side of the cay , composed of well-drained organic sand, and dominated by beach thicket and coconut palms. A hypersaline black mangrove lagoon of about 1.0 ha is located behind the beach. A search in 1994 revealed five recent, and three to four pre-1994 nests along a 240 m section of beach. Both mound and hole nests were found. All recent nests appeared to have been successful (producing viable hatchlings) and opened by females. When inspected on 29 June 1994, eggs of two nests appeared to have hatched within the previous two or three days. Hatchlings (20+) were observed in the adjacent lagoon. Return visits to this site were made on 15 and 20 June 1995, but no evidence of nesting activity was noted despite an intensive search and excavation of suspected nest sites. Two crocodiles were observed in the black mangrove lagoon, one of which was a large adult (TL ca. 300 cm).

A third nesting area was located in 1995 on a peninsula on the eastern side of Deadmans Cay (17° 12' 57.4 " N, 87° 51' 49.4" W). The nest was constructed on a beach ridge with a protected cove and red mangrove swamp immediately to the rear. The nest was discovered by the property owner who reported finding 13 eggs buried in a shallow hole. All but four of the eggs were subsequently destroyed by people. The average measurements of the remaining eggs were as follows: length = 74.3 mm (SE = 2.4; n = 4), width = 45.3 mm (SE = 0.9; n = 4) and mass = 87.1 g (SE = 8.1; n = 3). This site may have been an important nesting area in the past. During our first visit (1994) the property owner described finding a clutch of hatching crocodile eggs while clearing his homesite. Since our initial visit, the peninsula has been cleared and a number of tourist cabins constructed This is the only nesting beach that has been located in the southern region of Turneffe Atoll, and it is doubtful that any crocodiles will utilize this site in the future.

Bacalar Chico

Little evidence of nesting was found within the proposed reserve, although this survey was conducted at a time when hatching occurs and nests should have been readily obvious. An excavated hole nest was found on a small (ca. 0.10 ha) island in Santa Cruz Lagoon. The hole measured 40 cm wide x 15 cm deep and was constructed in a substrate of sand and crushed shells. The island is somewhat elevated and supported a sparse growth of hammock hardwoods. Several other islands in Santa Cruz Lagoon appeared to be suitable nesting habitat, but a search revealed no nests.

A ridge, which appears to offer suitable nesting habitat, and extends for about 1.5 km along the western shore of Laguna Cantena was intensively searched, but no sign of nesting activity was found. The ridge is elevated 1.0 m above normal water level, composed of a coarse, well-drained mixture of sand and soil, and borders shallow mangrove lagoons on the leeward side, which appear to be excellent nursery habitat for hatchling crocodiles (Lutz and Dunbar-Cooper, 1984; Thorbjarnarson, 1989). Future visits should be made to this ridge to determine if crocodile nests are present. It is also probable that nesting occurs in areas outside of the proposed reserve. Based on an examination of aerial photographs, suitable nesting habitat is found on Ambergris Cay south of the reserve in Laguna de Cayo Frances and Laguna de San Pedro. Hatchling C. acutus are known to disperse widely when suitable nursery habitat is not available near nests (Ogden, 1978; Mazzotti, 1983). Protection of nesting habitat outside of the reserve may be essential if a viable population is to be maintained.

Maps Cay

A recently hatched nest was found on the leeward side of the cay during a spotlight survey on 21 July 1994. The nest was a hole constructed about 1.0 m above water atop a spoilbank adjacent to a red mangrove swamp, in a mixture of organic peat, shell and coral. Spoilbanks are important nesting habitat in Florida (Gaby et al., 1985). Five eggshells were found in the hole.

Based on eggshells and unhatched eggs recovered at nest sites, an average clutch size of 9.5 (SD = 3.0, n = 7) was estimated. While this is most certainly an underestimate of true clutch size, it is considerably smaller than clutch sizes of 22 to 80 previously reported for the American crocodile in other areas of its range (Thorbjarnarson, 1989), possibly indicating small female size or energetic stress. Given the 80 to 90 day incubation period reported for the American crocodile (Thorbjarnarson, 1989), nesting in Belize probably follows the general Caribbean pattern with clutch deposition in March and April.

Raccoons are responsible for significant nest losses in other regions (Mazzotti, 1983; see review in Thorbjarnarson, 1989) and are probably a major predator of C. acutus nests in Belize. Raccoons are abundant in mangrove habitats throughout Belize and were sighted during spotlight surveys of all three study areas. Nest losses attributable to raccoons were recorded on Blackbird Cay. Raccoons were found on isolated islands in Santa Cruz Lagoon suggesting even nests in these habitats are accessible to predators. Coatis (Nasua narica) are also present in many coastal habitats and represent potential nest predators.

Food Habits

Two juvenile crocodiles (TL = 90.8 and 65.0 cm) were captured and stomach-pumped using the method of Taylor et al. (1978). Stomach contents from both animals contained insect and crab (Uca spp.) remains. Fresh fish was recovered from the smaller animal, and balls of mammalian hair, probably from rodents or a small opossum, were recovered from the larger crocodile. Unidentified nematodes (David Soucek, Dept. Biological Sciences, Clemson University, pers. comm.) were found among stomach contents of the smaller crocodile. Similar prey items have been recovered from juvenile C. acutus elsewhere (Alvarez del Toro, 1974).

Crocodile-Human Interactions and Conservation

Interviews of local fishermen and resort operators suggest that major crocodile-human conflicts occur when crocodiles frequent the vicinity of resorts and take dogs at fishing camps. Crocodiles are attracted to camps where fish are cleaned and offal discarded in the water. Turneffe Flats Resort has discontinued this practice because of the presence of several large crocodiles and alternative disposal techniques seem to have eliminated the problem. An open garbage dump on "Garbage Cay" near Cay Bokel has also been reported to attract crocodiles. Closure of this dump is recommended to reduce the possibility of crocodile-human conflicts and to address public health concerns. Several fishermen stated that crocodiles occasionally enter fish traps in the shallow waters off Ambergris Cay and consume the catch. Predation on free-ranging domestic dogs was frequently reported by residents in the cays. Keeping dogs penned or leashed, especially at night, would probably prevent predation. Several resort operators have also expressed concern over possible dangers that large crocodiles pose to swimmers and divers. While attacks on humans have been reported, American crocodiles are not normally regarded as man-eaters, and risks to swimmers are considered minimal (Pooley et al., 1989). Some illegal killing of nuisance crocodiles was reported by local fisherman, and Coral Cay Conservation Volunteers observed several crocodile skins drying at a fisherman's camp near Calabash Cay (Gail Bradley Miller, University College of Belize, pers. comm.). However, the extent of this harvest is believed to be small.

The major threat to the continued survival of American crocodile populations in the coastal zone of Belize appears to be the development of potential nesting beaches. Nesting habitat was found to be of limited extent and many of the potential sites we visited were either developed or showed signs of impending development. In the Turneffe Atoll, both Blackbird Cay Resort and Turneffe Flats Resort are constructed on suitable nesting beaches. The nesting area on Deadmans Cay is now occupied by a tourist lodge and unavailable for future nesting. The communal nesting site on Northern Cay was marked by "Keep Off" signs and much of the understory vegetation had been cleared. Greg Smith (pers. comm.) reported nesting in the vicinity of Rendezvous Point, but a search of the area revealed fishing camps on all suitable beaches. A recent draft of the Turneffe Islands Development Plan (Turneffe Islands Development Committee, 1995) included the nesting beach on Northern Cay in a list of areas suitable for development. Any forthcoming management plans must include provisions for the protection of nesting beaches. Protection of nesting habitat,whether or not located within existing reserves, is essential for the continued survival of the American crocodile in Belize.

Nursery habitat where brackish water is available may also be critical for the continued survival of the American crocodile, especially on offshore cays. Hatchling and juvenile American crocodiles cannot tolerate high salinity levels for long periods and osmoregulate by drinking freshwater (Ellis, 1981). Young crocodiles on offshore cays probably obtain freshwater from rainwater lenses (Mazzotti, 1983). Osmoregulatory failure is a significant cause of mortality among young crocodiles in some populations (Thorbjarnarson, 1989), and these brackish habitats are important for continued recruitment.

Future Research

A one year study of the status, distribution, and ecology of the American crocodile in Belize as part of the GEF/UNDP coastal zone management program is scheduled to begin in late spring of 1996. The specific priorities of this project are:

1. Train Belizean biologists in crocodilian research and management techniques.
2. Determine the present status of crocodile populations in coastal Belize.
3. Identify critical habitats.
4. Initiate a long-term (> 10 year) monitoring program.
5. Obtain basic ecological data on the ecology of crocodiles inhabiting barrier reef islands.
6. Resolve questions relating to the systematic status of the C. moreletii/C. acutus complex in coastal Belize.

Recommendations for a long-term crocodile management plan will be based on the results of this study. Primary consideration will be given to managing crocodile populations for non-consumptive purposes (e.g. wildlife viewing) as nature tourism is the country's largest industry, producing over $Bz 100 million per year, and the ecotourism potential of the coastal zone is considered great.

ACKNOWLEDGMENTS

This project could not have been completed without the generous assistance and logistic support of University College of Belize, Coral Cay Conservation, International Tropical Conservation Foundation, United Nations Development Program/Coastal Zone Management Unit, Department's of Fisheries and Forestry, New York Zoological Society-Wildlife Conservation Society, and Clemson University. Dorian Barrow, Susan Wells, Peter Raines, Melanie Dotherow, Gail Bradley-Miller, Jonathan Ridley, and Andrew Gill provided support throughout the project. Field assistance was provided by Martin Feather, George Hansen, Marcus Marples, Domingo Ruiz, Paul Scott, Mike Somerville, Auriol Samos, Jim Thomas, and numerous CCC volunteers. Greg Smith provided results of previous survey work. Richard Montanucci reviewed an earlier draft of this manuscript. The Belize Department of Fisheries and the Forestry Department issued the necessary permits. Boats and transportation were provided by the Belize Fisheries Department and Coral Cay Conservation.

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Table 1. Summary of distributional records for the American crocodile (Crocodylus acutus) in Belize. Sources in parentheses. Asterisk indicates nesting has been reported.

Coastal Mainland	Offshore Islands
Belize City (1)	Ambergris Cay (8, 12) *
Four-Mile Lagoon (2)	Cay Caulker (9) *
Mango Creek (3)	Cay Chapel (5, 8)
Northern Lagoon (4)	Hicks Cay (5)
Placencia Lagoon (3)	Lighthouse Reef (10)*
Punta Ycacos Lagoon (5)	Maps Cay (12) *
Chipstern Nature Reserve (6, 7)	Middle Long Cay (8)
Southern Lagoon (4, 12)	Moho Cay (8)
	South Long Cay (11)
	Tobacco Range (5)
	Turneffe Atoll (4, 8, 12) *

Sources: 1-Neill and Allen, 1961; 2-Bruce Cullerton, personal comment; 3-Mahler and Wotkyns, 1991; 4-Zisman, 1989; 5-Perkins, 1983; 6-Meerman, 1992; 7-Ouboter, 1992; 8-Greg Smith in Dotherow, 1995 and personal comment; 9-Meerman, 1993; 10-Colin Howell, personal comment; 11-Susan Wells, personal comment; 12- Platt and Thorbjarnarson, this study.

Table 2. Results of American crocodile (Crocodylus acutus) spotlight counts during 1994 and 1995 in the Turneffe Atoll, Belize.

Location	Date	Distance(km)	#Observed	#/km
	1994			
Blackbird Cay (Soldier Bight)	30 May	4.2	3	0.71
Northern Cay (Unnamed Lagoon)	2 June	1.3	1	0.76
Blackbird Cay (leeward)	2 June	16.0	3	0.18
Calabash Cay (leeward)	26 June	10.8	5	0.46
Shag Cay (leeward)	27 June	12.6	1	0.08
Calabash Cay (South-creek/lagoon)	28 June	2.0	6	3.00
Deadmans Cay (leeward)	29 June	12.0	4	0.33
Blackbird Cay (windward)	30 June	4.2	12	2.85
Northern Lagoon	2 October	14.1	10	0.70
Northern Cay (N. Lagoon Entrance to Dog Flea Cay)	2 October	8.4	3	0.35
Crikozeen Creek-Lagoon	5 October	9.0	2	0.22
	1995			
Turneffe Atoll (leeward, Cay Bokel to Creek mouth 17°14.8"N, 87° 56.3"W)	18 June	11.4	5	0.43
Calabash Cay (windward)	18 June	1.0	2	2.00
Turneffe Atoll (leeward, N. Lagoon Entrance to Crikozeen Creek)	19 June	10.8	9	0.83
Northern Cay (windward)	20 June	14.4	1	0.06
Total		132.2	67	

Table 3. Results of American crocodile (Crocodylus acutus) spotlight counts during 1995 in the proposed Bacalar Chico National Park, Ambergris Cay, Belize.

Location	Date	Distance(km)	# Observed	#/km
Santa Cruz Lagoon to Bacalar Chico Creek	27 June	15.0	0	0.0
Santa Cruz Lagoon	28 June	4.3	3	0.69
Bacalar Chico Creek	28 June	2.0	1	0.50
Laguna de Cantena	29 June	9.1	2	0.21
Unnamed Lagoon (see Figure 3)	30 June	2.7	1	0.37
Bacalar Chico Lagoon	30 June	2.1	1	0.47
Ambergris Cay (windward)	01 July	7.5	0	0.0
Total		42.7	8	

Figure 1. Map of Belize showing the location of three areas where American crocodile surveys were conducted in 1994 and 1995. Scale 1 cm = 25 km.

Figure 2. Map of Turneffe Atoll, Belize. Locality names in accordance with maps obtained from the Lands and Survey Department, Belmopan, Belize, or the Travellers Reference Map of Belize (International Travel Map Products, Vancouver, British Columbia, Canada, ISBN #09-21463-01-1). Scale 1:230,000.

Figure 1: Map of the proposed Bacalar Chico National Park, Ambergris Cay, Belize. Locality names in accordance with Ordnance Survey Map of Ambergris Cay, Belize (Ordnance Surveys Directorate, Southampton, S09 4DH, England). Scale ca. 1:50,000.

Table 4. Size-class distribution of American crocodiles (Crocodylus acutus) observed in spotlight surveys of the coastal zone of Belize. Crocodiles were classified based on estimated total length (TL) as juveniles (TL < 90 cm), subadults (TL = 90-150 cm), or adults (TL > 150 cm). Crocodiles that could not be placed in a size-class are classified as "eyeshine only" (EO). Total number of crocodiles in each size-class followed by frequency in parentheses.

Location	Juveniles	Subadults	Adults	EO	Total
Turneffe Atoll	4 (5.9)	28 (41.7)	16 (23.8)	19 (28.3)	67
Bacalar Chico	4 (50.0)	2 (25.0)	1 (12.5)	1 (12.5)	8
Maps Cay	3 (27.2)	0 (0.0)	1 (9.0)	7 (63.6)	11
Total	11 (12.7)	30 (34.8)	18 (20.9)	27 (31.3)	86

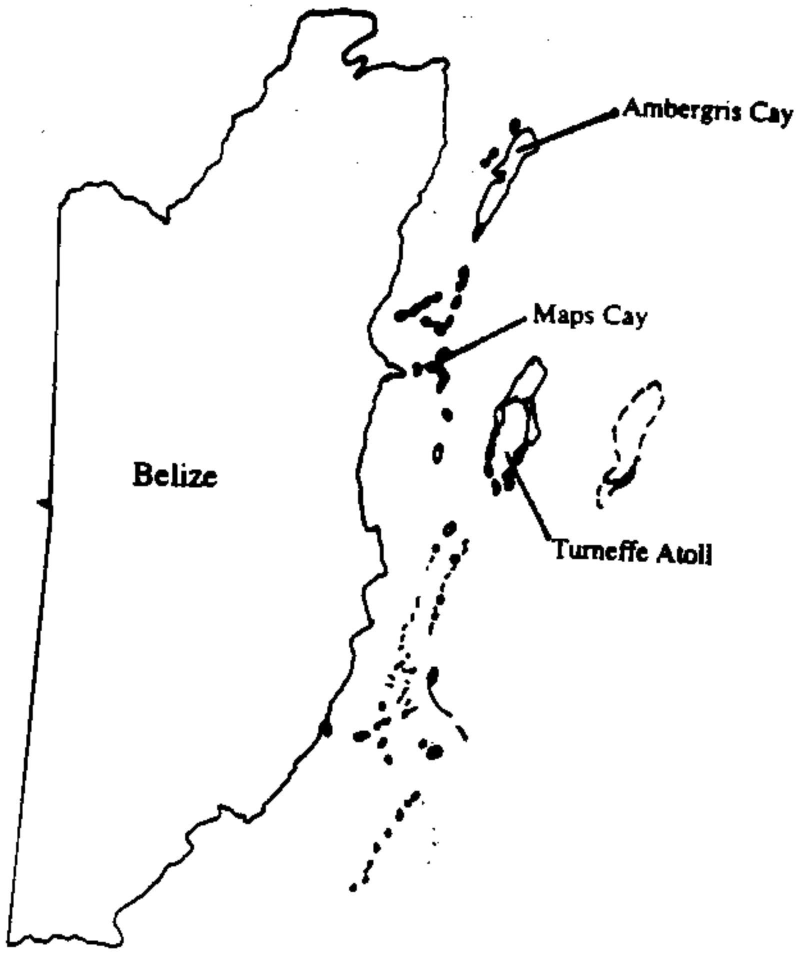


Figure 1. Map of Belize showing location of three areas where American crocodile surveys were conducted in 1994 and 1995. Scale 1 cm = 25 km.

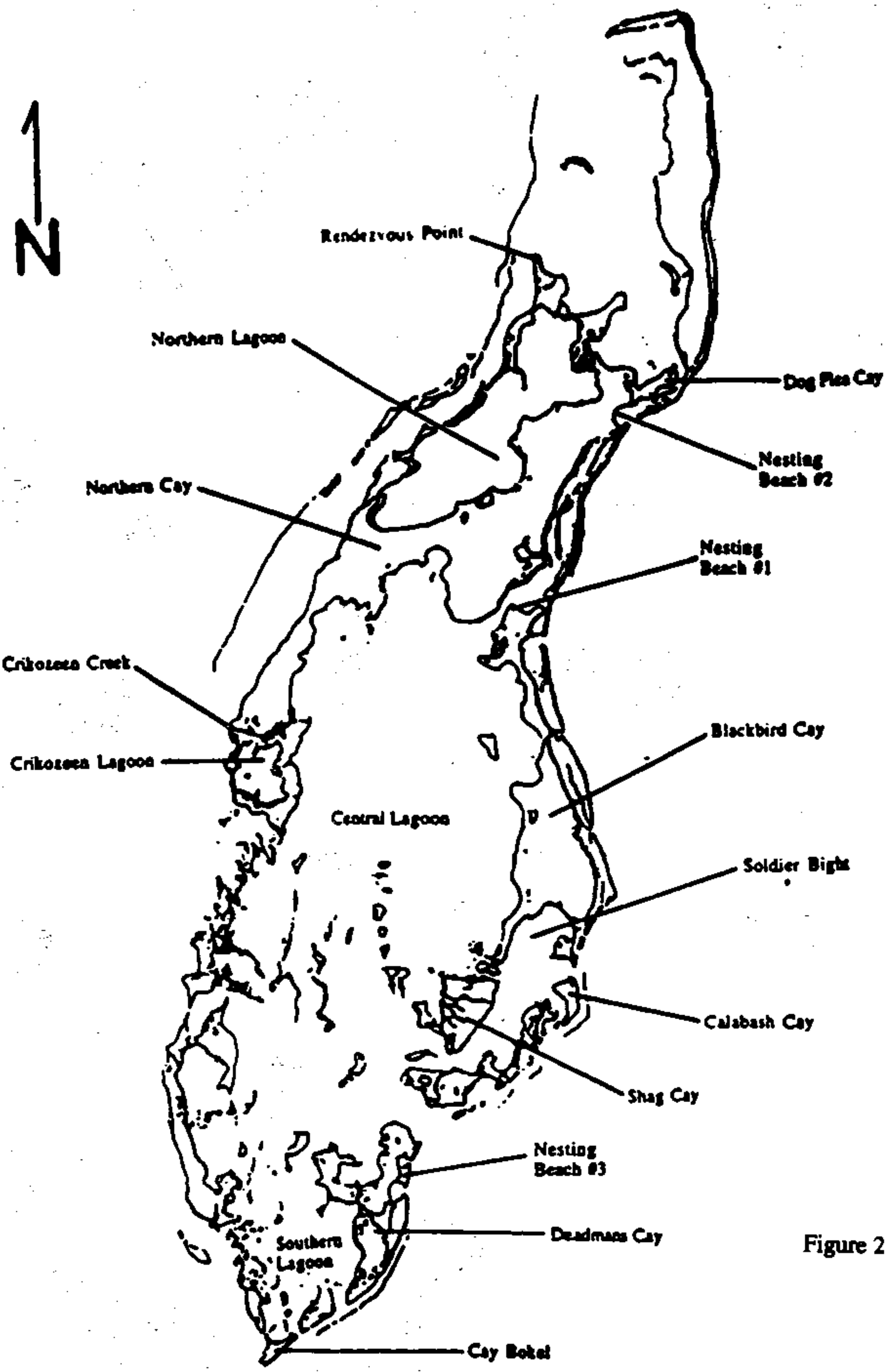
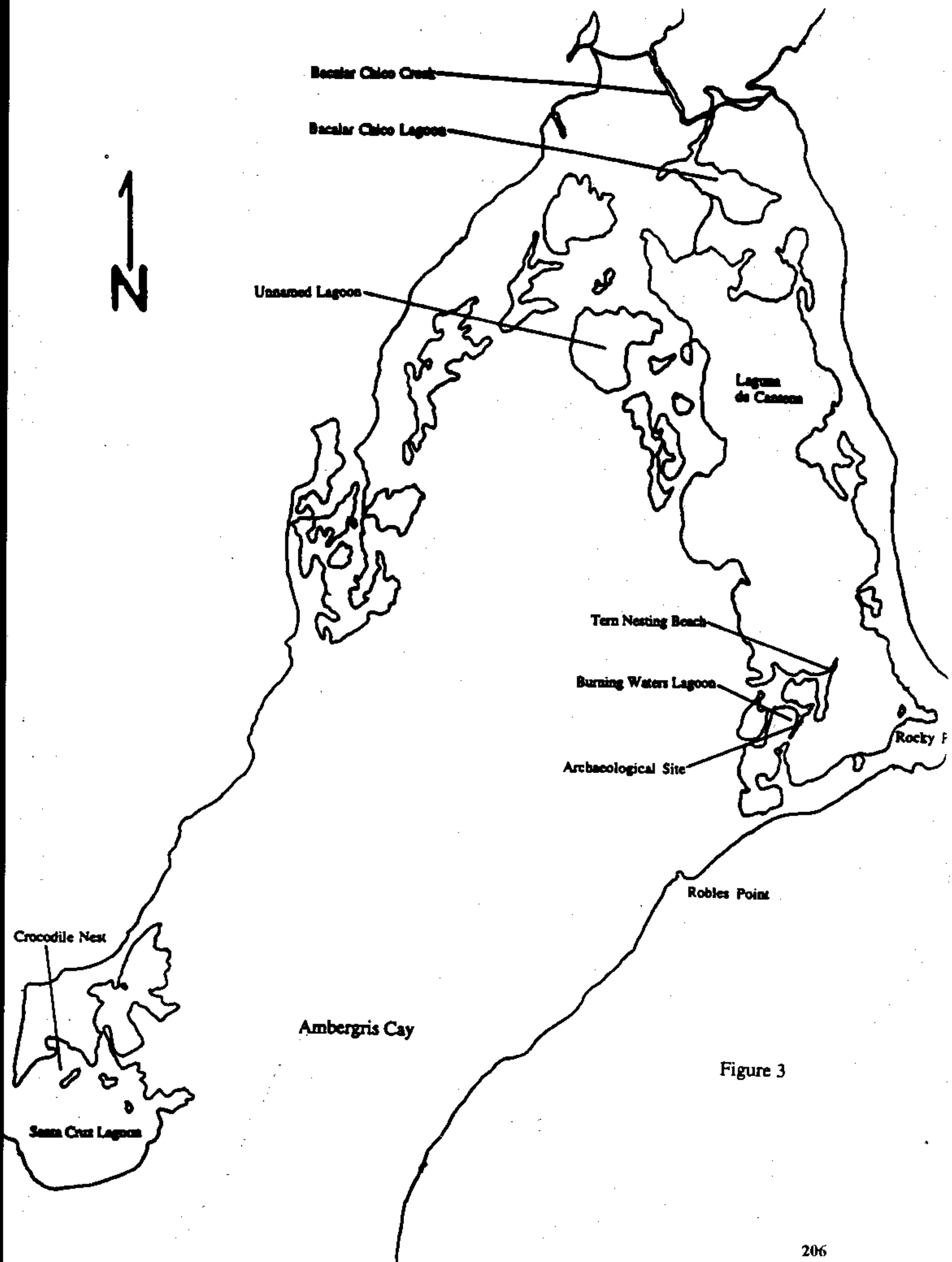

N
Rendezvous Point
Northern Lagoon
Dog Flea Cay
Nesting Beach #2
Northern Cay
Nesting Beach #1
Crikozeea Creek
Crikozeea Lagoon
Central Lagoon
Blackbird Cay
Soldier Bight
Calabash Cay
Shag Cay
Nesting Beach #3
Deadmans Cay
Southern Lagoon
Cay Bokel

Figure 2



Bacalar Chico Creek
Bacalar Chico Lagoon
N
Unnamed Lagoon
Laguna
Tern Nesting Beach
Burning Waters Lagoon
Archaeological Site
Rocky
Robles Point
Crocodile Nest
Ambergris Cay
Santa Cruz Lagoon

Figure 3

Evaluation of the reintroduction of *Crocodylus intermedius* in the Caño Guaritico Wildlife Refuge (Apure State, Venezuela).

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Summary
In the period from 1990 to 1995, were reintroduced a total of 514 Orinoco crocodiles (*Crocodylus intermedius*) in the Caño Guaritico Wildlife Refuge, in a combined effort of different national and international organizations. The crocodiles were reintroduced in three rivers: Caño Guaritico, within the boundaries of the Refuge and where 283 crocodiles (55.1%) have been released; Caño Macanillal, where the reintroduction program started and 227 crocodiles (44.2%) have been released; and Caño Mucuritas, where only 4 crocodiles have been released (0.7%). The last two localities are located inside the El Frío Ranch. Out of a total of 514 crocodiles released, 271 (42.2%) were produced in the Masaguaral Breeding Center; 114 (22.2%) came from the Estación Biológica El Frío Breeding Center; 92 (17.9%) came from the UNELLEZ Breeding Center and 41 (7.9%) came from the Puerto Miranda Breeding Center. Most of the crocodiles reintroduced were produced under a *farming* or closed cycle scheme (61.7%), while the rest (38.3%) were produced under a *ranching* or open cycle scheme. It is known the origin of most of these crocodiles, whose parents are from different geographic localities, in some cases quite distant. Out of the 514 crocodiles, there is data on length and weight for only 411 individuals (80.2%). In 1990 the average total length was 151.7 cm (SD = 22.25), in 1991 was 125.2 cm (SD = 30.9), in 1992 was 82.8 (SD = 35.1), in 1993 was 79.7 cm (SD = 13.17) and in 1994 was 86.9 cm (SD = 16.08). The decrease of the average total length is due to the fact that in the last three years were released animals of 1 year of age. The sex ratio is almost 1:2, with 264 males (64.07%), 144 female (34.95%) and 4 undetermined (0.97%). The total length and weight data were used to calculate a condition index, which shows that in general animals with TL greater than 100 cm (26%) and weights greater than 2.5 kg (46%) have indices that imply good physical condition. It is proposed the use of such indirect indices as an additional criteria to decide when the captive raised crocodiles should be released into the wild. The follow up study of the reintroduced crocodiles has not been constant, but an sporadic and partial effort, whose results show a very low mean abundance of 1.8 ind/km in the Caño Macanillal and 0.47 ind/km in the Caño Guaritico, that contrasts with a very high concentration of spectacled cayman (*Caiman crocodilus crocodilus*). A total of 16 animals have been recaptured, all of them close to the release sites, although one animal migrated a considerable distance in a year. Finally, it was determined that the mean growth rate of crocodiles recaptured in Caño Macanillal (0.5 mm/day) was lower than the growth rate of the crocodiles from Caño Guaritico (1.38 mm/day). However, further studies are necessary to confirm these results and determine the viability of this program

Evaluación de la reintroducción de *Crocodylus intermedius* en el Refugio de Fauna Silvestre Caño Guaritico, Venezuela.

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Fundación para la Defensa de la Naturaleza (FUDENA)- WCS.

Resumen

En el periodo entre 1990 y 1995, se reportó la reintroducción de un total de 514 Caimanes del Orinoco (Crocodylus intermedius) en el Refugio de Fauna Silvestre Caño Guaritico, dentro de un esfuerzo combinado de diferentes organizaciones nacionales y extranjeras. Las reintroducciones se ejecutaron en tres cuerpos de agua: Caño Guaritico, propiamente dentro de los linderos del Refugio y donde se liberaron en dos sectores 283 caimanes (55,1%); Caño Macanillal, lugar donde se realizaron las primeras liberaciones, con total de 227 individuos (44,2%); y Caño Mucuritas, donde solo se han liberado 4 caimanes (0,7%). Estas dos últimas localidades se sitúan en tierras del Hato El Frío. De los 514 caimanes, 271 (42,2%) provinieron del Zoocriadero Masaguaral, 114 (22,2%) del Zoocriadero El Frío, 92 (17,9%) del Zoocriadero de la UNELLEZ y 41 (7,9%) del Zoocriadero Puerto Miranda. Los caimanes liberados son en su mayoría son producto de la cría en cautiverio (61,7%), mientras que el restante proviene de la recolección de juveniles producidos en vida silvestre (38,3%). Se conoce el origen de la mayoría de los caimanes, los cuales provienen de reproductores de diferentes localidades, en algunos casos bastante distantes. De los 514 animales, se tienen solo medidas y datos de 411 individuos (80,2 %). En términos de longitud total en 1990 el promedio fue de 151,7 cm (DE= 22,25), en 1991 de 125,2 cm (DE= 30,9), en 1992 de 82,8 (DE= 35.1), 1993 de 79,7 cm (DE= 13,17) y en 1994 de 86,9 cm (DE= 16,08). La disminución de la longitud total se debe a que en los últimos tres años se liberaron ejemplares de 1 año. La proporción de sexos es casi 1:2, con 264 machos (64,07%), 144 hembras (34,95%) y 4 sin determinar (0,97%). Los datos de longitud total y peso se usaron para calcular un índice de condición, con lo cual se encontró que principalmente caimanes con medidas de LT mayores de 100 cm (26 %) y pesos mayores de 2,5 kg (46 %) tienen índices que denotan buena condición física. En este sentido, se propone el uso de tales índices indirectos como criterio adicional para establecer cuando los caimanes criados están en condición de ser liberados al medio natural. El seguimiento de caimanes liberados no ha sido permanente, ejecutándose solo estudios parciales y esporádicos, cuyos resultados arrojan índices promedios de abundancia muy bajos, de 1.8 ind/km en el Caño Macanillal y 0.47 ind/km en Guaritico, que contrasta con una alta concentración de babas (*Caiman crocodilus crocodilus*). Se han practicado 16 recapturas cerca de los sitios de liberación, aunque hay un caso de un ejemplar que emigró una distancia considerable durante un año. Finalmente, se encontró que el crecimiento promedio de caimanes capturados en Macanillal fue menor (0,5 mm/día), al crecimiento de caimanes colectados en el Caño Guaritico (1,38 mm/día). Sin embargo, se requieren mas estudios para corroborar estos resultados y establecer la viabilidad de este programa.

INTRODUCTION

Crocodylus intermedius is an endemic species of the Orinoco river basin, specially of the flooded savannas of the "Llanos" of Venezuela and Colombia. The commercial harvest of the Orinoco crocodile during the 1930s and 1940s, along with the habitat destruction, keep this species on the verge of extinction. The crocodile has virtually disappeared in Colombia (Lugo and Clavijo, 1991), while in Venezuela there are small isolated populations (Godshalk, 1978, 1982; Ramo y Busto, 1986; Franz *et al*, 1985; Ayarzaguena, 1987; Thorbjarnarson and Hernández, 1992; Seijas, 1993, 1994). These relicts are located mainly in areas where the human activity is minimal, and in some cases under official protection.

In 1984 it was included by the IUCN in the list of the twelve animal species more threatened with extinction in the world. The conservation of the Orinoco crocodile have been a collaborative effort by many national and international, both non-governmental and government organizations, among which are: the Fundación para la Defensa de la Naturaleza (FUDENA), the Sociedad de Ciencias Naturales La Salle, the Universidad Nacional Experimental de los Llanos Ezequiel Zamora (UNELLEZ), the Ministerio del Ambiente y los Recursos Naturales Renovables (MARNR), the Servicio Autónomo de Fauna (PROFAUNA), the Instituto Nacional de Parques (INPARQUES), the Masaguaral, Puerto Miranda and El Frío ranches, the Agencia Espanola de Cooperación Internacional (AECI), the Wildlife Conservation Society (WCS), the World Wildlife Fund (WWF-USA), World Wide Fund for Nature (WWF), the National Geographic Society, and the Smithsonian Institution.

The aim of this paper is to present the results of the evaluation of the reintroduction of Orinoco crocodiles in the Caño Guaritico Wildlife Refuge, using FUDENA's database as the main source of information. This evaluation is part of the Action Plan for the Survival of this species, proposed by the Venezuelan Crocodile Specialist Group (GECV) between 1993 and 1994 (Arteaga, 1993; Seijas y Chávez, 1994).

CAÑO GUARITICO WILDLIFE REFUGE

This Refuge was created the 11 of January of 1989, for the official protection of endangered species of the "Llanos" ecosystem, specially the Orinoco crocodile. This is the reason it was chosen as the main area for reintroduction of captive bred crocodiles. The Caño Guaritico is a tributary of the Apure river and is located between the towns of Samán de Apure and Bruzual in the Apure State, and it has a total area of 9300 has (Fig. No. 1).

RESULTS

Numbers and Localities

Between 1990 and 1995 were reintroduced approximately 514 captive bred crocodiles, all of them from the Masaguaral, UNELLEZ, El Frío and Puerto

Miranda Breeding Centers, as shown in Table 1. The number of crocodiles reintroduced increased every year between 1990 and 1993, mainly by the contributions of the Masaguaral Breeding Center, see Fig. 2. Between 1994 and 1995 the number decreased, and in 1995 were released only 80 animals from El Frío Breeding Center.

The firsts reintroductions were in two small tributaries: caño Macanillal and caño Mucuritas, being the first where most of the animals have been released, specifically at the Tapa de la Ramera site. As seen in Table 1, in 1992 crocodiles were reintroduced directly into the caño Guaritico, in the site of Las Ventanas in El Frío ranch, and at the site of Tres Ceibas in the Turagua ranch. To summarised, out of a total of 514 crocodiles reintroduced, 283 have been released in caño Guaritico (55.1%), 227 in caño Macanillal (44.2%) and 4 in caño Mucuritas (0.7%), see Fig. 3.

Number per Breeding Center and Origin

Of the 514 crocodiles reintroduced, 267 (51.9%) came from the Masaguaral Breeding Center, 114 (22.2%) from El Frío, 92 (17.9%) from UNELLEZ and 41 (7.9%) from Puerto Miranda, as seen in Fig. 4. Only for 491 crocodiles there is certainty about their origins, being 303 animals (61.7%) captive bred, and 188 animals (38.3%) collected in 4 rivers and one reservoir in the Llanos. The specific origin of the 491 animals is: 238 (48.5%) Masaguaral, 131 (26.7%) Cojedes river, 60 (12.2%) UNELLEZ, 38 (7.7%) Capanaparo river, 8 (1.6%) unknown, 6 (1.2%) Camatagua reservoir, 4 (0.8%) Portuguesa river, 3 (0.6%) FONAIAP-Puerto Ayacucho and 1 (0.2%) Orinoco river, see Fig. 5.

Sizes

Using data from only 411 (80.2%) reintroduced crocodiles, a comparison of their total length (TL) was done, which shows a decrease from 1990 to 1992, leveling till 1994, as seen in Fig. 6. In 1990 the mean TL was 151.7 cm (SD=22.25 cm), in 1991 was 125.2 cm (SD=30.9 cm), in 1992 was 82.8 cm (SD=35.1 cm), in 1993 was 79.7cm (SD=13.17 cm) and in 1994 was 86.9 cm (SD=16.08 cm). The decrease in TL is due to the fact in 1990 and 1991 animals of up to three years of age were released, and in the last three years only animals of one year of age have been released into this area.

Sex Ratios

The sex ratio is close to 1:2, with 264 males (64.07%), 144 females (34.95%) and 4 undetermined (0.97%). In Fig. 7 are presented the sex ratios of animals released per breeding center, showing for Masaguaral (1:3), El Frío (1:4) and Puerto Miranda (1:4), indicating that these centers have produced mainly males, while on the other hand, UNELLEZ have produced mainly females, with a sex ratio of 3:1.

Condition Index

Seijas (1993), proposed the calculation of a condition index using the total length and weight data for Orinoco crocodiles greater than 50 cm, assuming that below this size and for about six months after they hatch, the animals still have reserves, therefore not reflecting their adaptation to the new environment. According to this author the mathematical expression of this index is the following: $\mathbf{CI=a^{-1}.W.TL^{-b}}$, where **a** and **b** are the coefficients calculated in the lineal regression of **lnW** on **lnTL**.

According to the indicated by Seijas (1993) the CI is a measure of the relative "fatness" of the animals, so animals with a $CI<1$ would be relatively "skinny", and animals with a $CI>1$ would be relatively "fat".

Using the TL and W data for 411 crocodiles released between 1990 and 1994, a regression analysis of lnW on lnTL was done, resulting in the following equation:

$\ln W = -5.376950 + 2.911783 \ln TL$

($r^2=0.84608$, $p<0.00001$, 404 d.f.)

For the calculation of the CI of each crocodile the following equation was used:

$CI=216.351\ W\ TL^{-2.911783}$. In the Graps. 8 and 9 it can be observed the tendencies of CI with respect to TL and W of the group of reintroduced crocodiles. The values of $CI>1$ correspond to animals in a good condition and mostly greater than 100 cm in TL and 2500 g in W.

Night Surveys in Reintroduction Areas

A few sporadic night surveys have been conducted, most of them previous to the release of animals each year. In Table 2 are summarized the surveys completed mainly in two sectors of the caños Macanillal and Guaritico, indicating the relative water level, the number of surveyed kilometers, the number of crocodiles observed and an abundance index, presented in number of crocodiles per kilometer.

In 1991 approximately 7.8 km of the caño Macanillal were surveyed, counting 14 crocodiles and capturing 4. The number of crocodiles observed represented 25% of the total reintroduced crocodiles (62) to that date, in that caño. The survey also included the mouth of the caño Guaritico, where two adult animals were found.

Approximately 20 km of the caño Guaritico were surveyed in 1992, locating only 3 juvenile crocodiles. The low water level of that month made the study very difficult, due to the fact that there was a very high concentration of spectacled caymans in the caño. By the end of 1993 a series of surveys were conducted in the caño Guaritico, upstream and downstream of Las Ventanas site. Close to 17 km were surveyed and 8 crocodiles were observed and captured, most of them had been released in the Turagua ranch, about 50 km upstream, in June of the same year. It is important to note, besides the distance traveled by the crocodiles, that these animals grew at a higher rate than that reported for crocodiles in other areas (see table of recaptures).

Finally, in December 1994, 22 km upstream from Las Ventanas were surveyed and only one crocodile was observed amongst a high concentration of spectacled caymans, most of those between 120-180 cm and >180 cm of TL. Also were surveyed La Ramera lagoon and caño Macanillal, that were connected because of the high water level. An estimated 25 km were surveyed, observing only 3 adult crocodiles.

Recaptures

As it can be observed in the recaptures Table, 16 animals have been caught in 5 years, by different researchers. There are evidences that some crocodiles stay in the same river where they were released: the recapture in august 1991 in caño Macanillal of a crocodile released in that river in 1990; an animal recaptured in the Tres Ceibas site of caño Guaritico in 1994, this was released in 1993 in the same area; and the 8 animals previously mentioned that moved about 50 km within six months of their release in the caño Guaritico. Although in one instance, a crocodile recaptured in December 1992 at Las Ventanas site of the caño Guaritico had been released in 1991 in caño Macanillal, might indicate the possibility that some animals would move from one river to another.

The mean growth rate of crocodiles recaptured in caño Macanillal was 0.05 cm/day, much lower than that registered for crocodiles recaptured in caño Guaritico, which was 0.138cm/day. It is necessary to conduct further studies to verify these differences, considering a much bigger sample size.

Discussion

In order to accelerate the recovery of crocodile populations in the wild in Venezuela, in recent years have been promoted and carried out the captive breeding and release of these animals into the wild. Restocking has taken place in localities where still exist the species although in low numbers, and reintroduction has been conducted where the populations have been extirpated.

Seijas et al (1990) argue that this strategy has been tested in several parts of the world, and the ecological basis for such activity is that during the early life stages of crocodilians (eggs & hatchlings), a very high mortality occurs due to predators and other environmental factors. The collection of eggs or hatchlings in the wild, for their artificial incubation and raising, eliminates this high mortality and improves their survival probabilities. When these animals are about 1 year old and with a mean TL of 80-90 cm, are released back into the wild.

The effect of the release size of Orinoco crocodiles on their success in adapting to the conditions in the wild has not been determined. However, the results of the population surveys seem to indicate that larger animals stay close to the release sites, while juveniles and subadults tend to disperse. Thorbjarnarson (1989) suggests that the dispersion phase of juveniles and subadults, might be an integral part of the population dynamic of the American crocodile (*Crocodylus acutus*) as well as other species of crocodilians.

The authors found the intermediate size classes of this species were found frequently in marginal habitats. Mazzoti (1983) and Gaby *et al* (1981, 1985) indicate that intermediate size crocodiles tend to be found in inaccessible areas, isolated from the areas where hatchlings and adults are found, probably an effect of territoriality from adult or dominant adults. Such effect is even more significant if it is also considered the possible pressures from adult spectacled caymans, found in high densities in the release areas.

At first, the animals were released in caño Macanillal and caño Mucuritas with the idea that these would migrate to the caño Guaritico, which is the Refuge properly, while the management plan was written and facilities were built for the regulation of fishing and hunting activities. So far, none of these expectations have been fulfilled. Under these conditions, since 1992 the animals were released directly into caño Macanillal, because it was thought that the animals released in caño Macanillal would go to the Apure river in times of maximum floods, therefore outside the protected area of the Refuge.

Apparently, the caño Guaritico offers better conditions for the crocodiles, if it is considered that the growth rates are higher than those reported for the caño Macanillal. However, it is very important to conduct a more detailed study in order to confirm or deny this idea, because there are other factors involved, for instance, in caño Guaritico there is a very high density of spectacled caymans, which are certainly playing an important role, specially in regard to competition and predation. All this is important to fine tune the reintroduction program, which in the particular case of caño Guaritico seems to be the release of animals of the same size of the spectacled caymans found there, which is between 120-180 cm and >180 cm of TL. This would mean that the animals to be release there should be more than one year old, which would increase the costs, both for operation and building of new facilities in the breeding centers.

The crocodile reintroduction program in the Refuge was initially planned *a priori* for the release of 300 animals in a 5 year period, with the aim to establish a viable population with a stock of 10% of that total, that is 30 animals. Until now, 514 animals have been released which exceeds the established goal, all this indicates the necessity of implementing detailed follow-up studies that will answer the present questions and doubts.

Finally, it can be said that one of the major problems this reintroduction program faces today is the lack of information regarding: survival and growth rates, adaptability to the wild, movements and reproduction, among others. Although the program is 6 years old, there are no specific projects aimed to establish the present situation of the species in the area. In 1992, Eddie Escalona from the Venezuelan Wildlife Service (PROFAUNA) presented a proposal to the consideration of the GECV, but the funds could not be obtained. This year, one of the authors, Gustavo Hernández, will begin a follow-up project jointly funded by FUDENA and WCS, and it is hoped that this project will receive the collaboration of national and international organizations interested in the conservation of the highly endangered Orinoco crocodile.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to the following persons and institutions, that made this study possible: Glenda Medina and Diego Díaz, former and present Executive Directors of FUDENA; Fundo Pecuario Masaguaral and Mr. Tomás Blohm; Dr. John Thorbjarnarson, María Muñoz, Manuel Felipe Rodríguez. Also, the collaboration of the following persons was much appreciated: Tibisay Escalona, Nayibe Pérez, Carlos Chávez, Jesús Rivas, César Molina, Tito Avila, Pedro Vernet y Humberto Rivero (Kako). The data from the breeding centers was kindly provided by: Andrés Eloy Seijas and Ildemaro González (UNELLEZ), Estación Biológica El Frío (El Frío breeding center), and Manuel Denis, Pedro Azuaje and Ernesto Boede (Puerto Miranda breeding center). Finally, the authors recognize and are very grateful to VARIG Airlines and WWF-USA for their support and funding, which made possible to present this paper.

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Year	*Nº crocodiles*	*Breeding Center*	*Locality*
1990	*30*	*Masaguaral (16)* *UNELLEZ (14)*	*Caño Macanillal (26)* *C. Mucuritas (4)*
1991	*53*	*Masaguaral (39)* *UNELLEZ (6)* *El Frio (8)*	*C. Macanillal (53)*
1992	*78*	*Masaguaral (55)* *UNELLEZ (6)* *El Frio (17)*	*C. Macanillal (59)* *C. Guaritico (19)*
1993	*155*	*Masaguaral (98)* *UNELLEZ (45)* *El Frio (9)* *Puerto Miranda (3)*	*C. Macanillal (9)* *C. Guaritico (146)*
1994	*118*	*Masaguaral (59)* *UNELLEZ (21)* *Puerto Miranda (38)*	*C. Guaritico (118)*
1995	*80*	*El Frio (80)*	*C. Macanillal (80)*
Totals	*514*	*Masaguaral = 267** *UNELLEZ = 92* *El Frio = 114* *Puerto Miranda = 41*	*RFS Caño Guaritico = 5* *C. Macanillal = 227* *C. Guaritico = 283* *C. Mucuritas = 4*

Table No. 1: Description of the reintroduction program of Orinoco crocodiles, from the Masaguaral, UNELLEZ, El Frío and Puerto Miranda breeding centers, in the Caño Guaritico Wildlife Refuge (Caños Macanillal, Mucuritas y Guaritico) between 1990 and 1995. Source: Database GECV-FUDENA.

Date	*Locality*	*Water level*	*Kilometers*	*N° crocodiles*	*Croc/km*
August 91	Macanillal[1]	medium	7,8	14	1,80
May 92	Guaritico[2]	low	20,0	3	0,15
Dec. 93	Guaritico[2]	high	17,0	8	0,47
Dec.. 94	Guaritico[2]	high	22,0	1	0,05
Dec. 94	Macanillal[3]	high	15,0	3	0,20

Table 2: Night Surveys summary of two sectors of the Caños Macanillal and Guaritico, between 1991 and 1994. [1] Tapas La Ramera-El Jobo, [2] Las Ventanas, [3] Laguna La Ramera-Caño Macanillal. Source: Database GECV-FUDENA.

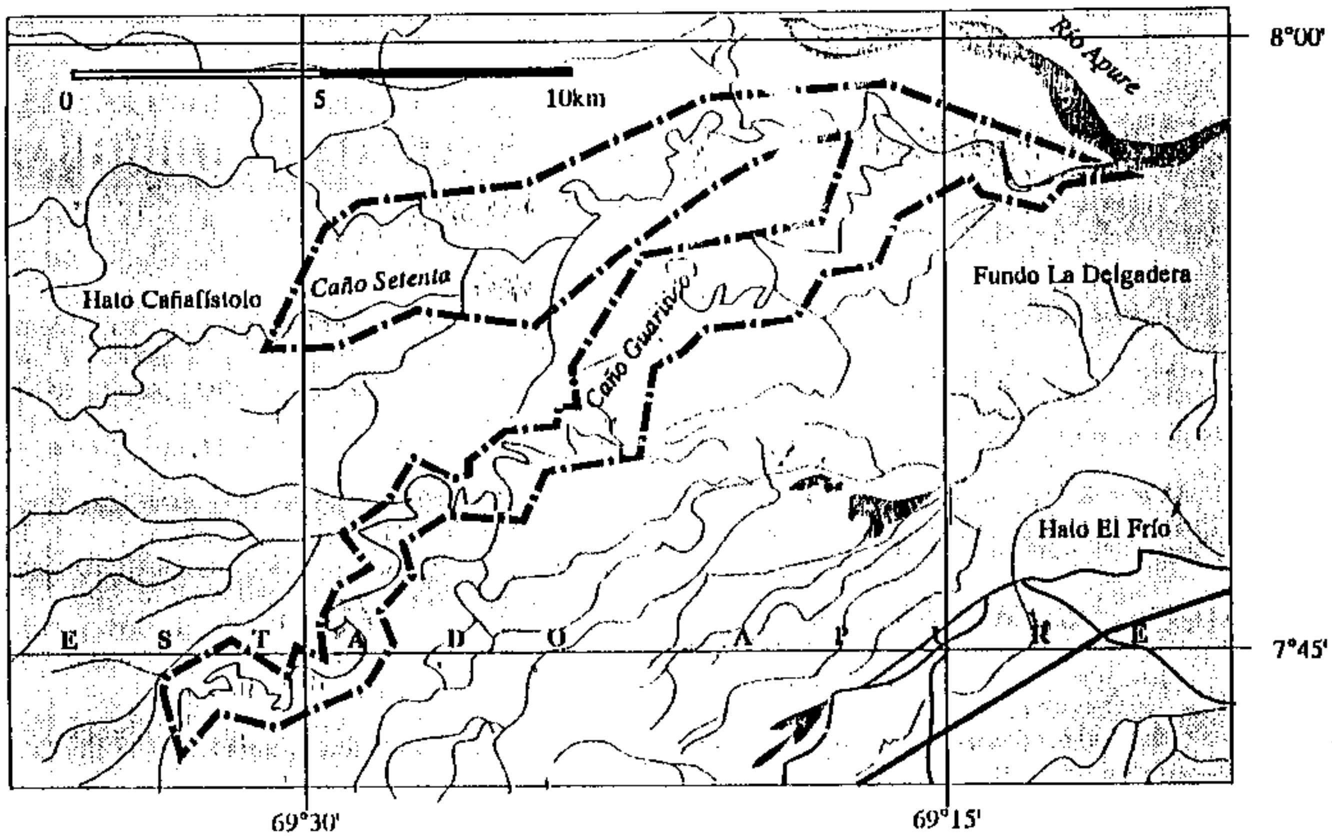


Fig. 1: Area of the Caño GuariticoWildlife Refuge, where the Orinoco crocodiles have been reintroduced. Apure State, Venezuela. Source: MARNR/DGSPOA/ACM/01

Fig 2: Total number by Breeding Center of Orinoco crocodiles reintroduced in the Wildlife Refuge Caño Guaritico between 1990 and 1995.

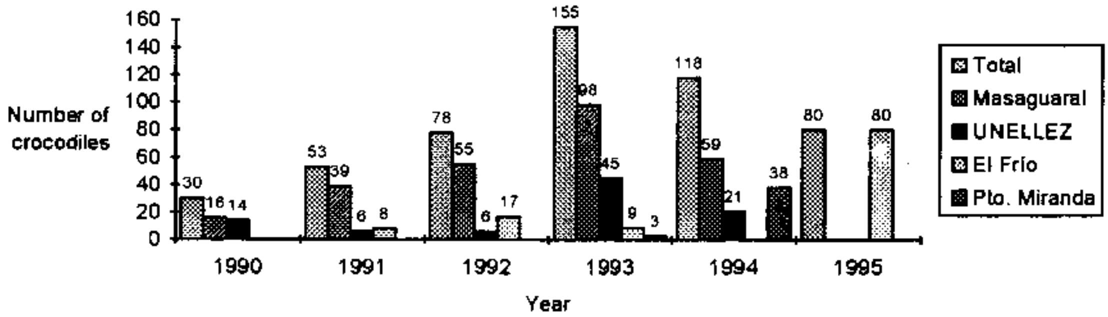


Fig 3: Orinoco crocodiles reintroduced by locality in the Wildlife Refuge Caño Guaritico between 1990 and 1995.

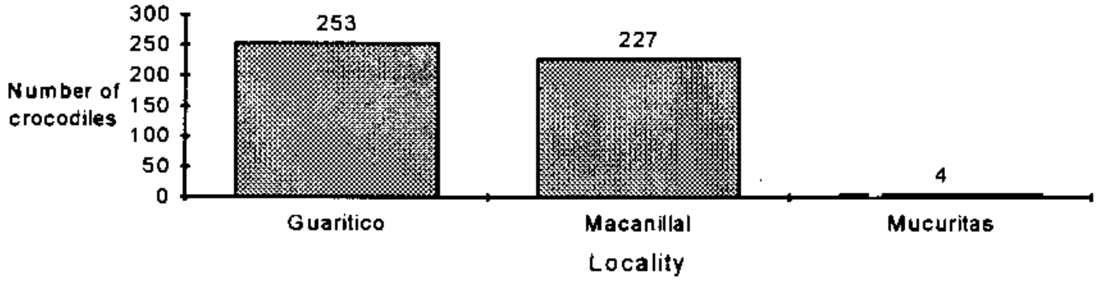


Fig 4: Number of Orinoco crocodiles in the Caño Guaritico Wildlife Refuge by breeding center between 1990 and 1995.

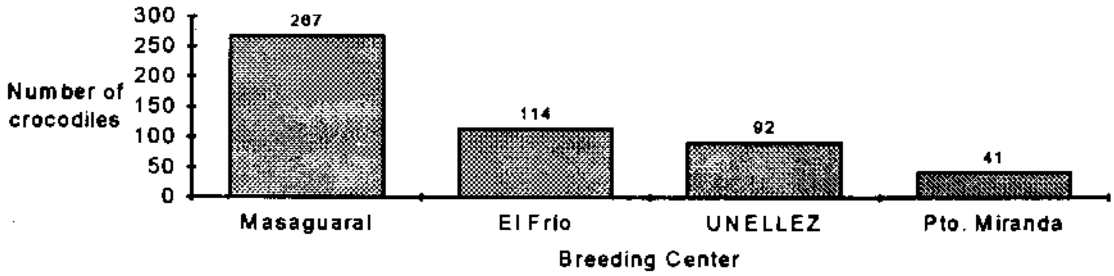


Fig. 5: Specific origins of Orinoco crocodiles reintroduced in the Caño Guaritico Wildlife Refuge between 1990 and 1995.

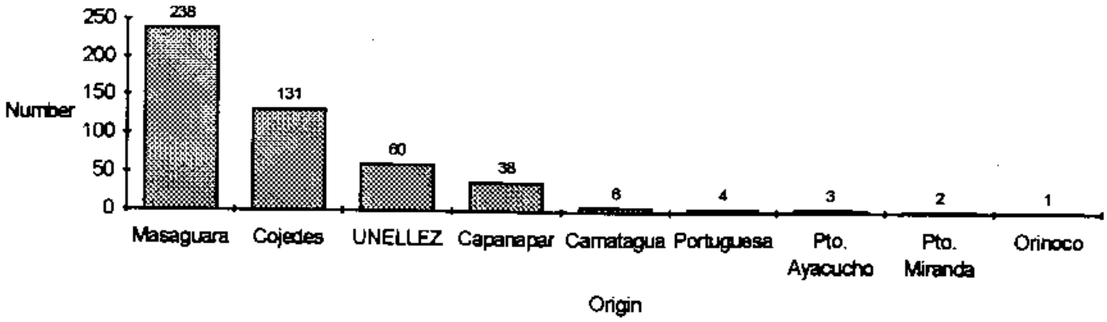


Fig. 6: Mean Total Length and Standard Deviation of Orinoco crocodiles reintroduced in the Caño Guaritico Wildlife Refuge between 1990 and 1994.

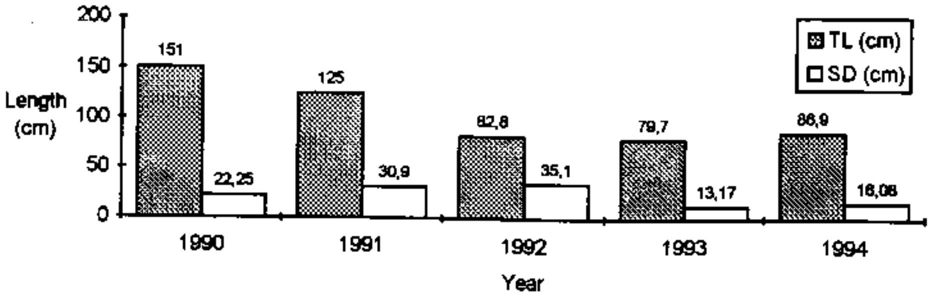


Fig. 7: Sex distribution of Orinoco crocodiles by Breeding Center reintroduced in the Caño Guaritico between 1990 and 1994.

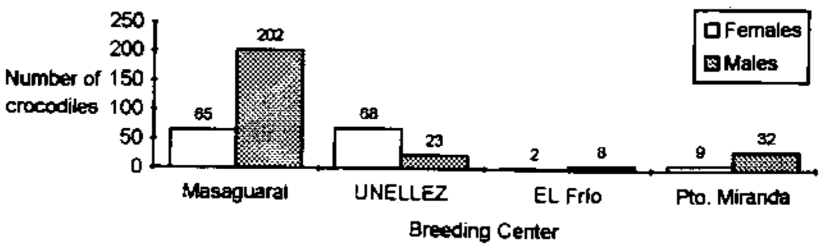
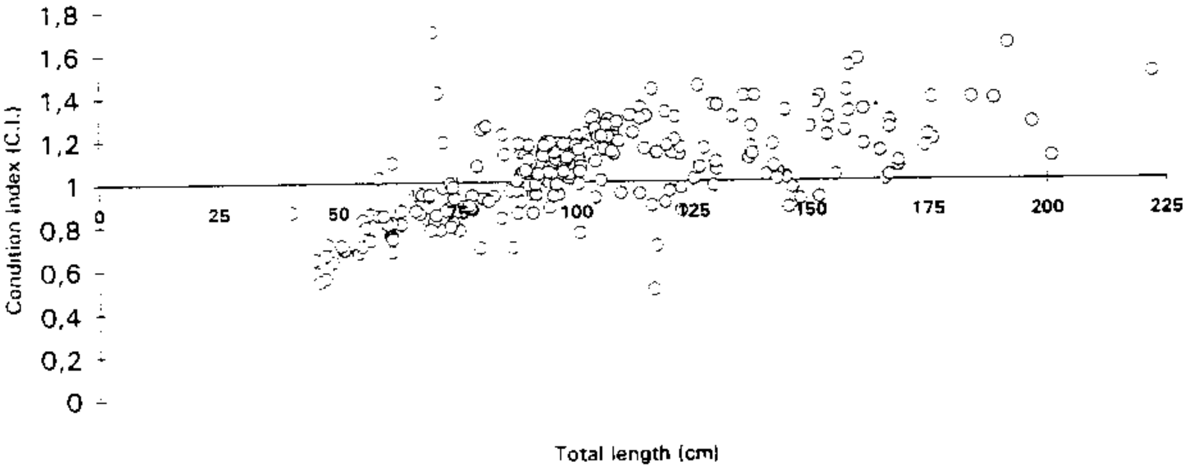


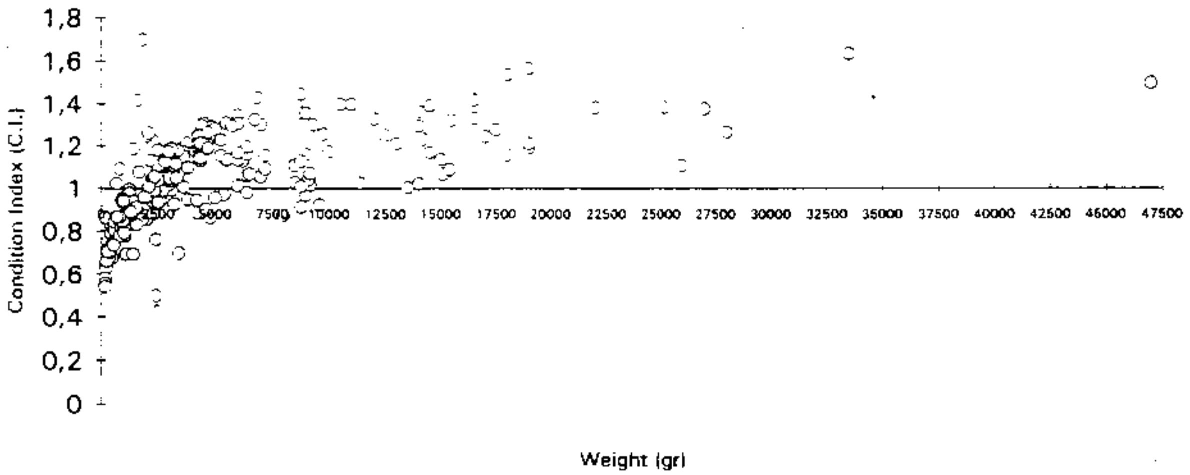
Fig. 8: Relationship between C.I. and TL of C. intermedius reintroduced in the Caño Guaritico Wildlife Refuge between 1990 and 1994.



RECAPTURES OF ORINOCO CROCODILES IN CAÑO GUARITICO WILDLIFE REFUGE

DATE	AREA	RECAPTURE	INCREASE TL
2 AUG 1991	Caño Macanillal	2 Masaguaral 1991 1 UNELLEZ 1990 1 El Frio	0.04 cm/day 0 06 cm/day ND ND
21 DEC 1992	Caño Guaritico	1 Masaguaral 1991	0.05 cm/day
17 NOV 1993	Caño Guaritico	2 Masaguaral 1993	0.08 cm/day 0.15 cm/day
13 DEC 1993	Caño Guaritico	4 Masagaural 1993	0.041 cm/day 0.169 cm/day 0.142 cm/day 0.148 cm/day
14 DEC 1993	Caño Guaritico	2 Masaguaral 1993 1 Pto. Miranda 1993 1 El Frio	0.175 cm/day 0.169 cm/day 0.148 cm/day ND
3 JUN 1994	Caño Guaritico	1 Masaguaral 1993	0.134 cm/day
		16 Recaptures	
ND: no data Source: database FUDENA			

Fig. 9: Relationship between C.I. and Weight of C. intermedius reintroduced in the Caño Guaritico Wildlife Refuge



Traditional methods used for hunting African dwarf crocodiles in the Congo

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Introduction

West African dwarf crocodiles Osteolaemus tetraspis inhabit water pools remaining in periodically flooded swamp forests (Waitkuwait, 1989). When threatened they may retreat into a burrow or hide amongst the stilt roots of mangrove trees at the edge of the pool.

Behra (1990) reported on the commercial exploitation of these crocodiles in the Congo for their meat. Rhodhain (1926) and Abercrombie (1978) described some traditional crocodile hunting methods, but the latter did not believe that the exploitation of O. tetraspis for food constituted an important danger to that species. Huchzermeyer & Agnagna (1994) examined wild-caught African dwarf crocodiles at markets in Brazzaville and reported on their pathology and parasites.

As the efficiency of hunting methods has an impact on the numbers of crocodiles which a hunter can collect in a given period, crocodile hunters were interviewed about the implements and strategies they employed, during a visit to the swamp forest area between Djéké and Mobenzélé, south of Impfondo during April/May 1995. This paper reports on the methods used by crocodile hunters in the visited area.

Materials and Methods

In the villages of Dzéké and Impondi on the river Likouala-aux-Herbes and in Mobenzélé on the river Oubangui (Figures 1 & 2) villagers were asked to lead us to known crocodile hunters, who were then questioned about the different hunting methods they employed.

As the hunters first were suspicious of our motives, it was found that it was not possible to adhere to a prepared question protocol. Instead the questions were posed informally, leading from one aspect to another. However, once the suspicions were allayed, we were also allowed to photograph most of the implements said to be used in crocodile hunting.

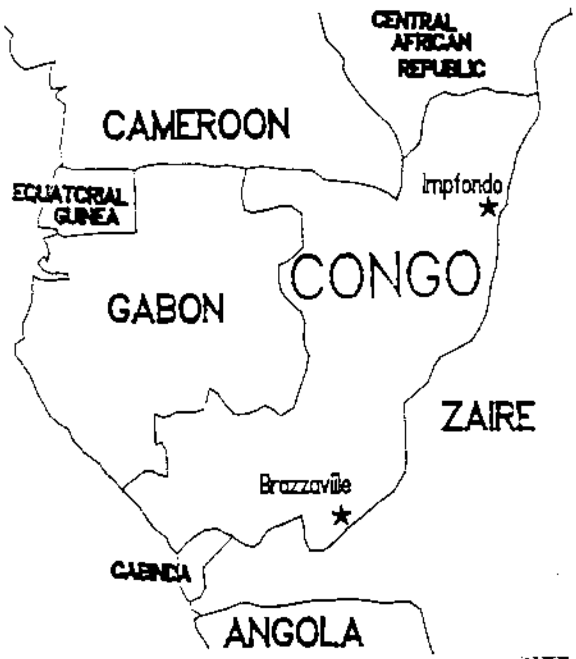

Fig 1 The Congo Republic

Results

Four crocodile hunters were found in Djéké, one in Impondi and two in Mobenzélé. In addition one of the guides accompanying the expedition demonstrated hunting methods in the swamp forest habitat of the dwarf crocodile.

The following implements and strategies were found to be used:

The **assegai** is used to stab the crocodile when it is hidden in its burrow. This makes it unnecessary to subdue the animal after its capture. This method is used when the crocodile is destined for immediate home consumption.

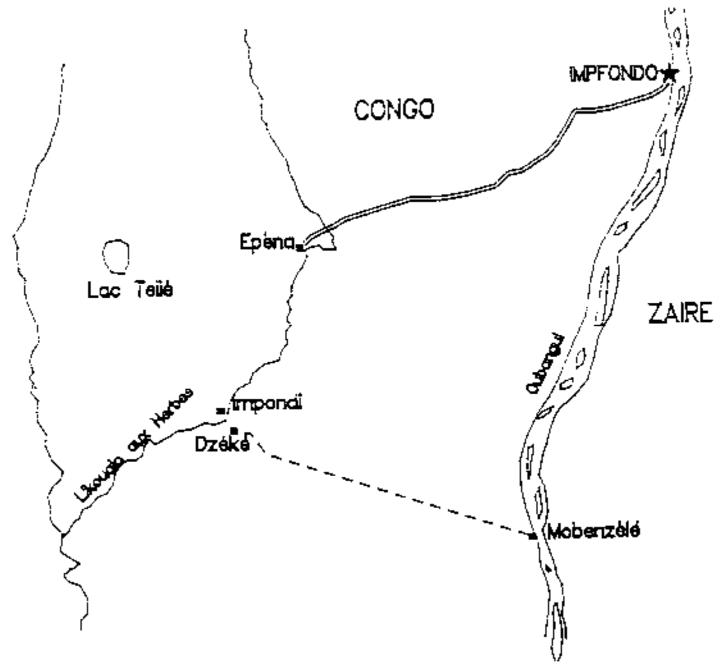

Fig 2 The research area south of Impfondo

The **torch and multipronged fishing spear** method is used in the rainy season when the floods connect the individual pools. At night the torch is used to pick out the reflection of the crocodile's eyes. While the crocodile is blinded, a second hunter slowly approaches the targeted animal and transfixes it with the fishing spear. The wounds caused by this weapon are not necessarily lethal.

Calling: By imitating the calls of adult crocodiles or of their hatchlings, the hunter induces the crocodile to come out of the water, where it is either caught with a fishing spear, with bare hands or most often with a **forked stick**. At night a torch may be used in addition.

Bare hands: During the day the crocodiles stay submerged in small open pools in the swamp forest with only the nostrils above the surface of the water. When the hunter approaches, the crocodile sinks to the bottom. The hunter notices the slight ripples caused by this movement and can make out the shape of the crocodile in the clear water, if it has not sought refuge in its burrow. The hunter then wades into the pool and grasps the crocodile's tail with his bare hands and swings it out of the water. He then places one foot on the crocodile's head, thus subduing it while he ties its snout and legs with lianas. As an alternative and more often a forked stick is used to fix the submerged crocodile at the bottom of the shallow pool.

The **iron hook - gaff hook** - is fastened to a long, rigid wooden shaft or to a strong but flexible length of liana and is used to pull the crocodile out of its burrow or hide, which usually is found under the roots of a tree at the edge of the pool. The flexibility of the liana allows the hunter to maneuvre the hook even around bends in the burrow. This appeared to be a widely used implement and method.

A large **iron fish hook** with a dead toad or fish as bait and on a long line, fastened to a tree at the edge of the pool, is left in the water overnight. If the bait is taken and swallowed, the crocodile can be pulled out of the water the next morning.

Two long thorns are used to fashion a "hook" by tying them together at the base with the points directed away from each other. The thorns are baited and placed in the same way as the iron fish hook. This method can cause severe damage to the victim, as thorns were found imbedded in internal organs of several crocodiles with subsequent septicaemia by Huchzermeyer & Agnagna (1994). A variation of this method consisting of a single stick with two pointed ends has been described by Schmidt (1919).

A piece of **cloth soaked in petrol** is tied to a long stick and introduced into the (dry) burrow. The crocodile is driven out by the strong smell of the petrol and when rushing out, it is apprehended.

Suffocation: The entrance of the submerged burrow is blocked with soil, wood and other materials, preventing the crocodile from coming out to breathe. It suffocates (drowns) and can be pulled out a few hours later.

Netting: During the floods the hunter can enter the swamp in a dug-out canoe, then he calls the crocodile and when one approaches, throws a net over it.

After capture snout and legs of the crocodile are tied and the animals are carried back to the village, where they are kept, still tied, in a hut before being transported to the market or sold to a buyer on a passing river boat.

The number of crocodiles that can be caught by a single hunter on a hunting trip is limited by their population density as well as by the need to transport them back to the village, sometimes a day's march or even further through difficult terrain. Alternatively the secured crocodiles are left in the swamp forest while the hunter returns to the village for help. One of the hunters boasted that he could catch up to 30 crocodiles in one day.

Discussion

In the Congo African dwarf crocodiles have traditionally been consumed by the inhabitants of the villages bordering on the swamp forests. With ongoing urbanisation affluent town dwellers are prepared to pay a good price for a delicacy which they remember from the olden days. Crocodiles, like other reptiles, live for a long time without being cared for and thus can be transported even to distant markets by relatively slow river craft. Huchzermeyer & Agnagna (1994) estimated the average time lapse between capture and slaughter at a market in Brazzaville to be 30 days.

The dwarf crocodile has many bony scales, making its skin valueless (Thorbjarnarson, 1992) and it is eaten therefore with the skin. The absence of dwarf crocodile skins from the international markets led Abercrombie (1978) and Thorbjarnarson (1992) to the erroneous conclusion that this species was not exploited commercially to any serious degree.

Capture methods resulting in the death of the crocodile are used if the animal is hunted for home consumption. For the capture of live crocodiles the hunter has to develop specialized skills. This is why only few villagers become crocodile hunters.

Acknowledgements

This project is supported and the April-May 1995 expedition was funded by the Brazzaville Office of the Projet Nouabalé-Ndoki of the Wildlife

Conservation Society, for which we are very grateful. JR was supported by travel grants from the Carnegie Trust and the Percy Sladen Fund (administered by the Linnean Society).

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Duodenal Morphology in African crocodiles

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Three species of crocodiles occur in Africa, the Nile crocodile *Crocodylus niloticus*, the slender-snouted crocodile *C. cataphractus* and the African dwarf crocodile *Osteolaemus tetraspis* and of the latter two subspecies *O. t. tetraspis* and *O. t. osborni*. The subspecies of the Nile crocodile are not subject of this paper.

The differences between the two subspecies of dwarf crocodiles affect the shape and length of the snout with the underlying skull bones as well as the nuchal and supracaudal scutes (Schmidt, 1919; Rodhain, 1926; Inger, 1948).

During the examination of 23 dwarf crocodiles in the Congo in 1993 and of a further 15 in 1995 as well as of a number of zoo specimens in South Africa, differences in the morphology of the duodenal loop of dwarf crocodiles emanating from different geographical regions were noted (Huchzermeyer, Penrith & Penrith, 1995).

One single juvenile specimen of *C. cataphractus* was also examined in Brazzaville in 1995, while large numbers of Nile crocodiles from South African crocodile farms were received as postmortem specimen over the last few years.

The examination of these specimens revealed that *C. cataphractus* has the longest double doudenal loop (Fig. 1). *C. niloticus* has a double duodenal loop which is shorter than that of the preceding species, but still elongate (Fig. 2). All Congolese specimens of *O. tetraspis* had a squat, almost square double duodenal loop (Fig. 3), while the West African specimens of *O. tetraspis* (from South African zoos) had a single duodenal loop (Fig. 4).

Fig. 1 Elongate double duodenal loop of *C. cataphractus*

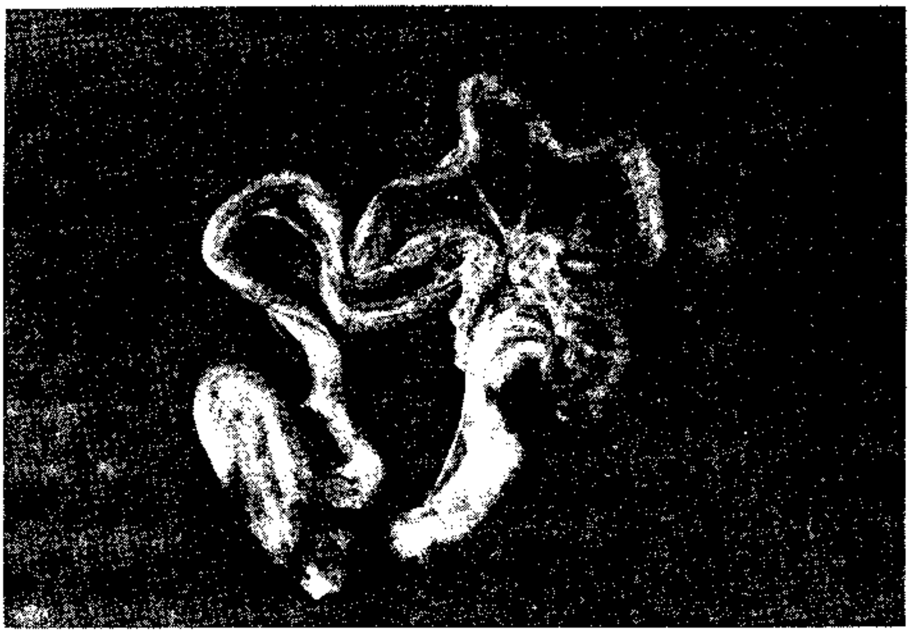

Fig. 2 Double duodenal loop of *C. niloticus*

Fig. 3 Double duodenal loop of Congolese *O. tetraspis*

Fig. 4 Single duodenal loop of a West African *O. tetraspis*

The lengthening of the duodenum is expected to increase the efficiency of duodenal digestion. It would be interesting to see whether this trait could be linked to differences in feeding habits.

It remains to be seen whether this newly discovered trait coincides with and further distinguishes between the two subspecies of *O. tetraspis*. A single duodenal loop would be regarded as the primitive form and its doubling as a specialization. If the Congolese specimens are taken as representing *O. t. osborni*, this would be in contrast with the interpretations by Inger (1948) who regarded the latter as the more primitive form.

It will be necessary to sample crocodiles at markets in other West African countries to determine the distribution of this trait in relation to the other distintive features of the two subspecies.

Occasionally malformations of the duodenal loop have been seen in Nile crocodiles (Fig. 5) and because of the possibility that similar malformations could occur in other species as well, studies of duodenal morphology should be based on the examination of a sufficient number of specimens.

Fig. 5 Treble duodenal loop in a Nile crocodile

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Ecology of the Nile crocodile, *Crocodylus niloticus*, in lake St Lucia, Natal, South Africa.

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Abstract
This paper presents preliminary results of a project looking at the Role of the Nile crocodile, *Crocodylus niloticus*, in the Lake St Lucia ecosytem in Natal, South Africa. The project commenced in January 1994 and is progressing well. An update on the project is provided looking specifically at the feeding ecology and reproductive biology of the Nile crocodile in St Lucia.

Introduction

The project was designed to study the "Role of the Nile crocodile in the Lake St Lucia Ecosystem in Natal, South Africa". This broad study topic has been narrowed down to four primary objectives, as follows:

1.To investigate the diet and feeding habits of the various age/size classes of crocodiles throughout the St Lucia system

2.To determine the population status, distribution and abundance of crocodiles in the various size classes in the Lake system

3.To study various aspects of the reproductive biology of the Nile crocodile

4. To discuss conservation implications and to propose management recommendations for the Lake St Lucia ecosystem.

Study Area:

Lake St Lucia forms part of the quarter of a million hectare Greater St Lucia Wetland Park in Natal, on the north eastern coast of South Africa. The lake body itself covers an area of $350km^2$ and comprises approximately 80% of the estuarine area of Natal province (Begg, 1978). St Lucia has also been described as being the largest estuarine system in Africa. Although extremely large, the lakes average depth is less than one meter (Blaber, 1985). Due to its shallow nature the lake is subject to long-term salinity fluctuations and irregular inflow of fresh water (Blaber, 1980). In a normal wet year five rivers feed the lake system. Salinities vary from fresh water in the northern reaches of the lake to 35ppt at the estuary mouth and there is a net outflow of water. During periodic drought periods salinities in the northern reaches of the lake can increase to 120ppt. There is a net inflow of sea water which helps to reduce salinities. It is a dynamic and fascinating system housing approximately 1500 Nile crocodiles of various size classes. This project has focused on determining the requirements of Nile crocodiles in this system.

Methods and Materials

Objective #1:

To study the diet and feeding habits of the crocodile, the animals are captured in the wild and their stomachs are pumped using water, tygon tubing and a scoop. Trap sites are chosen according to crocodile distribution determined by aerial, boat and foot surveys. Baited noose traps are used to capture crocodiles and inaddition more recently we began noosing juvenile and subadults from a boat at night. Once captured the animal is immobilized using a well known drug, namely flaxedil. The crocodile is moved to a safe working area and the animal is sexed and weighed, a cloacal body temperature is immediately recorded, numerous measurements are made, a blood sample is taken, the stomach pumped and it is finally tagged and released at the site of capture.

Objective #2

To determine the population status, distribution and abundance of crocodiles, boat, foot and aerial surveys are undertaken on a regular basis. Aerial surveys were carried out on a bimonthly basis during 1994 and on a quarterly basis in 1995. Two observers and a scribe were present during each flight. Flights are carried out over a two day period, flying in the morning at approximately 200 feet and at a speed of 110km/hour.

Objective #3:

To study certain aspects of the reproductive biology of the crocodiles in depth nesting surveys have been carried out during the past three breeding seasons - by air, by boat and on foot. Six primary nesting areas have been identified primarily on the Eastern shores of the lake. An annual survey of crocodile nests is conducted to obtain baseline data for estimating the size of, and year to year variation in the breeding population. Surveys are also conducted to monitor changes in habitat usage.

Results and Discussion:
Objective #1:

To date we have caught 69 animals ranging in size from 1.4 to 4.3 meters. This figure includes 36 females, 22 males and 11 recaptures. This total also includes 3 juveniles (1.4 - 1.9m) and 2 subadults (2.2 - 2.6m).
Approximately 30% of the captured animals have had prey items of some sort in their stomach. To date prey items have included primarily fish scales and bones, fish roe, remains of ducks and other birds, and pieces of various crustaceans that occur in the system. A number of items of anthropogenic origin have also been found, such as plastic bags, fishing hooks and sinkers and even pieces of rope. Due to the stomach scooping technique which merely sub samples stomach contents, quantifying prey consumed has not been possible.

Objective #2:

Nine successful aerial surveys of the system have been conducted. The only disadvantage with aerial surveying is that crocodiles smaller than 1.5m are not usually seen. However, these surveys do provide good baseline data as to the number of adults in the system and to their seasonal distribution pattern.
During surveys over the past two years, the highest count was in July 1995, when 771 adult animals were counted.. Counts during the winter months were generally higher - not necessarily because there are more crocs in the system, but the animals are more concentrated around the available fresh water sources and more of them are usually basking in the early morning, which makes them more visible. During periodic boat surveys many of the tagged crocodiles have been seen. Some have been found 18km from the site of capture.
The distribution and abundance of juveniles and subadults in the system still needs to be determined. Animals in this size class are rarely seen. We have been radio tracking a 3.2m female for the

past 51 days in order to determine her home range, and we also plan to track a number of juveniles and subadults to determine their distribution and abundance in the system.

Objective #3:

The six nesting areas we identified occur primarily on the eastern shores of the lake. This region receives twice the annual rainfall when compared to the western shores and it is inundated by fresh water seep lines originating from the nearby sand dunes. It is also characterized by flat, low lying sandy areas.
A total of 90 nests were counted in the 1993 season, 69 nests in 1994 and 127 in 1995. Nest counts for the 1993 and 1994 seasons were low, due to a three year drought we experienced. Constraints of both time and manpower limited previous survey efforts to areas where nesting was known to occur before. Nontheless, some comparisons can be made between the past three years results and results of three earlier surveys carried out in the mid to late 1980's. Some minor changes in both the number and distribution of nests over the years is apparent in the system. Most notable is the southwards shift of nesting areas. This shift could have resulted from a human disturbances, varying salinites, availability of fresh water, food availability, alien plant invasion, or other factors. However, further research is required before any conclusions can be made. There is some natural recruitment into the system and we recently started a hatchling notching program catching them from a boat at night.

Conservation Implications:

The most recent red data list categorizes the Nile crocodile as being at a "low risk", yet conservation dependent (Figure 1). The St Lucia Nile crocodile population is one of three major breeding nuclei of wild Nile crocodiles in South Africa, all of which are under some form of protection. Additional surveys have reflected isolated populations in most rivers and waters of the Eastern side of the country, although these crocodiles are not afforded any form of protection. Westward distribution in South Africa is restricted by climatic conditions as well as human pressure. Over the last hundered years these isolated populations have been sadly depleted by hunting, intolerance and destruction of habitat. Unless steps are taken to control poaching, which is carried out primarily for medicinal products, and to improve available habitat, crocodiles will only survive in the sanctuaries of South Africa. Unfortunately even these sanctuaries are now being threatened. During the 1995/1996 breeding season we lost an estimated twenty breeding females in one particular region of Lake St Lucia.

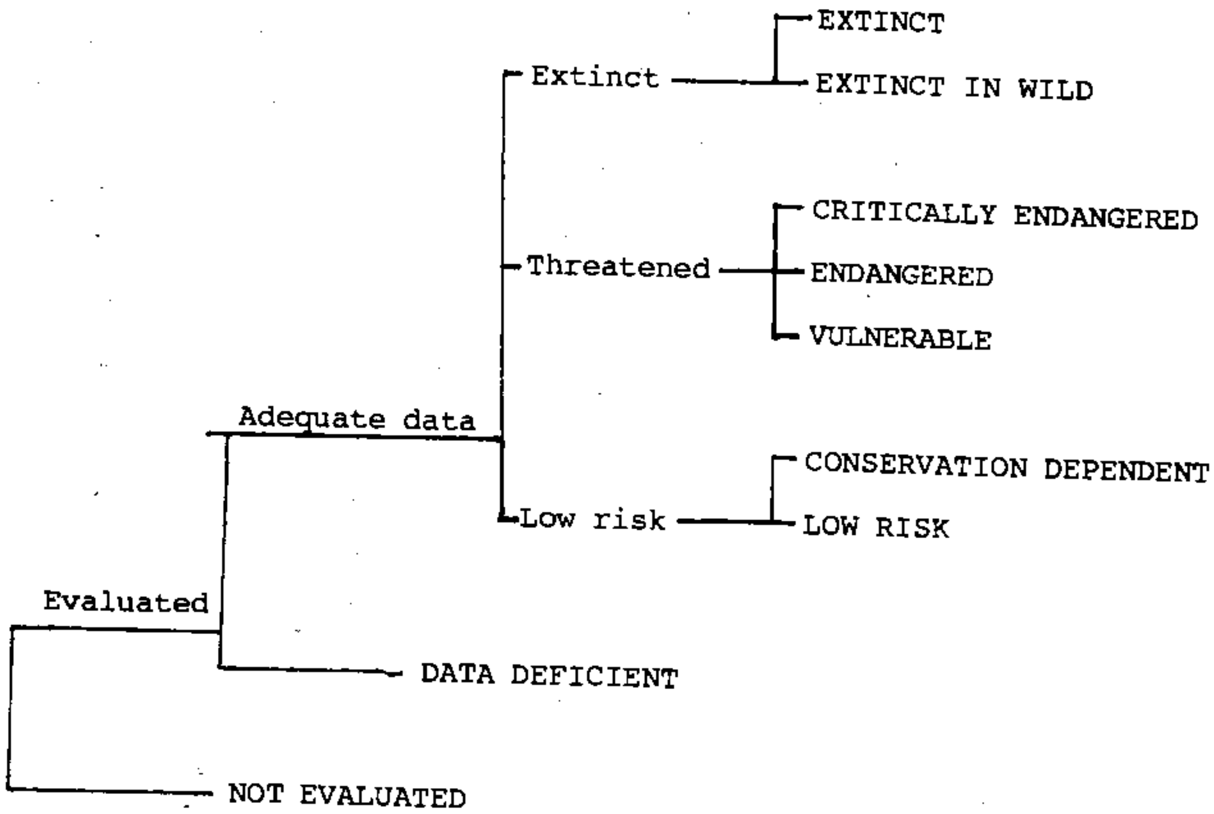

Figure 1: RED LIST CATEGORIES, VERSION 2.2

Future management:

If the Nile crocodile in South Africa is to survive outside of the available sanctuaries and for that matter even within the sanctuaries, a number of steps need to be taken to ensure their future:

1) Educational programmes and a neighbour relations policy need to be established
2) River systems need to be correctly managed and
3) a network of reserves needs to be established to adequately conserve the genetic diversity of the species and to protect populations throughout their range.

Future project plans:

The project will continue for an additional twelve months. By mid-June 1996, a food consumption versus growth rate experiment will be implemented. This experiment will look at osmolarity and growth rates of various age classes of crocodiles under varying salinities, various diets and ambient temperatures.
With the results of the above mentioned experiment, our additional field data, and assimilation and digestion rates from Games' (1986) study in Zimbabwe, we will be able to construct an energy budget for the various size classes of crocodiles in the Lake St Lucia ecosystem.
We plan to design and implement a management plan for the St Lucia crocodile population.

Acknowledgements:

The authors would like to thank the following organizations and companies for their generous financial assistance and for thus making this study possible:
Drexel University, USA
Earthwatch, Inc., USA
Natal Parks Board, South Africa
Alusaf, South Africa
Leomat, South Africa

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Conversation Starter:
Summarizing Croc Growth Using Von Bertalanffy Curve

Note: This brief paper reflects a disjointed series of continuing conversations amongst Zilca Campos, Chris Hope, Paul Moler, Franklin Percival, Kenny Rice, Wayne VanDevender, and Phil Wilkinson. The summary provided here was typed up by Ab Abercrombie.

We have been concerned with (among other subjects) the von Bertalanffy growth curve. We like the curve OK for four reasons. (1) In some cases it appears to describe adequately the shape of croc length as a function of time. (2) It has been used by a number of researchers, and mathematical procedures exist to permit cross-population comparisons amongst such descriptions. (3) It at least purports to rest upon semi-reasonable biological assumptions. (4) In practical applications familiar to us, it has been statistically indistinguishable from (more complex) higher-order Richards curves.

In this meditation we want to do four things. First, we'll list the von Bertalanffy assumptions; this is just to remind you what they are. Second, we'll show in considerable detail the math by which the equations for growth in length are derived from the assumptions.[1] Third, we'll tell you our feelings about those underlying assumptions. We'd really like for you to think about this-- to show us where we are incorrect and to help us expand any interesting insights we might have. Fourth, we want to give you the chance to review just a little bit of the calculus-- which is, of course, the language we'll need to use (a) if there is a heaven and (b) if we get there.[2]

If you want to talk about growth-type issues, one possibility would be to get into electronic correspondence with Ab Abercrombie at **abercrombicl@wofford.edu** (note that the final "e" in "Abercrombie" is dropped). Add to or subtract from this non-paper. Tell us whether you found it at all interesting or helpful-- and whether we should complete the second-verse meditation we've planned for the next CSG meeting. You may write in English, Spanish, or Portuguese, but any reply will be in English.

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[1] We do this for two reasons. First, you might catch us in an error and thereby teach us both algebra and humility. Second, we used the von Bertalanffy curve for a long time without understanding <u>why</u> the equation looked the way it did. Perhaps we can help a few people avoid such blind application.

[2] We do not necessarily advise wagering the entire research budget on either (a) or (b).

INTRODUCTION

If your entire goal is to <u>describe</u> your data[3], then it is often appropriate to present an age-size graph without fancy summarizing lines. This can be particularly useful if you are dealing with known-age animals. Furthermore, some other croc workers will be most appreciative if you will also offer to share your raw data for their analysis.

If you believe it is important to summarize your data with lines, then you might ask yourself exactly <u>why</u> you want to do such a thing. Here are a few possible answers-- and some tentative suggestions on appropriate and inappropriate techniques.

1. Perhaps you simply wish to draw a representative line through a "busy" descriptive graph of size against age. Please do not fit a straight line; technically, such a model will almost always be "underspecified." Polynomial regressions can give very tight fits, but some of your readers may not be able to resist the temptation to extrapolate the line's equation beyond the data, which is intellectual suicide (please see our paper from the 1992 Zimbabwe conference)[4]. One appropriate technique might be to apply a (relatively) assumption-free locally weighted regression such as SYSTAT's "Lowess" curve. When using any such curve you will probably end up playing around with an inclusion "window"[5] that will affect how the computer program treats your

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[3] We recognize that many journals are unlikely to be enthusiastic about such descriptions. However, some of us in the "croc community" like to see regular old length-as-a-function-of-age descriptions of study animals, and our CSG proceedings may offer a vehicle for their publication.

[4] An example of a polynomial regression would be to specify croc length as a function of age, age squared, age cubed, etc. In our more lucid moments a few of us remember that any function can be expressed with any desired degree of precision (yielding an R-square arbitrarily close to 1.0) by piling higher powers into the polynomial equation. Technically this can be OK for pure description. However, if one projects a polynomial regression beyond the confines of sample data, one often derives spectacularly stupid results! We've demonstrated this by simulation.

[5] Lowess-type techniques work sort of like this: They choose a Y-value (a size) for Age = X_1 by taking account of points within a region $X_1 \pm W$. W is (or is a function of) a user-selected parameter that we might call the examination window. There are no firm guidelines for choosing how wide to make this window, and choice of window-width involves a tradeoff. If you make your window wide, then you obtain a smooth curve that considers many of your observations in selecting each Y value;

observations. Because there is no widely accepted formal procedure for selecting window width, and because window width affects curve shape, **the shape of each fitted Lowess curve will reflect not only the distribution of data points but also the researcher's gut-level professional judgment on how the curve should look.** We don't see anything wrong with that subjective component. However, it does largely preclude formal comparisons[6] of growth curves from different studies.

2. You might wish to compare descriptions of two (or more) populations. One common exercise might be to compare a description of your crocs against a published report. In that case you could beg the author for the original data and re-analyze them however you wanted to. Otherwise you may be trapped by the original author's techniques-- and (for your own data set) would need to duplicate as precisely as possible those techniques applied in the published report. On the other hand, if you own all relevant data sets, then you might wish to use the von Bertalanffy curve, described below.

THE VON BERTALANFFY CURVE AS AN EXAMPLE OF GROWTH MODELS.

Here, as promised, are the assumptions and mathematical operationalizations of them.

Assumption 1. An organism's overall growth may be defined as the change in that organism's volume over time. This change in volume may be considered as the difference between material added through anabolic processes and material lost through catabolic processes.

Assumption 2. The addition of material to an organism is constrained by the rate at which the organism's surface can expand; or, to put it differently, gains in "stuff" must be reflected by gains surface area. I.e., von Bertalanffy's model posits a functional relationship between anabolic gain and organism surface area.

Thus, if A is a rate constant representing the combined effect of anabolic processes, then

$V_{g,t} = AS_t\delta t$, where

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such a curve can obscure local changes in the age-size relationship but will be relatively free of "noise" (a particular animal's life-history effects, measurement-error effects, etc.). If you make the window narrow, you will obtain a relatively jagged curve. This curve should reflect how the animals' size changes with age but may also include all sorts of unwanted "noise."

[6] By formal comparisons we mean "comparisons on which you can do arithmetic to generate numbers that mean something."

A, a positive number[7], is the anabolic rate constant,
$V_{g,t}$ is "material" (in the loose sense, meaning "stuff," or "that which constitutes Volume"[8]) gained around time **t** (due to anabolic processes),
S_t is surface area at time t, and
δt is an arbitrarily short period of time.

Assumption 3. Catabolic loss processes can operate anywhere throughout the entire volume of the organism. Therefore, catabolic loss is a function of the organism's volume. Thus, if C is a rate constant representing the combined effect of catabolic processes, then

$V_{l,t} = CV_t\delta t$, where

C, a positive number, is the catabolic rate constant,
$V_{l,t}$ is "material" **lost** around time **t** (due to catabolic processes),
V_t is volume at time t, and
δt is an arbitrarily short period of time.

Note that by these three assumptions an organism's small amount of volummetric growth across a very short time is given by

$$\delta V_t = AS_t\delta t - CV_t\delta t,$$

or, as a differential equation,

$$dV/dt = AS - CV, \qquad \text{Equation 1}$$

where we drop all the t-subscripts for convenience.

Assumption 4. Some organisms may be said to retain approximately the same shapes throughout their lives-- so that x and y (both positive numbers) may be considered shape constants in the following equations:

$$S = xL^2 \quad \text{and} \quad V = yL^3,$$

where S is surface area, V is volume, and L is a linear dimension of the organism.[9]

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[7] Note that $V_{g,t}$ is the gross gain, not the net gain, in stuff; thus it can make sense to require that A be positive.

[8] It sounds a little better to talk about Volume rather than "stuff," material, or mass. Here we are assuming that any of those things may be appropriately considered to be a linear function of Volume.

[9] It should be easy to see what is meant by **shape constants** if we think about an easy, specific example. Consider, for

Now let's look at a little of the math. Substituting the relationships from assumption 4 into Equation 1, we obtain,

$$d(yL^3)/dt = AxL^2 - CyL^3.$$

If we divide both sides of this equation by y, we obtain

$$d(L^3)/dt = (x/y)AL^2 - CL^3.$$

Let's simplify the left-hand side of that equation. From our first semester of differential calculus we should recall that the first derivative of L^3 with respect to time is $3L^2\ dL/dt$; substituting this identity into the above equation, we obtain

$$3L^2\ dL/dt = (x/y)AL^2 - yCL^3.$$

Now divide[10] both sides of this equation by $3L^2$ to obtain:

$$dL/dt = Ax/3y - CL/3 \qquad \text{Equation 2}$$

Since all elements of Equation 2 are positive, we should note that growth-rate is now demonstrated to be a linear decreasing function of the length-dimension, L, for $L > 0$: the bigger they are, the slower they grow.

It is possible (see Appendix 1) to solve differential Equation 2 and show that under the 4 above assumptions,

$$L_t = L_{max} - (L_{max} - L_0)e^{-kt}, \qquad \text{Equation 3}$$

where L_t is length[11] at time t, L_{max} is the maximum length[12] to which the organism can obtain, L_0 is the length when $t = 0$, e is the base of natural logarithms, k is the catabolic growth

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example, a cube, the surface and volume of which would be given by xL^2 and yL^3 respectively, where L would the length of an edge: in this case shape-constant $x = 6$ and shape-constant $y = 1$. Try that with any cube you like.

That is to say, one more time, if a growing organism does not substantially change its shape, then one may consider x and y as fixed parameters of the organism under consideration.

[10] We can do this only if L does not equal 0 (that is, if the organism has some length). Note that the degenerate case also makes a sort of sense: if L does equal 0, dV/dt also equals zero; organisms without size do not grow.

[11] Or of course L could be another linear dimension such as snout-vent length or head width.

[12] In Appendix 1 we show that this maximum length is equal to Ax/Cy.

constant, C, divided by 3, and t is time. For some purposes it is convenient to express this equation as:

$$L_t = L_{max}(L_{max} - Pe^{-kt}), \qquad \text{Equation 3}'$$

where $P = 1 - L_0/L_{max}$; P may be understood as the proportion of the maximum length remaining to grow when t = 0. Anyhow, either way you write it, this function is known as the von Bertalanffy growth model[13].

Perhaps you understand completely all the elements in Equations 3 and 3'. Some of us, however, have difficulty in visualizing what k might mean. We sometimes try to think of it as a shape parameter indicating when crocs grow fastest. Of course, under the von Bertalanffy model, all crocs grow faster when they are little-- but k indicates how much faster. All other things being equal, **larger values of k** indicate crocs that concentrate larger proportions of their **growth in the early years**. Appendix 2 provides three example graphs.

If the world were kinder to us, then croc researchers might always have sufficient size data from animals of known ages. In such a world researchers favoring the von Bertalanffy curve would presumably fit Equations 3 or 3'. Actually, of course, we are more usually forced to describe growth rates using data from capture-recapture studies. In this case it is still possible to estimate L_{max} and k as used in the von Bertalanffy Equation 3 above. We usually do this as follows (see Appendix 3 for a derivation):

$$L_S = L_{max} - (L_{max} - L_F)e^{-k(\Delta t)} \qquad \text{Equation 4}$$

where L_S is length at second capture, L_F is length at first capture, and Δt is the length of time between first and second captures.[14]

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[13] Unfortunately, it's also known as a number of other things. In our paper for the 1992 Zimbabwe meetings we called it "the von Bertalanffy model for linear growth." It is also commonly termed "the Monomolecular model." To make things particularly confusing, there is another model, for volummetric growth, that is also termed "the von Bertalanffy model." We'll mention this one in another footnote below.

[14] Occasionally animals are caught more than two times. In such cases you can, of course, employ any two captures (and the relevant inter-capture interval) for fitting this model. Most folks usually use first and last captures. There can be instances in which one might wish to use other capture-recapture pairs. In general you should not use more than one inter-capture interval per animal; otherwise your data points will not be independent. (That is, animals captured more than twice will contribute more than their "fair share" to the estimate of growth

If you accept assumptions 1-4, then Equations 3, 3', and 4 express the way you think crocodilians grow. But the important question is, do you really want to accept the assumptions? Let's look through them all.

Assumption 1. An organism's overall growth may be defined as the change in that organism's volume over time. This change in volume may be considered as the difference between material added through anabolic processes and material lost through catabolic processes.

It is difficult to disagree with the essential idea of this assumption. Basically it states (1) that any change in size is the mathematical difference between stuff added and stuff subtracted, (2) that additions are not simply glued on and subtractions are not simply chopped off. For purposes of the mathematical model, it shouldn't really matter very much what anabolic and catabolic mean. We buy this assumption; can you find any problems in it?

Assumption 2. The addition of material to an organism is constrained by the rate at which the organism's surface can expand; or, to put it differently, gains in "stuff" must be reflected by gains surface area. I.e., von Bertalanffy's model posits a functional relationship between anabolic gain and organism surface area.

We like the verbal statement fine, but we are troubled by the assumption that the anabolic gain "constant," A, is truly constant for all values of S (surface).[15] We also believe that this assumption (as well as the #3, that follows) will crash if assumption 4, on conservation of shape, does not obtain. What do you think?

Assumption 3. Catabolic loss processes can operate anywhere throughout the entire volume of the organism. Therefore, catabolic loss is a function of the organism's volume.

We feel the same way about assumption 3 as we did about # 2 above. The words sound OK, but we are not convinced that (for

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parameters.)

[15] We can prove an analogous proposition under reduced dimensionality-- e.g., for change in area as a function of change in perimeter for 2-dimensional bacterial colonies-- given biologically reasonable assumptions about growth. We also believe this assumption might hold for growth of spherical colonies of bacteria. We are less confident about crocs.

Maybe we do need to know a bit more about the definitions of anabolic and catabolic.

crocs) the catabolic loss "constant," C, is truly constant across all values of V.[16]

Assumption 4. Some organisms may be said to retain approximately the same shapes throughout their lives.... It is trivial to point out that the shape of an adult crocodilian is different from the shape of a hatchling, so assumption 4 is not precisely true. However the shapes of sundry-sized crocs are basically a lot alike, so this proposition may hold. We have tried to write some analytical models for testing this assumption, but the algebra gets pretty ugly, there are many opportunities to make small mistakes, and our output has been difficult to interpret. Nevertheless, we have scared ourselves a little because it appears that (at least toward the ends of a von Bertalanffy growth curve) relatively minor changes in shape may affect the model. As far as we know, nobody who does von Bertalanffy work seems to worry about this. If you do, let us know, and maybe together we can tease out the effect of shape.

OK, folks, that's all we want to say at this time. Pretend that this is an Internet communication, embryonic and poorly thought out. If it bores you, then neglect it. If not, let's figure out a way to deal with it together.

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[16] We are not as worried about this assumption as we are about # 2 above.

Appendix 1

$dL/dt = Ax/3y - CL/3$ Equation 2, from text above

factor out C/3:

$dL/dt = C/3(Ax/Cy - L)$ Equation A1

Recall from intro calculus that we can maximize L[1] (or, put differently, determine L_{max}) if we set $dL/dt = 0$:

$dL/dt = 0 = C/3(Ax/Cy - L_{max})$;

$L_{max} = Ax/Cy$

Thus, if we substitute and also re-name C/3 as k, we have

$dL/dt = k(L_{max} - L)$ Equation A2

Now let's work on differential equation A2. We separate the variables and integrate:

$$\int \frac{dL}{(L_{max} - L)} = \int (k\,dt)$$

Next we evaluate the integrals to give:

$-\log_e(L_{Max} - L) = kt + c,$ Equation A3

where c is the constant of integration. Now we impose the initial condition that $L = L_0$ when $t = 0$, and we plug $t = 0$ into equation A3 so that we can afterwards solve for c:

$-\log_e(L_{Max} - L_0) = k(0) + c,$

$c = -\log_e(L_{Max} - L_0),$

and we substitute this value of c into equation A3 to give:

$-\log_e(L_{Max} - L) = kt - \log_e(L_{Max} - L_0)$

---

[1] Note that this will indeed be a maximum, and **not a minimum**, for L. We explained in the text that when L is small, growth rate, dL/dt, is greater than zero, and as L gets larger, dL/dt gets smaller. It should be clear that small dL/dt will be associated with a big L (biologically,, big animals increase more slowly in length).

Taking exponentials of both sides of this equation, we get

$$1/(L_{Max} - L) = e^{kt}/(L_{Max} - L_0)$$

Invert both sides of that equation and you get:

$$(L_{Max} - L) = (L_{Max} - L_0)e^{-kt};$$

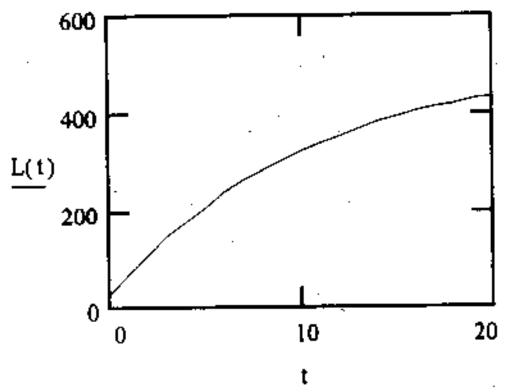
Now just solve for L, also restoring its t-subscript:

$$L_t = L_{Max} - (L_{Max} - L_0)e^{-kt}$$ Equation 3 in the text above

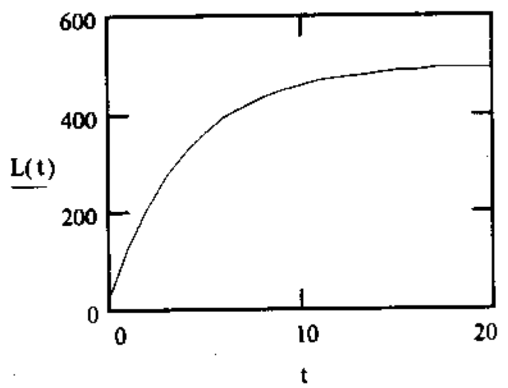
Appendix 2: The Mysterious k Parameter

The precise numerical effect of changes in the k-parameter will depend on the hatchling and maximum sizes of the varmint in question (our hypothetical example hatches at 25cm and maxes out at 500cm) as well as the units in which t is measured. However, the relative mathematical shapes of the growth curves will be as illustrated below.

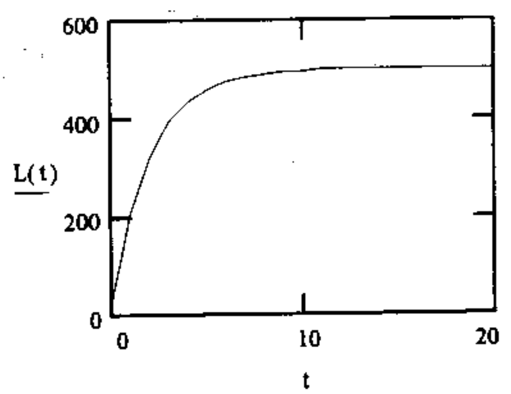
First diagram: k = 0.10:



Second diagram: k = 0.25:



Third diagram: k = 0.50:



Here's the deal: Other things being equal, larger values of k indicate faster initial growth.

Appendix 2

Fitting the Von Bertalanffy growth model to data generated by capture-recapture studies on animals of possibly unknown age.

Look back to equation A3 in Appendix 1:

$$-\ln(L_{max} - L) = kt + c \qquad \text{Equation A3}$$

Now let us take a specific time, say the time at which $t = F$ (eventually we may want to think of F as being age at first capture). We can represent length at $t = F$ by L_F. Now let us enter those values into Equation A3 and solve for c:

$$-\ln(L_{max} - L_F) = (k)(F) + c$$

$$c = -\ln(L_{max} - L_F) - (k)(F)$$

Now substitute this value for c into Equation A3:

$$-\ln(L_{max} - L) = kt - \ln(L_{max} - L_F) - (k)(F) \qquad \text{Equation A4}$$

Say we wish to think about length, L, at the time $t = S$ (eventually we may want to think of S as being age at second capture). We can represent length at $t = S$ by L_S. Now let us enter those values into Equation A4:

$$-\ln(L_{max} - L_S) = (k)(S) - \ln(L_{max} - L_F) - (k)(F)$$

Our next goal is to solve for L_S. First we shall collect the terms that include k:

$$-\ln(L_{max} - L_S) = -\ln(L_{max} - L_F) + k(S-F)$$

Next we shall rearrange terms algebraically:

$$-\ln(L_{max} - L_F) = -\ln(L_{max} - L_S) - k(S-F)$$

Now we take "take the antilog" of both sides of the above equation:

$$1/(L_{max} - L_F) = (e^{-k(S-F)})/(L_{max} - L_S)$$

Rearrange a little (multiply both sides of the equation by both denominators to get everything up on the same line):

$$L_{max} - L_S = (e^{-k(S-F)})(L_{max} - L_F)$$

Solve for L_S; note that we could define the difference between times $t = S$ and $t = F$ as Δt; rearrange just a little:

$$L_S = L_{max} - (L_{max} - L_F)e^{-k(\Delta t)}$$

THE ENVIRONMENT AND ITS RELATIONSHIP WITH EGG SIZE CLUTCH SIZE AND HATCHING SUCCESS IN DIFFERENTS *Caiman latirostris* POPULATIONS AT SANTA FE, ARGENTINA

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Introduction

As was reported by Larriera (1995) in the distribution range for *Caiman latirostris* in Santa Fe province, is possible to find five differents nesting environment with specific characteristics each one:

- **Artificial water bodies (ponds or channels):** Man made facilities for water reserve or transport for cattle ranch exploitation. This places are normally far from natural water bodyes, but has been colonizated for broad snowted caimans for a while. The preferred construction materials here are the gramineous.

- **Ridge in swampy land:** Small elevations in swampy lands with predominance of *Spartina argentiniensis* , *Typha sp* y *Scirpus sp*. No arboreal and bush vegetation could be found here.

- **Ridge in (or arround) water bodyes:** Small elevations arround lakes, narrow rivers and broks, periodically flooded. Nests are found relatively close from the water and are normally build by gramineous, *Spartina* and *Tipha*.

- **Floating vegetation in swampy lands:** Floating formations in swampy lands, formed from death vegetation and sediments. Sometimes are colonized for bush and always by grass (gramineous) that is the nesting material used here.

- **Forest :** Environments with variable density of trees and bushs, elevated with respect to the main water bodies. Nests here could be found in some cases moore than 2 kms. far from water bodies, but in general, close to a small pond within the forest. Nesting materials here are grass, soil and some sticks and branchs.

The objective of this work is to evaluate if there are diferences on cluthc size, egg size and hatching success in the environment categories described before.

There are not previous research relating environment with *Caiman latirostris* nesting, but Campos and Magnusson () and Campos *et. al.* () report some information for *Caiman crocodilus yacare*.

At the moment to evaluate the results, must be considered that there are remarkables variations in the climatological situation at the breeding season, that certainly will incide in the finnal reproductive success. Moderate rain, heavy rain, drought, and severe drought could happen in differents years, so this work must be replicated in the sucesive years in order to improve and adjust the results.

The severe drought occured this year could explain the fact that were found nests from just three of the five categories. No nest were found at artificial pond and chanels, neither in ridges in (or arround) water bodies. The exploitation at this places is cattle ranching, so the animals were frecuently concentrated at this places looking for water what certainly could disturb the reproductive process.

Methods

Eighty four nests were harvested between January and February 96' in differents environments northern Santa Fe. For this work were considered 74, and from those, seven correspond to Forest, 20 to Ridge in (os arround) water bodies, and 46 to Floating vegetation in swampy land.

Nests were marked for local inhabitants and for us when the helicopter was used. The harvest and transportation was made by horse, track, boat or helicopter, depending the place.

The working area was minuciously studied, so we can suppose that most of the nests were found.

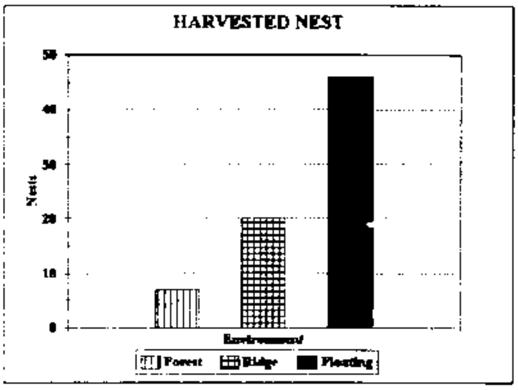
Harvested and marked eggs were transported to the incubator at the breeding station. There were measured with a caliper and the volume was calculated.

Hatch occured since the end of February until the middle of April. The clutch size and number of hachlings per nest was recorded, and from this information the hatching success was calculated.

Results

1- The preferred environment for nesting this year was Floating vegetation (Embalsado). **(Fig. 1)**

Figure 1



In order to evaluate significative differences between Habitat prefernece a Chi square Test was made.

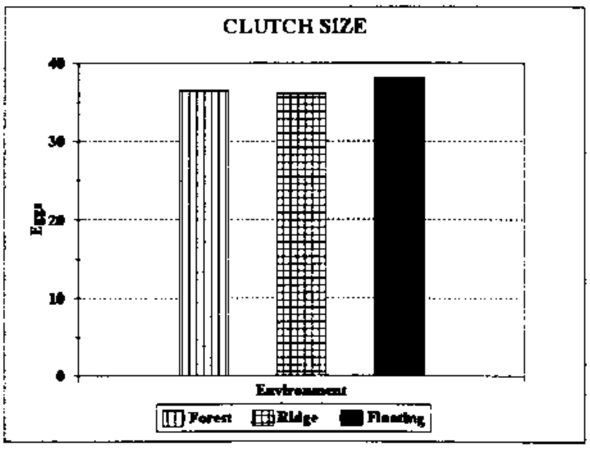
Chi - square Goodness of fit Test

Environment	Observed Frecuency	Expected Frecuency	Chi Square
Monte	10	33	16,90
Albardón	27	33	1,05
Embalsado	63	33	26,49

Chi square = 44,4341 with 2 d.f.
Sig. Level = 2,22451E - 10

2- In **Fig. 2** are showed the differents clutch size recorded for each environment tipe.

Figure 2



In order to evaluate if the differences were significatives, a Kruskall Wallis Test was made, showing that they are not significative differences.

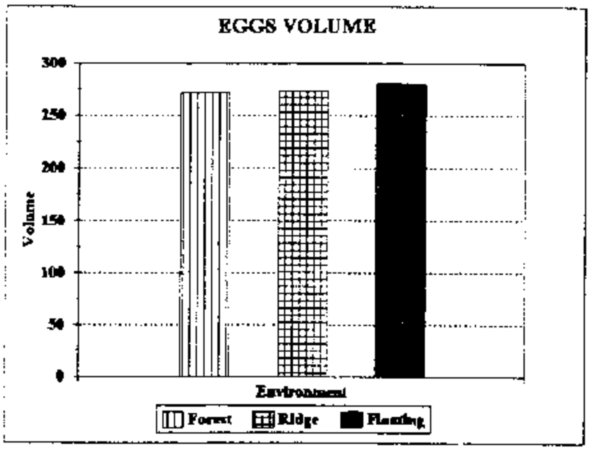
Kruskal - Wallis Test

Environment	Sample Size	Average Rank
Monte	7	39,5
Albardón	20	34,1
Embalsado	46	37,8

Test statistic = , 551908 p-value = ,758848

3- In **Fig. 3** is showed the different eggs volume for each envaironment tipe.

Figure 3



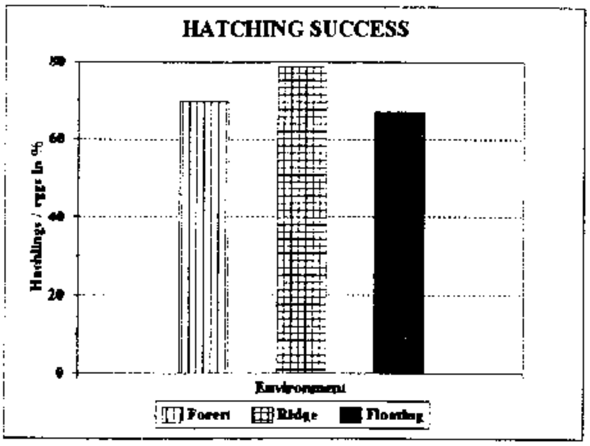
In order to evaluate the different eggs volume between environments, an Analysis of Variance was carried out.

ANOVA Table - Analysis of Variance

Sourse	Sun of Squares	Df	Mean square	F - Ratio	p - value
Between groups	1595,2	2	797,601	1,33	,2725
Within groups	40927	68	601,868		
Total (Corr.)	4522,2	70			

4- In **Fig.** 4 are displayed the differents Hatching success recorded for each environment tipe.

Figure 4



In order to evaluate differences, a Kruskal Wallis Test was made, showing that there are significative differences between environments.

Kruskal - Wallis Test

Environment	Sample Size	Average Rank
Monte	7	35,1429
Albardón	20	47,375
Embalsado	46	32,7717

Test statistic = 6,63523 p-value = ,0356997

Conclusions

Taking into account the fact that most of the nests were found in the working area, the floating vegetation in swampy lands appear as the preferred nesting environment for this year., followed for the ridge in (or arround) water bodies, and f nnally for the forest.

Despite the fact that the preferred environment was the floating vegetation in swampy lands, the hatching success there was lower than in the other places. The question is, caimans nesting there because preference or because they have no choice?.Further studies could respond it.

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EGG SIZE ON *Caiman latirostris* AND ITS RELATIONSHIP WITH CLUTCH SIZE, HATCHING SUCCESS, SURVIVOR AND GROWTH

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Introduction:

Broad snouted caiman (*Caiman latirostris)* is one of the two species occuring in Argentina, it is widely distributed in northern Santa Fe and certainly is the most abundant in Santa Fe province.

The experimantal ranching program is currently developing differents researchs about various issues. One of the most important is to evaluate reproductive parameters relating clutch size, hatching success, surviviorship and growth with the egg size, and by this mean eventualy, with the female size.

The objective of this particular paper is to give some information about the recorded differences on hatching success from wild harvested *Caiman latirostris* eggs and its relationship with egg volume and clutch size. We investigate too, the relationship between the egg volume and the hatchlings size.

Materials and Methods

Eggs come from wild nests harvested in different places, (San Cristóbal, and San Javier States, where the "Proyecto yacaré INTA \ MAGIC \ MUPCN", develops its program of recovering and monitoring wild populations of "Broad snouted caiman" (*Caiman latirostris*).

The 365 eggs of *C. latirostris* were measured with a caliper (0.1 mm). The volume of the eggs was calculated according the ellipsoid equation; $\frac{3}{4}\pi * A * B * C$, being A the larger diameter and, B and C the smaller ones.

The weight of the clutch (only hacthlings) was measured with a pesola of 10 gr. precision at the hatch moment and with a 100 g precision when they were released.

The results are presented in mm± SDT, the weights are the averages recorded in each nest.

Results

Table N°1: Maximum medium and minimum values with its SDT, of 365 *Caiman latirostris* eggs

n=365	Big axis	Small axis
max. value	76,6	47
midium	66,53±3,31	40,71±1,85
min. value	56,65	31

Table N°2: Big and small axis midium values from 11 *C. latirostris* nests eggs with its clutch size.

Nest	Big axis	Small axis	Clutch size
1	71,38±2,52	44,96±0,58	41
2	68,53±1,43	41,16±0,75	43
3	60,46±3,95	40,82±1,57	29
4	68±2,32	40,23±0,75	33
5	68,58±2,58	37,14±1,42	35
6	72,18±1,77	44,99±0,69	39
7	67,09±2,44	40,57±0,35	38
8	66,96±2,9	40,05±0,75	37
9	65,47±1,76	42,40±0,42	49
10	65,45±1,84	40,19±0,68	41
11	63,27±1,27	40,08±0,81	43

Table N° 3: Averange weight of the nests at moment of hatching and releasing.

Nest	Weight during hatching*	Weight during releasing
1	40	140
2	40,24	177,5
3	40	200
4	36,84	192,86
5	33,33	104
6	40	153,33
7	39,29	111,53
8	44,12	173,53
9	45,65	250

10	40,26	202,5
11	36,25	315,15

*Weights are the averanges of the clutch
The averange weight of all animals is: 40,23 g.

Table N° 4: Clutch size, hatching success and survival of the 11 nests in relation to the eggs volume.

Nest	Volume (cm^3)	Clutch	Hatching success	Survival
1	339,96	41	0,98	1
2	273,55	43	0,95	0,98
3	237,36	29	0,35	0,8
4	259,3	33	0,58	0,74
5	222,88	35	0,94	0,46
6	344,23	39	0,41	0,94
7	260,18	38	0,74	0,93
8	253,06	37	0,92	1
9	277,31	49	0,92	0,98
10	249,08	41	0,95	1
11	239,47	43	0,93	0,83
Averange	268,76	38,91	0,81	0,89

Discussion

Verdade (1995, in São Paulo, working with 17 nests, collected in 6 years, obtained an average of 33 eggs per nest, being its range from 18 to 49; the hatching success was 7,33 hatchlings per nest (average); the average size of the eggs was 67,3 mm (big axis) and 42,8 mm (small axis), being its range 60 mm to 75 mm and 34 mm to 45 mm.

The values recorded by other authors range from 57,1 to 75,5mm and 37,2 and 46,6mm, big and small axis respectively (Achaval and González, 1983). This values are included within our range recorded in this paper (Table N° 1).

Ferguson (1984) and Ferguson and Joanen (1983), described a relationship between the female age and the size of the eggs and the clutch size; they conclude that young females (younger than 15 years) laid few and little eggs, the females between 15 to 20 years laid big clutch and the eggs are big; and the females older than 30 years laid few but the biggest eggs.

The picture N° 1, shows the relationship between clutch size and the volume averange of the eggs; an increase can be appreciated of the clutch size when the volume raises, until eggs bigger come from clutch smaller. In South Carolina, Wilkinson (1985), report the relationship between the eggs size, clutch size and the female size. Casas Andreu and Rogel (1986), did not found correlation between the female size and the eggs size, not either between the female weight and the number of laid eggs. When they try to make a correlation between the female weight and the clutch weight, they did not found any significative result. Others works in species such as *Alligator mississippiensis* (Deitz and Hines, 1980; Joanen, 1969; Joanen and Mc Nease, 1975; 1989) and *Crocodylus porosus* (Webb *et al.*, 1977; 1983), did not found relationship neither. The clutch size (averange n=11) found in this work was higher than the described by Larriera (1991) (37,1 eggs/nest n=12). Values for other specie (*C. yacare*), range between 55,8 and 75,5mm for the larger axis and 33,5 to 46,6mm for the smaller (Tables N° 6 and 7); this ranges are narrower than the range found in this work to *C. latirostris* (Table N° 1).

In the relationship between the eggs volume with the animals weight at hatch (Fig N° 2), appears a weight raise of the hatchlings when the eggs volume increase. The regression of this relationship shows a low R^2 value (R^2=0,42) suggesting that exist a lots of other factors influencing on the hatchlings weight, but the correlation between the same relationship shows a significant r value (r = 0,65; P<0,05), this means that the relationship between the eggs volume and the weight of the hatchlings at hatch is significative. Schulte and Chabreck (1990), found that the hatchlings size was affected by the nesting environment and the incubation temperature, but certainly were more influenciated by the nest itself. In the same paper, Schulte and Chabreck (1990), found that the hatchling weight was strongly influenciated by the eggs volume. In others species of crocodilians, the same relationship was found too (Deitz and Hines, 1980; Staton and Dixon, 1977; Webb *et al.*, 1983). Casas Andreu *et al.* (1993), observed a significative relationship (r = 0,72; P<0,05) between the weight of the eggs and the hatchlings at hatch; they foun that possibly the hatchlings of the big eggs, have a larger survive rate.

After 9 mouth, when the animals were released, they were weighted (Fig N° 3), the result of this correlation (R^2=0,048; b=-0,34) shows that the eggs volume do not act on the following growth of the animals.

Speculating about the relationship between the regression value and the information displayed on figures 4 and 5, seems that from nests with small eggs, hatch and survive few (sometime large)animals, because the trend show that hatching success and survivorship are increased as larger are the eggs and the fact of its larger weight could be explained for errors calculating average in few animals.

Figures

Figure N° 1: Relation between clutch size and the volume average of the eggs.

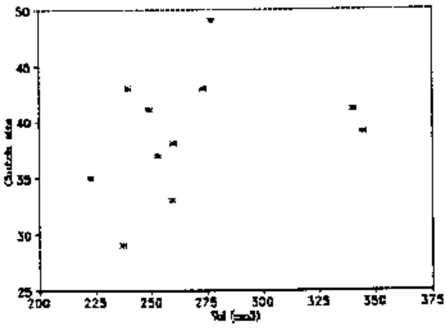


Figure N° 2: Relation between eggs volume and the animals weight at hacht.

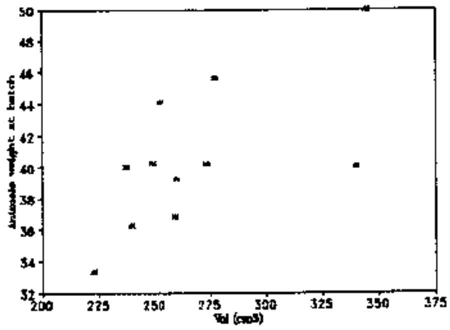


Figure N° 3: Relation between eggs volume and the animals weight at releasing time.

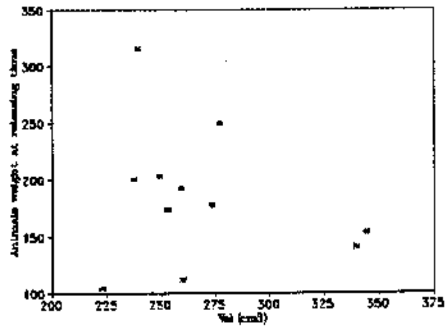


Figure N° 4: Relation between eggs volume and the hatchling-success.

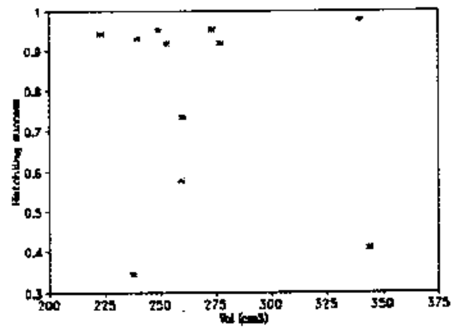
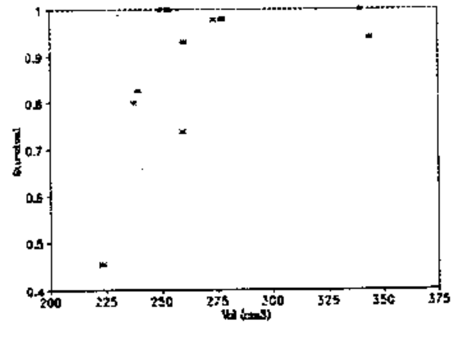


Figure N° 5: Relation between eggs volume and survival.



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CALCIFICATION BAND AND EMBRYO DEVELOPMENT OF *CAIMAN LATIROSTRIS* EGSS INCUBATED AT THREE DIFFERENT TEMPERATURES

Larriera, A., P. Donayo, A. Imhof & C. Piña

INTRODUCTION

The opaque band we see in eggs changes as the egg content reorganizes itself, during the development of the embryo (Webb et al.1987).

Such opacity would be caused by structural changes and changes in the optical properties of the shell, caused by dissolution of calcium carbonate crystals, as the albumen dehydrates and the chorioallantois expands or the embryo membranes (Ferguson.1982 and Webb et al.1987). This way, until the egg become completely opaque, it is possible to calculate the embryo age, according to extent of the band.

These facts, as well as the total period of embryo development (from the laying up to the eclosion) and the influence of temperature during the development time have been reported from different crocodilians species, being the study in *Alligator mississippiensis, Cocodrylus porosus* and *Cocodrylus jobstoni* more detailed.

For this species, *Caimán latirostris*, only total average time has been calculated from the laying up to the eclosion in the wild (Larriera.1992-1993).

OBJETIVES

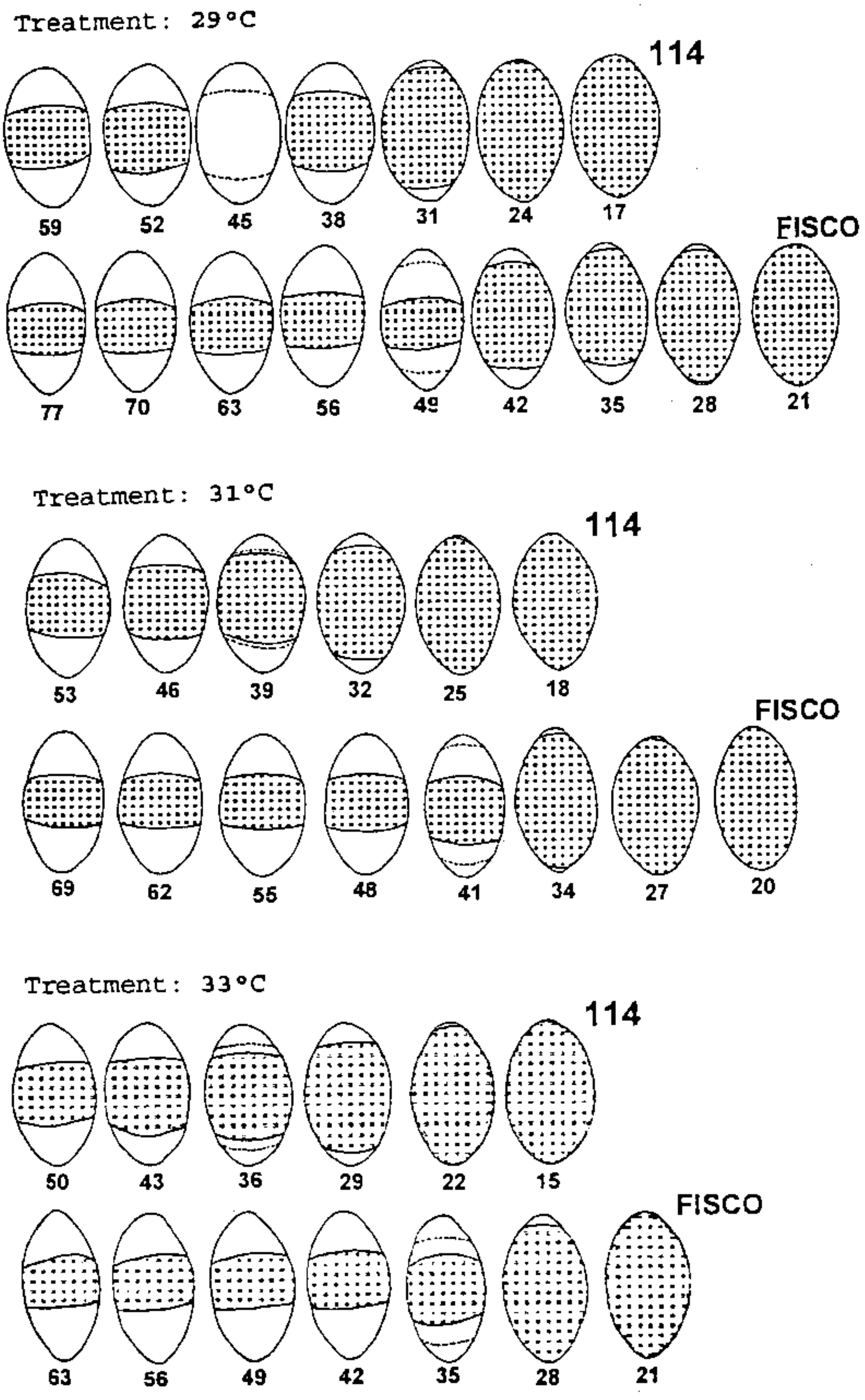
- To develop a cheap and fast technique that allows to know the degree of embryo development from eggs collected in the wild to determine the date of the laying.
- To determine the temperature effects on the embryo development time.

MATERIALS AND METHODS

Eggs coming from two nests of the harvesting of wild eggs or experimental Ranching collected through the ordinary routine were used (Larriera.1990-1992-1994), being the date of laying estimated according to what Larriera had previously recorded. In one of the nests (Town 114) the development time (from the laying) has been estimated in 14±2 days, and for the other (Fisco), in 5±2 at the moment the artificial incubation started.

Three hand-made incubators were used. They consisted of plastic punts of 47 cms tall and a diameter of 50 cms, 2 cms thick tergopol lids,and a -30°C to +30°C thermostat. Each of which was filled with 10 cms water to keep humidity and ten eggs of each harvested nest altogether with nest material. The eggs were 8 cms above the water with a plastic grille that supported them.

Fig. 1: OPAQUE BAND DEVELOPMENT DURING ARTIFICIAL INCUBATION
Days prior to eclosion



Incubators were kept at three different temperatures: 29°C, 31°C and 33°C. The only condition that changed during the incubation period was tempetature.

The calcification band that we observed with the "ovóscopo" (directed powerful light fountain which acts by contrast), was individually measured with a caliper every seven days in the greater axis of the egg, without variation in the position they had in the nest from the first day of artificial incubation until they become completely opaque. The average value was calculated in each nest.

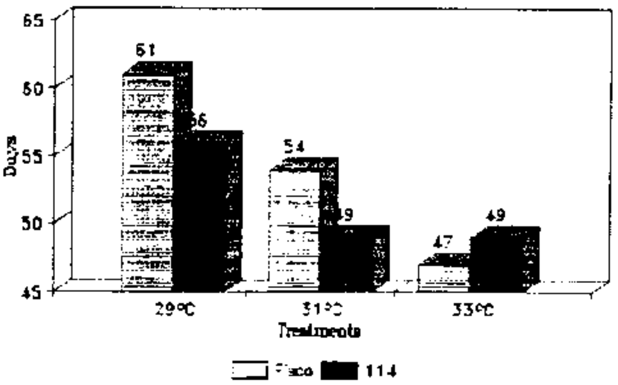
RESULTS

It has been observed that the extent of the calcification band increases simultaneously with the development time, the same as for the other crocodilians already studied (Webb et al.1987 for *C. porosus* and *C. jobnstoni*; Joanen and McNease.1991 for *A. mississippiensis*).(Fig.1)

Total opacity has been reached between the second and third week prior to the eclosion (15-21 days) without markely differences in the different temperature treatements. But if we take into account the two nests, Fiscons ended its opacity in every temperature long before its eclosion.

If the estimated laying date is considered, total opacity is reached between 47 and 61 days after the laying, increasing time as temperature diminishes (Fig. 2). Approximately 65 days have been estimated for *C. porosus* eggs incubated at 30°C (Webb et al.1987), and 52 days for *A. mississippiensis* eggs incubated between 29.4°C and 32.7°C (Joanen and McNease.1991).

Fig. 2: ESTIMATED TIME UP TO TOTAL OPACITY (from the laying)



It is also observed a period in the two nests and in the three temperature treatments where the band limits are diffuse, with a generally darker zone in the center that coincide with a fast and great extension of the band. It has to be considered that as the band was weekly measured, in many cases we may be talking about a process that has just begun or may be ending. (Fig.1)

The time in which the diffuse band takes place since artificial incubation started is the same for the three treatment of the same nest, although they are different if we compare the two harvested nests. The period required for the Fisco nest eggs is larger in all temperatures in relation with Town 114 nest eggs. (Fig.3)

The same happens if it is considered when the diffuse band is reached from the estimated lying date. (Fig.4)

In *C. porosus* eggs, there is an evident band expansion approximatelly to the 40-45 days from the time of laying (Webb et al.1987); the estimated total incubation time is an average of 100 days (Magnuson and Taylor.1980). Also a *C. porosus* study in which embryos are slaughtered to assess morphological changes that occurs altogether with development shows that about 38 days after the laying a noticeable development is observed in embryos. It can be seen, for instance, in the increase of forelimb length and hindlimb length as well as in the head (Magnuson and Taylor.1980).

Therefore, the band diffuse limits in *C. latirostris* could be due to continuous and quick changes in the eggshell components and in the egg membrane due to vascularization and reorganization of its contents during its development. This would be the reason why they cannt be delimited.

On the other hand, the time that lasts to the eclosion varies starting from this situation in the different treatments and in the two nests, being this greater as temperature diminishes. (Fig.1)

Fig. 3: TIME UP TO DIFUSE BAND
(from artificial incubation)

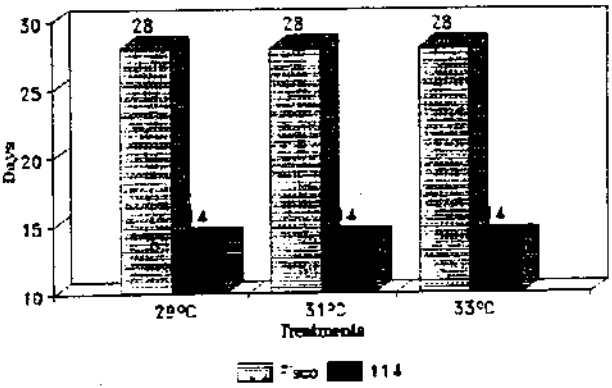
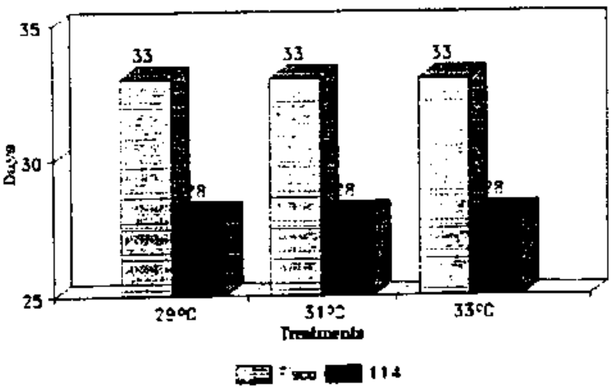


Fig. 4: ESTIMATE TIME UP TO DIFUSE BAND
(from the laying)



If the artificial incubation time in the higher temperature treatment (33°C) is analized, it is less. On the contrary, in lower temperature treatment (29°C), it is larger. (Fig.5)

The same happens if total development time is considered (from laying estimated date up to eclosion) which varies between 64-82 days; in the wild, this period had been estimated between 71-79 days (Larriera.1992-1993). In the higher temperature treatment, time is less; and in lower temperature treatment it is larger (Fig. 6), which can also be seen in *C. porosus* and *C. johnstoni* (Webb et al.1987).

Fig. 5: ARTIFICIAL INCUBATION TIME

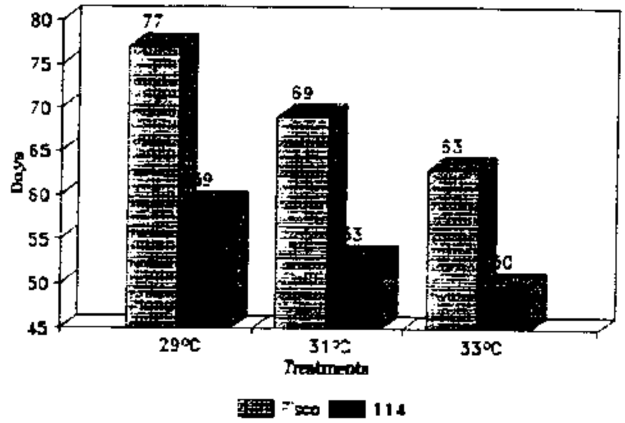
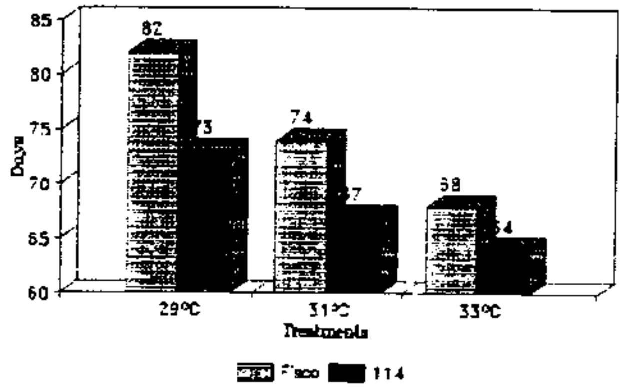


Fig. 6: DEVELOPMENT ESTIMATED TIME
(from the laying up to eclosion)



In embryos of the same nest and whatever treatement is being considered, it can be seen that therens not markedly differences in the early stages of embryo development (approximately up to the diffuse band, close to half the total development time). From now onwards it is harder to estimate the embryo age. These results are similar to those of *C. porosus*, in which most differences take place after 60 days development (Magnuson and Taylor.1980).(Fig.1)

At the same time, in the two nests harvested, and taking as reference the medium temperature treatment (31°C), therens always a wider difference (greater amount of days) between 31°C and 29°C treatment (lower temperature) than between 31°C and 33°C treatment (higher temperature) (Table 1). Temperature influenced a lot delaying the development.

In addition, more markedly differences can be observed among Fisco nest eggs three treatments (regarding difference in days between the three treatments) taking into account the estimated total development time and the artificial incubation time (Table 1). This nest was the one that had less development time at the moment of artificial incubation. This would suggests that as soon as posible the treatment stars, temperature will influence much more in the development. Complementary studies should be carried out since this difference could be due to individual variations among the nests.

Table 1: DEVELOPMENT ESTIMATED TIME
(from the laying up to eclosion)

	29°C	31°C	33°C
Fisco	82±2	74±2	68±2
114	77±2	67±2	64±2

CONCLUSIONS AND DISCUSSION

- The opaque band observation is an useful method to estimate the embryo age in the early development stages.
- Temperature has an inverse effect on the embryo development time.
- Temperature would influence much more delaying the development rather than speeding it up.
- Temperature effect on develpment time would be larger as soon as posible the treatment starts.

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EFECTOS DE LA TEMPERATURA DE INCUBACION SOBRE EL CRECIMIENTO Y DESARROLLO EMBRIONARIO DE *Caiman crocodilus fuscus.*

C. L. **SIERRA** D., M.A. **RODRIGUEZ** M., G. A. **ULLOA** D., P. M. **RUIZ-CARRANZA** & G.GALVIS.

Durante el desarrollo embrionario se suceden en forma secuencial cambios morfològicos y funcionales. Al considerar estos cambios surgen tres aspectos importantes del desarrollo como son: diferenciaciòn celular , morfogènesis y crecimiento. Estos tres aspectos en los Crocodylia y los Testudinata estan regualados por la temperatura de incubaciòn y por esta asociadas la humedad relativa y el ambiente gaseoso del medio en que se desarrolla el proceso.

Packard y colaboradores (1987) afirman que las varaciones temporales y espaciales en la humedad y la temperatura dentro y entre nidos naturales probablemente sean las responsables de variaciones ecològicas importantes en el tamaño y sexo de neonatos, de ahì la importancia de determinar experimentalmente los efectos de la temperatura de incubaciòn sobre el desarollo.

Se incubaron entonces 815 huevos embrionados de *Caiman* provenientes de 405 nidos obtenidos por reproducciòn en condiciones controladas del nucleo de parentales mantenidos en la granja Monterrey Forestal de Pizano S.A. De estos 310 fueron incubados a 29.5 C, 265 a 31.5 C y 240 a 33 C, mantenièndose constantes las variables hùmedad relativa (98%) y tensiòn de oxìgeno (20.5%).

Se estableciò un patròn de colecciòn , sacrificio y fijaciòn de los huevos que permitiò obtener cinco embriones en cada uno de los estadios de desarrollo y para las cuales se conocia exactamante la edad a partir del dìa de postura. Para la fijaciòn y obtenciòn de los embriones se siguiò la metodologìa propuesta por Ferguson (1985).

Una vez cada embriòn fue separado de sus menbranas extraembrionarias se procediò a tipificar su estadio de desarollo , para posteriormente tomar 14 dimensiones morfomètricas : Longitud total, Longitud de la cola, Longitud cefàlica, Longitud cefàlica 1, Longitud del tronco, Longitud del brazo, longitud del antebrazo, longitud del muslo, Longitud de la pierna, Longitud del pie, Distancia axila- ingle, Longitud ojo- narina, Diàmetro orbital, Altura cefàlica y Anchura màxima de la constricciòn interorbital.

Perìodo de Incubaciòn: El perìodo de incubaciòn de *Caiman crocodilus fuscus* variò con la temperatura; asì, tomò 85 dìas cuando el proceso se realizò a 29.5 C , 75 dìas a 31.5 y 70 dìas a 33.0 C .

No obstante lo anterior se presentan algunas variaciones en cuanto la duraciòn total del perìodo entre 4y 6 dìas .

El incremento continuo en la temperatura de incubaciòn , no produce un descenso lineal en la duraciòn del perìodo de incubaciòn. Asì, el incremento de 29, 5 a 31,5 disminuye el perìodo en 10 dìas , mientras que el incremento de 31.5 a 33 solo lo reduce en 5 dìas.

Cronologìa del desarrollo: para la caracterizaciòn de los estadios embrionarios se siguieron tanto el mètodo morfològico como el morfomètrico. El primero no sigue una secuencia estrictamente continua de organogènesis por lo cual no produce relaciones respecto al tiempo de incubaciòn, mientras que el segundo si contempla los cambios en las dimensiones del embriòn durante el perìodo de incubaciòn, cuantificando la variaciòn en forma cuantitativa y secuencial, lo que permite establecer relaciones con variables como el tiempo y la temperatura.

La relaciòn entre los estadios morfològicos de desarrollo descritos y la edad del embriòn en secuencias logradas bajo regimenes de temperatura constante : En los primeros estadios, cuando los cambios son evidentes y ràpidos la relaciòn tiende a ser lineal, no asì a partir del estadio 21, cuando los cambios morfològicos son apenas perceptibles, lentos y priman las variaciones morfomètricas las cuales no son tenidas en cuenta durante la descripciòn morfològica, pues simplemente hay un incremento ràpido en el tamaño del embriòn.

De otro lado, un incremento en la temperatura de incubaciòn como tambièn se observa no produce un descenso lineal en la duraciòn de los estadios en particular , pasàndose por alto las diferencias especìficas en el desarrollo originadas por la temperatura. .

Para la evaluaciòn de las tasas de desarrollo se compararon las 19 varaibles morfomètricas y su comportamiento a travès del tiempo de incubaciòn mediante gràficas cartesianas, con las cuales se probò el ajuste de los datos a diferentes modelos de crecimiento:

El modelo logìstico de crecimiento explica el comportamiento de las variables longitud total, longitud de la cola, longitud del tronco,longitud de las extremidades, longitud axila- ingle,longitud ojo narina, longitud interorbital, longitud internarinas y màxima anchura de la cabeza.

De otro lado, el incremento de peso a travès del tiempo se ajusta al modelo de Gompertz, mientras que el comportamiento de la altura cefàlica y la longitud cefàlica se representan con modelos potenciales. Aunque los modelos de crecimiento de los seres vivos tradicionalmente se ajustan a la ecuaciòn de Von Bertalanfy , este no se ajusta a los datos de crecimiento obtenidos de los embriones y fetos en desarrollo y crecimiento, encontràndose bàsicamente la diferencia en el valor del màximo tamaño calculado del observado (388.4 vs 270.5) en el caso de la longitud total.

Un caso interesante y para el cual no fue posible calcular ningun modelo de crecimiento es el avance del diàmtero ocular.

Con base en los modelos de crecimiento registrados para la variable longitud total , peso, altura cefàlica y longitud cefàlica se calcularon las ecuaciones que permiten predecir la edad del embriòn o del feto cuando se conoce la temperatura a la cual se desarrolla el proceso de incubaciòn.

Variable	Temperat	ECUACION	r2
Long Total	29.5	264/ 1+ e exp -(0.08343 * t - 3.3105)	0.9695
Long Total	31.5	264/ 1+ e exp -(0.12060 * t - 3.5272)	0.9885
Long Total	33.0	264/ 1+ e exp -(0.12196 * t - 3.4095)	0.9802
Peso	29.5	10 exp(- 1.934 + 3.3065* (log t))/1000	0.9689
Peso	31.5	10 exp(- 1.290 + 3.1005* (log t))/ 1000	0.9931
Peso	33.0	10 exp(- 1.143 + 3.0532 *(log t))/1000	0.9597
Alt. cefal	29.5	10exp10exp(0.5453+0.2847*(log(log t)))	0.9932
Alt cefal	31.5	10exp10exp(0.5579+0.2587*(log(log t)))	0.9584
Alt cefal	33.0	10 exp10exp(0.5585+0.2561*log(log t)))	0.9446
Long cef	29.5	e exp (-0.8257 + 0.9868 * (ln t))	0.9510
Long cef	31.5	e exp (-0.5777 + 0.9601 * (ln t))	0.9619

Long cef 33.0 e exp (-0.6816 + 1.0164 * (ln t)) 0.8591

Con base en las ecuaciones calculadas se graficò la primera derivada de la funciòn correspondiente a cada modelo como valor representativo del cambio diario de las dimensiones del embriòn.

Se alcanza la mayor tasa de incremento en la longitud total en embriones incubados a 33 C en el dìa 28 de la incubaciòn (8.04 mm/dìa) y que corresponde al estadio morfològico 22. Dicha tasa es 0.11 y 0.45 veces mayor que la tasa calculada para embriones incubados a 31.5 y 29.5 para el mismo dìa de incubaciòn.

Al aumentar la temperatura de incubaciòn 3.5 grados, la tasa dìaria de crecimiento longitudinal se incrementa en un 69.52%, para el estadio 22. Hasta este mismo estadio, los procesos de organogènesis va acompañados de un incremento gradual de las tasas de crecimiento las cuales en este estadio alcanzan su màximo valor, a partir de este punto cuando la organogènesis cesa y se continua una etapa de crecimiento las tasas disminuyen gradualmente hasta la eclosiòn.

En lo que respecta, se obtienen las màximas tasa de incremento en masa embrionaria en fetos incubados a 33 C (0.96 g/dìa) a partir del dìa 60 de incubacion, dicha tasa es 0.13 y 0.57 veces mayor que la tasa de incremento observada en embriones incubados a 31.5 y 29 5 respectivamente, mantenièndose la proporcionalidad hasta el final del desarrollo

Las tasas diarias de incremento de la variable altura cefalica , son mayores durante los primeros 10 dìas de incubaciòn. En embriones incubados a 33 la tas diaria de incremento es 0.026 y 0.29 veces mayor que a 31. 5 y 29.5 respectivamente.

En lo que respecta a la tasa de crecimiento longitudinal de la cabeza se aprecia un leve aumento pero continuo con valores màximos al final del desarrollo (70 dìas) en embriones incubados a 33 C. La tasa diaria de cambio de la longitud cefàlica es 0.87 y 0.23 veces mayor en fetos incubados a 33 C que en individuos incubados a 31.5 y 29.5.

Se puede concluir entonces que los embriones de ***Caiman crocodilus fuscus*** incrementan su masa y su longitud dìa tras dìa a diferentes tasas segùn la temperatura. A altas temperaturas las tasas diarias de incremento son mayores durante todo el perìodo embrionario, a temperaturas medias (31.5) dichas tasas son mayores que las registradas a baja temperatura.

Finalmente indicar la edad de un embriòn en campo, resulta fàcil con base en las ecuaciones desarrolladas, siempre y cuando se conozca la temperatura de incubaciòn, lo que resulta mas fàcil que el realizar un examen detallado de la morfologìa embrionaria.

Temperature Dependent Sex Determination in St Lucia Nile Crocodiles in Natal, South Africa.

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Abstract
The factors controlling sexual differentiation in crocodilians are unknown, but heteromorphic sex chromosomes are absent from all species. The sex of *Crocodylus niloticus* was shown to be determined by the temperature of egg incubation in constant temperature and in shift temperature laboratory experiments. Temperature shifts from 32.0°C to 33.0°C and visa versa were conducted at varying times during the incubation period in order to define the thermosensitive period (TSP). The duration of the incubation period varied with temperature and was 74 days at 33°C, increasing to 87 days at 31.0°C. Preliminary results indicate that the TSD pattern is female-male-female; females are produced at low and high incubation temperatures, while males are produced at intermediate temperatures.
The shading effect of *Chromalaena odorata,* an alien plant found to be invading crocodile nesting sites in the Lake St Lucia area, may reduce nest temperatures thereby altering the sex ratio of crocodile hatchlings entering the lake ecosystem.

Introduction

Lake St Lucia forms part of the Greater St Lucia Wetland Park which is located in the north eastern corner of South Africa. The lake body covers an area of 350km^2 and comprises approximately 80% of the estuarine area of Natal Province (Begg, 1978). It has been described as being the largest estuarine system in Africa. This dynamic and fascinating system is home to approximately 1500 crocodiles of various size classes.

Temperature dependent sex determination (TSD) is a phenomenon nearly restricted to certain taxanomic groups of reptiles (Bull, 1980 and 1983; Ewert and Nelson, 1991; Janzen and Paukstris, 1991). However, the majority of animals possess genotypic sex determination in which the sex of the individual is determined at or before conception. During TSD the sex of the individual is determined by the temperatures experienced during embryonic development. Other environmnetal factors may also affect sex determination and for this reason the phenomenon may also be called environmental sex determination or ESD. Throughout this paper we use the term TSD.

Among crocodilians, the universal absence of heteromorphic chromosomes (Cohen and Gans, 1970)points to the likelihood that all living crocodilia exhibit TSD (Ferguson, 1985). Lang and Andrews (1994) state that at the present time, half of the 22 species of extant crocodilians show evidence of TSD. However, the TSD patterns in a few studied representatives differ substantially and therefore Additional species have to be studied before valid generalizations may emerge. The presence of TSD in reptiles has important implications for their sex ratios, habitat requiremnets and reproductive success. From a management perspective the relevant information for conservation and/or utilization programmes must therefore be species specific.

Since the discoverey of this sex determining mechanism by Charnier in 1966, the effort of most researchers has been directed toward laboratory studies of TSD with relatively little attention being paid to the operation of TSD in nature. This study however, was designed to include both laboratory and field experiments.

Methods and Materials

a) Laboratory experiment:

During the 1994/95 and the 1995/96 nesting seasons, four clutches of wild crocodile eggs were collected from three different nesting areas in the Lake St Lucia area. The eggs were randomly placed onto one of seven styrofoam incubators which were maintained at the following temperatures: 31.0°C, 31.5°C, 32.0°C, 32.5°C, 33.0°C, 34.0°C and 35.0°C. An "open" method of egg incubation was used. In the 1994/1995 nesting season a shift experiment was carried out with an additional 40 eggs in order to determine the thermosensitivce period or TSP, which is the time phase during incubation that the sex of the individual is determined. For this experiment, at various stages during incubation, 10 eggs at any one time were shifted from a higher to a lower temperature and visa versa.

b) Field Experiment:

In 1994 we hypothesized that an alien plant, namely *Chromalaena odorata* (commonly known as parrafin bush) was negatively impacting breeding success by: 1) invading crocodile nesting areas and preventing nesting and 2) reducing incubation temperatures by creating shade. The alien plants invasion of nesting sites is a particular problem due to the fact that crocodilians have been shown to demonstrate nest site fidelity. In order to test this hypothesis, during August and September of the same year we cleared experimental areas on the banks of the Mpate river, one of the nesting habitats on the western shores of the lake. Some areas were previously utilized nesting sites that had since been invaded by *C. odorata.* We also created a number of totally new experimental sites within the dense stands of *C. odorata.*

We established two thermal and moisture transects, 12m in length, perpendicular to the river bank. One transect was in full sun and the other in full shade, shaded primarily by *C. odorata.* Thermocouples connected to a CR10 data logger, which was buried and powered by a solar panel, recorded soil temperatures on the hour at 4 depths at the 8 transect stations for the duration of the incubation period. Soil tensiometers measured soil tension at average nest depth at all stations.

To complete the entire picture, it was of vital importance to collect data on incubation temperatures in wild crocodile nests. "Hobo" thermal recorders were placed within a number of wild nests, programmed to record temperatures every one hour and twenty minutes throughout the incubation period.

Results and Discussion:
a) Laboratory experiment:

Hatching commenced at 74 days of incubation at the warmer temperatures and continued for an additional 10 days for both nesting seasons. We attempted to sex the individuals macroscopically at 3 months of age and then again at 6 months and 8 months of age according to criteria described by Hutton, 1987. However, we had difficulties doing this. We developed a technique for sexing the hatchlings using a laparoscope. Although time consuming this technique is an important one as most studies to date have had to sacarifice the hatchlings in order to verify their sex. Blood samples have been taken from the 1994 hatchlings and in collaboration with Dr. Val Lance we will be looking at hormone concentrations in order to verify their sexes. Preliminary results indicate a pivotal temperature between 31.5°c and 32.0°C. Although lower than the 32.5°C pivotal temperature for Zimbabwean

Nile crocodiles, it is not surprising due to the fact that Lake St Lucia is at the southern most extent of the Nile crocodiles breeding range and they would therefore be more cold adapted in this region.

b) Field experiment:

When comparing daily mean temperatures between the sunny versus the shaded sites at a depth of 25cm (average croocodile nest depth) we find that soil temperatures in the shaded sites are on average 5-6°C cooler than those in the sunny sites (Figure 1).

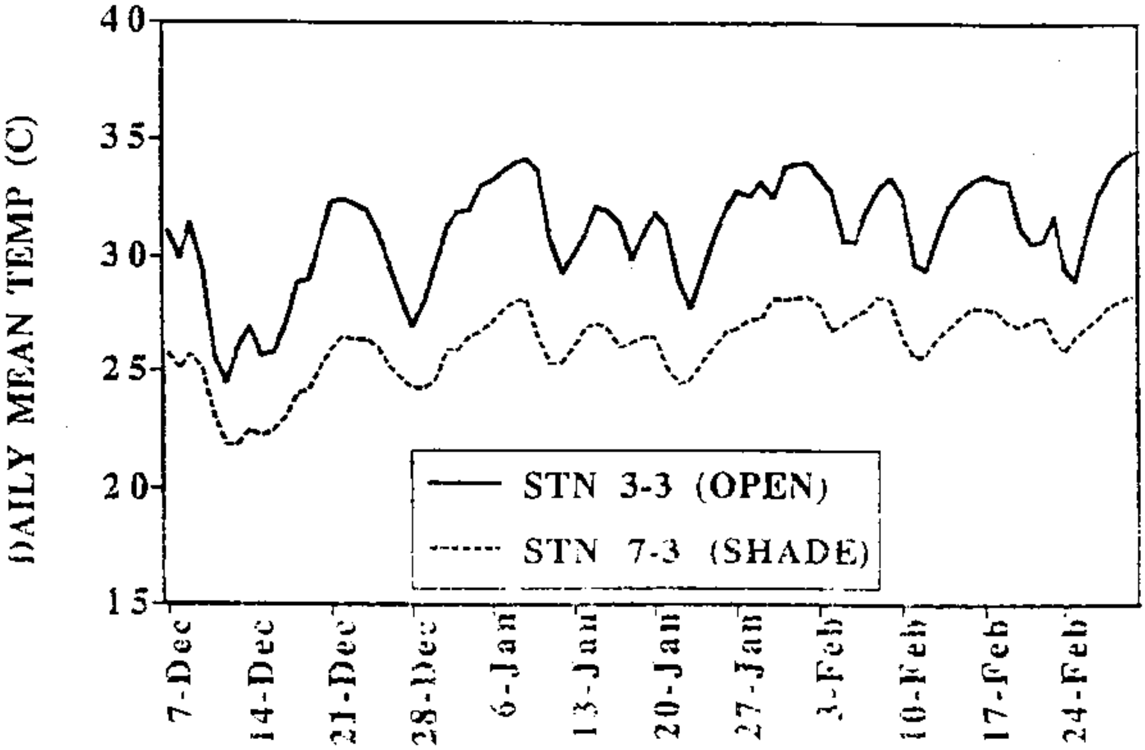

Figure 1: 25cm daily mean temperatures - Mpate River

The 32.5°C dotted line seen in figure 1, represents the predicted pivotal temperature for Nile crocodiles based on research by Hutton (1987). Hutton's pivotal temperature was used because the results from both seasons of this TSD experiment have not yet been verified. Therefore even if we consider metabolic heat production within the nest, shaded site temperatures may still be too low for the development of Nile crocodile embryos. Lang and Andrews (1994) found that at 28°C most American alligator eggs complete development but fail to hatch; Chen (1990) found that survivorship of Chinese alligator eggs was poor at temperatures below 27°C and according to Magnusson et. al. (1990) survivorship of Dwarf caiman eggs was also reduced below 27°C. Hutton (1987) states that Nile crocodile eggs incubated at 27°C never hatch. This alien plant is therefore not only altering the sex ratio of partly shaded nests, but it may very well prevent embryonic development in a totally shaded or partially shaded site.

We obtained some very valuable incubation temperature data. Figure 2 shows data from a nesting site on the eastern shores of lake St Lucia. Control temperatures were recorded at the same nest site, approximately 0.5m from the eggs themselves and at the average nest depth.

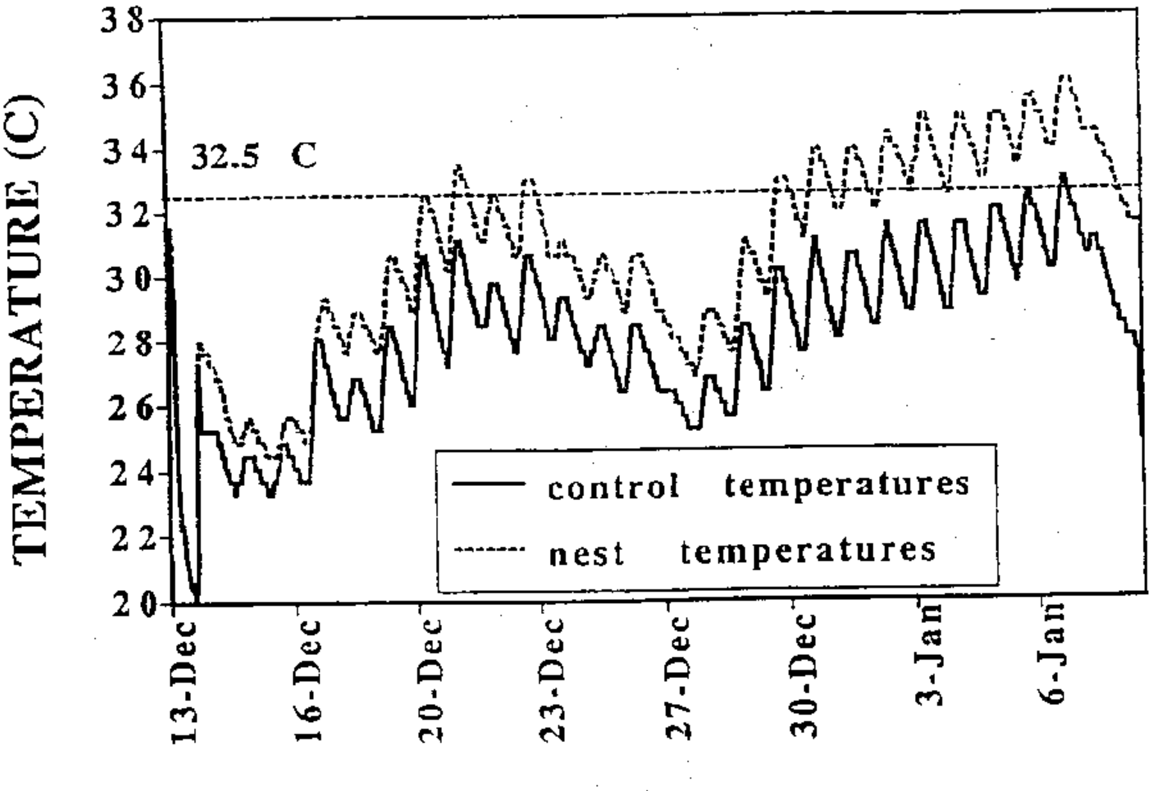

Figure 2: Nile crocodile nest vs control temperatures - Nkazana Stream

The upper line on Figure 2 represents metabolic heat production within the nest which ranges from 1 - 2° C. As development continues, metabolic heat production increases. The predicted thermosensitive period for the Nile crocodile, based on work by Hutton (1987), is between day 30 and day 50. It is approximately around this time that metabolic heat production increases and incubation temperatures reach the predicted pivotal temperature of 32.5°C.

When comparing results from nesting sites on both the eastern and the western shores of the lake - we found a substantial difference in soil temperature between the two areas (Figure 3). These temperatures were all measured in the sun transects. The Mpate river area is characterized by reeds, shrubs, high sand banks and it is generally a more open area. Nkazana stream, on the other hand, is a 1km long woody riverine area bordering a grassland. We would thus expect, and as the graph in Figure 3 confirms, soil temperatures at the average nest depth in the Mpate area to be higher than those recorded in the Nkazana stream area. Figure 3 shows a comparison in soil temperatures in both the two nesting areas.

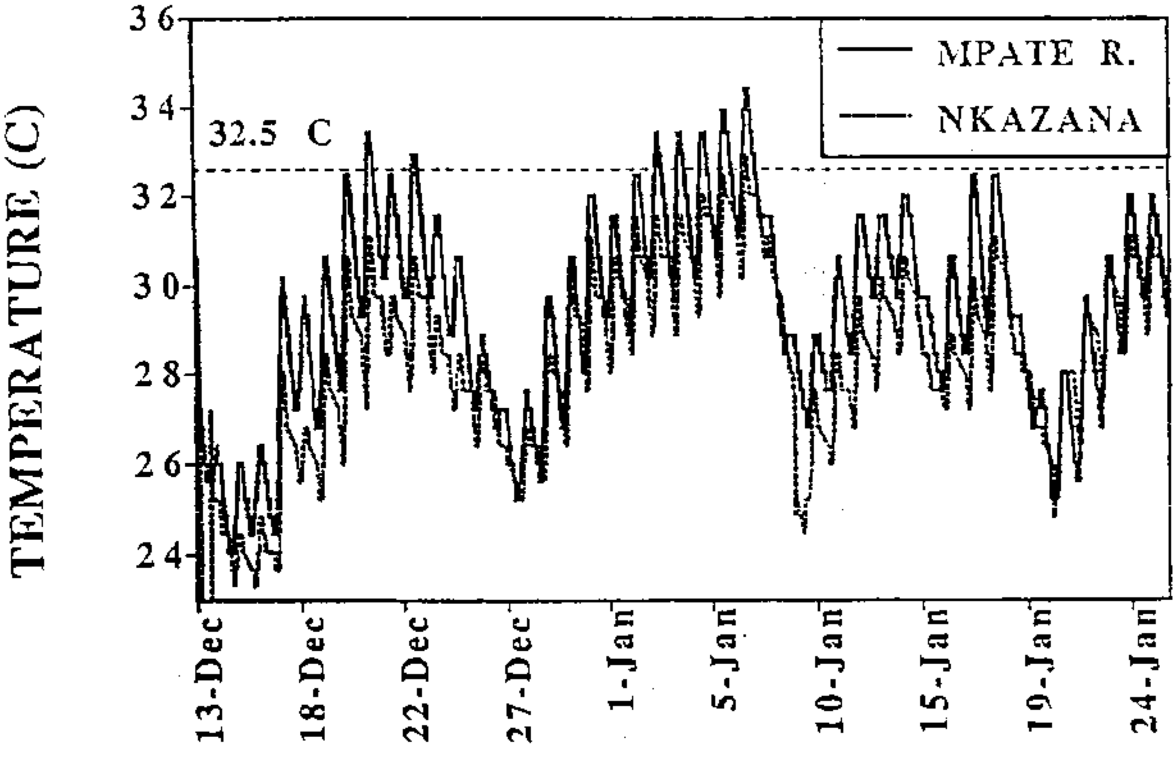

Figure 3: Nesting area soil temperatures - Nkazana Strean vs Mpate River

If we add the predicted 2.0°C metabolic heat production to the sun transect temperatures (as seen in figure 3) in the Mpate area, the 25cm depth temperatures are more centered around the 32.5°C pivotal temperature and actually go a little higher into the primarily male producing temperatures. Bear in mind that this finding excludes the influence of *C. odorata*, which is not true for the 25cm depth shade transect profiles. When metabolic heating is added to the Nkazana stream temperatures, incubation temperatures approach the pivotal temperature, resulting in a balanced sex ratio. This nesting area is still unaffected by *C. odorata*.

Conclusions:

1. Nesting areas of Nile crocodiles in the Lake St Lucia ecosytem are thermally marginal for the production of males.

2. Without the combination of full sun and metabolic heating it is unlikely that croc nests will ever achieve enough heat to produce male crocodiles

3. Continued alteration of nesting habitat by C. odorata in the Lake St Lucia system, will result in a female - biased sex ratio and eventual extinction of the species.

In Late May we once again attempted to macroscopically sex my yearlings. Preliminary results show that at 31.0°C and 31.5°C we obtained 100% female hatchlings; at 32.0°C over 80% male hatchlings were produced and at 33.0°C , we obtained 100% male hatchlings. However, even with the possibility of a lower pivotal temperature for Nile crocodiles in the Lake St Lucia region, *C. odorata* is still encroaching upon nesting sites and in so doing affecting the hatchling success and sex ratio balance of hatchlings.

Acknowledgements:
A special thanks to Drexel University, the Natal Parks Board, Earthwatch, Inc.and numerous others who have helped make this project a success.

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A PRACTICAL METHOD FOR SEXING NEONATES CROCODILIANS

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INTRODUCTIO. Like many of reptiles, crocodilians do not have external sexual organs neither visible sexual characteristics, even when the hatchlings are neonates. In the cloacal cavity three systems crowds, the digestive, the urinary and the reproductive. Also two musk glands are found inside. The common techniques for sexing are based on the appreciation by touch or at sight of the male sexual organ called penis. The female of course is lack of this, however it posses an erectil structure known as clitoris but smaller in size and with remarkable differences in its color and structure. During the males life, the penis will be loccated inside of the cloacal cavity and only will be exposed in the natural way during mating, or when the position and applied management over the animal makes that the visceras make pressure over the penis exposing it. In case of cloacal tissues inflammation, the penis will be exposed as well.

In order of knowing the sex of the crocodilians at birth, several methods has been employed:

A) Euthanasized animals to identify their gonads.
B) Abdominal pressure and dorso-ventral flexion of the lumbosacral region.
C) Cloacal digital inspection.
D) Cloacal endoscopy using the otoscopy.

The objective of this paper is to present a practical and economic technique for sexing crocodilian neonates by using the rinoscope.

MATERIAL AND METHOD. The employed rinoscope (Medicon Germany) number 25 stainless steel sizes 13.5 cm, the inserting edge measures 2.5 mm wide, 6 mm length without applying pressure. It can be inserted to a depth 25 mm inside the cloaca and opened to 30 mm. The technique for sexing by the use of the rinoscopy requires that the hatchling can be placed in dorsal recumbency and introducing kindly the inspection edge of it. Pressure is applied over the forceps and the cloaca opened laterally. If the crocodilians is a male will be observed the penis with a characteristic shape and a darker color than the rest of the cloacal epithelium. Generally the stimulation with the rinoscope produces the urine excretion through the penis.

RESULTS With this instrument were sexed 7.0.0. *Caiman crocodilus fuscus*, 31.0.0. *Crocodylus acutus* and 73.0.0. *C. moreletii* obtained by artificial incubation at Miguel Alvarez del Toro Zoo. Also have been sexed 57.7.0. mexican crocodilians of the three species captured in the wild.

DISCUSSION. Since two years ago the rinoscope has been employed with very good results at Miguel Alvarez del Toro Zoo, since the crocodilians could be sexed few days after hatch, all were males and we could restructure our incubation techniques. Our project is focused to the crocodilians reintroduction and obtaining females is our principal goal now. The euthanasia technique for gonads identification is out of practical objectives of breeding centers, zoos and conservation sites. The abdominal pressure and the dorso- ventral flexion of the lumbosacral region requires that the crocodilians be bigger than 600 mm and their body condition be adecuate so that the penis be exteriorized; if the animal is thinner, the internal pressure will not be enough. The cloacal digital inspection is an accurate method but is needed that whom makes the inspection possess a thin finger able to be introduced through the cloacal vent without injuring the tissues. By introducing the otoscopy through the cloacal vent it can stimulate the liquid secretion that make difficult the sight through the instrument cone.

CONCLUSION The use of the rinoscopy is recommended for sexing neonates crocodilians with no error margin .

Grow rates of *Caiman latirostris* under two different diets

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Introduction

Breeding animals with the aim of production, feeding is one of the priorities to be taken into account to their optimum development. Monitoring and recovering program comes from an arrangement between INTA\MAGIC\MUPCN, and its aim is to determine if the Ranching technique (CITES Res. Conf. 3.15), used successfully in other countries , is adapted to our species conditions and environmental situation.

Broad snouted caiman (*C. latirostris*), is one of the two species that lives in Argentina, it has a wide distribution in the North of the country, covering almost Buenos Aires province (YANOSKY, 1990).

There is a lot of bibliography about crocodilians diets (ALVAREZ del TORO, 1974; JOANEN *et al.*, 1988; KERCHEVAL, 1990; LARRIERA y AGUINAGA, 1990; NcNEASE *et al.*, 1983; MORPURGO *et al.*, 1990; POLANCO, 1991; SEIJAS y RAMOS, 1980; VERDADE *et al.*, 1990; VERDI *et al.*, 1980; WILDHOZER *et al.*, 1986), where costs, quality, availability in market, and the possibility of stocking are examined although we don't have many papers referred *to C. latirostris* (LARRIERA y AGUINAGA, 1990; VERDADE *et al.*, 1990).

ALVAREZ del TORO (1974) and VERDI (1980) have determined that in the wild *C. crocodilus fuscus* diet for animals shorter than a meter is:

Insects:	67.7%	Crustaceans:	2.9%
Arachnids:	5.8%.	Fish:	1.4%
Amphibious:	14,5%	Reptiles:	1.4%

Little mammals: 1.4%

LARRIERA and AGUINAGA (1990), published a paper where two diets for *C. latirostris*, are compared, in which those animals fed on red meat develop much more than those fed on fish.

The objective of this paper is to give information about the development of broad snouted caiman hatchlings under two different diets , compareing the grow between them.

Materials and methods

Two treatments were made from different diets with animals coming from 23 nests with a total of 570 animals (288 fed on chicken and 282 fed on fish). The basis of one of the diets consisted in chicken, the other was based on "sábalo" (*Prochilodus lineatus*), both with sawdust and a vitaminic-mineral complex.

The characteristics of each diet were:

		Chicken	Fish
Humidity (Heater 105-110°C)	%	65.1	60.1
Ethereal extract (Fat)	%•	22.8	32.5
Total protein	%	17.3	19.2
Total fiber	%•	8	5.3
Ashes	%•	12	12.1
Phosphorus (expressed as P)	%•	0.8	1
Calcium (expressed as Ca)	%•	3.6	3

•Dried weight

The experiment started in May 1995, when animals were distributed in six pools. During 15 days they were fed on a mixture of the two diets, with the intention that both treatments change the food composition. Animals were fed three times a week *ad libitum*, from 8 AM to midday, when leftovers were taken away. Animals were kept in concrete pools, which were 50% filled, and where they were fed. During the cold season the environment was heated with a combustion turbine of 100,000 BTU.

Animals were weighed and measured individually at the beginning and the end of the experiment (after six months). They were weighed with an analytical balance of 1 gr., and measured with a 1 mm precision meter. Data were analyzed through Kruskal-Wallis test (SOKAL and ROHLF 1979).

Results

Table N°1: Animals growing in average weight during the experiment

Days	Chicken	Fish
1	82.51	97.63
49	108.83	103.7
172	159.5	143.96

Table N°2: Average length of animals at the beginnings and at the end of the experiment

Day	Chicken	Fish
1	28.18	29.67
172	37.63	36.79

Table N°3: Cruskal-Wallis test results

		H	H Vs χ^2
Beginning			
	Weight	75.28	>*
	Length	59.26	>*
End			
	Weight	102.3	>*
	Length	4.99	>

Value of χ^2 (0.05; 1)= 3.841

* Significant values up to α= 0.005

Table N°4: Maximum and minimum values recorded on both treatments

	Maximum		Minimum	
	Chicken	Fish	Chicken	Fish
Length	32.7	34.1	23.2	24.1
Weight	127	157	38	58

Discussion and conclusions

Our results are different from the MORPURGO *et al.*'s (1990) results, working with Nile crocodile, where they tested 3 diets, fish (live and dead), red meat and chiken breeding. Animals preferred fish, whitout signifficant differences in growing among the 3 treatments. In this paper, we have found signifficant differences as regard growing, as much in lenght as in weight (Table N°: 1, 2 and 3). Animals from chiken treatment were heavier and longer than those feed on fish (159.5 gr Vs 143.96 gr and 37.63 Vs 36.79 average values) (Tables N°: 1 and 2). This differences can be attributed to the fact that animals preffered chiken. In the pools where animals were fed on fish, the food that remained was larger than in others pools. Although it is supposed that the diet based on fsh (pag. 2) has a better nourishing quality, those animals fed on chicken grew much more.

Though animals fed on chicken grew much more, red meat seems to be better for animals growing. GARNETT *et al.*, (1986); McNEASE *et al.*, (1983); LARRIERA and AGUINAGA, (1990) papers agree that animals fed on red meat have a better development than those fed on fish, not because of the amount of food that they ate (dry weight) but for the converion rate is lower (GARNET *et al.*, 1986).

LARRIERA and AGUINAGA (1990), reached an average daily growth in weigth on fish diet about 0.21 gr, our treatment based on chiken reported 0.06 cm/day growing and 0.45 gr daily increase. LARRIERA and AGUINAGA (*op. cit.*) benefited notoriously from the diet based on red meat (0,80 gr/day); these results are only useful to show us different growing rates since you can't compare them because they worked with the animals in a different way. Although red meat diet is more expenive it is more profitable from the growing point of view, which coincide with McNEASE and JOANEN, (1983) and GARNETT *et al.*, (1986) results.

When PACHON was working with animals fed on fish he foung that the *C.Crocodilus* growing curve agreed with the equation: $ln\ y=3,11+0,057x$, where y=length in cm and x=time in months.

LIEBERMAN and HILDEBRAND (1979) when feeding animals on *Iguana iguana* and *Hydrochaeris hidrochaeris* they found that the growing of young *Caiman crocodilus* was equivalent to the equation $Ln\ y=3.15+0.60x$. Fifty animals bred in Monterey Farm, fed on inlaid made of bones and meat fish, cattle visor, red meat and vitaminic complexes, allowed to establishe as a developing pattern the following equation $Ln\ y=3.15+0.068x$, RODRIGUEZ (1988). According to this equation young animals show an increment of about 0.66mm/day, almost the same we reached in this work with animals fed on chicken (0.6 mm/day).

McNEASE *et al.* (1983), report a difference of 20% in weight and 3% in length, in this work the difference in weight isn't too big, just 11%, however the difference in length is approximately the same as the above mentioned 2.3%, what suggests the same length grow rate in animals fed on chicken and red meat regarding those fed on fish. LARRIERA and AGUINAGA (1990), report a difference of 49% (those fed on red meat grew much more) between red meat diet and fish diet, that make us suppose, that a diet based on chicken and red meat could be better to one based on chicken only.
When we observe the big range in weight and length of the two treatments (Table N°: 4) we could deduce that we are far away to reach the optimum potential rate of *Caiman latirostris*. RODRIGUEZ (1988), report the same after finding that the growing equation of *Caiman crocodilus fuscus* in the wild is $Ln\ y=3.15+0.12x$ and in captivity is $Ln\ y=3.15+0.064x$, being y= length in cm, and x= time in months. PIÑA (*in press*), quotes that the growth of C. latirostris, fed on chicken, bran and a mineral-vitaminic complex is $Ln\ y=3.771+0.0061x$ in length and $Ln\ y=3.168+0.002x$ in weight, being x= time in days and "y" is gr. or cm.

The regression (weight and length) values of the two treatment show a good relation between them, the R^2 value for animals fed on fish was 92.1%, and the other 93% (Fig.: 1 and 2).

Survival during the experiment was similar in both treatments, 94.4% and 97.16% for the animlas fed on chiken and fish respectively.

Figures

Figure 1: Regresion values and dotted line for chicken treatment.

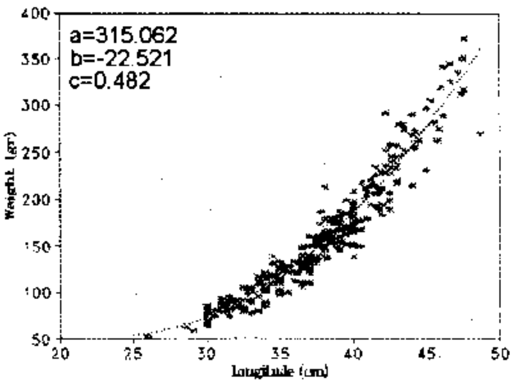
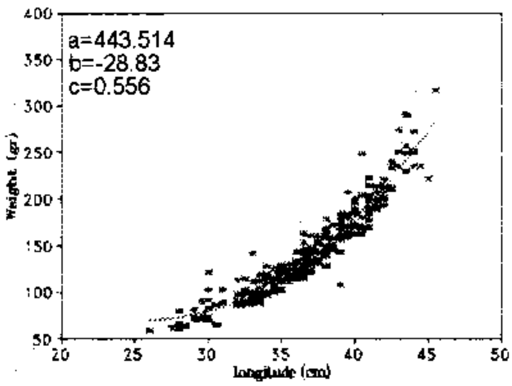


Figure 2: Regresion values and dotted line for fish treatment



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Abnormalities in Eggs, Embryos, and Juvenile

Farmed Estuarine Crocodiles, *Crocodylus porosus*.

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Poster paper presented at:

The 13th Working Meeting of the IUCN Crocodile Specialist Group,
Santa Fe, Argentina, 13-17 May 1996.

Abstract

A survey of abnormalities in eggs, embryos and juvenile *Crocodylus porosus* bred in captivity at a commercial crocodile farm was carried out during 1992 - 1994. A photographic record was made of the deformities found and preserved examples of some of the more interesting cases were kept for display at the farm.

Eggs with the following anomalies were observed:-soft shells; partial shell formation; no shell; additional calcareous protrusions on the external shell surface; under- or over-sized eggs; eggs of deformed shape with incomplete sealing.

Recorded abnormalities in embryos or hatchlings were:- unabsorbed yolk sac; dizygotic twins; malformation or absence of tail; kyphoscoliosis; shortened body; misaligned and/or reduced upper or lower jaw; anophthalmia; microphthalmia; exophthalmia; meningoencephalocele.

Aim

To record abnormalities in eggs, embryos and juvenile estuarine crocodiles, *Crocodylus porosus* for future scientific reference.

Introduction

Research into fungal disease in farmed *C. porosus* commenced in 1990 as a part-time Master of Applied Science research program (Hibberd, 1996). During 1990 and 1991 various abnormalities in eggs, embryos and hatchlings were observed in passing however no record was made of these. From 1992 to 1994 inclusive, photographs were taken of any abnormalities observed, and preserved specimens were kept as a reference collection.

Methods and materials

Animals, facilities and staff support were provided by Koorana Crocodile Farm.

During breeding seasons clutches of eggs were routinely collected for artificial incubation. The condition of any abnormal clutch or individual egg was recorded. The eggs were then cleaned and incubated with apparently normal eggs. During incubation, eggs which failed to develop were opened and the contents examined. After the expected hatching date, those eggs which failed to hatch were also opened and the condition of the embryo recorded. All live hatchlings were also checked for abnormalities.

Hatchlings with only minor defects were housed with the rest of their clutch. Live hatchlings with gross malformations and little chance of survival were euthanased. Specimens to be kept for future reference were injected with and then stored in 10% formalin. These were placed on display in the farm's tourist facility.

Photographs were taken by the Author using a Canon AE1 Program camera with a variety of lenses and microscope attachments.

Results

Eggs with the following anomalies were observed:-
soft shells; partial shell formation; no shell (ie. membrane only); additional calcareous protrusions on the external surface of the shell (*ie.* pimpling); under- or over-sized eggs; eggs of deformed shape with incomplete sealing (Plate 1).

Embryos and hatchlings with the following deformities were observed:-
- abnormally large yolk sac (Plate 2)
- dizygotic twins (Plates 3 and 4)
- malformed tails (Plates 5 to 10)

- congenital kyphoscoliosis (Plates 11 and 12)
- absence of tail (Plates 13 to 16)
- shortened body, misaligned jaws, and bilateral anophthalmia (complete absence of eyes) (Plates 17 and 18)
- microphthalmia (undersized eyes) (Plate 19)
- misaligned and/or reduced lower jaw (Plates 20 and 25)
- multiple abnormalities, no tail, reduced and/or misaligned upper jaw, anophthalmia, exophthalmia (abnormal protrusion of the eyeball), meningoencephalocele (protrusion of brain through defect in the skull), (Plates 21 to 24, and 26 to 28).

Discussion

Twinning was reported in *C. niloticus* (Blomberg, 1979 cited in Frye, 1991). Suggested causes were sudden changes in incubation temperature, abnormal incubation temperature, and occasional period of anoxia (oxygen deprivation) (Frye, 1991). Various congenital deformities were reported in *C. niloticus* (Foggin, 1987) and were thought to be directly related to extreme incubation temperatures (Ferguson, 1985 cited in Foggin, 1987).

Birth defects in *A. mississippiensis* were recorded by Ferguson (1989) and included scoliosis, microphthalmia, anophthalmia, hydrocephalus (accumulation of cerebrospinal fluid on the brain) and incomplete twinning. Causes of the defects were breeding age of female (very old or very young), maternal diet, egg incubation at the extreme limits of the temperature range, and egg dehydration.

Kyphoscoliosis was recorded in *C. siamensis* by Frye (1991) however it was not known whether the deformities were genetic or acquired through environmental or nutritional disturbances.

A wide range of congenital anomalies in *Crocodylus* sp. (*C. siamensis*, *C. porosus*, and hybrids) were reported by Youngprapakorn *et al* (1994). These included maxillo-facial malformations, meningoencephalocele, exophthalmia, microphthalmia, anophthalmia, twinning, and eggshell abnormalities. No causes of the defects in the hatchlings were reported. However, lack of dietary calcium and/or oviduct abnormality in the laying adult was suggested as the possible causes of poor eggshell formation.

Egg, embryo and hatchling deformities in both *C. porosus* and *C. johnstoni* were observed by Webb and Manolis (1989). High incubation temperature was cited as the cause of spinal abnormalities, strongly coiled tails, skull malformations, and protruding lower jaws.

In this study, low levels of calcium in the breeding females' diets were thought to have caused the faulty egg formation reported here. Addition of calcium di-phosphate and shell grit to the meat rations of the females prior to the subsequent breeding season almost eliminated the production of malformed eggs.

Unscheduled high incubation temperatures for the 1990 and 1991 breeding seasons were assumed to be the cause of the embryo and hatchling deformities for those years. However, in subsequent years different temperature and humidity monitoring and control methods were employed with fewer fluctuations in 1992 and none in 1993 or 1994. What then caused the deformities in embryos and hatchlings for those years? Were they due to the breeders' ages? Was there a genetic factor? Was overheating or desiccation of the eggs in the nests prior to collection the cause? Since not all eggs from individual clutches were affected, perhaps none of these questions will give the answers. A proposed cause may be microbial contamination of the egg immediately after laying thus compromising the developing embryo and causing abnormalities as depicted in the following plates.

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Acknowledgments

This survey of abnormalities in farmed crocodiles was carried out in conjunction with a Master of Applied Science research program by the Author at Central Queensland University. The work had the approval of the CQU Animal Experimentation Ethics Committee, and operated under the relevant Queensland National Parks and Wildlife Service Permits. The survey was jointly sponsored by the Biology Department at

CQU and Koorana Crocodile Farm and was supported by a CQU Research Grant in 1994. Funding for attendance at the 13th Working Meeting of the CSG was provided by the Biology Department, the Faculty of Applied Science, and the Pro-Vice Chancellor Research, all of CQU, and Koorana Crocodile Farm. Thanks are extended to the CSG for providing student accommodation for the duration of the meeting.

List of photographs used on poster.

Plate 1 Infertile malformed eggs, incompletely sealed and leaking albumen, highly susceptible to microbial attack.

Plate 2 Abnormally large yolk sacs in both hatchlings, anophthalmia (complete absence of eyes) and meningoencephalocele (protrusion of brain through defect in the skull) in the hatchling to the left.

Plate 3 Dizygotic twins at hatching (separate yolk sacs).

Plate 4 Dizygotic twins from Plate 3 shortly after hatching, the larger survived for three months, the smaller survived for ten days.

Plate 5 Permanently coiled tail, live hatchling.

Plate 6 Permanently curled tail, live hatchling.

Plate 7 Permanently curled tail, live hatchling.

Plate 8 Permanently kinked tail, live hatchling (scale in cm).

Plate 9 Shortened and reduced thickness tail, at hatching.

Plate 10 Hatchling from Plate 9, 2 months later with normal hatchling.

Plate 11 Congenital kyphoscoliosis (curvature of the spine with accompanying hump), live hatchling.

Plate 12 Hatchling from Plate 11, several months later.

Plate 13 Absence of tail.

Plate 14 Absence of tail, live hatch.

Plate 15 Absence of tail.

Plate 16 Absence of tail, ventral view of hatchling in Plate 15.

Plate 17 Shortened body, misaligned jaws, and bilateral anophthalmia, live hatch.

Plate 18 Hatchling from Plate 17, survived for 5 months.

Plate 19 Microphthalmia (undersized eyes) and shortened lower jaw, live hatch.

Plate 20 Reduced lower jaw (scale in mm).

Plate 21 Multiple abnormalities, no tail, reduced and misaligned upper jaw, anophthalmia, meningoencephalocele (scale in cm).

Plate 22 Close-up of hatchling from Plate 21.

Plate 23 Ventral view of hatchling from Plate 21 and 22.

Plate 24 Multiple abnormalities, reduced upper jaw, anophthalmia, meningoencephalocele, abnormally large yolk sac.

Plate 25 Misaligned and reduced lower jaw, exophthalmia (abnormal protrusion of the eyeball).

Plate 26 Incompletely sealed skull (scale in cm).

Plate 27 Multiple abnormalities, reduced and misaligned upper jaw, anophthalmia and exophthalmia, meningoencephalocele (scale in cm).

Plate 28 Close-up of hatchling from Plate 27, left and right views.

Winter sores, a dermatitis in farmed Nil Crocodiles kept at suboptimal temperatures

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Introduction

Although they are poikilothermic, crocodiles try to maintain a constant core temperature of approximately +32C. They achieve this by thermoregulatory behaviour making use of temperature gradients in their habitat. In the wild the components of these temperature gradients are sunshine and shade, warm and cold air, warm and cold substrates, warm and cold water as well as burrows. From these the crocodiles can choose the appropriate spot where to warm up, to cool down or to maintain the achieved temperature. It is believed that blood circulation from the skin to the internal organs is used to enhance the flow of thermal energy to the core and that the flow of blood to the skin is reduced when the crocodile is trying to conserve heat.

Farmed crocodiles are either kept at a near-constant temperature of around +32C or are exposed to temperature fluctuations in an environment with limited scope for behavioural thermoregulation. In the latter case they are kept either in outdoor enclosures with shallow water and little cover or in a poorly insulated building with widely fluctuating temperatures.

The smaller the crocodile, the poorer is its surface to mass ratio. Therefore, smaller or younger crocodiles are more prone to be affected by adverse thermic conditions than adult ones.

On most farms the hatchlings are pampered. Thus it is the juveniles, which also require more space and which are believed to be quite hardy, that are likely to be kept under less then ideal conditions and consequently to suffer from temperature problems.

Winter sores

On several farms where juvenile Nile crocodiles were kept under such adverse conditions, between 10 and 50% of the animals developed a dermatitis towards the end of winter. This dermatitis affected mainly the ventral skin and was characterized by crusty lesions between the scales which were eating into the scales. The crusts were cream to light brown in colour. Because of the brownish colour of the crusts the farmers usually suspected them to be pox lesions.

Histopathologically there was a destruction of the epidermis, the crusts being formed from necrotic cells and many bacteria. There was an accumulation of round cells in the dermis. Inclusion bodies were never seen in the epidermis cells.

Bacterial culture produced a very large variety of nonpathogenic, potentially pathogenic and known pathogenic bacteria, typically in mixed culture from single specimens.

After correction of the thermic environmental conditions the lesions healed slowly without the need to resort to an antibacterial treatment. However, there was a tendency for scars to remain visible.

Discussion

Under crowded conditions which are typical for all crocodile farms the ventral skin is often subjected to minor wounds such as scratches or small bite wounds. Under the same crowded conditions there is also a likelyhood of a massive bacterial build-up. These bacteria contaminate and try to infect the minor wounds.

At constant warm temperatures the defenses of crocodiles easily overcome such infections, but when in cold or repeatedly cold (fluctuating) conditions the blood supply to the skin is chronically reduced and the immune system is thermically compromised as well, the bacteria can gain a foothold and chronic , scarring lesions result. However, the crusts on these lesions are much lighter in colour and larger or more confluent than those found in pox in Nile crocodiles (Huchzermeyer, Huchzermeyer & Putterill, 1991).

As this condition is typically seen at the end of winter on farms with poor temperature control, the term "winter sores" was chosen for this type of dermatitis.

Even in well insulated and fully environmentally controlled houses a thermogradient can be offered to the crocodiles by heating the air to +34C or even +35C and bringing in the water at a lower temperature of between +25C and +30C.

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Huchzermeyer, F.W., K.D.A. Huchzermeyer and J.F. Putterill. 1991. Observations on a field outbreak of pox virus infection in young Nile crocodiles (*Crocodylus niloticus*). Jl S. Afr. vet. Ass., 62: 27-29.

Poliartritis asociada a micoplasma en cocodrilos de criadero (*Crocodylus nilocotus*). Se transmite verticalmente?

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Resumen

Por primera vez hemos informado acerca de brotes de poliartritis asociada a micoplasma en cocodrilos en cautiverio de diversos criaderos en zimbabwe. Reprodujimos la enfermedad experimentalmente en cocodrilos de 1 a 3 anos. Sin embargo la fuente y modo natural de transmision no pudieron ser identificados (Mohan et.al., 1995). Al principio, los criadores pensaron que la fuente de la enfermedad eran las aves de corral y los menudos con que se alimentaba a los cocodrilos; pero en los cultivos no parecia estar entre los micoplasmas conocidos de las aves de corral y los menudos. Una caracterizacion mas amplia de los animales aisaldos en el instituto para microbiologia de la escuela veterinaria de hanover ha confirmado que los mismos pertenecen a una nueva especie (Kirchhoff,1995). Y lo que es aun mas importante, recientemente se han registrado brotes similares en Israel. Los cultivos portaban similitudes en los fenotipos con las cadenas de Zimbabwe (Levisohn, 1995).

Para poder identificar el modo natural de transmision, intentamos la transmision experimental de la enfermedad a traves un contacto cercano entre los cocodrilos infectados experimentalmente (de 1 a 3 anos) y los aparentemente sanos (de 1 a 3 anos). Nuestros intentos no tuvieron exito, a pesar de que tanto a los cocodrilos sanos como a los enfermos se los mantuvo durante 12 semanas en una misma pileta, la posibilidad de que esta enfermedad se transmita verticalmente como la infeccion *M..gallisepticum* y *meleagridis* en aves de corral se discutieron en esta presentacion.

Is *Mycoplasma*-associated Polyarthritis in Farmed Crocodiles (Crocodylus niloticus) a vertically Transmitted Disease!

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Introduction

Outbreaks of polyathritis from several crocodile farms affecting only the rearing stock with *Mycoplasma* sp. as its etiology were reported for the first time from Zimbabwe. The disease was later experimentally reproduced in crocodiles of the same age groups (Mohan et al., 1995). The source of infection and natural mode of transmission could not be identified. With a view to understand the natural mode of transmission we attempted to transmit the disease through close contact between experimentally infected and apparently healthy crocodiles. Results of this study and the possibilities that this disease might be vertically transmitted are being reported in this paper.

Materials and Methods

Details of affected farms, disease manifestations, pathology, technique of isolation and characterisation of the isolates have already been reported (Mohan et al., 1995). Six crocodiles (1-3yrs old) were selected from a particular farm which had not reported the *Mycoplasma* - associated disease. These animals were left under observation in the Crocodile Unit of the Veterinary Research Laboratory for four weeks. Nasal swabs from all the six were cultured for *Mycoplasma* and other pathogenic aerobic bacteria at intervals of two weeks, following the procedure described earlier (Mohan et al., 1995). These animals were also observed for clinical signs of arthritis or any other disease. After having been found free for *Mycoplasma* and any potentially pathogenic bacteria, four of these were infected intra-peritoneally each with 2.5ml of 48 hrs. old broth-grown culture comprising $6x10^8$ CFU/ml of a field isolate in its second subculture. The four inoculated animals and the two healthy ones shared the same especially designed rearing ponds (Foggin et al., 1988) for 16 weeks under observation. Weekly examinations for lameness and signs of arthritis were carried out. Animals which showed lameness and/or swollen joints were considered to have picked up the infection. Synovial exudate from affected joints was cultured for *Mycoplasma* and aerobic pathogenic bacteria (vide supra). Giemsa stained smears of the exudate were also examined for Chlamydia and Rickettsia. One of the infected animals with swollen joints was euthanised twelve weeks post-infection and attempts made to reisolate *Mycoplasma* from heart-blood, spleen, lungs and synovial exudate.

Results

Neither *Mycoplasma* nor any potentially pathogenic bacteria could be cultured from the nasal swabs of the six animals prior to infection. Two of the infected animals developed lameness three weeks post-infection, movement of these was characterised with dragging of the limbs when made to move on the ground outside the pond water. The joints of the affected limbs gradually developed swelling, more pronounced in the rear ankles. The third one discerned lameness and swelling of right shoulder joint six weeks post-infection while the fourth infected crocodile developed similar manifestations nine weeks post-infection. Mycoplasma but no other bacteria was reisolated from the swollen joints of all the four animals. The disease manifestations gradually tapered-off but swelling in some of the affected joints persisted despite absence of lameness. The two uninfected incontacts showed no signs of lameness or any other disease throughout 16 weeks' period of observation.

When the fourth infected animal was sacrificed 14 weeks post-infection *Mycoplasma* could be reisolated only from the affected joints but the culture from heart-blood, spleen and lungs could yield no bacteria. The smears of the synovial exudate were also found to be negative for Chlamydia and Rickettsia.

Discussion

Several aspects of the new disease, *Mycoplasma* - associated polyarthritis have been investigated; the etiology has been confirmed and the disease experimentally reproduced (Mohan et al., 1995). Experimental trials with an alum precipitated vaccine have given encouraging results (Mohan et. al., 1996). Nevertheless, the source of infection and mode of transmission in nature remained elusive. The isolates have been characterised in detail and assigned to a new species yet to be named, ecology of which is not known (Kirchhoff, 1996). These information have brought out evidence that the disease might be native to crocodiles and the earlier notion of the farmers to incrimate the poultry and goat offals fed to the crocodiles as the source of infection lacked scientific evidence.

Knowing that any infection spreads either vertically or laterally (contact) or both, we mounted this study to establish the lateral mode of transmission by close contact. The incubation period among the experimentally infected animals ranged from 4-9 weeks. We therefore exposed the healthy with the diseased crocodiles in the ratio of 1:2 for a period of 16 weeks to ensure a sustained and intensive contact. Despite this long and sustained exposure the disease could not be transmitted. *Mycoplasma* remained confined to the joint sacs following infection: neither the visceral organs nor the heart blood was found to be infected. Consequently, the possibilities of dissemination of the infectious agent to outside environ, a prerequisite to lateral spread appear remote. Experimental evidence thus rules out the possibility of the disease being transmitted through close contact.

Vertical mode of transmission now remains to be investigated as the other method of spread of this disease in nature.

Wide spread prevalence of polyarthritis in Zimbabwe and no such record in South Africa (Huchzermeyer, 1995) is difficult to explain. The farmers in Zimbabwe have emulated the management and breeding practices of the South Africans; the species being commercially exploited and the disease spectrum happens to be the same (Foggin, 1987, 1992). Nevertheless, the Zimbabwean farmers, besides raising hatchlings from their breeding stock also collect eggs from wildlife to raise hatchlings (Foggin, 1992), whereas the South Africans do not do so (Huchzermeyer, 1995). Having collected the eggs from wildlife the farmers do not use a marker to identify the hatchlings originating from wildlife and those from inbred stock. Could the eggs collected from wildlife be infected? We have already commenced investigations in this direction.

A new dimension to the epidemiology of this disease has been added with the recent report from Israel of isolation of *Mycoplasma* similar to the Zimbabwean strains and Chlamydia from cases of polyarthritis in farmed crocodile (Levisohn, 1995). Chlamydia has been incrimated in South Africa and Zimbabwe in causing hepatitis in crocodiles hatchlings and yearlings (Huchzermeyer, et al. 1994).

Although we have not been able to confirm that this disease is egg-transmitted but the preliminary results of investigation suggest that this *Mycoplasma* infection might be transmitting in nature like some of the avian *Mycoplasma* sp. which are known for transovarian transmission and the possibilities that eggs collected from wildlife might be the source of its spread to commercial farms cannot be ruled out.

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Diseases of Juvenile Farmed Estuarine Crocodiles, *Crocodylus porosus.*

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The 13th Working Meeting of the IUCN Crocodile Specialist Group, Santa Fe, Argentina, 13-17 May 1996.

ABSTRACT

A summary of necropsy examinations, histological findings and bacterial and fungal isolations from 62 juvenile, farmed crocodiles *(Crocodylus porosus)* is described. Ill-thrift, anorexia, gum degeneration and skin ulcerations were the most frequently observed clinical signs. Necropsy findings included granulomatous masses in the visceral organs and fibrinous exudates associated with the pericardium and pleura. The bacterial pathogens most commonly isolated from were *Salmonella* spp. and *Providencia rettgeri*. Fungal isolates included *Fusarium* sp, *Penicillium* spp. and *Aspergillus* spp. Superficial and deep mycoses, salmonellosis, pericarditis, hepatitis and suspected stress related mortality were the most common diagnoses.

AIMS

- To identify the causal agents of diseases in juvenile *Crocodylus porosus* at a sub-tropical commercial crocodile farm. The information obtained would enable the farmer to modify farm husbandry methods to reduce disease morbidity and mortality, thereby increasing the numbers of healthy animals for skin and meat production.

- To add to the crocodilian disease database those causal pathogens which may have not been previously reported.

INTRODUCTION

This applied research carries an economic significance to what is still a fledgling Australian primary industry. Major losses of juveniles due to disease cause financial problems for crocodile farmers (Lever, pers. comm). This report represents the preliminary investigation of mortalities in a high latitude crocodile farm.

In 1980 Koorana Crocodile Farm was established as a commercial enterprise near Rockhampton on the Tropic of Capricorn. It consists of 113 hectares of melaleuca and eucalyptus open woodland, mangroves, mud flats and salt pans. The farm is bordered by tidal creeks on three sides, becoming an island with causeway access at 4 metre tides. Salt water used for adult and sub-adult lakes was pumped from the creeks at high tide. Koorana is the most southerly crocodile farm in Australia and is on the southern extremity of the estuarine crocodiles' natural east coast range. Because of cold winters (range 5°C to 25°C) hatchlings and juveniles must be kept indoors in a heated environment. The farm was officially opened in 1981 with nine crocodiles. Captive breeding on the farm commenced by 1985 with some mortality of hatchlings in 1986. From then until 1990, hatchling and yearling losses continued to be a problem. The major cause of mortality and morbidity was found to be systemic mycoses, predominantly caused by the fungus *Fusarium solani*, an ubiquitous fungus normally only pathogenic to plants. Losses of hatchlings up to age one year had been in excess of fifty percent (J. Lever, pers. comm.).

This survey of diseases of juvenile farmed crocodiles was carried out during 1992, 1993, and 1994 in conjunction with a Master of Applied Science research program (Hibberd, 1996) by the primary author at Central Queensland University. Information on mycotic disease has been reported previously (Hibberd and Harrower, 1991, 1993; Hibberd, 1994a, 1994b, 1994c). A survey of abnormalities in eggs, embryos and juvenile farmed *C. porosus* is the subject of a poster at this meeting.

Literature review

Reports of diseases of crocodilian species have been published by several authors. Foggin (1987, 1992) reported a range of bacterial, fungal, viral and parasitological infections in farmed *C. niloticus*. Huchzermeyer and Agnagna (1992) described parasites and pathology of *Osteolaemus tetraspis* which had been recently captured from the wild. Jacobson (1989) reviewed viral, bacterial and fungal diseases as well as parasitic infections of a range of crocodilian species, including American crocodiles and alligators, gharials and muggers, caiman, and several *Crocodylus* species. Frye (1991) also reviewed crocodilian diseases (viral, bacterial, fungal and others) in a comprehensive text on captive reptilian husbandry.

Ratanakorn (1993) reported the health problems of captive crocodiles in Thailand, including congenital defects, non-infectious disease (metabolic disease and toxicosis), and infectious bacterial and fungal disease. Youngprapakorn *et al* (1994) illustrated and described a comprehensive range of diseases and abnormalities of crocodilian species (*C. porosus*, *C. siamensis* and hybrids of these two species) in their colour atlas.

Ladds and Sims (1990) investigated diseases of captive *C. porosus* and *C. novaeguineae* in Papua New Guinea. The animals had been caught in the wild as hatchlings then held locally until transported to a commercial farm. Bacterial septicaemia and coccidiosis were common as were parasitic infections. Adaptation failure was also suggested to be a contributing factor to mortality. Ladds *et al* (1995) reported the major diseases of captive *C. porosus* and *C. novaeguineae* in Irian Jaya to be coccidiosis, pentastomiasis, and bacterial pneumonia and septicaemia. Fungal pneumonia was also reported. Multiple parasitism was the major cause of mortality in the crocodiles which had been collected from the wild as hatchlings.

Melville (1993) reported parasitic, infectious (viral, bacterial, fungal) and nutritional and other diseases diagnosed in farmed *C. porosus* and *C. johnstoni* in the Northern Territory of Australia. The most commonly identified diseases were bacterial hepatitis and septicaemia, and superficial and deep mycoses.

Buenviaje *et al* (1994) investigated disease-husbandry associations in *C. porosus* and *C. johnstoni* from four farms in the Northern Territory and three farms in Queensland, Australia. Major disease findings were similar to those reported by Melville (1993). Minor diseases were probable adaptation failure and chronic infections of unknown cause. Highest mortality and disease occurrence were highest during winter months and in farms at greater latitude. Parasitic infections were reported to be relatively infrequent. Bacterial septicaemia and mycoses were becoming less common where artificial heating was provided.

A comprehensive literature survey of fungal disease in all crocodilian species was carried out by Hibberd (1996) as part of an epidemiological investigation into a long term and major fungal disease problem in *C. porosus* at a Queensland crocodile farm.

METHODS AND MATERIALS

Clinical history and gross examination

Sixty two moribund or dead crocodiles with age range from newly hatched to two years old were presented for post-mortem examination and disease diagnosis. Representative specimens had been selected from groups of animals exhibiting similar clinical signs. Carcasses had usually been refrigerated from the time of collection at the farm which was approximately 40 km from the laboratory. Live crocodiles were euthanased at the laboratory. Where possible carcasses were weighed and the snout-vent length measured. Year and clutch of origin were recorded from the identifying pattern of removed tail scutes. Prior history and time of death, if known, was recorded. Any external signs of disease were noted. Observations of internal pathological changes were also recorded during the post-mortem examinations.

Histology

Tissue for histological examination was fixed in 10% buffered neutral formalin, processed to paraffin embedding and sectioned at 5µ. Sections were routinely stained with haematoxylin and eosin. Grocott's Methenamine Silver (GMS) stain was performed for the detection of fungi, and bacteria were detected using either the modified Brown and Brenn or Churukian and Schenk procedures.

Bacteriology

Bacteriological cultures were incubated at 37°C on Sheep Blood Agar. Bacteria were identified using standard techniques and confirmed with the Microbact computer identification system. *Salmonella* species were cultured at 37°C on a variety of media (Blood Agar, MacConkey's Agar, Xylose Lysine Desoxycholate Agar and Tetrathionate Enrichment Broth) and were serotyped at the Institute of Medical and Veterinary Science, Adelaide.

Mycology

Mycological cultures were incubated at 28°C on Sabauroud's Dextrose Agar for two weeks and identified at the Animal Research Institute, Yeerongpilly.

Other investigations

Viral and parasitological infections were not investigated in this study. Biochemical and haematological studies were specifically carried out for a separate research program and results have been reported elsewhere (Hibberd, 1996).

RESULTS

Sixty-two animals in the following age groups were examined:- newly hatched (3), one to six months (26), seven to twelve months (12), thirteen to eighteen months (18), nineteen to twenty four months (1) and twenty-four to thirty months (2).

Clinical history

Moribund animals presented for clinical and post mortem examination had one or more of the following clinical signs:- lethargy, depression, ataxia, poor response to stimuli, partial paralysis of the limbs, body tremors, abnormal head inclination and ulceration of the gums, limbs and ventral abdominal skin.

Gross examination

The most frequently observed external abnormality was ulceration of the skin between the scales of the ventral abdomen. Abrasions and ulcerations of the digits was common in more severe cases with extensive changes occurring between the leg and body wall.

Some animals had no significant gross abnormalities. The severity of internal abnormalities varied from a mild excess of turbid fluid in the pericardium and/or abdominal cavity to severely affected cases with up to ten, white caseous masses (1.5cm diameter) scattered throughout the liver, kidney, spleen, lung and other tissues. Post-mortem decomposition was common in carcases delivered more than six hours after being found dead. The actual post-mortem interval was most likely considerably longer as most deaths occurred during the night.

Histological examination

Severely affected livers with large granulomas had extensive necrosis with large numbers of branching, septate, fungal hyphae surrounded by a granulomatous response. Similar changes were found in the spleen, kidney and lung.

The least severe changes in the skin appeared between the scale margins as crusted abrasions and ulcerations. Fungal hyphae were located between layers of partially exfoliated epithelium. Severe ulceration of the gum mucosa around the teeth extended to deeper necrosis and granulomatous inflammation. Branching, septate, fungal, hyphae were common throughout the necrotic debris and the adjacent epidermal layers.

Pleuritis and a moderate to severe epicarditis was seen in some younger animals (four to six months). Fibrinous pericarditis was common in more severely affected cases.

Bacteriology

All bacterial isolations associated with a suspected or confirmed diagnosis are listed in Table 1. Bacteria were most commonly isolated from the liver (8), lung (6) and heart (5). Bacterial isolations occurred most frequently in the age groups one to six months (18), and thirteen to eighteen months (10).

Species	No. of isolates
Salmonella typhimurium	6
Salmonella spp.	4
Salmonella johannesburg	1
Providencia rettgeri	10
Edwardsiella sp.	2
Morganella morganii	2
Enterobacter agglomerans	1
Pasteurella multocida	1
Pseudomonas sp.	1

Table 1: Frequency and species of bacteria isolated from juvenile crocodiles.

Mycology

All fungal isolations associated with suspected or confirmed diagnoses are listed in Table 2. Fungi were most commonly isolated from skin (17), gum and tooth (10) and liver (10). Fungal isolates occurred most frequently in the age groups thirteen to eighteen months (25), and seven to twelve months (15). However, fungi were isolated from at least one animal in each age group from newly hatched to two year old.

Species	No. of isolates
Fusarium sp.	24
Penicillium sp.	9
Paecilomyces sp.	5
Aspergillus niger	4
Aspergillus flavus	2
Aspergillus versicolor	2
Geotrichum candidum	4
Geotrichum sp.	2

Table 2: Frequency and species of fungi isolated from juvenile crocodiles.

Diseases diagnosed

Table 3 lists the range of conditions diagnosed in the 62 animals. Each animal may have more than one diagnosis.

Diagnosis	Number
Congenital Abnormality	5
Conjunctivitis	2
Dermatitis	20
Epicarditis	6
Fungal Granuloma	31
Hatching Abnormality	3
Hepatitis	8
Hypoglycaemia	2
Nephritis	3
Pericarditis	6
Pleurisy	2
Pleuropneumonia	1
Pneumonia	5
Polyserositis	1
Retained Yolk Sac	1
Salmonellosis	5
Septicaemia	1
Skeletal Muscle Myositis	1
Splenitis	3
Stress Related Mortality	9

Table 3: Frequency of all diagnoses made on juvenile crocodiles.

DISCUSSION

Animal deaths usually occurred during the night. Carcases collected during the 6 am daily inspection often showed most severe autolysis when presented for necropsy during the afternoon. Prolonged exposure to the heated environment (32°C) exacerbated the post mortem changes. Severely autolysed carcases were unsuitable for histological or bacterial examination.

On this farm all crocodiles up to the age of two years were housed in heated, indoor pens with heated water supply. Indoor air and water temperatures were normally regulated to 32°C. Due to this heated environment, temperature stress was not a normal occurrence. However, two major episodes of high stress-related mortality/morbidity were suspected in cases where no bacterial or fungal disease could be identified. One episode corresponded to a short period of heating malfunctions in one indoor facility when air and water heaters failed concurrently. For several days indoor air temperature dropped to overnight minima of ~26°C (external air temperature overnight minima in the range 4-13°C). Ambient temperature of unheated water at entry to the pens dropped to ~13°C. Forty animals died in the subsequent week, all without external signs of disease. Nine representative animals from that group were necropsied. A similar situation occurred to a lesser extent during and subsequent to a heat wave when indoor air temperatures reached approximately forty degrees without use of heating devices.

Temperature and its effect on disease in farmed *C. niloticus* has been demonstrated by Foggin *et al* (1988) and indicated as being a contributing factor to disease by Buenviaje *et al* (1994) and Melville (1993).

Other stresses on the animals were reduced over the survey period during concurrent fungal disease investigations (Hibberd, 1996). Changes which markedly reduced the incidence of fungal disease included:- sourcing a more consistent food supply and the regular addition of food supplements to eliminate nutritional stress; a reduction in animal numbers in each pen to reduce possible density stress; provision of additional covered retreats in each pen and regular grading of animals according to size to avoid social stresses.

Bacterial infection in eggs at the time of deposition may be one of the sources of hatchling infections, as are environmental contaminants after hatching. Washing and disinfecting eggs prior to artificial incubation has reduced the incidence of fungal infections in both embryos and hatchlings on this farm (Hibberd, 1996).

Environmental sampling of pen water, food preparation implements, storage and work areas during a period of low hygiene isolated five *Salmonella* species. Increased standards of hygiene and changes to the cleaning regime were put into effect to reduce or eliminate possible infections from these sources.

This report represents the preliminary investigation of mortalities in a high latitude crocodile farm. Further research is required to confirm the association of fungal and bacterial isolates with histological changes where the post-mortem interval is reduced.

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ACKNOWLEDGMENTS

This survey of diseases in juvenile farmed crocodiles was carried out in conjunction with a Master of Applied Science research program by the primary author at Central Queensland University. The work had the approval of the CQU Animal Experimentation Ethics Committee and operated under the relevant Queensland National Parks and Wildlife Service Permits. The survey was jointly sponsored by the Biology Department at CQU, the Queensland Department of Primary Industries and Koorana Crocodile Farm and was supported by a CQU Research Grant in 1994. Funding for attendance at the 13th Working Meeting of the CSG was provided by the Biology Department, the Faculty of Applied Science, and the Pro-Vice Chancellor Research, all of CQU, and Koorana Crocodile Farm. Thanks are extended to the CSG for providing student accommodation for the presenting author for the duration of the meeting.

Our thanks are also extended to the staff of Koorana Crocodile Farm, the staff of Rockhampton Veterinary Laboratory (Department of Primary Industries) for their technical assistance, Grant Campbell (Department of Primary Industries, Toowoomba) for pathology examinations, the Institute of Medicine and Veterinary Science, Adelaide for *Salmonella* identification, and Dr K M Harrower for editorial advice.

Research on Juvenile Farmed Saltwater Crocodiles

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The Queensland Department of Primary Industries (QDPI) established a research facility in Townsville in late 1993 to investigate the effects of environment and nutrition on farmed saltwater crocodiles from hatching to one year of age. Plans are currently underway to construct a second facility in which research on 'grower' crocodiles (one year to slaughter size) can be conducted. The aim of this paper is to present an abbreviated outline of major research projects carried out to date. Each year QDPI will publish a "Crocodile Research Bulletin" containing full scientific details of the research carried out at Townsville. Please contact the authors at the above address if you would like to be put on the mailing list for this publication. It should be noted that the thrust of our research relates to commercial farming applications for *C. porosus*.

INTRODUCTION

Tours of commercial crocodile farms in the 2 main farming areas in Australia, Queensland and the Northern Territory, indicated that farming practices varied considerably in terms of environmental conditions provided for the animals, management practices, and diets used. About the only commonly adopted practices were providing 32°C water in juvenile crocodile growing tanks and use of mixtures of red meat, chicken heads and vitamin/mineral supplements for diets. Many farms have access to meat from wild animals (horse, pig, kangaroo, donkey) but some of these sources are dwindling or are becoming more expensive to buy. Industry recognises the need to develop a dry food pellet for *C. porosus* to

- reduce direct feed costs
- eliminate the need for costly freezer storage of meat
- enable precise dietary requirements of the animals to be met.

For juvenile crocodiles there were a whole range of different environmental factors being used on farms, especially relating to light, type of tank (material, design, with or without lids), water quality and depth, type of hide-board, use of radios to provide noise. Farms also employed different management strategies and feeding regimes (morning or afternoon, use of "fasting" periods), animal density per tank, and grading on size or clutch. This signified the need for quantitative research to be carried out on these issues, and results to be extended to the industry. Consequently it was decided, with the aid of an Australian Government grant (through the Rural Industries Research and Development Corporation) to build a special purpose research facility for juvenile crocodiles with flexibility to cater for a wide range of different environmental, management and nutritional issues. Although most of the crocodile farms in Queensland are located in the far north around Cairns and on Cape York, the necessary infrastructure in QDPI was located in Townsville at the Oonoonba Veterinary Laboratory site. There was ample land available and specific scientific skills of staff at the laboratory as well as research laboratory equipment and facilities. Members of the current research team on crocodiles all work on other research programs as well in a multi-disciplinary regional role. In all there are currently 10 team members contributing the equivalent of 3.7 full time positions on crocodile research, development and extension.

METHODS

Research Animals

Each year some 250-300 hatchlings are provided by a commercial farm in Queensland (the Edward River farm, now called the Cairns farm). These are hatched at the Edward River Aboriginal Community enterprise on western Cape York Peninsula. At the end of the year's experiments these animals are returned to the farm. Crocodiles are tagged individually (using small stainless steel web tags) and number series on the tags are linked to clutch of origin.

Research Facility for Juvenile Crocodiles

Crocodiles are housed in a fully insulated, environmentally controlled building. The building measures 26 metres long by 4.6 metres wide, with a 5 degree sloping roof 2.4 to 2.1 metres high. It is divided into six equal sized rooms. The building is constructed of insulated polystyrene sandwich panelling, incorporating 0.6mm white colorbond skins internally and externally (coldroom panelling). The roof is 100mm thick, external walls 75mm and internal walls 50mm thick. Each room contains two fibreglass tanks, one radio speaker and a wall mounted air conditioner. The floor of the shed is concrete. An additional 'hospital' tank has been set up in a separate building at the site and can cater for 30 animals in 3 compartments.

Hot water is supplied to the building through 3 x 315L hot water systems (one per 2 rooms). Hot water runs through copper piping and cold water through PVC piping. Incoming water comes into the shed at three points only, along the internal walls between rooms 1 and 2, 3 and 4, 5 and 6. Each tank has its own set of taps and a hose for hosing out and refilling. When filled, water temperature in the tanks is controlled through solenoid valves, which pulse in hot or cold water when required.

Control panels for water, air temperatures, lighting and radio are situated on the outside of the shed so that servicing and data recording does not have to be done in the rooms. Only repairs to plumbing and sensors are done in the rooms.

Water temperature is controlled by Brainchild microprocessor based auto tuning controllers. A stainless steel sensor is placed in the middle of each tank. A diffuser tube made of copper pipe runs along the bottom of each tank and six small equally spaced holes along the tube disperse the incoming water. When the sensor detects the preset temperature the controller closes the solenoid valve. Water temperature control range is ± 1°C of the set point. Digital faceplate display gives current temperature and set point.

Air temperature is controlled by reverse cycle room air conditioners. A sensor on the wall of each room controls the air temperature. A digital display unit gives set point temperature and actual room temperature. Control range is ± 1.5°C set point.

Lights are on timers and dimmers, so that light duration and intensity can be controlled. Each room is illuminated by two 100 watt light bulbs in clear covers located over the two tanks.

Tanks are made of fibreglass, grey in colour and are 3 metres long x 1.3 metres wide 650mm high on water side 500mm on land side. The dryland area is flat and slopes down to the water area. To provide an equal area of land and water the water depth is maintained at 160mm. A stand pipe at one end of the tank controls water depth. A laminex hideboard, 1200mm long x 600mm wide, is suspended by an aluminium frame across each tank 60mm above the dry land, increasing over the water due to the sloping of the tanks. The height of the hideboards above the tank bottom can be adjusted to allow for growth of the animals.

Food Preparation Room

A feed storage and preparation room has been provided close to the rearing unit. This room houses a refrigerator and freezers for food supplies, mincer, bench space for preparation and washing facilities for equipment used in food preparation and feeding. It also contains television monitors connected to video viewing equipment which can be rotated among the rooms in the research building.

Egg Incubation Room

A crocodile egg incubator room has recently been added to the complex. The room contains 6 hatching incubators each capable of holding 50 eggs. This will permit laboratory studies on microbial contamination of eggs, hatchability and cleaning and disinfection of eggs.

DNA Laboratory

This is currently being set up in the veterinary laboratory for fruit and vegetable breeding programs and beef cattle research. We hope to develop the technique for use on crocodiles as well. There has been interest shown by conservation groups in Queensland in using DNA to test whether there are differences between animals from different geographic locations (eg. one location seems to contain crocodiles with just 4 prominent nuchal scales, compared with the more common 6, and there is a theory that crocodiles in another area may be naturally smaller or 'dwarfed').

Statistical Design of Experiments

Researchers have shown that clutch differences in crocodiles are very important, so statistical designs of experiments must take this into account. Where different types of treatments are to be trialed, such as food types, at least two replicates (statistical repeats) of each treatment are used and, in every case, the experimental unit is a tank of animals. For each replicate, animals are allocated to tanks on the basis of their original clutch and then by body size, so that each group is as similar as possible before the different treatments are applied.

Different sets of clutches can be used to form different replicates, since clutch differences are thereby taken in account. Farms tend to avoid mixing clutches as much as possible because clutches vary in temperament. The only problem with this research strategy occurs if clutches respond differently to the experimental treatments. For experiments when the animals are older, there is a natural wide spread of sizes, even within clutch, so replication is based on different size classes: this generally necessitates mixing animals from all clutches together in tanks, but is regarded as a better strategy than mixing animals of very different sizes.

For experiments with treatments consisting of a range of levels, like water temperature, the emphasis is on estimating response trends, and replication is reduced, or more commonly, sacrificed to achieve a greater number of levels of the treatment. Again, animals are allocated to tanks by the methods described above.

There is a settling down period of at least two weeks between successive experiments, during which all tanks are kept at the same conditions. A grading strategy is used for the hospital tank, where smaller animals are transferred in and out between experiments. Special extra attention is sometimes given to runts to try to get some of them up to trial useable size.

In any temperature trial, water and/or air temperatures are gradually increased or decreased by 1°C each day.

Collecting Research Data

Amounts of food given to each tank, and any uneaten residue left on food trays are recorded at each feeding. Any food scattered in the water is not measured. Because of the stress caused by measuring, animals are not fed on measuring days. Measurements are generally done on a Monday morning, following the weekend fasting. This results in fasted liveweights, which are more accurate measures of actual size. An experienced catcher, wearing a chain-mail butcher's glove, catches an animal firmly behind its neck. Usually, he catches the animals in the water, where they generally display less aggression.

Measurements are taken only at the commencement and the conclusion of each experiment, and then again after the 'settling down' period. Scientifically it would be useful to collect data several times during the trial but

- the extra stress that this causes can affect comparison between treatments, and also invalidate direct application to commercial applications
- it is only the final response difference that is really useful.

Data recorded include liveweight, total length, snout-vent length, head length, skin colour, temperament exhibited, and any skin disease or blemish. At one weighing, the belly scale pattern of each animal is recorded by photo-copy. Scute material from the 1995 research animals has been stored for possible future DNA investigation.

RESULTS

Temperature Trials

In experiments using *C. porosus* between hatching and one month of age, Webb *et al.* (1990) showed that when temperatures of 30°C to 34°C were imposed, maximum body weight was achieved at 32°C. Hutton *et al.* (1993) claimed a marked improvement in growth and survival of crocodile species reared at temperatures between 30°C and 32°C over animals reared at temperatures only a degree or two cooler, but hypothesised that the optimal rearing temperature for individual animals could vary depending on clutch origin and incubation temperature, among other things.

An experiment using 140 *C. porosus* hatchlings from five clutches was conducted, subjecting balanced groups of animals to a range of temperature regimes over a 10 week period (Turton *et al.* 1994). The stress levels in animals were assessed by measuring their levels of plasma corticosterone - the hormone which is released into the bloodstream in response to stress. Results indicated that at the highest temperature of 36°C, animals were more stressed than at 32°C but that there was no difference between 28°C and 32°C. Over the period of 10 weeks, body weight changes in the animals were not significantly affected by water temperature differences.
Historical research indicates that water temperature is perhaps the most important environmental factor influencing the growth and well-being of young crocodiles. So, it was essential that the best rearing temperature for different ages of research animal be established for the specific nature of the Oonoonba rooms/tanks, taking account of factors such as design of tank, depth of water, type of hide-board, humidity, air flow, level of noise and lighting.

'Experiment on 2 - month old hatchlings'

Since water temperatures in native crocodile habitats are generally between 25°C and 28°C, and some crocodile farms in Australia have been set up in sub-tropical areas such as Rockhampton and Fremantle, it was decided to research the effects of water temperatures as low as 26°C. These temperatures are directly relevant to the many zoos and wildlife sanctuaries in southern Australia which keep crocodiles. There is a school of thought that farmed animals should be given the chance to adjust their temperature by farms providing a thermal gradient in the animals' rearing environment (Lang 1987). The Oonoonba facility consists of just six rooms, each of which can be maintained at a certain air temperature, so there is a limit to the degree of thermal gradation that can be imposed as part of a research treatment. From published literature, an upper limit of 34°C water temperature was chosen for this initial experiment, carried out when animals were two months of age.

A serious fungal disease occurred in room 1, tank A (the coldest treatment) requiring animals to be caught and treated with Betodine. There were seven deaths in this tank so it was decided to terminate this experiment at the six week stage and return all tanks to a water temperature of 32°C.

The experiment consisted of imposing different air/water temperature combinations and recording growth over the 6 week period. For the 6 rooms, air temperatures were set at 28°, 30° and 32°C in a randomised block design, with 2 replicates. Within each room, water temperatures in the 2 tanks were set at 2°C above and 2°C below the particular air temperature, resulting in a range from 26° to 34°C. Three different clutches of animals constituted each replicate and animal density was either 18 or 20 per tank (0.20 or 0.22 square metres per animal). Animals were fed daily on the standard diet of chicken heads, kangaroo and beef, fortified with a special vitamin/mineral supplement powder, and a fasting period of 2 consecutive days each week to aid complete digestion of food. The average liveweight of the hatchlings at the start of the trial was 106g (range from 40g to 200g). Figure 1 shows the average final weights for animals reared at the different water temperatures. There was no significantly detected additional effect of air temperature to this response trend.

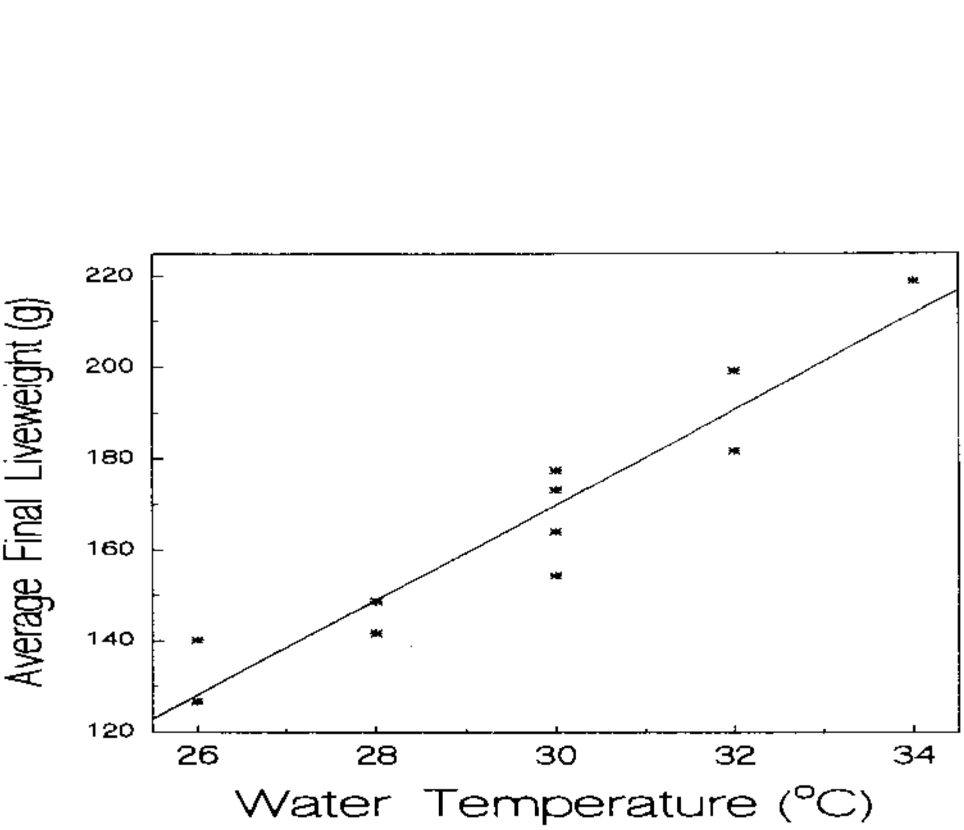

Figure 1: Liveweight response of 2-month old hatchlings to water temperature

Because of the nature of the tanks with their high, solid walls, it is not surprising that room air temperature differences of 2°C around a particular water temperature did not have any significant effect on animal growth. For air temperature warmer than the water, there would be a cooler layer of air sitting just above the water, and spilling on to the land area. Conversely for air temperature cooler than the water, the water would be constantly warming the air inside the tanks with the air rising. Hence, the actual air temperature in the immediate crocodile land environment would be closer to the water temperature than the air in the rest of the room.

'Experiment on 7-month old juveniles'

At this age there were large differences in size of the animals (200g to 1900g) so it was decided to divide the animals into 2 size classes, called 'small/medium' (av. weight 460g) and 'medium/large' (av. weight 910g), and investigate the effect of different water temperatures from 31° to 37°C on each group over a period of 9 weeks. Air temperatures were maintained within 1°C of water temperatures in each tank. Densities were 17 and 14 per tank for the 2 size classes, and the diet was the same as for the initial experiment on temperature, but minced more coarsely. There was no significant response to water temperature over this range for the small/medium group, but a detrimental affect at higher temperatures for the medium/large group is indicated by the final average liveweights as shown in Figure 2.

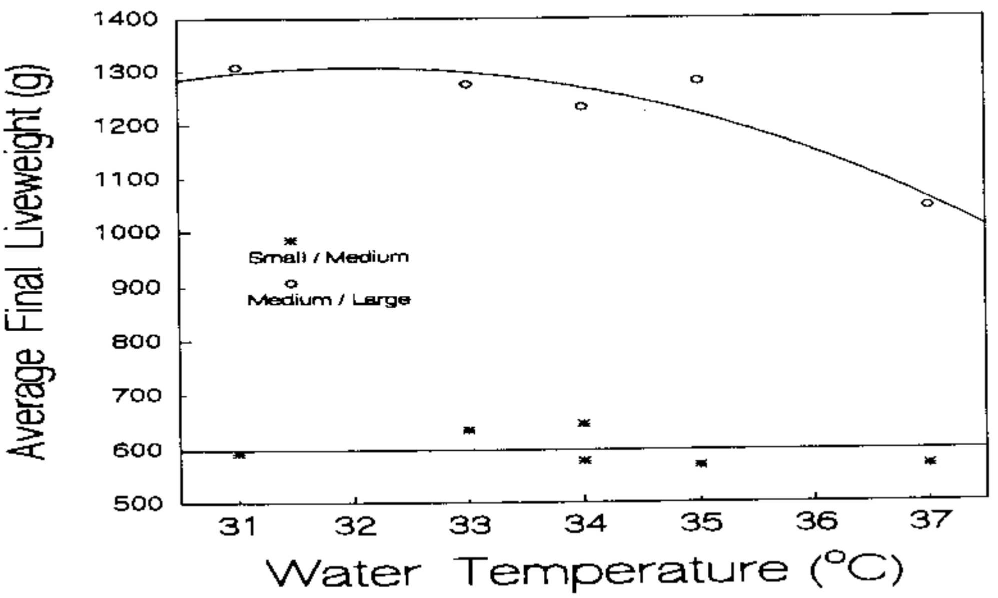

Figure 2: Liveweight response of 7-month old juveniles to water temperature

'Experiment on 10-month old juveniles'

This was a repeat of the experiment on 7-month animals, with a lower limit of 32° instead of 31°C, to see whether the same responses would occur in slightly older animals. It was run over a 7 week period, and there were again 17 small/medium or 14 medium/large animals per tank. The average initial weights were 650g and 1250g for the 2 size groups. Figure 3 shows the final average liveweights for each temperature treatment and the estimated response trends. These trends reinforced those observed in 7-month animals.

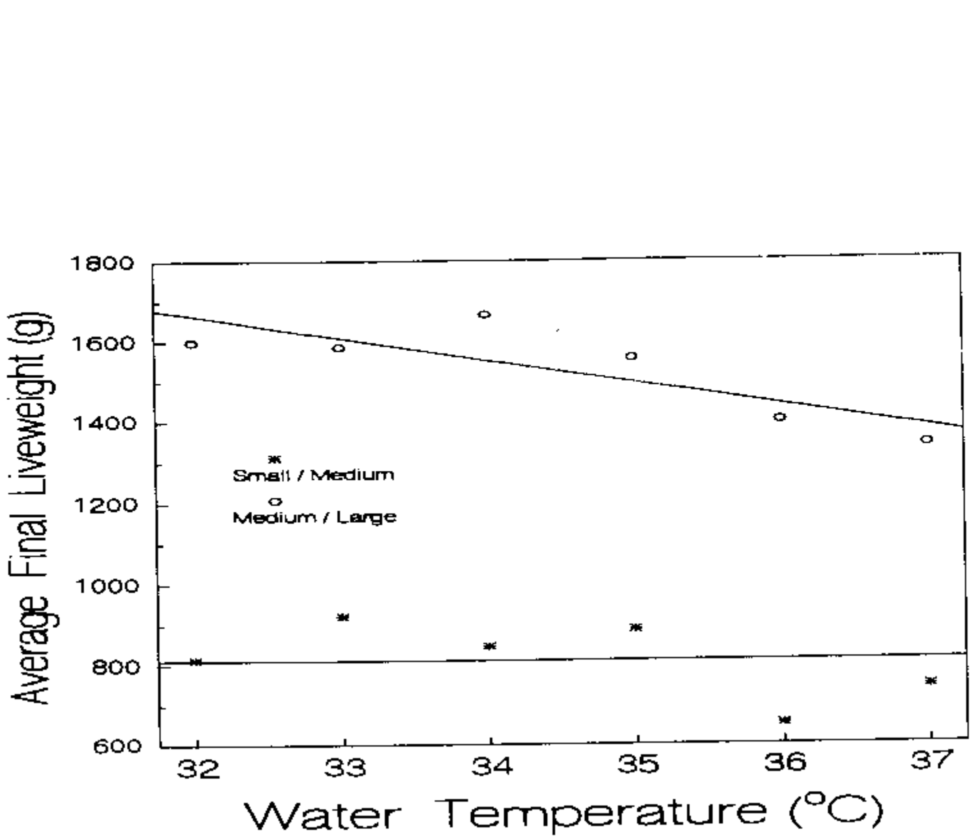

Figure 3: Liveweight response of 10-month old juveniles to water temperatures

The results from the experiments on 7 and 10 month old animals indicate that the smaller specimens at these ages seem to be quite tolerant to air/water temperatures anywhere between 31° and 37°C. However their heavier relations suffer a slow down in growth when temperatures climb to more than 34° or 35°C.

Pellet Development and Evaluation

A feed milling company has been cooperating on this project, and has manufactured 5 prototypes of pellets for evaluation. The first four were distributed to commercial farms for them to try on their different aged animals. At the same time we were trying a range of pet foods (both dry and wet) on some of our runt animals. The only success we had was with one high priced, fish based tinned cat food. Following is a summary of industry's reaction to the prototypes.

'Prototype 1'

This was a small, hard base-shaped extruded pellet, and was released to farmers in January 1993. None of the farmers recorded any success, although one did get animals to eat pellets when mixed with meat and another crushed the pellets and added it to the diet, which was eaten. Suggested improvements were

- a softer, rubbery texture needed
- a different aroma (suggest prawn)
- a pellet that would float, yet not breakdown readily in water.

'Pr otype 2'

Thi was manufactured in May 1993, and was smaller and softer, with a prawn flavour. Aga n, the only success was when mixed with minced meat. Farmers suggested that an eve softer, moister pellet was needed.

'Pr totype 3'

Th pellet had a higher moisture content of 21%, and so required the addition of an anti-spc age agent. Protein content was 30% and protein sources consisted of cotton seed, so bean and fish meal. Juvenile crocodiles would still not eat pellets by themselves at any of the farms.

'Prototype 4'

Moisture content was raised to 25%, protein to 40%, and a prawn flavour was added. As well as being distributed to commercial farms for evaluation, a proper scientific experiment was set up using our research facility. Animals were 3 months old at the start of the investigation, and were fed 3 different treatments consisting of mince:pellet mixtures (by weight).

	Diet for week			
Treatment	**1**	**2**	**3**	**4**
A	100 : 0	100 : 0	100 : 0	100 : 0
B	100 : 0	75 : 25	50 : 50	50 : 50
C	100 : 0	75 : 25	50 : 50	0 : 100

Thus, treatments B and C were attempts to 'wean' the crocodiles from their standard meat diet onto pellets. Unfortunately, at the 50:50 rate food consumption dropped off with the animals picking out the pieces of mince and for the week when treatment C animals were fed only pellets, they did not eat anything.

A second experiment was run, in which different quantities of pellet were actually put through the mincing process, and so thoroughly incorporated into the mince (so animals could not pick out pieces of pure mince). The treatments were imposed as follows:

	Diet for week					
Treatment	**1**	**2**	**3**	**4**	**5**	**6**
D	100 : 0	100 : 0	100 : 0	100 : 0	100 : 0	100 : 0
E	100 : 0	85 : 15	70 : 30	55 : 45	50 : 50	60 : 40
F	100 : 0	85 : 15	70 : 30	55 : 45	40 : 60	50 : 50

It had been planned to take treatment F right up to 100% minced pellets, but the results on weeks 4 and 5 showed little of the mixed diets of E, F were being consumed, so on week 6, the mince content was increased. This experiment was aimed more at evaluating the nutritional aspects of a pellet/mince diet, rather than trying to get animals to eat pellets by themselves.

'Prototype 5'

We have just received the new products which consist of

- small, soft, ball-shaped pellets of different colour (red and brown)
- the same basic ingredients but in a 'mash' form.

We are trialing these on hatchlings which have not been exposed to any other food since hatching.

Light Trial

This experiment was conducted on 6½ month old juveniles and ran for 8 weeks. Animals had been reared under previous experiments on a diurnal light cycle, with artificial light provided in the enclosed rooms from 6.30am and until 5pm each day. For this experiment animals were divided into 2 size groups, with average weights 262g and 544g, and stocked at 19 and 16 per tank respectively for each group. Three light treatments were imposed:

- artificial light kept on continuously
- normal diurnal cycle
- rooms kept continually as dark as possible (very dim lights put on during feeding and cleaning operations).

The design used was 2 room replicates of each light treatment in a randomised block array, and within each room the 2 tanks contained the 2 different size groups resulting in a split-plot design. Responses, in terms of liveweight change for the 2 size groups, and shown in Figure 4.

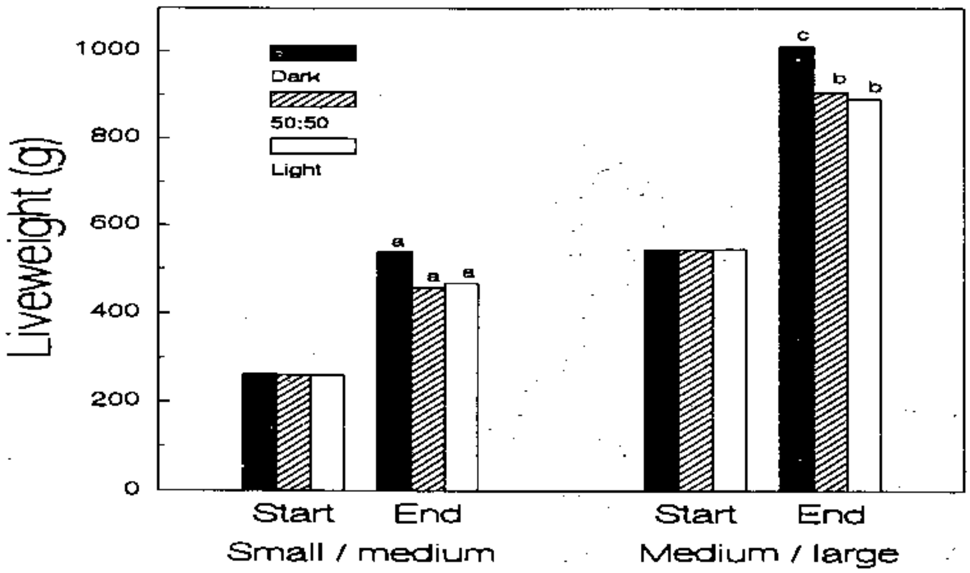

Figure 4: **Average initial and final liveweight for the 2 size groups reared under 3 different light regimes. Columns headed by similar letters do not differ significantly (p>0.05).**

Density Trial

This was the final experiment conducted on the 1995 animals, which were 8½ months old. The animals ranged in weight between 200g and 1710g, and were split into 2 groups about a division point of 690g, resulting in average weights of 470g and 945g for the 2 size groups. The smaller group were allocated to 6 randomly selected research tanks at densities of 5, 10, 15, 20, 30 and 40 per tank (area 3.9 square metres), and the large group to 6 other tanks at densities of 4, 9, 13, 17, 23 and 30 per tank. The trial was run for an 8 week period, on a dimmed light diurnal cycle. Figure 5 shows the response patterns of final average liveweight to density for each size group.

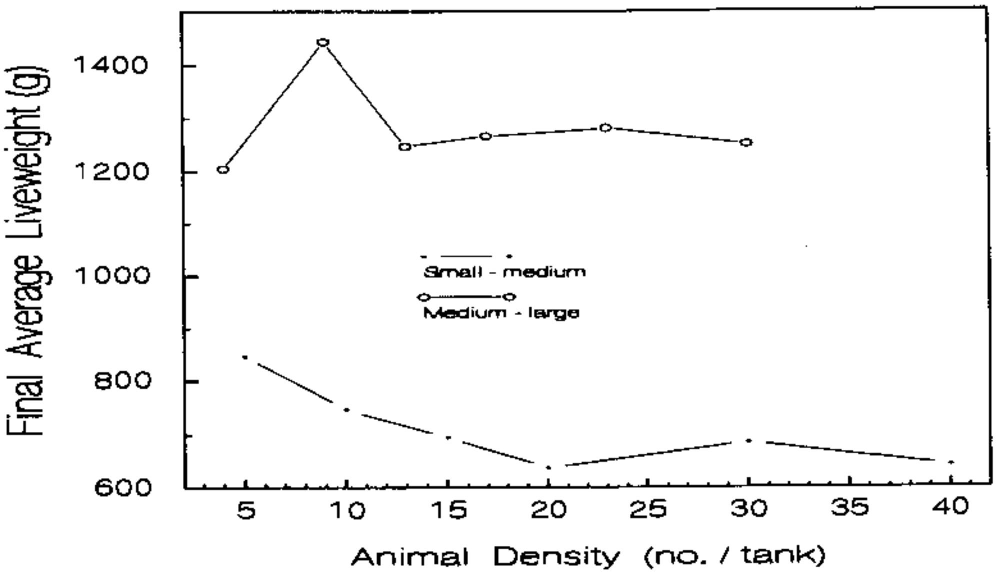

Figure 5: Final average liveweight for the 2 size groups reared at different densities

This shows that for the smaller animals there was a general decrease in growth rate with increasing density from 5 to 20 per tank (or 0.8 sqm to 0.2 sqm per animal) but no further decrease up to 40 per tank (0.1 sqm per animal). For the larger animals, apart from the one tank which produced a extraordinary response, there seemed to be little effect on density (in the range 4 - 30 per tank) on growth rates.

The odd result occurred at a density of 9 medium/large animals per tank. Compared with an overall average weight gain of 35% among all the large sized animals (945g to 1277g increase), 6 of these 9 animals recorded weight gains of more than 50%. This cannot be explained by clutch differences, since, as part of the standard design allocation procedure, animals at the different densities were selected from the available clutches in the same proportions: for this group of 9, there were single representatives from 5 clutches and pairs from another 2 clutches. This highlights some of the difficulties in having to deal with crocodiles as research material. From this single experiment there is no way of knowing whether a density of 9 per tank for larger animals is some magical number or whether it was a result of putting a particular mix of animals together which may have interacted with each other in some beneficial manner (eg. more tolerance, especially during feeding).

FUTURE RESEARCH

QDPI is committed to pursuing research into further aspects of nutrition, environmental effects and management practices as applied to farmed *C. porosus* from eggs to slaughter. Research to date has necessarily focussed on single, specific issues. However it is recognised that employing optimal individual practices does not necessarily translate into an optimal combined strategy (eg. response to different diets may change depending on environment or animal density). Thus, research will naturally lead to experiments looking at selected combinations of near optimal individual factors.

The research team recognises it strengths and weaknesses and has established links with the farming industry and with other crocodile researchers around Australian to draw on their expertise and ensure that research is focussed on key issues. It has drawn together the required skills of veterinarian, bacteriologist, biometrician, geneticist, animal attendant, industry manager, extension officer and computer programmer from QDPI staff.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the invaluable contributions made by other members of the research team: Dr Steve Johnson, Dr Annette Thomas, Dr Cam McPhee, Bernie Davis, Rob Jack, Rod Bloomfield, Honor Stephenson and Scott Blyth. For providing us with research animals each year we would like to thank Vic Onions and Don Morris (Edward River Farm) and Keith Cook (Cairns Farm). The product research unit at the feed milling operations of Ridley Agriproducts, Paul Mason and Andrew Stallman, have supplied a range of prototype feed pellets, and Rhôone-Poulenc Animal Nutrition has supplied the crocodile vitamin/mineral supplement used in our diets. Individual members of the Queensland crocodile industry have been very supportive of our activities and we would especially like to thank Harry and Peter Freeman (Hartley's Creek Farm), Vic Onions and Keith Cook, and John Lever (Koorana Farm) for the many times they have shown team members and visiting scientists around their farms, and time spent discussing R & D issues. We have established useful dialogue with researchers at the universities of Queensland (Brisbane), Central Queensland (Rockhampton) and James Cook (Townsville), and also with Steve Irwin (Qld. Reptile and Fauna Park), and we acknowledge their input and support. Dr Peter Mullaney (Primary Tasks) is assisting the team in its extension program.

The Rural Industries Research and Development Corporation has supported our research effort through several research funding grants, and the program coordinator Dr Peter McInnes has maintained a close personal interest in our work and provided invaluable support.

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DISEASES ENCOUNTERED IN GENUS *CAIMAN* INTENSIVE BREEDING

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SUMMARY

The differents pathologies and diseases found in five years of work in captive crocodilians of the genus Caiman , are presented . For practical purposes the diseases are listed as follows;

a. Diseases caused by inapropiatte management .
b. Alimentary Diseases.
c. Parasitic Diseases.
d. Infectious Diseases.
e. Miscelaneous Diseases.

For each group of pathologies; symptoms, etiology , lesions, treatments and prevention measures are presented . We conclude that the principal diseases affecting Caiman in cap tive condition are the palmar and plantar abration caused by rough and abrasive soil, wounds caused by interespecific agresive behaviour . Alimentary diseases caused by an inapropiatte Calcium: Phosporous ratio cause Metabolic Bone Diseases in growth animals feed with raw beef meat .

On the other hand, the parasitic and infectious diseases are less common and not cause diseases and death as describe some authors and only few number of parasites has been described to be dangerous for the crocodilians Finally, some miscelaneous diseases as development abnormalities are described.

Key Words: Pathologies - Intensive Breeding - Caiman - Prasitic Diseases - Infectiuos Diseases- Alimentary Diseases.

INTRODUCTION

Compared with the knowledge and amount of scientific papers in upper vertebrates pathologies , the amount of information in reptilian , and specially, in crocodilian pathologies and diseases is poor. Only few reports are found in scientific publication and only in the last five years , some publication are available.This fact is more notorious in Latin American country , in wich the management of captive crocodilians , have importance , due mainly to the decreased natural population or habitat destruction.

Is the aim of this repport to comunicate the experience of te authors in five years of working in this field of investigation and secondary a revision of the available literature in Argentina about this topics .

MATERIALS AND METHODS

The work was carried out under different captive populations of both genus of Caiman that live in Argetina ***(Caiman latirostis*** and ***Caiman crocodylus yacare***) mantained in different locations in Northern Arghentina (Corrientes and, Chaco province) and, Buenos Aires Zoological Garden . The animals are feed in choped beef , chicken meat,and fish meat , entire fish, chicken carcasses, etc., depending the location and the disponiblity of the food. The animals was from different ages, sexs and sizes .of both *Caiman* species .

RESULTS

a. Diseases caused by inapropiatte management

In this pathologies ,two mainly problems was found. The interespecific agresive behaviour and the palmar and plantar skin surface abration..
In the first case , overcrowding , different sizes of animals in the same pool , lack of amount of food, different sizes of animals , was the predisponenet factor to this behaviour .The type and deep iof the wound appears to be dependent of the size of the animals .You can see in the **photo** 1. a severe wound caused by other animal . This wound was able to cut the rostral bone of the atacked animal, but it survive the attack , cicatrize the wound and live., with some difficult to eat and breath.
Other slides show different wounds, varying from a simple wounds to phalanx and other bones severe loss . The treatment of this wounds is not difference with the same wounds seen in other animasl as mammals and the treatment ibclude the gently cleaning , dessinfectaNt aplicattions (Povidone Iode), bandagge if it is necesary and in some severe cases broad spectrum parenteral antibiotics as Enrofloxacine (10 mg/kg/24 hs s.i.d) or another commercial available quinolones
The palmar and plantar skin surface abration caused buy rough and abrasive concrete was a cronic problemas for years in many breeders.as mentioned some authors (Jacobson, 1984 - Bolton, 1989) The construction of new pools , with polyestrirene coberture in the soil, painting the bottom of the pools with sintetic pinture, were some of the solution . In this cases , the animals were treated with a dairy gently clean of the abration with iodine, bandage with parafinned band and aplication of parenteral broad spectrum, antibiotics as quinolones . In some cases te wounds of the abrated surfaces were contami nated with bacterial and/or fungal agents. In this cases it was necesary to remove the necrotic tissue , and keep moisture of the bandagge ., in order to avoid further complications to cause death.

b. Alimentary Diseases

The bibliography mentioned a variety of pathologies and diseases caused by lack or deficit of minerals and/or vitamines (Jacobson, 1984- Bolton, 1989 - Kuhen, 1990). In our exprience , we only found one of this pathologies and we think the most important of the alimentary diseases found in all vertebrates , specially when this animals are bred in captive condition. with artificial alimentation.
The **photo 2** show a litlle ***Caiman crocodylus yacare*** , wich are affected by a disease so callled "Metabolic Bone Diseases " or in the classic veterinary book test "Ricket", "Osteomalacia', Fibrous Osteodystrophia", "Secondary Hipeparatyroidims Nutritional Disease". The basic patagenic mechanism is the lack in the Calcium aported by food, an excess of Phosporous, when the animal fed in meats with high muscle content, lack of Vitamine D caused by inapropiatte sun exposition and another situation as lack of proteins in the diet, excess of Phtalic acid in diet ,etc. In this cases above mentioned, the animal is not able to maintain the blood Calcium levels and develop the diseases wich are caracterized by inflamation of the ribs and limbs, curvature of the dorsal spine, paresia or in some cases complete paralysis.and softness of some bones as the jaw and limbs bones with visible deformations.and spontaneous fractures

The treatment is based in the adecuate aport of cacium slts in form of Carbonate by oral route or Gluconate or Lactate if the parenteral route if prefered. In the first case, the adittion of Calcium Carbonate in the food at a dosage between 10-20 mg/kg of food is need to prevent and in some cases revert the paralysis, the softness of the bones.

If the second option is selected, the dosage of the drug (Calcium Lactate or Glucona-te) is 10 mg/ kg of body wrigth, by intramuscular route , using a syringe. The adequate prevention of this pathologie is the best practice. The control the Blood calcium level in suspected animals (Normal values 7 - 10 mg%) is an adequate practice or an periodical evaluation of the adequate balance in Calcium -Phosporous relation(normal values 2:1 or 1.5: 1) This technique have a low cost, is available in the majority of the diagnostic laboratories and need few blood for the determination.

The supllies of Calcium Carbonate is necesary in growth young animals and the easy manner to suply this salt is add crushed egg-shell in the meat or supply powered Calcium Carbonate

Another pathologies related to inadequate nutritional balance, as deficit of vitamine B or vitamine C and the so called Steatitis caused by lack of vitamine E is still not found in our work.

c. Parasitic Diseases

The description of all parasites is not the aim of this report, because at this date , more than 450 species of parasites affecting crocodiles was described (Jacobson, 1984- Frye, 1990- Reichembach -Kilnje &Elkan ,1964 - Bolton, 1989 - Liegh, 1978 - Lombardero-Apostol, 1953, Medem, 1988) including Cestodes, Trematods, Nematodes, Acanthocephales or thorny-head worm., Pentastomides and some Artropoda as Insects of Diptera order (Tabanidae familiy); we only described two of our finding in ***Caiman*** species. One of them , is a filaroid nematode wich was found free in the coelomic cavity of sudden dead animals . The parasite was clasified as ***Micropleura vazii*** Some authors conulted found this worms in the stomach and gut of the same definitive host (***Caiman crooylus yacare***) but we only found in coelomic cavity.Interestingly, microfilaries was not observed in peripheric blood

The second of our findings is a pentastomid , ***Alofia platycephala***, first described in our country by Lombardero and Apostol and now redescribed. This Pentastomid was found in the lungs of animals and we think that is not a principal cause of death, however a high number of this parasites was found in afected animals .

In the periodical routinary fecal and blood examination of the animals was possible to see some eggs of unclassified parasites and in blood ,intraerythrocytic parasites resembling ***Hepatozoon*** or ***Hemogregarina***.

d. Infectious Diseases

This infectious agents was not found in the variety and quantitie described by others report found in the bibliography. In our country, the use of electronic microscopic technique is still unapproachable, because it high cost ;so, the viral agent wich cause pathologies and diseases in crododiles are , at the moment , imposible to determinate.

The fungal and bacterial agents was isolated from mouth, skin, stoch, liver, lungs and another oragans and systems .The most commmon isolated fungal agent is ***Aspergillus fumigatus*** and ***Cladisporium spp*** from skin lesions.

Aeromonas hydrophyla, A liquefasciens, Pseudomonas putrida, Pseudomonas aeruginosa, Escherichia coli, Proteus retgerii, Proteus mirabilis, Sphaerophorus necrophorus were the most common bacterial agents isolatated from the lesions in the above mentioned organs and systems.

e. Miscelaneous Diseases

In this topic we include different types of congenital abnormamlities,one of wich are show in the **photo 3**. The most common findings was anomalous tail, lack of tip of the tail, bicephalic animals , lack of limbs and one case of albinism.

CONCLUSIONS

Based in our findings and the available bibliography in our country , the first conclutions was that the inapropiatte care and management of captive condition was the major source of diseases and pathologies in captive ***Caiman*** species . The agressive behaviour and the palmar and plantar skin abration due to the rough soil or floor of the ponds and pools in wich tha animals live.are probe of this bad condition

Infectious and parasitic diseases appears not to be an important impact in the aparition of ill and death of ***Caiman*** in captivity, but some parasites as ***Alofia*** and ***Micropleura*** can be found and some unclasified eggs and intraerythrocytic parasites required further studies in order to eluicidate their exact pathological role.

Finally, the Metabolic Bone Disease ,appears to be an importat pathologie in young growth animals , that fed in meat with high muscle content and their prevention is most i important than the treatment.-

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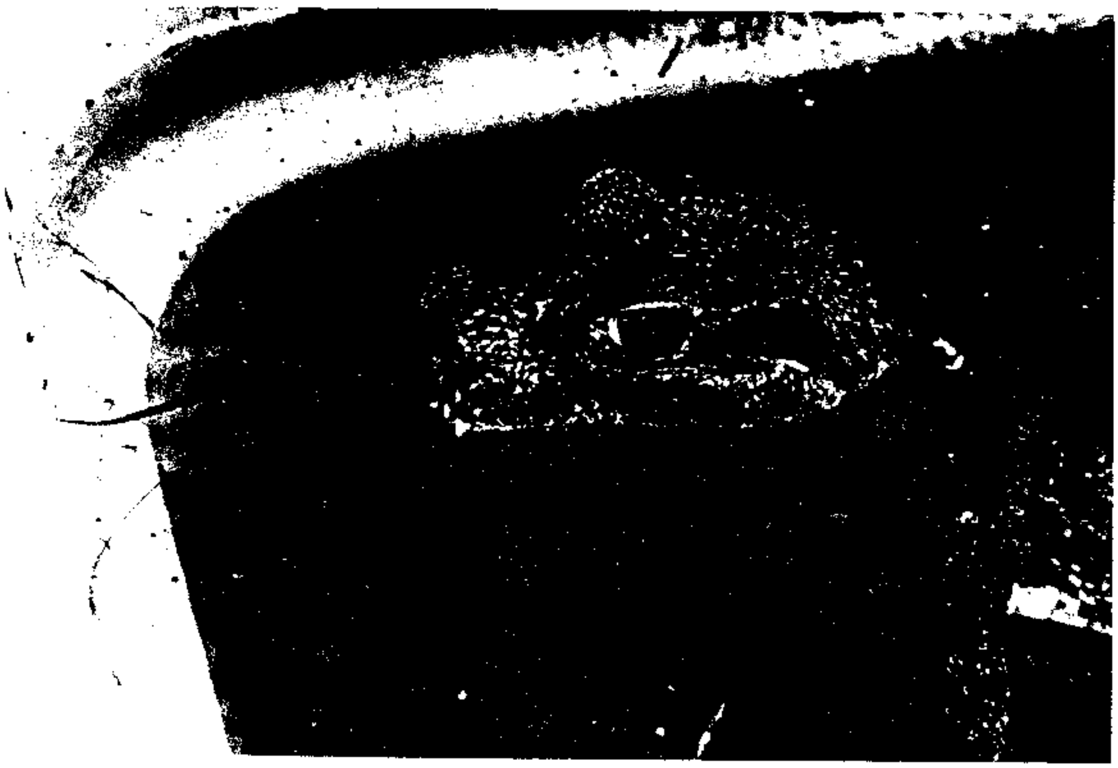

PHOTO 1 - CAIMAN CROCODYLUS YACARE LOOS OF ROSTRAL BONE. AS CONSEQUENCE OF AGRESIVE BEHAVIOUR

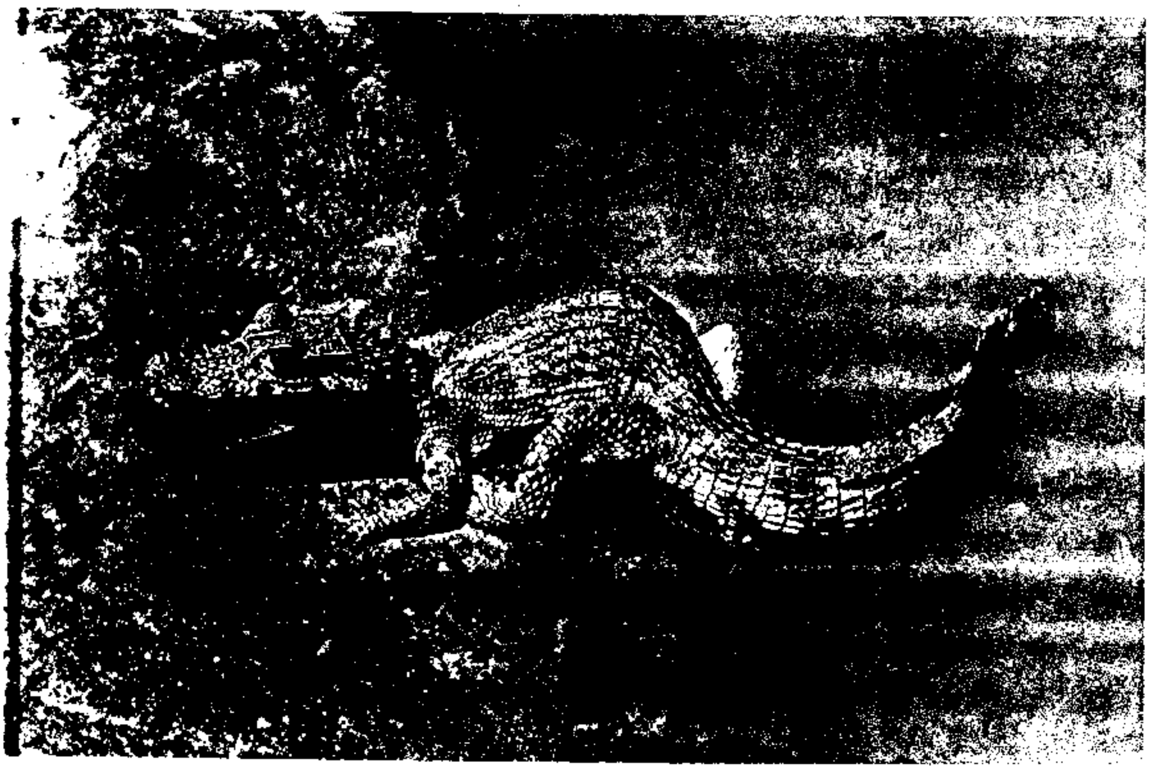

**PHOTO 2 - CAIMAN CROCODYLUS YACARE
METABOLIC BONE DISEASE**

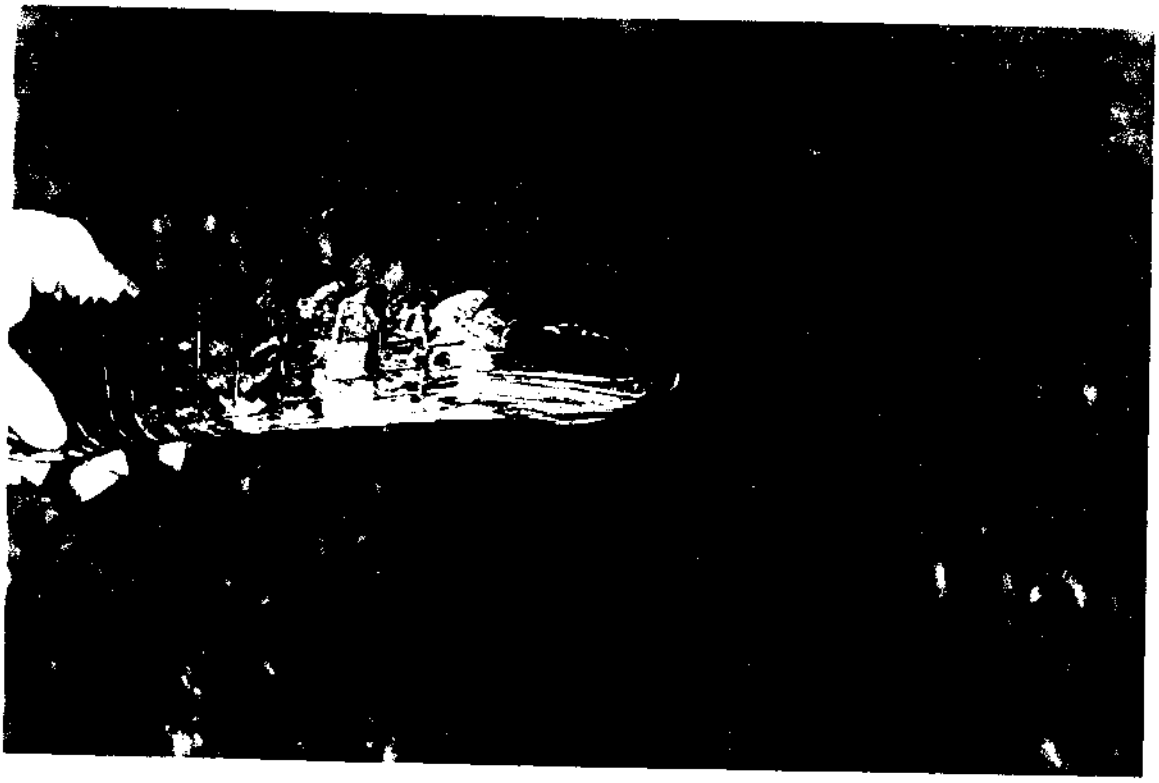

PHOTO 3 - CAIMAN LATIROSTRIS ANOMALOUS TAIL

ALOFIA PLATYCEPHALA; PENTASTOMID WORM IN LUNG OF *CAIMAN CROCODYLUS YACARE*

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SUMMARY

A finding of tongue worms or Pentastomida in lungs of ***Caiman crocodylus yacare*** in Northern Argentine is reported. The morphology of the larval stage and the adult is described , also the localization, the definitive host and the lack of macrocopic lesion in the lung parenchima.
Based in the morphology and the localization in the host , was posible to stablish that the tongue worm is ***Alofia platycephala*** (Lorhman,1889) Giglioni, 1922.
Key Words: Tongue Worms - ***Alofia platycephala*** - Lungs - ***Caiman crocodylus yacare*** - Northern Argentina

INTRODUCTION

Poorly know,the pentastomid or tongue worms are internal parasites, when adults, of the respiratory system of various vertebrates, specially reptiles.Since its first description by Leuckart in 1860, it exact systematic position remain still in discussion, for some authors it is included in the Phyllum Artropoda, because the perforatory aparatous in the larval stage resembling the mouth pieces of Insecta .On the other hands, another described closely analogy to the Anelidae due to the internal and external body segmentation [13,14,15] or recent investigations found that the morphology of the spermatozoa is similar at wich of the Crustacea, specially the Argulidae [11]. Finaly, a fourth opinion give a range of Phyllum((Pentastomida)..

Into this Phyllum are two Orders. The **Cephalobaenida** order are the most primitive and their biological cycle include insects, fish, amphibians and reptiles.Their biological cycle is related to be direct, without intermediates host.[13,14,15]

The **Porocephalida** order required the utilization of mammmals as intermdiate host and the reptiles as definitive host and are in a superior evolutionary scale of the another order..

This last order includ some families, as adult, parasites of reptiles and are caracterized by have a quitinous mouth sourrounded by five hooks and the vulva in the posterior end of the body.

Sebekidae family include the tongue worms or pentastomids of respiratory tract of crocodilians, with a variety of genus, one of the most important is *Alofia;* malayan, african and southamerican crocodiles internal parasite.

Genus *Alofia*, with the species ***A.ginae***, ***A.merki***, ***A. indica***, ***A. adriatica*** y ***A. platycephala***,is the genus described in this report. In Argentina, Lombardero y Apóstol were the authors of the first decription and finding in 1951 [5], but the definite host was described in a unclear form.

The objetive of the present paper is a revision of the definitive host originaly cited by Lombardero y Apóstol in their original paper and the redescription of the larval and adult stages morphology as well as the localization in the respiratory system of the affected animals.

MATERIALS Y METHODS

During four years of works , necropsies was made in specimens of e ***Caiman crocodylus yacare*** and Caiman latirostris, that die suffering a variety of diseases and derived for the diagnostic at the Laboratorio de Identificacion de Parásitos de los Animales Silvestres, of the Cátedra de Zoologia y Recursos Faunicos , U.N.N.E., Corrientes city , Argentina. The procedence of the animals was Jardín Zoológico de Buenos Aires, Zoológico de Roque Sáenz Peña (Chaco province), Zoológico de Corrientes, Zoológico de Goya (Corrientes province).

The necropsy techniques was carried out following the decription of E.Jacobson,1984.

The parasites found in the lungs of the affected animals was fixed by Raillet's solution for further observation under stereocopic microscope, previuos diafanization and clear the cuticule by means of the glicerine technique .

The parasite eggs was obtained by means of the pression lungs washing with saline solution and a syringe ,whereas the gravid females and observed under optic microscope .

RESULTS

From the lungs of the death animals was taken 12 to 15 , white, litle parasites measuring 2 cmts in large, round body,with a sharp end. The media of the parasites found was 14 ±3 by animal, and already 80% of ***Caiman crocodylus yacare*** examined have this parasites in their lungs.

The microscopic observation of the parasite , show a dorventraly aplaned, segmentd body with thorny tegument extended side to side of the parasite.The cefhalic or pregenitaly region named Prosoma is wide, measuring 0.6 to 1 mm, with males and females significative variation (p:< 0.01).

In this area the mouth was encountered, surrounding with a quitinous frame and four retractile hooks ,conforming the fixing system. Each hooks have 86,4 -97,2 μ in long and 12,9 - 21,6 μ in width.

The abdominal portion or Metasoma is narrow, segmented and their measuring are 1 to 1,8 mm . In the female is 10 mm in width and the male is litle, 1 mm in width.

The entire genital system was observed in females , with a uterous filled with eggs,and opening in the posterior end of the body through a genital porus .

The eggs was obtained by bronquial and lungs washing, they are oval, double membranous yellowish , measuring 99,3 to 64,8 μ , with a develop larvae in difrent growth stage. In the first larval stage ,the larvae are amorfous, but is posible to see the three further body segmentation (see figure). Also was posible to observe a eggs containing a well develop second larval stage measuring 83 μ ,with four legs and claws measuring 13,6 to 16 μ.

Macroscopic evidence of bronquial epitelium and lungs parenchima lesions was not observed.

CONCLUSION Y DISCUSSION

In accordance with the bibliography available was posible determinate that the parasite bellow describe is ***Alofia platycephala*** (Lorhman 1889) Giglioni ,1922. Likewise, the description is in accordance with the parasite originaly describe in our country by Lombardero and Apóstol in 1952.The definitve host of the parasite is mainly ***Caiman crocodyylus yacare*** or " black yacaré" "yacare negro"or "yacaré de hocico largo" in our report.. This fact is in dissapointing with the Lombardero and Apóstol description , which cites ***Caiman latirostris*** as definitive host in their original paper. Without doudt concerning the validity of the morphology and lung localization of the parasite, is necesary to enfatized the validity of ***Caiman crocodylus jacare as*** the true definitive host and not ***C.latirostris***. In the same time, we carried out necropsies in ***Caiman latirostris*** (n: 13), and we never found tongue worms in the lungs of this animals . We think that the invluntary error in the original paper is an inadequate zoological classification, because the photo in the original paper is clearly an specimen of ***Caiman crocodylus jacare***, but the epigraph say ***Caiman latirostris***. In the rest of the paper, we are in accordance with the morphology and the clasification of the penstatomid parasite cited and this report is the second cite of the parsite for our country , and a different host.

The absence of macroscopic local response in bronquial epithelium and lung parenchima is the first notable finding. In accordance with some authors , The Pentatomids have cephalic glands that secreted a glucoprothein covering the cuticule included the hooks [11]. This secretion act as barrier between the interface parasite - host and impide the inmune response .

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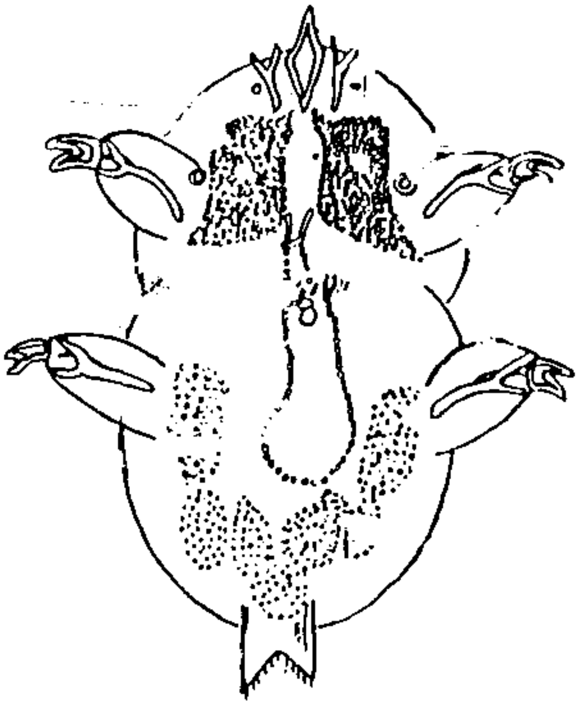
EGG OF PENTASTOMID



PENTASTOMID LARVA

PRINCIPALES ENFERMEDADES QUE AFECTAN A ALGUNAS EXPLOTACIONES COMERCIALES DE *Caiman crocodilus fuscus* EN LA COSTA NORTE COLOMBIANA

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RESUMEN

El presente trabajo es una recopilación de las enfermedades de mayor importancia epidemiológica, detectadas a partir del año 1990 en la Costa Norte Colombiana, que afectan a individuos cautivos de la especie *Caiman crocodilus fuscus*. Basándose en biopsias, necropsias, exámenes de laboratorio, índices de morbimortalidad y demás factores de importancia epidemiológica, se presentan algunos detalles de especial interés como son: síntomas, lesiones microscópicas y posibles agentes.

A pesar de ser animales altamente resistentes, los individuos de la especie *Caiman crocodilus fuscus* son susceptibles a enfermar y morir por múltiples enfermedades de distinta índole, situación que se agrava por el desconocimiento de algunas de las técnicas básicas de producción y las altas poblaciones que manejan algunos de los criaderos evaluados. Se observa como las enfermedades infecciosas tienen su principal acción durante los primeros meses de vida, incluso desde el desarrollo embrionario, mientras que más adelante la aparición de estas disminuye considerablemente, dando paso a las deficiencias e intoxicaciones nutricionales.

Entre las enfermedades infecciosas sobresalen: dermatitis, panoftalmitis, rinitis y encefalitis de posible origen viral, las cuales comúnmente se complican con hongos y bacterias. La *Pseudomona spp.* es la bacteria de mayor impacto, como agente infeccioso secundario y como agente causal primario en

infecciones alimenticias y posiblemente malformaciones embrionarias. Infecciones menores, en hígado, páncreas, estómago, etc., se encuentran normalmente asociadas con los animales de más lento crecimiento. La deficiencia de Vitamina E en juveniles y reproductores se constituye en un problema de gran importancia, responsable de altas mortalidades, bajas en la producción y de lo que podría describirse como un problema de envejecimiento prematuro.

1. INTRODUCCION

Los problemas sanitarios disminuyen el consumo de alimentos, la conversión alimenticia, el peso del animal al momento del sacrificio, los índices reproductivos y deterioran la calidad de la piel. Sumado a todo esto, las pérdidas por mortalidad y una mayor edad al momento del sacrificio, hacen que los costos de producción se eleven, afectando la rentabilidad de la cría en cautiverio de cualquier especie.

Este trabajo expone brevemente los síntomas, lesiones patológicas, posibles agentes etiológicos y otros factores relacionados que se han podido extractar de las principales enfermedades que regularmente han venido atacando a algunos Zoocriaderos ubicados en la Costa Norte Colombiana, desde 1990 hasta la fecha y que de una forma u otra afectan la productividad de esta industria.

Los hallazgos obtenidos son una base para prevenir, detectar y tratar oportunamente las enfermedades y reorientar algunas técnicas de manejo; además motivan la realización de otros estudios más específicos y profundos en beneficio de esta actividad.

2. MATERIALES Y METODOS

Los reportes de patología que sirven como base para este trabajo se han venido estudiando desde 1990; los animales de los que se obtuvieron estos casos pertenecen a diferentes zoocriaderos ubicados en la Costa Norte Colombiana. Se tuvieron en cuenta individuos de todas las edades, que de alguna manera mostraron síntomas de estar padeciendo alguna enfermedad. El parámetro base usado para caracterizar cada una de las enfermedades fue la histopatología, para lo cual se utilizó rutinariamente la técnica de fijación de tejidos en formol buffer al 10%, inclusión en parafina, para cortés de 5 micras, con coloración de Hematoxilina y Eosina.

En algunas ocasiones, cuando las circunstancias lo facilitaron, se intentó el aislamiento de bacterias, hongos y virus; de igual forma se utilizaron innumerables coloraciones especiales y técnicas de laboratorio.

Para su mejor comprensión, las enfermedades se presentan agrupadas teniendo en cuenta la edad de los animales afectados.

3. RESULTADOS

3.1. Neonatos

Los primeros 6 meses de vida representan un período crítico para los animales, especialmente durante el primer mes y a partir del tercero.

Durante las primeras semanas, en las cuales los animales se adaptan a las condiciones que le ofrece el criadero, las principales pérdidas se deben a fallas en la calidad de los huevos, o la incubación, lo que se traducirá en neonatos prematuros, débiles o malformados con una alta probabilidad de morir en este primer período.

Al alcanzar los tres meses, comienza a presentarse una enfermedad conocida comúnmente como *Conjuntivitis*, con la cual los animales muestran una secreción cerosa en nariz y ojos, tornándose inapetentes; algunas veces, el cuadro anterior se hace más grave con la presencia de síntomas nerviosos, consistentes en pérdida del equilibrio, opistótonos y depresión intensa. Morfológicamente la lesión se observa como una rinitis aguda, con ulceraciones, erosiones, reacción inflamatoria, congestión y cambios degenerativos a nivel glandular, uveitis anterior linfocitaria y plasmocítica y encefalitis igualmente linfocitaria y plasmocítica. Las lesiones anteriormente descritas, orientan el diagnóstico hacia un proceso de origen viral, hasta ahora indeterminado. Esta teoría toma aún mas fuerza al tener en cuenta la forma repetitiva en que los tres órganos (nariz, ojo y encéfalo) se ven afectados conjuntamente todos los años, en una determinada época y en animales de la misma edad, tal y como sucede en procesos virales de aves y mamíferos.

Del buen o mal manejo que se le de a los animales, dependerá que el cuadro anteriormente descrito sea benigno o severo; pero necesariamente siguiendo siempre la misma estructura.

Simultáneo con la sintomatología anterior, los neonatos empiezan a enfermar de poxvirus; una lesión superficial de la epidermis, de poca o ninguna incidencia sobre el normal desarrollo del animal, contrario a lo reportado en otras especies de cocodrilos. Histopatológicamente se caracteriza por la presencia de grandes corpúsculos de inclusión intracitoplasmáticos y eosinofílicos. Esta enfermedad continúa presentándose durante la etapa juvenil, donde genera pérdidas económicas por depreciación de la piel.

3.2. Juveniles y Reproductores

Al comparar los hallazgos patológicos de numerosas muestras provenientes de eutanasias de juveniles aparentemente sanos, catalogados como lento-crecedores, con los de animales rápido-crecedores, igualmente de apariencia sana, se encuentra que en los primeros es casi que una constante la presencia de una o varias de las siguientes lesiones: hepatitis necrótica, hepatitis granulomatosa y úlcera gástrica. Las anteriores, si bien necesitan de un factor predisponente, a su vez deben estar colaborando para que los animales no expresen plenamente su potencial productivo.

La gran demanda de alimento por parte de los zoocriaderos estudiados, hace que en ocasiones los animales sean alimentados con materias primas de regular calidad; situación que conduce a deficiencias e intoxicaciones nutricionales, de presentación crónica o aguda, capaces de generar en juveniles y reproductores severos episodios de mortalidad. Así, los juveniles y reproductores ocasionalmente pueden morir bajo sintomatología netamente nerviosa, a causa de un cuadro patológico caracterizado por una intensa metamorfosis grasa del hígado, con fibrosis leve, proliferación de conductos biliares, encefalomalacia y presencia de manguitos perivasculares. Los hallazgos mencionados son compatibles con una intoxicación con micotoxinas principalmente y en segundo lugar con una deficiencia de vitamina B1.

La deficiencia de Vitamina E ha sido reportada en otras especies de Cocodrilos, como un hallazgo secundario. Esta enfermedad adquiere especial importancia convirtiéndose en la principal causa de mortalidad en juveniles y reproductores. Los cambios morfológicos son: necrosis de la grasa, necrosis del músculo esquelético y miocarditis. El origen es el enranciamiento de las grasas dietéticas ocasionado por el mal manejo del alimento. De esta manera, los criaderos que incurran en este error pueden estar sufriendo sin darse cuenta de un deterioro de los animales, que disminuye los índices de productividad y que en el caso específico de los reproductores adicionalmente les acorta la vida útil, por un mecanismo que podríamos comparar con un envejecimiento prematuro.

3.3. Enfermedades Reproductivas

Al hacer un estricto seguimiento a huevos de varios nidos y zoocriaderos, durante todo el período de incubación, pudieron observarse dos factores muy probablemente de origen materno y definitivamente ajenos a la incubación. El primero de ellos consiste en mortalidad embrionaria temprana, con inferiores índices de incubabilidad y neonatos débiles, de baja sobrevivencia.

Al estudiar huevos abortados de estos nidos, se encontró una estructura redondeada y de membrana doble, compatible con coccidiosis (actualmente en estudio), un parásito otras veces reportado en cocodrilos a nivel digestivo. La segunda enfermedad consiste en el nacimiento de animales con deformidades a nivel de columna vertebral, extremidades, depresión intensa y muerte temprana; de los respectivos hemocultivos se aisló la bacteria *Pseudomona spp*.. Las madres y padres de estos neonatos habían sufrido una infección de origen nutricional con *Pseudomona spp* durante la época de apareamiento. La participación de la *Pseudomona* en este caso no es clara, puesto que si por una parte la *Pseudomona* se aisló en forma constante de la sangre de estos animales, las lesiones microscópicas, típicas de esta bacteria en otras especies, no coinciden con las aquí observadas.

Lesiones como gota visceral, miocarditis, nefritis, etc., además de despertar interés desde un punto de vista académico, aparentemente no muestran mayor importancia epidemiológica o económica y no influyen considerablemente sobre los porcentajes de morbimortalidad.

4. CONCLUSIONES

El desarrollo de la Zoocría en el país esta relacionado con numerosas patologías que menoscaban su rentabilidad y que deben ser identificadas. El potencial de la Zoocría amerita estudios permanentes y profundos de especialistas que visualicen los posibles factores de riesgo, evitando así perdidas económicas.

La poca disponibilidad de literatura y de trabajos similares motivan la necesidad de implementar trabajos de investigación en este campo, que permitan un mayor conocimiento de la problemática, así como la evaluación de las soluciones planteadas en función de su beneficio.

Con este trabajo, se desea motivar la búsqueda de respuestas a las limitantes en salud y producción en especies de alto valor.

AVANCES EN LA NUTRICION DE *Caiman crocodilus*.

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En las granjas Colombianas para la producción de ***Caiman crocodilus***, el costo de la alimentación representa entre el 50% y el 60% del costo total de producción. Esto significa que es en este renglón donde se deben hacer los mayores esfuerzos tanto para mejorar la eficiencia en el uso del alimento suministrados como para controlar el costo de producción de la ración balanceada.

Una vez que determinamos los requerimientos de proteína, grasa, fibra, ceniza, y minerales como calcio y fósforo, necesarios para mantener en las granjas tasas de crecimiento superiores a las que muestra ***Caiman crocodilus*** en condiciones naturales, hemos estado estudiando la aplicabilidad de diversas técnicas empleadas en la producción de otras especies, al caso de la produccion de ***Caiman***.

Se abordaron entonces aspectos relacionados con:

- El efecto del nivel de materias primas vegetales en la ración.
- El empleo de enzimas para mejorar la digestibilidad de la ración
- El uso de promotores de crecimiento del tipo antimicrobiano
- El efecto de la concentración de la Vitamina E en la ración sobre la fertilidad.

1.- Uso de materias primas vegetales en la ración de los crocodileos.

Para las granjas de crocodileos en Colombia, aun es valida la pregunta sobre el valor alimenticio de las proteínas de origen vegetal, no solo por la abundancia de materias primas de este tipo, sino por la disponibilidad de algunos aminoácidos asi como por su menor costo en comparación con las fuentes animales.

Aun cuando Coulson y Hernández (1983) afirmaban que los cocodrilos son incapaces de ingerir y digerir proteínas de origen vegetal , Staton (1986) demostró la factibilidad de emplear Maíz extruído en la formulación del alimento de *A. mississipienssis*.

En el presente estudio se evaluó el crecimiento de ***Caiman crocodilus fuscus*** a los que se les suministraron dos raciones con niveles similares de proteinas, grasas, minerales y vitaminas, pero que difieren en el tipo de materias primas empleadas para constituirlas.

A un primer grupo de 54 animales la ración suministrada incluía un 35% de ingredientes de origen animal y un 65% de material vegetal extruido, mientras que para el segundo grupo (n = 54) se incluyo un 25% de materias de origen vegetal, estando el 75% restante constituido por ingredientes de origen animal.

Tabla 1.- Valores Bromatológicos de dos concentrados suministrados a dos grupos de 54 ejemplares cada uno de ***Caiman crocodilus fuscus***. Zoocriadero Monterrey. Pizano S.A.

COMPONENTE	35 % A - 65% V	75%A - 25%V
Humedad	10.2	8.0
Materia seca	89.8	92.0
Grasa	6.62	5.50
Fibra	4.60	1.54
Cenizas	7.80	13.78
Proteínas	46.26	47.0

En la tabla 2 se presentan los resultados del ensayo mantenido durante 60 días, en los que se suministro el alimento diariamente:

Tabla 2. Valores de eficiencia y conversion a 60 dias experimentales

	35%A - 65%V	75% A - 25%V
Consumo total medio .	470.73 gr.	517.95
Incremento peso medio	58.27 gr.	95.94
Materia seca consumida	235.36 gr.	258.97
Conversión peso seco	4.04	2.70
Conversión peso húmedo.	8.08	5.40
Eficiencia	24.76%	37.05 %

Los resultados obtenidos indican que se presenta una disminución de la tasa de crecimiento (en peso) de 1.6 veces cuando la inclusión de materias primas vegetales se incrementa 2.1 veces.

Estos resultados junto con la información disponible, de ensayos anteriores o la publicada por otros autores, permitieron construir un modelo que permite relacionar el crecimiento, con la tasa de inclusión de materias primas vegetales en la dieta de acuerdo con los valores que se presentan en la tabla 2

Tabla 3.- Tasas de crecimiento en longitud (mm/dia) de ***Caiman crocodilus*** de acuerdo al nivel de inclusion de materias primas vegetales, extruidas, en la racion.

PORCENTAJE DE INCLUSIÓN	INCREMENTO mm/ día
25	1.10
30	1.05
50	1.0
64	0.80

Los valores aquí presentados indican que bajo procesos de **extrusión**, las materias primas vegetales se constituyen en una alternativa util en la formulación de raciones balanceadas, faltando aún por determinar en que medida las diferentes tipos de materias primas de este tipo pueden aportar nutrientes al crecimiento, disminuyendo el costo de la racion.

2.- Empleo de enzimas digestivas.

En las raciones empleadas para alimentar animales de granja se pueden adicionar enzimas digestivas a la formulación con diferentes objetivos entre los que se cuentan: la remoción de factores antinutricionales, para aumentar la digestibilidad de los nutrientes existentes, para aumentar la digestibilidad de polisacaridos no almidonosos, para suplementar las enzimas endógenas o finalmente para nivelar la ingésta del alimento.

En la industria de alimentos para animales se emplean ya sea mezclas de enzimas (Proteasas, Amilasas, Celulasas, Lipasas, y Pectinasas) o simplemente enzimas proteoliticas. Con las primeras se pretende mejorar la digestibilidad de las raciones, mejorando la absorción de carbohidratos, carbohidratos reducidos, proteínas y aminoácidos solubles.(Enzytech).

En el caso de las enzimas proteolíticas el objetivo es el de mejorar la utilizacion de la proteina (Bio Feed Pro MG).

El experimento aquí presentado tuvo por objeto estudiar la factibilidad de emplear enzimas tanto para mejorar la eficiencia de los alimentos balanceados que comercialmente se emplean en Colombia, así como también el de determinar si este tipo de productos podría mejorar el nivel de uso de las materias primas vegetales que se pueden emplear en la formulación.

La tabla 4 muestra la composición de 10 tratamientos experimentales asignados a 540 ejemplares neonatos de ***Caiman crocodilus***

Tabla 3.- Composicion de tratamientos experimentales

TRATAMIENTO	ALIMENTO	ENZIMA
1	35 A 65 V	No
2	35 A 65 V	Mezcla 0.5 g/kg.
3	35 A 65 V	Mezcla 1.0 g/kg.
4	35 A 65 V	Proteolíticas 0.5 g/kg.
5	35A 65 V	Proteolíticas 1.0 g/kg.
6	75 A 25 V	No
7	75A 25V	Mezcla 0.5 g/kg.
8	75 A 25V	Mezcla 1.0 g/kg.
9	75 A 25V	Proteolíticas 0.5 g/kg.

10	75 A 25V	Proteolíticas 1.0 g/kg.

Se empleo un diseño de bloques al azar con 10 tratamientos, en arreglo factorial de 2*5 y tres repeticiones por tratamiento con 18 animales por repetición/tratamiento.

En la tabla 5 se registran los promedios en peso y longitud observados durante el periodo experimental:

Tabla 5. Incrementos en longitud y peso de 10 tratamientos experimentales

Fuente de variación			Inc. Lon (mm)	mm/día	Inc.Peso (gr.)	gr./día
Alimento		1	38.24	0.68	46.70	0.83
		2	59.02	1.05	88.24	1.57
Dosis Ez		1	54.10	0.97	77.11	1.37
		2	47.89	0.85	75.27	1.34
		3	49.41	0.88	65.52	1.17
		4	45.85	0.81	61.15	1.09
		5	45.88	0.82	58.31	1.04
Alimento	1	1	44.46	0.79	58.27	1.04
	1	2	41.18	0.73	53.02	0.94
Dosis Ez	1	3	36.50	0.65	49.68	0.88
	1	4	35.16	0.63	36.06	0.64
	1	5	33.68	0.60	36.48	0.65
	2	1	63.74	1.13	95.94	1.71
	2	2	54.61	0.97	78.01	1.39
	2	3	62.33	1.11	100.87	1.80
	2	4	56.33	1.00	86.24	1.54
	2	5	58.09	1.03	80.14	1.43

Las pruebas de contrastes para el incremento en longitud y el incremento en peso entre y dentro de grupos mostró diferencias significativas entre los dos tipos de alimento probados (Con diferente contenido de inclusión de materias primas vegetales), así, el crecimiento en longitud no se ve influenciado ni positivamente ni negativamente por la suplementación de enzimas en la dieta, pero si por el tipo de alimento empleado

En el caso del incremento del peso no se observa ningún efecto al adicionar enzimas al alimento en que el 75 % de las materias primas son de origen animal, mientras que en el caso del alimento con mayor contenido de materias primas vegetales si se observan efectos significativos, observándose una mejor respuesta de las enzimas proteolíticas que en de la mezcla de varios tipos de enzimas.

La poca efectividad de las enzimas puede estar asociada con la selectividad de las Proteasas, así como por factores tales como la dosificación, la calidad de la enzima, y las condiciones del medio donde se lleva acabo la reacción. (temperatura, pH, enzimas endógenas, cofactores, desdoblamiento etc., etc.).

Finalmente, el menor crecimiento de los animales a los que se les suministro la mezcla de enzimas, puede estar indicando un efecto deletéreo del producto sobre el epitelio de absorción.

El análisis de regresión indica que los crecimientos mas acelerados se obtuvieron con los animales alimentados con concentrados en que predominan las materias primas animales, y cuando a este se le adicionan en la formulación Proteasas a razón de 1.0 g/kg. de alimento, pero sin que este difiera significativamente del crecimiento observado cuando no se adiciona la enzima.

Finalmente los valores de conversión y eficiencia (Tabla 5) demuestran que la adición de las enzimas en los dos tipos de alimentos empleados no mejoro la transformación en biomasa del alimento suministrado.

Evidentemnete aun hace falta profundizar en la fisiología enzimática de los crocodileos a fin de poder emplear eficientemente esta tecnología que ya se emplea operativamente en otras industrias pecuarias.

3.- Uso de promotores de crecimiento de tipo antimicrobiano.

De los diferentes promotores antimicrobianos disponibles para la producción animal dos han sido ensayados en las granjas de ***Caiman crocodilus***. El flavofosfolipol fue empleado experimentalmente por Barragán y Torres quienes no encontraron ningún efecto importante de este promotor cuando se suministraba en dosis de 8 ppm por Kg. de alimento suministrado.

En el presente estudio se evalúo el efecto del olaquindox, un producto antimicrobiano no antibiótico cuya formula es 2- (N-(2-hidroxi-etil)-carbamoil)-3metil-quinoxalin-1,4-dioxido

Se emplearon 300 ejemplares de tres meses de edad, los cuales se mantuvieron en grupos de 50 ejemplares en tanquillas de 12m^2 de superficie, Se establecieron entonces dos tratamientos y un control, estando constituido cada grupo experimental por 100 ejemplares Los tratamientos probados aparecen en la tabla 6.

Tabla 6.- Distribucion de tatamientos para suministro de olaquindox.

GRUPO	TRATAMIENTO	
1	50 mg/kg.	Suministro diario
2	50 mg/kg.	Suministro semanal
3	0 mg/kg.	Control.

Con base en los registros mensuales de peso y longitud de todos y cada uno de los ejemplares mantenidos en el ensayo durante 180 días se establecieron las tasas medias de crecimiento en peso y longitud de los ejemplares sometidos a cada tratamiento, valores que aparecen en la tabla . 7

Tabla 7. Tasas relativas de crecimiento en peso y longitud de ejemplares de ***Caiman crocodilus*** en tres tratamientos de suministro de olaquindox.

GRUPO	Tasa relativa incremento peso		Tasa relativa increment longitud	
	gr./día	gr./mes	mm/día	cm/mes
1	6.51	195.39	1.75	5.25
2	5.30	159.09	1.53	4.59
3	4.64	139.24	1,33	3,99

El análisis de varianza, con un 95% de confianza indica que las diferencias observadas entre los valores medios de crecimiento entre grupos son estadísticamente significativas.

Se puede concluir entonces que el olaquindox suministrado en dosis de 50 mg/ kg. de alimento diariamente incrementa en 1.4 veces la tasa de crecimiento en peso y en 1.3 veces la tasa de crecimiento en longitud de ***Caiman crocodilus***.

A fin de determinar el modo de acción del olaquindox se efectuaron evaluaciones cualitativas y cuantitativas de la flora bacteriana de algunos de los ejemplares sometidos a los tratamientos. Los perfiles medios de composición de la flora de cada grupo no permitieron encontrar diferencias que se puedan explicar con base a la actividad del antimicrobiano, como se aprecia en la tabla 8

Tabla 8. Perfil medio de la flora bacteriana de ejemplares de ***Caiman crocodilus*** a los que se les suministra olaquindox. Pizano S. A

BACTERIA	50 mg/kg. diario	50 mg/kg. semanal	Control
E. coli	413,333	413,333	460,000
Salmonella	74,500	123,333	103,333
Shigella	16,666	1,666	50,000
Proteus	11,666	0	13,333
Staphyloc. epidermis	60,833	9,333	5,833
Staphyloc. aureus	0	0	16,333
Candida kruseii	33,333	16,666	0
Candida albicans	0	16,666	0

4.- Efecto del nivel de Vitamina E sobre los parámetros reproductivos de ***Caiman***.

En *Caiman* como en otros crocodileos las deficiencias de Vitamina E y de selenio pueden ser responsables de la muerte embrionaria durante la incubación. (Ferguson, 1982), por lo cual resulta conveniente determinar el efecto que sobre los parámetros reproductivos tiene la dosificación de la vitamina E suministrada a los reproductores en las granjas comerciales.

Para tal efecto se emplearon 360 ejemplares adultos de ***Caiman crocodilus fuscus*** los cuales fueron alojados en corrales de reproducción en grupos de 80 ejemplares en los que se mantuvo la relación 3 a 1 hembras a machos. Cada corral de reproducción tiene 3000 m^2 de superficie por lo cual la densidad de los ejemplares fue de 37.5 m^2/animal.

A los cuatro grupos se les asigno una dosificación de Vitamina E, suministrada en la ración tal como aparece en la tabla 9 . El ensayo se realizo durante la estación reproductiva de 1995 entre los meses de Enero a Julio.

Tabla 9 Dosificacion de Vitamina E para cuatro gruposexperimentales.

GRUPO	VITAMINA E UI/ Kg.
1	90
2	120
3	150
4	180

Siguiendo el esquema operativo de la granja, diariamente fueron recogidos las nidadas puestas, las cuales se incubaron bajo las condiciones estándar de la granja (32 C, 98% H.R y 20.5% O)

En la tabla 10 se registran los valores de los parámetros reproductivos observados en cada uno de los grupos a los que se les suministraron niveles diferentes de Vitamina E en la ración.

Tabla 10.- Parametros reproductivos de ***Caiman crocodilus*** bajo cuatro dosificaciones de Vitamina E en la dieta.

Parámetro	90	120	150	180
% Apareamientos	45.0	63.3	38.3	60.0
Huevos por nido	30.26	28.87	30.13	28.31
% Fertilidad	78.3	83.3	88.6	89.8
% Natalidad	90.9	92.2	89.4	92.2
Crías/ madre	21.5	22.1	23.8	23.4

Los resultados obtenidos indican que el suministro de la vitamina E a los reproductores tuvo un marcado efecto sobre la fertilidad, mas no sobre el porcentaje de apareamientos, el numero medio de huevos obtenidos por nido ni sobre la natalidad.

A nivel de fertilidad es interesante observar como la respuesta a la adición de la vitamina E a la ración es prácticamente lineal. Queda aun por demostrar hasta que punto se pude incrementar la dosis de Vitamina E, logrando entonces los máximos valores de fertilidad.

LA CRIANZA DE COCODRILOS EN MEXICO: COCODRILOS MEXICANOS, S.A. DE C.V.

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INTRODUCCION:

Cocodrilos Mexicanos, S.A. de C.V. (antes Cocodrilos de Sinaloa, S.A. de C.V.), es una empresa fundada en 1989 y dedicada a la crianza comercial de cocodrilos de pantano Crocodylus Moreletii (Morelet's Crocodiles). El criadero está ubicado a 20 Km. Al suroeste de la ciudad de Culiacán capital del estado de Sinaloa, en México. La granja ha ido creciendo paulatinamente a través de los años, tanto en su población total como en el número y tecnología de las instalaciones existentes. La granja cuenta con los servicios de infraestructura básicos: excelentes vías de comunicación, energía electrica, agua dulce y cercanía (5Km) con plantas procesadoras de aves y ganado vacuno. La granja de Cocodrilos Mexicanos, S.A. de C.V., es la única en funcionamiento en el estado de Sinaloa y está considerada como la más grande y avanzada teconológicamente en todo el país.

Cocodrilos Mexicanos, S.A. de C.V., es una granja intensiva que produce sus propias crías a partir de un lote de pié de cría concesionado por el gobierno Mexicano . Con un total de 369 cocodrilos procedentes de diferentes criaderos tanto del gobierno como privados, el criadero cuenta a la fecha con una población total de 7000 cocodrilos Moreletii. La granja es cuidada por un staff de 7 personas (entre ellos 2 biólogos) dedicados a labores de mantenimiento, cuidado, experimentación y mantenimiento de registros de los cocodrilos del criadero.

El compromiso de la granja con el gobierno mexicano es entregar el 10% de los animales que nacen anualmente en el criadero cuando éstos tengan de 1 a 2 años de edad, dichos animales se emplearán en tareas de repoblación o bien para abastecer de cocodrilos a criaderos de nueva creación.

Con el fin de contribuir con el cuidado y conservación de los cocodrilos, la empresa promociona y permite que estudiantes y personas interesadas la visiten y conozcan la vida de los cocodrilos.

INSTALACIONES FISICAS

Las instalaciones fisicas se encuentran ubicadas en un lote de terreno de 25 Has., actualmente las instalaciones ocupan una extensión de 4 Has. En ellas se encuentran 3 acuaterrarios exteriores para reproductores con una extensión de 21,500 m2, los cuales en conjunto, albergan 400 cocodrilos en edad reproductiva. También se cuenta con una incubadora tipo " walk in" con una capacidad para incubar 6000 huevos. Para separar y mantener a los cocodrilos recien nacidos durante sus primeros dos meses de vida, se tiene en operación una caseta de 316 m2 con tanques de concreto de diferentes tamaños donde se controla la temperatura del agua., después de los dos meses de vida los cocodrilos se distribuyen en las casetas de ambiente controlado con calentamiento por debajo del piso. Actualmente la empresa cuenta con 10 casetas que en conjunto representan 780 m2 de instalaciones para crecimiento y engorda de los cocodrilos. Para tratar los afluentes provenientes de las actividades de la granja existe una laguna de oxidación de 1800 m2. Para el sacrificio de los cocodrilos se están terminando de construir las instalaciones de un rastro con una capacidad para procesar 80 cocodrilos diarios, además de cuartos fríos para almacenar la piel y la carne, almacen de materiales, baño, vestidores, área especial de preparación de alimento y oficinas para los biólogos.

La empresa también construye actualmente 11 nuevas casetas circulares de ambiente controlado de 10 m. de diámetro, mismas que estarán terminadas en el mes de junio de este año incrementando con ello 850 m2 adicionales de instalaciones con temperatura controlada para crecimiento y engorda de los cocodrilos.

Se ha puesto especial atención en el diseño, ambientación y seguridad de los acuaterrarios para reproductores, para proveer de sombra y hojarazca a los cocodrilos se han plantado más de 800 árboles frutales, ornamentales y forestales. La relación tierra agua en los acuaterrarios es de 70:30.

La granja mantiene un alto nivel de seguridad para evitar escapes, especial cuidado se tuvo durante la construcción al colocar rejillas de acero ahogadas en cemento a la entrada y salida del agua. El cercado del acuaterrario está enterrado en promedio 30 cm. por debajo del suelo, la orilla del agua se encuentra reforzada con postes de madera para evitar la construcción de cuevas, la distancia de la orilla de los estanques al cerco es en promedio de 15 a 20 metros. Así también, se instaló un doble cerco perimetral que rodea todas las instalaciones de la granja.

REPRODUCCION

El cocodrilo Moreletii se reproduce en colonias construyendo nidos tipo montículo ovipositando en promedio 35 huevos por nido, la temporada de reproducción inicia a principios de Abril con el cortejo y apareamiento, apareciendo los primeros huevos en Junio y durante las tres primeras semanas de Julio. La eclosión abarca desde la segunda semana de Agosto hasta fines de Septiembre de cada año.

Los parámetros reproductivos obtenidos durante las últimas temporadas (1994-1995), nos indican que los logros reproductivos que se han alcanzado últimamente en Cocodrilos Mexicanos, S.A. de C.V., son favorables comparados con los obtenidos por otras granjas a nivel mundial. Para evitar la endogamia nociva (inbreeding) se tiene implantado un programa de reproducción basado en el conocimiento de la procedencia de los reproductores de cada acuaterrario (orígen geográfico). Como los animales proceden de 4 localidades diferentes, los descendientes son seleccionados para que al alcanzar la edad reproductiva solo se apareen con animales de diferentes acuaterrarios, gracias a esto, el porcentaje de fertilidad de los huevos es alto y las malformaciones de los recien nacidos representan menos del 1% del total de nacimientos anuales.

CRIANZA

A la fecha no existe un estándar en la forma de criar cocodrilos, por lo que cada granja opera tratando de cumplir principios fundamentales y detalles biológicos comúnes a todas las especies. La mayoría de los criadores sabemos que una buena incubación de los huevos y un adecuado manejo de los recién nacidos, así como mantener una rigurosa sanidad, temperaturas y nuitrición adecuadas junto con la máxima eliminación de estress durante la engorda, constituyen los lineamientos básicos para lograr una crianza exitosa. En cocodrilos Mexicanos, S.A. de C.V., se tiene especial cuidado en cumplir estos lineamientos.

Los procedimientos para la crianza y engorda de cocodrilos en nuestra granja se han delineado a través del tiempo. En los 3 acuaterrarios externos, los animales son alimentados AD LIBITUM de 1 a 3 veces por semana. El alimento es fresco y está compuesto de pollo y visceras de res (bazos e higados). Se vigila el no sobrealimentar a los reproductores. 75 días previos al inicio de la temporada reproductiva se adiciona al alimento 1% de harina de hueso, así como un porcentaje similar de una premezcla mineral y vitaminica. Para esta temporada 1996 hemos aplicado vitamina BT conocida como - L carnitina, la cual ha dado excelentes resultados en aves aumentando la eclosión y mejorando la calidad de la cría así como su viabilidad.

La incubación de los huevos producidos en la granja es uno de los procesos que más atención y cuidado recibe, pues ahí se centra la futura producción de pieles del criadero.

Los huevos son colectados diariamente muy temprano o al caer la tarde, se usa material del nido como sustrato para la incubación y se empacan los huevos en cajas de poliestireno siendo muy cuidadosos en su manipulación. La temperatura de los huevos, del aire y del material del nido son registradas para evitar cambios de temperatura durante la colecta y transporte de los huevos.

Los huevos son recogidos en su mayoría dentro de las primeras 48 horas de incubación y son seleccionados dentro del cuarto de incubación. La temperatura de incubación que utilizamos oscila entre 32 y 32.5 grados centígrados con humedades relativas mayores al 90%. Los huevos se incuban en promedio durante 72 días, naciendo el cocodrilo con un promedio de longitud de 23.1 cm. y pesando 42.3 gramos en promedio.

Los cocodrilos al nacer son lavados con una solución hipersalina y dejados en las cajas vacías de poliestireno durante 48 horas dentro de la incubadora, durante este lapso, se les rocía de agua yodada a 32 grados centígrados de 3 a 4 veces al día. Esta técnica nos ha dado excelentes resultados al acelerar la absorción del vitelo y por ende el cierre de la abertura umbilical, evitando con ello disminuir las infecciones de vitelo.

Las crías son colocadas a una densidad de 20 animales por metro cuadrado y son mantenidas durante 2 meses en la caseta de ambiente controlado para posteriormente ser transferidas a las casetas circulares donde se mantienen hasta su talla comercial. Previo a su traslado, las crías son marcadas con pequeñas grapas interdigitales con un número progresivo. Las casetas circulares mantienen temperaturas del aire y del agua entre 31.5 y 32 °C. En estas casetas se sigue un riguroso programa de limpieza, por ello, cada caseta es limpiada y desinfectada cada 48 horas, utilizando detergentes biodegradables, hipoclorito de sodio y sulfato de cobre. Las densidades de animales que se mantienen en cada caseta dependen del tamaño del cocodrilo, generalmente cada caseta contiene cocodrilos de similar tamaño.

El crecimiento de los animales mantenidos dentro de la caseta es evaluado mensualmente tomando una muestra representativa. Los cocodrilos en las casetas son alimentados con un alimento balanceado húmedo que contiene un 40% de proteína cruda más lisina y metionina . Los cocodrilos durante su primer año de vida son alimentados seis veces por semana y a partir de los doce meses tres veces por semana. El crecimiento promedio en nuestros animales oscila entre 4 y 5 cm/mes.

Durante el período de crecimiento y engorda de los animales se tiene especial cuidado en evitar al máximo el estress en los animales, poca manipulación de los mismos y rutinas de trabajo constantes, son factores de rigurosa aplicación en nuestra granja. Actualmente con el uso de la tecnología de las casetas circulares en promedio lograremos producir cocodrilos de 1:30 a 1.50m de longitud total en un período de 24 a 30 meses.

Respecto a las enfermedades que se han presentado durante el período de vida de la granja éstas han sido muy pocas, las principales han sido micosis profundas en casos aislados y problemas con elitros de coleópteros (escarabajos) que son ingeridos en abundancia por los recien nacidos ocasionándoles obstrucción gástrica e inanición. Otros padecimientos comunes son: dermatomicosis, infección del saco vitelino en enanos y enfermedades bacterianas que con una oportuna detección y tratamiento se corrigen con éxito la mayoría de las veces.

Hasta el momento nunca se han presentado brotes epidémicos de ningún tipo, no obstante, día con día se supervisa el cumplimiento de las medidas sanitarias para la prevención de enfermedades. Cuando un animal muere, rapidamente se le analiza postmorten y los órganos sospechosos son enviados para su análisis a un laboratorio de patología animal.

Actualmente la empresa está esperando le otorguen el registro CITES internacional para poder iniciar la comercializción de pieles Moreletii. Antes de 1970 México era el principal abastecedor de pieles de ésta especie a nivel mundial, pero a partir de 1970 fecha en que se implantó la veda de cocodrilos en México no están presentes en el mercado internacional.

Cocodrilos Mexicanos, S.A. de C.V. conciente de su misión en la conservación del cocodriliano, ha financiado la realización de estudios de investigación poblacionales de Crocodylus Moreletii y Crocodylus Acutus en México. Actualmente la empresa tiene firmados convenios de colaboración con la escuela de Biología de la Universidad Autónoma de Sinaloa, México para la realización de dichos estudios.

La crianza comercial de cocodrilos en México es aún incipiente y poco conocida, sin embargo nuestro criadero consituye un estímulo para que nuevos granjeros se incorporen a la actividad. México ha formado un frente común integrado por autoridades gubernamentales, investigadores y conservacionistas enfocados en el estudio, conservación, manejo y aprovechamiento sostenible de los cocodrilos y el caimán, lo que se traducirá dentro de pocos años en un notorio crecimiento de la industria en México.

A Preliminary Wet Season Survey of Caimans in the Iwokrama Reserve, Guyana.

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Abstract:
A wet season survey of caimans at the Iwokrama International Rain Forest Programme (IIRFP) field site in central Guyana produced the four species of caimans expected to be present; namely: *Caiman crocodilus crocodilus*, *Melanosuchus niger*, *Paleosuchus palpebrosus* and *Paleosuchus trigonatus*. *M. niger* and *P. palpebrosus* were seen in too low a density to perform population surveys on these species. A population survey of *C. crocodilus* indicates that the Iwokrama population follows the same demographic structure as that of a healthy, unhunted population of *Alligator mississipiensis* (Taylor, 1992) despite the low densities observed. A survey of *P. trigonatus* in the Burro Burro river which bisects the Reserve, resulted in a similar pattern. The implications for the IIRFP (which plans a programme of sustainable harvesting of forest species) are discussed.

Introduction:
The Iwokrama International Rain Forest Programme (IIRFP) in central Guyana was set up due to the presentation of 400,000 hectares of pristine rain forest to the Commonwealth at a meeting of the Heads of the Commonwealth in Kuala Lumpa in 1989. The primary aim of the Programme is to identify the areas of greatest biodiversity within the Reserve for conservation and to design management strategies for sustainable exploitation of natural resources.

A Glasgow University undergraduate expedition to the IIRFP site was organised by the author to perform a number of ecological projects including a wet season survey of caimans. An aim of the IIRFP is to sustainably exploit viable natural resources, a role which caimans would fulfill, providing an income for the upkeep of the Programme and ensuring the long term survival of caimans and their habitat within the Reserve.

Methods:
Spotlight surveys were performed in and around various water bodies between 1900 hrs and 0000 hrs during the months of July and August. The Essequibo main channel, Burro Burro river and Malali creek were surveyed using a 20 ft, 44 Hp engined boat, Tiger creek was surveyed using a 16 ft Amerindian dugout canoe and swamps, flooded borrow pits (artificial hollows excavated for road material) and creeks along the Linden Highway were surveyed on foot.

Once observed, the caiman was approached, its head and snout vent length (SVL) were estimated and capture was attempted using a 1m dog-catcher noose with quick release mechanism. Upon capture the caiman was identified using the key in Gorzula and Woolford (1990), sexed and the following measurements were taken: SVL, tail length, total length, head length, snout length (all in cm), weight (in Kg) and the number of horizontal dorsal scale rows, longitudinal dorsal scale rows, horizontal ventral scale rows and longitudinal dorsal scale rows were counted. Photographs of the caiman were then taken and the animal was released back into the body of water from which it had come.

Results:

Species Inventory:

The following species were identified, the numbers of specimens of each observed prefixing in brackets:

i) *Caiman crocodilus crocodilus* (23)
ii) *Melanosuchus niger* (3)
iii) *Paleosuchus palpebrosus* (1)
iv) *Paleosuchus trigonatus* (9)

Size Frequencies:

Species:	**Life Class:**	**Numbers Observed:**
C. crocodilus	1	0
	2	19
	3	4
	4	2
P. trigonatus	1	0
	2	3
	3	2
	4	1

Table 1: Numbers observed and Life Classes of *C. crocodilus* throughout the Reserve and *P. trigonatus* in the Burro Burro river.

The sex ratio of both species was approximately 1:1. In addition, the *M. niger* observed were approximately 1.2m, 1.5m and 1,8m total length. The single *P. palpebrosus* observed was a sub-adult female of approximately 1m total length.

Observed Densities:

Water Body:	Description:	Dimensions surveyed:	Observed No. caimans:	Observed Density:
Essequibo river	Large channel (>2000m wide)	15km	0	0/km
Burro Burro river	Large channel (100-200m wide)	10km	(6)	(0.6/km)
Malali creek	Medium channel (10-20m wide)	1km	0	0/km
Tiger creek	Small channel (5-10m wide)	3.5km	3	0.86/km
Snapshots of creeks*	Small channels (1-15m wide)	6.3km	6 (1)	1/km
Swamps	Roadside swamps (varying sizes)	2.975Ha	5	1.68/Ha
Borrow pits and ponds	Artificial and natural pools	4.008Ha	3 (2)	0.75/Ha

Table 2: Observed densities of *C. crocodilus* and *P trigonatus* (no.s in ( ) brackets) in various water bodies within the Reserve.

Interviews:
Interviews held with local indigenous people from Kurupukari and Surama villages indicate that both *C. crocodilus* and *M. niger* densities are considerably higher during the dry season. The latter species is said to be a nuisance as it accumulates in abundance close to fishing boats and enters seine nets, as they are drawn in, to extract the fish. The nets are thus damaged at the expense and annoyance of the local fishermen. Very few personal attacks have ever been reported in this area however, and *M. niger* was the species involved in the 3 attacks reported in the last decade.

The species are known locally as Alligator (*C. crocodilus* and *P. palpebrosus*, which are not discriminated between), Mountain Alligator (*P. trigonatus*) and Caiman (*M. niger*). No indigenous people who use the Reserve utilise caimans.

Discussion:
Very low densities of each species were observed due to the research being conducted during the wet season (caimans disperse throughout flooded forest and into temporary water bodies during the wet season) but this was unavoidable due to the timing of UK university vacations. The data provided is intrinsically valuable however, since these are values calculated infrequently.

The Life Class structure of *C. crocodilus* is very similar to the theoretical ideal plotted for *Alligator mississippiensis* by Taylor (1992) suggesting that a dry season survey and mark and recapture exercises would indicate a healthy population structure. This combined with the increased observability and thus increased observed density of caimans inherent to the dry season as well as favourable reports from local indigenous people would suggest that the Iwokrama forest area of Guyana contains a healthy and abundant population of *C. crocodilus*. This being the case, a sustainable harvesting programme of *C. crocodilus* should be strongly considered by the IIRFP due to the considerable revenue that could potentially be generated from the successful marketing of skins and meat from this resilient, renewable resource.

The assumption was made that the Life Class intervals for *P. trigonatus*, being of a similar maximum size to *C. crocodilus*, were similar to those of the latter species (the author is unaware of such intervals being calculated for the former species). This being the case and despite the low overall numbers observed, the same comments apply to *P. trigonatus* as for *C. crocodilus*. This species, as well as *P. palpebrosus*, however, have no commercial value and thus are only of consequence to the IIRFP for preservation and research purposes.

Despite very few *M. niger* being observed reports from local people suggest that dry season densities are considerable. If this proves to be true, and since it is reported as being a nuisance to local fishermen, this species should be concentrated on to establish densities and social structures. Such research may suggest that it is appropriate to down-list the Iwokrama/Guyana population to CITES Appendix II to allow harvesting to levels safe for local people and to ensure the long term survival of this species without illegal, indiscriminate persecution. The revenue provided by the sale of the valuable skins of *M. niger* would also be of great benefit to the IIRFP and local hunters.

Acknowledgments:
I would like to thank Glasgow University Court, The Carnegie Trust for the Universities of Scotland, the British Ecological Society, the Gilchrist Educational Trust, the Albert Reckitt Charitable Trust, the Institute of Biology and the Royal Geographical Society for funding this research, the management and staff of the IIRFP for providing the facilities, advice and logistical support, the members of the Guyana '95 expedition for all their help, encouragement and friendship and Dr. P. Ross of the CSG for inviting me to present my results at the Santa Fe meeting.

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SUMMARY REPORT ON THE STATUS OF CROCODYLUS POROSUS AND CROCODYLUS NOVAEGUINEAE POPULATIONS IN PAPUA NEW GUINEA. 1981 - 1996

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Acknowledgements.

On behalf of the PNG Department of Environment and Conservation I would like to acknowledge the significance of organisations and individuals who have contributed either directly or indirectly to enable this report to be presented at the 13th working meeting.

I would like to thank ACSUG (Asia and PNG) for provision of funding which enabled the Independent Observer (Mr.C Manolis) to under take the observers role to the 1995 C.porosus and C.novaeguineae surveys in the Upper Sepik of PNG.

A vote of appreciation is also extended to Mr Manolis of Wildlife Management International for critically reviewing the analysis of PNGs aerial survey data, the management programme and the recommendation for various faciets that needs improvements

Television New Zealand (Natural History) whilst production of the Documentary "The Old Enemies" in the Sepik during the course of the surveys provided financial support to NCMU for the services of Mr.Jack Cox. Jacks availability for the last 3 surveys, his time has also been valuable for new NCMU staff.

Lastly but not the least I would like to acknowledge my colleagues of the National Crocodile Management Unit who are attempting to bridge many technical deficiencies in all aspects of the NCMU programme however have contributed immensly in preparation of the various components of this paper.

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1. Introduction.

Papua New Guinea (PNG) has two species of crocodiles, (Crocodylus novaeguineae) the New Guinea fresh water and the (Crocodylus porosus) the commonly known as the salt water crocodile. Both species are widely distributed through out most of PNGs suitable lowland, wetlands habitat.

The significance of the PNGs species has been the commercial trade of their skins which has been going on for the last six decades. For PNGs situation as a developing country the potential drawing of internal revenue and foreign earnings is of significance and the attention is drawn from both the Government and the Industry to develop strategies for its long term conservation and management.

Papua New Guinea has been considered one such successful programme, case of sustainable utilisation with control mechanisms of both its crocodilian species by developing ranching programmes combining with skin harvests from the wild.

Both the PNGs crocodile populations are listed on Appendix 11 of CITES which allows controlled export trade. The Management Programme in Papua New Guinea has acquired from the start a dual commitment with conservation of wildlife and improvement of the well being of the communities which are dependent on the resource.

2. Distribution.

Despite difference within the species, similarities exists which allows regulation and management of PNGs crocodile populations under the same regulation. Both are long lived and relatively slow growing. Data for some wild populations suggests C.novaeguineae takes up to 10 years to reach sexual maturity 1.8 -2m for females and 2.5m for males; and that sexual maturity is reached after 10 - 16 years in C.porosus at sizes of 2.2m for females and 2.5m for males. (Grombridge 1978)

Using the number of skins and animals taken from the wild populations as an indicator it can be approximated that C.novaeguineae out numbers <u>C.porosus</u> by the ratio of 4 or 5 to 1. The economic observance, this is unfortunate as the skins of the latter species are rather 2 to 3 times more valuable than of the former. (Figure 1. Distribution of the <u>C.novaeguineae</u> and <u>C.porosus</u> populations in PNG).

FIGURE 1: DISTRIBUTION OF C. NOVAEGUINEAE AND C. POROSUS IN PAPUA NEW GUINEA

: Distribution of C.novaeguineae
(Source: Osborne, 1987)

The major areas of alluvial riverine plains and tidal swamps containing crocodiles in Papua New Guinea

Distribution of C.porosus
(Source: Osborne, 1987)

The major areas of alluvial riverine plains and tidal swamps containing crocodiles in Papua New Guinea.

2.1. Crocodylus novaeguineae.

The New Guinea fresh water crocodile occurs only on the main Island of New Guinea including Irian Jaya and PNG. The species is present in the suitable lowland wetland habitats in both North and South of the central cordillera that runs through the middle of the country.

The largest PNG C.novaeguineae populations are present in the hinterlands freshwater systems and overland freshwater swamps and lakes. Known strong holds of these habitats are in the localities within upper Sepik (May River/Green River areas) and upper Ramu systems of North PNG and likewise the Bamu and Strickland systems in the South.

Other large populations exists in the middle to upper reaches of some of the tributaries of the Sepik and Ramu wetland river systems.

2.2 Crocodylus porosus

The Distribution of saltwater crocodiles is found on the main Island of New Guinea but can also be found on the larger off shore Islands as (Manus, New Ireland, East and West New Britain and Bougainville) also occuring on smaller island of Eastern Milne Bay (Kiriwina, Woodlark, Fergussion, and Misima). . It inhabits the costal and tidal habitats and can also be found further up some of the major river systems.

3. Crocodile Population Status.

In attempting to understand, monitor and manage wild crocodile populations we the officers (wildlife managers) of the National Crocodile Management Unit (NCMU) have been confronted with daunting array of logistical and fiscal hurdles. This and together with the knowledge that crocodile are by nature elusive creatures which inhabits the remote habitats which makes the evaluation of wild crocodile populations a real challenge.

The heart of any crocodile monitoring programme is in the field. The Department of Environment and Conservation (DEC), of which the National Crocodile Management Unit is reporting to, plays an integral part of the programme in carrying out research, monitor, and assess the effects of harvesting on wild populations and provide the understanding and designing of appropriate management decisions compatible with social, political and economic requirements.

The PNG programme has been an active one although there are still methods at our disposal having their limitations. After all the only realistic aim, with conditions relating to our situation is to provide appropriate data for looking at population trends using (raw counts) regression analysis on sample sites in the upper Sepik River system in Papua New Guinea.

The programme was introduced as a safe guard for the industry and is employed by concentrating the monitoring programme in the heavily utilised crocodile area and that the objective of monitoring natural populations can be generally expressed in terms of population levels and in the case of PNGs population which is exploited, the harvested levels.

3.1. Aerial Surveys.

This report present a summary of the " Regression Analysis" (raw counts) of all the data relating to aerial surveys that have been collated for the past 15 years of the programme. It should be noted that during the 15 year aerial survey programme there was 3 surveys (1986 *C.novaeguineae,* 1994 *C.novaeguineae,* and 1987 *C.porosus)* The 1986 and 1994 surveys were not conducted due to circumstances which are beyond the managements control. The 1987 survey although conducted, the data was not included for analysis due to some inconsistencies in the conduct of the survey.
(Table 1. Updated *C.novaeguineae* data from various sites in the Middle Sepik, 1981 - 1995).
(Table 2. Updated *C.porosus* data from various sites in the Middle Sepik, 1982 - 1996).

Although population monitoring programmes are continuing with the existing locations; an that an expected expansion of the programme including the Ramu system which was initially surveyed in October 1992 (*C.novaeguineae*) and March 1993 (*C.porosus*) to provide a country wide wild population situation; it cannot be maintained annually as financial limitations is the reality that the management has to priorities its monitoring programme.

The predominance of heavily vegetated swamps as the primary habitat occupied by crocodiles in most of the country has let the utilisation of the Aerial surveys of nests numbers as the principal field monitoring technique (Graham 1981, Hollands 1982, Cox 1984) The method of aerial surveys has proved applicable in the Sepik flood plains in that the recording of nests numbers provides a measure of reproductive effort.The methodology of survey has been constant since the beginning of the programme, enhancing the comparability of the results over time.

Unlike previous reports to the CSG which are published in the proceedings detailing the methodology employed in the analysis of the data "Wilcoxson Signed Rank Test" in determining the population nesting indices, this report is an updated (review) summary following an independent observers recommendations prompted by the ACSUG and CSG to have a detail look into the PNGs Crocodile Management Programme at their meeting held at Bond University, Brisbane in February 1995.

The PNG Management together with the Industry from those concerns requested for an independent observer of which Mr Charlie Manolis of Wildlife Management International, Darwin, Australia was recommended by ACSUG and CSG to undertake the independent

TABLE 1.0 : Annual Crocodylus novaeguineae nest counts in various sites in the Middle Sepik region, 1981 -1995.
Numbers in brackets refers to sites combined in some years: Syar, Wisowai and Wasui, 1981 -1989; Kamiemu baret and West Kamiemu from 1981 - 1985 and Kokopaguwa and Ningium from 1981- 89 . Burning extent within each site is also given.

Sites	Hab	1981	1982	1983	1984	1985	1987	1988	1989	1990	1991	1992	1993	1995	Fire
PRIMARY SITES															
Biimba	L	3	3	1	4	4	1	2	1	0	1	1	0	1	9
Bowami Lakes	L	4	2	0	0	3	1	0	3	1	2	3	1	5	0
Hauna Levels	OL	11	13	9	5	10	11	16	9	5	13	3	8	10	3.5
Kubkain Lagoons	SOL	4	7	4	3	5	5	5	7	10	8	5	10	10	0
Kubkain Oxbow	O	3	2	5	5	4	1	1	0	1	1	0	1	1	0
Kwandimbe	L	7	5	7	3	9	3	3	5	5	3	4	1	1	0.5
Kwasenam/Kangovel	OL	1	5	6	6	5	10	14	7	13	11	8	7	6	7
Lapangai	S	1	3	2	1	2	3	4	1	3	2	2	3	2	8
Nyali/Kanai	SOL	5	5	10	11	6	3	6	10	12	6	12	9	13	0
Pwimakiyapa	SL	13	20	20	10	1	2	7	7	7	4	7	8	10	0.5
Kokopaguwa	OL	[7]	[9]	[8]	[6]	[8]	[3]	[3]	[2]	1	1	1	1	2	0
Ningyum	L	*	*	*	*	*	*	*	*	0	0	0	0	1	0
Walmau	L	1	1	3	1	1	3	3	5	1	2	4	3	2	9
Yambi Yauwe	L	0	7	2	1	5	1	6	2	2	4	1	4	4	0
West Kamiemu	S	[10]	[14]	[22]	[11]	[27]	3	3	5	7	4	1	2	1	0.5
Kamiemu/Panau	SO	*	*	*	*	*	14	18	17	16	14	14	11	16	0.5
Kaphar Baret	OL	0	0	1	1	1	1	1	2	0	3	1	1	4	0
Biaga Scrolls	S	3	4	4	3	9	3	3	1	3	1	1	1	2	0
Wisowai	L	[2]	[2]	[3]	[4]	[5]	[5]	[8]	[3]	1	0	1	0	0	8
Syar	L	*	*	*	*	*	*	*	*	0	1	2	1	0	0
Wasui	OL	*	*	*	*	*	*	*	*	1	2	1	0	0	8
Index (N=21)		75	102	107	75	110	73	103	87	89	83	71	72	91	
Kabat Baret	O	3	5	10	5	3	8	5	5	4	5		8	10	0
Kubkain Scroll	S	0	0	3	4	2	1	3	0	0	1		0	0	0
Kwaiangur	O	2	3	1	2	2	2	2	2		2	2	3	2	0
Index (N=3)		5	8	14	11	7	11	10	7	–	8	–	11	12	
SECONDARY SITES															
Numahar	SL						3	3	4	0	3	1	2	1	9
Yigei	L						1	2	3	2	0	0	0	1	0
Yessan Scroll	S						6	9	8	6	5	3	2	5	0
Wetok	O						2	3	5	1	3	3	2	5	0
Sop Scroll	S						4	2	2	1	1	1	0	1	0
Sop Baret	O						3	3	3	2	1	3	2	1	0
Wihab *	SL	0					1*	0	0	0	0	0	0	0	0
Mapolu	O				3	4	2	4	6	2	2	1	2	1	0
Index (N = 7)							21	26	31	14	15	12	10	15	

CROCODYLUS NOVAEGUINEAE NEST COUNTS, 1981-1995 SEPIK REGION PNG.

Nambahar *	L							0	0	0	0	0	0	0	0
West Yesan Scroll	S							7	10	9	6	1	5	1	0
Gambatauba	O							0	0	1	0	1	1	1	0
Prembet	S							2	1	0	1	1	1	2	0
Oum Scrolls	SOL							6	5	4	7	1	5	6	3.5
West Hauna Levels	L							1	3	2	1	2	0	1	0
Index (N=5)								**16**	**19**	**16**	**15**	**6**	**12**	**11**	
Japandai	SL		0	0					2	0	1	0	0	0	9
Keipi	LO	3	3	2	2				3	2	3	0	3	8	0
Sopai *	L								3 *	0	0	0	0	0	0
Amer *	L								0	0	0	0	0	0	5
Angauwi *	L								0	0	0	0	0	0	0
Yukwaikwa	L								0	2	0	3	1	2	0
Kiskatamwen	O								1	1	1	0	0	0	3
Urupfwa *	L								0	0	0	0	0	0	8
Wetok Ox Scroll	O								1	1	0	1	0	1	0
Waskuk Ov Oxbow	O								0	1	0	0	0	1	0
Yamanumbu	S								4	5	7	3	4	2	0
Swamp SK 065	O								0	0	0	0	0	0	0
East Biaga Fringes *	L								0	0	1 *	0	0	0	0
N.Bowami Lakes	L								0	0	0	1	1	5	0
South Iniok	L								2	2	2	2	2	3	0
North Iniok	L								0	1	1	1	1	2	1
West Iniok	O								3	0	4	2	4	4	0
Index (N=12)									**16**	**15**	**19**	**13**	**16**	**28**	
Kandingei	S								3	3	1				
Suapmeri	S	1	1	1				1	0	0	0				
North Suapmeri	L								3	2	0				
Ship	S									3	4	0	4	7	0
West Tauri	L										1	1	2	4	0
Mindimbit/Momeri	OL								3	5	5				
Yesimbit	L									0	0				
South Kapaimeri	L								0	2	0				
Chambri Barets	O							0		0					
Krosmeri	L		0	3		9	2								
Kwalsi			6	6											
Kapaimeri	L		0	1											

Footnote : * indicates sites ; Amer, Wihab, Sopai, Nambahar, Angauwi, Urufpwa, E /Biaga Fringes and sub-sites 1, 3, 10 and 11 of Oum scrolls (no nests recorded) are proposed to be erased
hence nests numbers have not been included in the totals.
Number of Primary sites will still remain as 21 sites with the Secondary sites decreasing from 52 to 45 nests.

Table 2: Annual Crocodylus Porosus nest counts in various sites in the Middle Sepik River, from 1982 - 1996.
Nesting indices for three sets of data are also shown.
Data for three sites (Syar, Wisowai and Wasui) were combined as Wagu lagoons from 1982 - 1987; number in brackets refers to the combined total nests for the three sites in those years.

Sites	Hab	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Fire
Hauna Levels	OL	1	1	0	1	2	7	3	2	3	4	5	4	2	6	3	0
Kamiemu/Panau	SO	4	6	6	8	8	16	9	5	6	7	7	7	6	9	5	2
Kokopagwa/Ningyu	SOL	6	1	3	8	7	3	6	6	7	4	7	4	3	4	5	0
Kubkain Lagoons	SOL	7	5	8	10	10	22	11	10	11	7	12	11	9	18	16	0
Kubkain Oxbow	O	0	0	2	2	2	4	0	1	1	0	0	0	0	0	0	0
Kwaiangur	O	0	2	2	1	1	0	2	1	1	2	2	2	1	2	1	0
Kwaindimbe	L	2	3	3	3	4	5	5	3	2	3	4	3	4	4	1	8
Kwasenam/Kangov	OL	15	2	2	6	5	17	5	8	11	10	11	9	5	9	10	5
Nyali/Kanai	SOL	0	0	3	3	4	3	0	1	1	0	0	4	3	5	3	0
Syar	L	*	*	*	*	*	*	6	7	7	10	6	8	5	8	7	0
Wasui	OL	(10)	(10)	(14)	(7)	(8)	(25)	3	3	1	5	4	6	4	6	6	0
Wisowai	L	*	*	*	*	*	*	0	5	3	5	5	4	4	7	4	3
Japandai	SL		3	1	2	2	2	0	3	3	2	3	2	1	2	1	5
Numahar System	SL		2	2	10	5	12	5	6	2	8	5	5	8	9	9	5
Walmau	L		3	3	4	2	1	2	4	4	2	4	4	2	3	2	0
Sop Scrolls&Barat	SO				3	2	12	2	3	3	3	4	2	6	2	5	0
West Kamiemu	S				4	5	10	6	7	7	7	7	10	5	8	11	0
Biaga Scrolls	S					3	2	0	0	0	0	0	1	2	0	1	0
Mapolu	O					1	0	1	1	0	0	0	0	0	1	0	0
Angaui *	L						0	0	0	0	0	0	0	0	0	0	-
Biimba	L						0	0	0	0	1	1	1	0	0	0	3
East Biaga fringes *	L						0	0	0	0	0	0	0	0	0	0	-
Gambatauba	O						0	1	1	3	1	1	0	1	1	1	0
Karpar Barat	OL						0	4	0	2	3	3	4	2	2	6	0
Lapangai	S						2	0	0	0	1	0	1	1	1	1	3
Nambahar *	L						1	0	0	0	0	0	0	0	0	0	-
Oum Scrolls	SOL						0	7	9	8	8	4	10	12	7	7	5
Washkuk Baret	O						0	0	2	3	2	3	2	2	2	2	0
Wetok	O						0	0	1	1	1	1	1	4	0	1	0
Wihab	SL						0	2	0	1	4	2	4	1	4	2	2.5
Kiskatamwen	O						0	1	1	1	0	2	0	0	0	0	7
Yugwaikwa	L						0	1	2	0	1	0	3	4	4	5	0
Index 1 (N=12)	SOL	45	30	43	49	51	-	50	52	54	57	63	62	46	78	61	
Index 2 (N=15)	SOL	-	38	49	57	57	-	57	66	63	69	75	73	57	92	73	
Index 3 (N=29)	SOL	-	-	-	-	-	-	82	92	92	101	103	112	97	124	115	

CROCODYLUS POROSUS NEST COUNTS, 1982-1996 SEPIK REGION, PNG.

Amer	L								1	1	1	1	1	2	3	1	8
North Bowami Lakes	O								1	1	2	2	0	2	0	2	0
Swamp SK65	O								1	0	0	1	0	0	1	2	0
Urufpwa *	L								0	0	0	0	0	0	0	0	-
Wangren Baret	O								0	1	1	3	0	0	2	1	5
Bowami Lakes	L										1	1	2	0	5	3	0
Kamofai *	L										1	1	1	0	0	0	-
Keipi	L										2	1	2	2	2	2	0
Prembet	S										3	5	4	5	1	1	-
Ship	S										4	4	4	1	3	3	0
West Yessan Scroll	S										1	3	3	2	2	5	2
Wetok Ox- Scroll	S										0	0	1	0	0	0	0
Yamunumbu	S										2	2	1	0	1	2	0
Yessan Scroll	SL										1	1	2	0	1	0	6
Yigei *	L										0	0	0	0	0	0	-
Chambri Baret	O			2	3					3	7	3			6		
Kabat Baret	O								2		0				0		
Kandingei	OL										3	1			3		
Krosmeri	L		0	4						8	2	1			0		
Kuvenmas	L			2	2						0						
Mindimbit/Momeri	OL			1	2					2	1	2			2		
North Bowami Patch	O										1	1	1		1	0	0
North Kubkain Scroll	S											0		0	0	NS	
North Iniok	L									0			0			NS	
Pusik	S													2	1	2	0
SK Extension	O													1	1	0	0
South Iniok	L									0			0		NS	NS	
South Kapiemeri	L										2	2			3	NS	
South Tauri	L									0	0		0	0	0	NS	
Suapmeri	S										0	0			0		
West Hauna Levels	O									0	0			0	1	0	0
West Iniok	O									0			0		NS	NS	

Footnotes: Sites dropped from the 1996 SW survey include, Yigei / Sopai, Urufpwa, Angauwi, Nambahar, East Blaga Fringes, North Kubkain Scrolls and South Tauri as indicated by the astericks.
All Iniok systems, kabat baret and the Chambri system were also not surveyed

observers role.

With that recommendation two surveys were conducted as part of the on going 15 year Crocodile Monitoring Aerial Survey Programme in the Sepik (the *C.porosus* in March 1995 an *C.novaeguineae* in October 1995) in which both survey conducts were being observed as to the methodology and the management regimes employed.

It has therefore been necessary to adopt a highly flexible attidute, and to continually review management options in the light of best information that is available. With that consideration and recommendations, the application of regression analysis of the aerial surveys,(Manolis,(1995) *C.porosus* nesting survey in PNG. A review with recommendations). The 15 year monitoring data are collated, reviewed and presented in tables 1 and 2.

3.2. Nesting Trends.

Crocodylus novaeguineae 1981 - 1995
The 21 primary sites have accounted for a high proportion of total nests counted in the 45 sites, surveyed consistently between 1981 - 1995 and can be considered to be more representative of primary nesting habitats in the area. (Manolis,.1995). Again annual nest counts for this sites are on Table 1.0

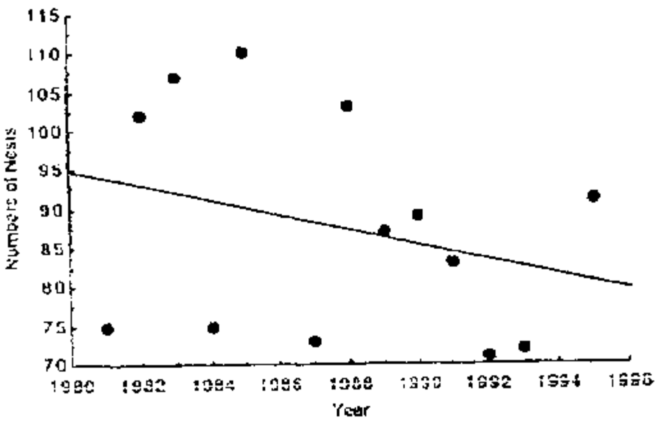

Figure 2: Annual C.novaeguineae nests counts for the 21 primary sites surveyed between 1981 - 1995. The line indicates the regression relationship which was not significant.
Crocodylus novaeguineae. 1989-1995

Nests counts were highly variables between 1981 and 1988, see table ranging from 73 to 110 nests. From 1989 to 1995, counts were less variable, ranging from 71 to 9\$ nests. Regression analysis indicated no significant relationship between total nests counts and year with or with out 1995 data included, although the trend is towards decreasing numbers.

Nests counts were compiled for *C.novaeguineae*, 52 sites were surveyed consistently between 1989 and 1995. Following site reviews, 7 sites were culled owing to non sightings of nests, (see Table 1: sites with asterisks). That we have 45 sites divided into five sets, based on the time period over which they had been surveyed. [1981-95 (N=21); 1987-95 (N=7); 1988-1995 (N=5); 1989-1995 (N=12); and 1989-95 (N=45). Each group thus refers to the same sites surveyed over the same years.

Regression analysis of nests counts against year were carried out for each group, with and without the 1995 data. Without the 1995 data two groups (N=21, N=45) revealed significant decreases in numbers of nests over time. (r sq=0.81, p=0.04; r sq=0.84, p=0.03). With the inclusion of the 1995 data, it renders the two relationship non significant. (r sq=0.02, p=0.80; r sq=0.08, p=.58). All other relationships examined were not significant. Nesting trends for *C.novaeguineae* for 45 sites are on Table 1.

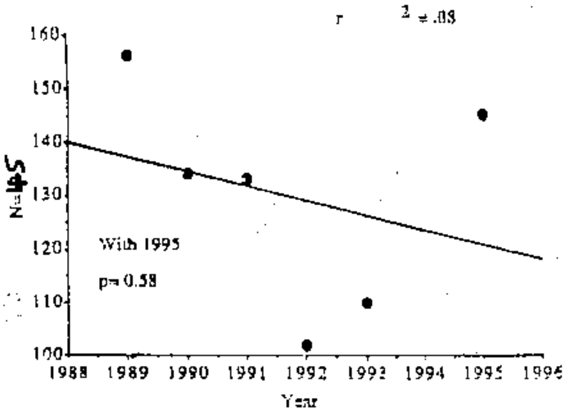

Figure 3: Annual *Crocodylus novaeguineae* nests counts for 45 sites surveyed between 1989 and 1995. The line indicates regression relationship which is not significant.

Crocodylus porosus 1982 - 1996.

Nests counts for *C.porosus* were compiled for 64 sites, of this 12 have been surveyed consistently since 1982 (Figure 4: Regression relationship for 12 sites surveyed between 1982-1996) (r sq=0.54, p=0.003) when the monitoring programme initially commmences. Counts for 12 sites surveyed since 1982 and 15 sites since 1983 are in table 2. These data indicates increases in nesting. From 1985 to 1988 the nests counts remained stable. From 1988 there has been a steep increase in the number of nests. From the 29 sites surveyed consistently since 1988 nests counts increased 82 to 115 (40.2% increase). Three site were dropped due to non sighting of nests, however does not affect the data in any significant way as the sites did not yield any nests since 1988. (Angauwi, Nambahar,and East Biaga Fringes). The dry season preceding 1994 was a dry one, thus the analysis of the data have been with and with out the 1994 data for all sets. Formulae for regression relationships are listed as from 1988-1996 [*C.porosus* - 12, 15 and 29 sites with 94 data.] (N=12) r sq=0.29, p=0.14;

(N=15)
r sq =0.33, p=0.10; (N=29) r sq =0.75, p=0.0.003. Regardless of which data sets (with or with out 94 data) are used the results indicate increasing rather than decreasing or stable nesting.

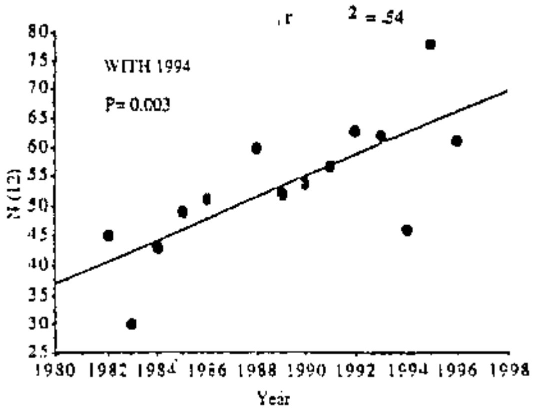

Figure 4: Nests counts for 12 sites survey annually since 1982 - 1996 (r sq=54; p=0.003) which indicates a significant increase in nest numbers.

3.3. Ground Surveys.

In areas where aerial surveys are restrictive by habitat stance ground survey is the option to compensate for identifying population status and that for the recent years since 1992 ground surveys have not been consistently conducted to determine the population dynamics of many swamps and river systems through out PNG.

PNGs prohibitively in accessible tropical swamps which characterise most crocodile habitats favours the *C.novaeguineae* species. The swamps of the hinterland are expected to support more crocodiles than the accessible larger rivers as they offer better conditions.

Although there is some available ground survey data, dating back from 1991, it is difficult to analyse this scattered data as most surveys were not consistently done. Problems includes availability of funds to effect surveys, logistical requirements, timing of surveys, seasonal conditions, migration and emigration for some adjoining system

From various studies the *C.porosus* populations, application of night spotting/and tagging is more appropriate to this species, as the species is more confined to open bodies of water.

Wa[redacted]ess [redacted]crocodiles[redacted]om distances[redacted]f >20 me[redacted]s also [redacted]ribu[redacted] to visibi[redacted] guesstimate[redacted]f adult [redacted]al sizes, [redacted]ten [redacted]der croco[redacted] >1 metre ar[redacted]ifficult [redacted] approach at

Wariness of crocodiles from distances of >20 metres also contributes to visibility guesstimates of adult animal sizes, often older crocodiles >1 metre are difficult to approach at certain distances and that identifying species would be difficult.

Two latest ground surveys were conducted to the East and West New Britain provinces. The surveys were done in 1993 and 1994, and the survey covered some of the known reported crocodile areas of the provinces (Table 3. Results of sightings and taggings in East and West New Britain Province, 1993 and 1994) .

Table 3 : Summary Results of <u>C.porosus</u> Crocodiles Tagging and Sightings.

1993

Location	Map Ref.	No.Tagged	No.Sighted	Totals.	Kms Covered.
Kapiura	KU330753	4	4	8	10
Kudu	HP220920	3	3	6	8
Ania	KU570340	-	3	3	8

NB: All are tidal river systems, survey of Kudu only on the north branch. Ania river dense water weeds.

1994.

Location	Map.Ref.	No.Tagged	No.Sighted	Totals	Kms Covered
Kapiura	KU330753	-	4	4	10
Kudu	HP220920	3	1	4	8
Lake Lalile	KU230710	7	35	42	

NB: Lake Lalile is an overland lake system, with drainage/opening in to Kapiura river. The lake system has good natural habitat stance and is approximateky 1Km in width and 2Kms in length.

Our data was derived from usual surficial night time spot lighting surveys employing all manner of man and motor powered boat. Night spotting is typically accomplished by illuminating both shore line and forward along rivers, channels or lakes borders with powerful hand held 9 volts spotlights which activates characteristics reflective crocodilian eye shines although the method has its limitation. The method is applicable to accessible habitats with distinct water - land interface. Despite favourable appearances of the river systems and the over

Table 4: Total number of Crocodiles Harvested in Papua New Guinea 1977 - 1995.

Year.	Harvests of C.novaeguineae. Wild Skins	Live Purchase	Totals	Harvests of C.porosus Wild Skins	Live Purchase	Totals
1977	26500		26500	6500		6500
1978	31500		31500	7100		7100
1979	35500	3500	39000	7300	1000	8300
1980	27800	7700	35500	5700	7200	12900
1981	14200	8600	22800	3900	1100	5000
1982	23500	8500	32000	3900	2800	6700
1983	14000	2000	16000	3100	1900	5000
1984	13800	2500	16300	3100	1500	4600
1985	16900	5100	22000	3400	3800	7200
1986	22000	9800	31800	3800	5400	9200
1987	20000	9500	29500	3400	3100	6500
1988	12000	5500	17500	3200	4300	7500
1989	14500	4500	19000	3800	3300	7100
[redacted]						
1992	14803	9624	21429	3936	1127	5063
1993	15914	3289	19203	9296	3660	12956
1994	10230	1706	11936	3374	878	4252
1995	12594	9612	22206	2384	13246	15630
Totals:	~~375663~~ 325741	~~101431~~ 90430	~~475006~~ 414174	~~103379~~ 87590	~~56011~~ 54211	~~159890~~ 131501

land lagoon system, the sightings are relatively low.

More ground surveys are needed before any significant scientifical analysis are done, to determine population dynamics of each system to compliment the harvest data of Rabaul (East and West New Britain Province) consistency of surveys to other provinces is also a priority for any real value to be realised in the analysis.

4. Exploitation and Trade.

The Cites Management Authority and the Scientific Authority are designated by the Government of Papua New Guinea, which is the Department of Environment and Conservation with the former the Conservator and the latter the Nature Conservation Division. Given the priority of the Government to ensure that the crocodilian resource in PNG is managed at a sustained level for the benefit of resource owners living in the major wetlands, dialogue for investment with the private enterprise and other line agencies is needed to ensure that wild harvest of skins and ranching conforms to the Governments regulations. Owing to recognition of strong and mutual benefits linking needs of conservation and commercial interests, private enterprises be also encouraged to play a leading role if ever there is a need for rehabilitating PNGs crocodile resource. With some more than a third of the PNGs population directly dependent for their livelihood on collection activities of skins and lives, the peoples participation and support is essential.

After the major restructuring under the UNDP/FAO project shifting from uncontrolled hunting to village farming, the industry has since now consolidated into a system of both hunting of live animals for larger farms where skins and lives often share the same market.

PNG is currently exporting both wild and ranched skins. Pursuant to conditions under the legislation a small export trade also exists for crocodile meat, backstraps, skulls and teeth.

4.1. Harvest Data.

Harvesting and in possession of crocodiles in PNG is illegal under the Crocodile Trade (Protection) Act. Ch.213. and that through legislation is a controlled activity. Crocodiles are harvested from the wild including both lives and skins and only recently in 1985 when the egg harvest programme was initially trialed.

The skins and lives are the major components of the activity involving the resource owners throughout the wetlands.The marketing trends involving skins are set up by various licensed exporters.The live harvest for ranching programme has been well established with the lives sold to major ranching operations in PNG. Mainland Holdings the current biggest buyer of live animals provides chartered fixed wings for pick up at strategic locations in PNG. The resource owners and legal traders are supportive of the current marketing arrangements.

Although the number of crocodiles harvested as of 1990 for both lives and skins (Table 4 : Total number of crocodiles harvested in PNG 1977 - 1995) indicated staple harvest levels for both lives and skins.

Our priority now in line with the recommendations from the independents observers reports (Manolis (1995) C.porosus and C.novaeguineae nesting reports in PNG. Reviews with recommendations) is to redesign all reporting formats under the Crocodile Trade Regulations, and source funding for both user friendly hardware and software packages to effectively upgrade to bar our database reporting system. The sub divisions of monitoring or harvests zones by province or river systems is now being considered for implementing. This will enhance detail assessment of trade and its impacts of wild populations and the information be used for delebrating on management strategies.

4.2. Export Data.

Since 1981, when the International Trade in (Fauna and Flora) Act took effect, export of crocodile products from PNG has been regulated by provisions of Convention of International Trade in Endangered Species (CITES).

Over 100 countries, by signing this Convention, have agreed to co-operate in preventing illegal, uncontrolled trade and over exploitation of wild species which at the same time supporting trade based on controlled, sustainable, legal harvests of healthy wild populations.

Exporting of crocodile skins in PNG are carried out by licensed exporters only and that all live crocodile exports are restricted by the Government. Export licenses are approved by either the Minister or his delegate the Conservator (Secretary) Department of Environment and Conservation.

All export applications are submitted to the Management Authority together with payments of management levies.

The contents of the shipment are than inspected by gazetted Wildlife Rangers for any illegal skins, that is the minimum of 18cm and maximum 51cm bellywidth prior to the approval of permits.

The skins tagged with different coloured codes (according to species and product) Red - C.porosus, Green - C.novaeguineae, Orange for Backstrap - C.porosus and Blue for Backstrap - C.novaeguineae.

The application is then approved by the Conservator of Fauna to effect the export of the shipment.

The 1995 Crocodile exports of both C.porosus and C.novaeguineae species which included various products as wild skins,

Table 5. Export of Crocodile Skins from Papua New Guinea, 1977 -1995.

	A: Crocodylus novaeguineae						B. Crocodylus Porosus						[redacted]
Years	Wild Skins 18 - 51cm	Wild Skins <18cm	Ranched Skins 18 -51cm	Captive Breds 18 -51cm	Tanned Skins	Sub Totals.	Wild Skins 18 -51cm	Wild Skins < 18cm	Ranched Skins 18 - 51cr	Captive Breds 18 -51cm	Tanned Skins	Sub Totals	
1977	14900	11700				26600	3000	3600				6600	33200
1978	17200	13800				31000	3600	3600				7200	38200
1979	22600	12600	700			35900	3900	3500	200			7600	43500
1980	19000	8300	500			27800	3500	2200	100			5800	33600
1981	13200	1100	700			15000	3500	400	400			4300	19300
1982	23300		1500			24800	3900		900			4800	29600
1983	13800		1300			15100	3100		300			3400	18500
1984	13200		8100			21300	3100		2000			5100	26400
1985	16400		3400			19800	3400		1200			4600	24400
1986	22100		2300			24400	3900		500			4400	28800
1987	20100		3400			23500	3400		1100	800		5300	28800
1988	12000		5200			17200	3200		2300			5500	22700
1989	14400		7100			21500	3900		3100			7000	28500
[redacted]													
1992	14803		1060	1500		17363	3936		182	900		5018	22381
1993	15914		5498			21412	9296		5315	389		15000	36412
1994	10230		10395		137	20762	3374		6200		11	8298	29060
1995	12594		6621			19215	2384		8605			10989	30204

ranched,captive breds and tanned skins are indicated in (Table 5.Crocodile Skins Exports PNG 1977 - 1995).

The overall exports indicated 1995 (30,204 - 36,412) from 1993, that showed a drop of 17.04% in total skins exports, 8.52%/yr (n=2). The drop although not significant and does not correlate with the harvests data, PNGs still maintains its total exports levels from 1977, comprising both wild,ranched and captive bred skins.

5. Egg Harvest Programme.

Launched in 1985 for C.porosus and 1988 for C.novaequineae, the egg harvest was initially trialed as a way to salvage nests that are at risks from flooding or human predation. Most of the eggs collected from the wild in the Sepik, (Table 6. Total number of wild crocodile egg harvest in the Sepik) all go to the Mainland Holdings hatchery. Eggs are collected primarily during the conduct of the Annual DEC crocodile surveys by NCMU personnel, due to technical difficulties involved in handling of eggs thus ensuring good hatching success rate.

The continuation of the programme was suspended in 1994 after the C.porosus harvest due to mixed responses by some land owners although with no biological evidences that the programme is detrimental to recuperating of juvenile population in the wild.

After some consultations with the land owners,local politicians and the management it was agreed that the harvest should be conducted bi annually for both species.

Table 6. Total number of Wild Crocodile Egg Harvest in PNG.

C.novaequineae Egg Harvest.

Year	1988	1989	1990	1991
Egg Harvested.	807	1307	1218	

C.porosus Egg Harvests.

Year	1985	1988	1989	1990	1991	1992	1993	1994	1996
Egg Harv	661	647	1198	1324		1656		1545	2145

Land owners were initially paid K1.00 per viable egg, taken from the nest on their land, and in order to avoid loss in protein, a chicken egg was given to supplement the loss of eggs

Table.7: C.POROSUS EGG HARVEST DATA, MARCH 1996, MIDDLE - UPPER SEPIK RIVER REGION.

NEST NO'S	NEST SITE	CLUTCH SIZE	VIABLE EGGS	DEAD EGGS	HARVEST DATE
123	Kubkain Lagoon	53	51	2	14.03.96
122	" "	35	24	11	"
119	" "	~~60~~ 68	~~60~~ 68	-	"
130	Bowami lakes	48	5	43	"
125	Kubkain lagoon	73	66 68	5	"
114	Nebgoibag	65	63	2	"
126	Bowami lakes	35	32	3	"
41	Syar	51	41	10	"
115	Nebgoybag	65	48	17	"
120	Kubkain lagoon	65	64	1	"
139	Oum Scrolls	61	24	37	"
124	Kubkain Lagoon	61	56	5	"
92	Panau	61	38	23	"
140	Hauna Levels	25	9	16	"
110	Nobyoibag	48	46	2	"
118	Nobyoibag	35	28	7	"
95	Ningium	63	62	1	13.03.96
89	Sop	45	45	3	"
112	Kubkain Lagoons	56	48	8	14.03.96
83	Panau	60	43	17	"
121	Kubkain lagoon	62	51	11	"
101	Waskuk Baret	66	63	3	"
107	Pusik	53	47	6	"
108	Pusik	63	51	12	"
98	Ningium	67	65	2	15.03.96
97	Ningium	56	36	20	"
44	Yugwaikwa	14	-	14	11,03.96
40	Yugwaikwa	71	31	40	"
57	Kharpar	80	57	23	"
58	Kharpar	72	44	28	"
45	Yugwaikwa	69	54	2	12.03.96
47	Yugwaikwa	67	52	15	"
39	Syar	59	54	5	"
27	Wangion	62	55	7	"
79	Keribeamo	73	69	4	"
81	Kamiemu/Panau	59	57	2	"
80	Kamiemu/ Panau	67	54	3	"
70	Keribesamo	68	36	32	"
75	Keribesamo	44	36	8	"
76	Keribesamo	35		35	"
69	Keribesimo	62	47	15	"
84	Kamiemu (Panau)	71	60	11	"
95	Ningium	63	63	-	13,03.96
	Kanai	59	25	34	"
	Kanai	69	62	7	"
	Syar	67	60	7	"
	Paiyangat	41	25	16	Not in survey route

Total Clutch Size	2722		
Total Viable Eggs		~~2145~~ 2145	
Total Dead Eggs			577

Note : Nest no's 40 and 41 had the same GPS coordinates allocated. (At Syar on the Vegetation bridge)
Nests harvested at Kanai and Syar were counted as active nests during the survey, however actual nest numbers are still unkown after been harvested
* : Nest at Paiyangat not in survey route.
: Double asterix indicates cordinates of nests harvested along the survey route.

as payment. The price for the 1994 egg harvest rose to K2.50 for C.porosus and K2.00 for C.novaeguineae, including chicken eggs.

The recent C.porosus egg harvest in 1996 (Table 7. C.porosus Egg harvest data) saw an improvement in the prices of K3.00 for every single (viable) egg that includes giving away 2 chicken eggs (a 20% increase) an added value to the potential of saving eggs from human predation. That indicates on observations in C.novaeguineae surveys 1995, there was no nests raided during the surveys. The 1996 C.porosus surveys indicated only 4 nests were raided and that is also a marked decline in human predation of nests from previous recorded reports.

From a total of 139 nests counted this survey, 115 nests were recorded on the (N - 29; 1988 - 1996), (Table 1: Index 3) , Of the 47 nests harvested, [(2 nests Pusik, 1 nest Wangren) both secondary sites and (1 nest at Paiyangat) off survey route but requested to be harvested)], excluding above 4 nests, there were 43 nests harvested, giving 62% of nests remaining in the survey area.

The total clutch size was 2722, less 577 dead eggs, giving 2145 good eggs (78.7%) indicating the cash value of K8,166.00 paid to the resource owners.

6. Extension Services and Farming.

Findings have demonstrated that crocodilian ranching versus the closed system is the preferred form of sustained utilisation (Hutton and Webb 1992). Ranching is economically an added advantage than closed breeding systems which are costly and labour intensive to initiate, and always have little success for the initial years.

Ranching enables wise use of crocodilian eggs and hatchlings which other wise would encounter excessive looses through natural mortalities. Ranching also plays an important role to restocking the wild to which harvest of eggs and hatchlings originate, usually at sizes large enough to reduce chances of natural mortality. The ability to obtain eggs from the wild is also important as sexes is temperature dependent. Incubations under ideal conditions allows for maximum growth rates to be programmed for the entire life of the animal which enhance performance and profit.

The ranching operations in PNG have had their success and failures. Some could well be financial mismanagement, some husbandry management and the list goes. For PNG it is not even that easier for an average level farmer to maintain/establish the category of commercial farms alas what is termed as collecting/holding for temporary village level, most well below 200 stock. Reporting of stock in those farms are not listed for reporting in this report and that below is the figures of registered captive operations.

Table 8. **Estimated Captive Stock on Farms in PNG (April 1996)**

Farms	C.nova equineae	C.porosus.	Totals	Males Porosus	Female Porosus	Total
Mainland	9445	19522	28967	128	310	439
Illimo	1000	126	1126			
Maningulai	595	101	696	-	-	-
Madang	1126	216	1342			
Sita	700	250	950			
Seeto		300	300			
TOTALS	12866	20515	33381	128	310	439

Back up extension services provided by DEC to village level operations through out PNG have been scaled down, in line with the Governments policy under the Reformed system to delegate this activities to the provincial authorities whilsts maintaining with DEC the policy and management aspects.

7. Wetland Activities.

It has been calculated that at least one third of PNG may be classified as wetlands, and that recently provided the potential for the establishment of the Wetlands country programme in 1993. PNG is the first from the Pacific Islands Nations to be a signatory to RAMSAR convention. Although the programme has some broarder functions, NCMU has been able to source some assistance from the organisation in training aspects. However there is long term prospects of the PNG Wetland programme to assist boost the NCMU capabalities in crocodile surveys and wetlands education to ensure that the wetlands and its habitants the crocodiles remain viable in PNG.

With the knowledge of PNG wetlands and their conservation values it is far from complete since no systemic national inventory has been conducted and that oservations made whilsts conducts of the surveys, is the need to find solutions, not only scientifically acceptable, but also adaptable to policies and procedures which will actually work under social and economic conditions of PNG.

These are:

a) changes in the habitat stance generally reported over the years. A thriving future for the crocodile industry in the country will require close intergration of ecological findings, policies for government control, the requirements of the industry and the need of the local resource owners. It is certain that crocodile nesting habitats degradation will deteriorate.

b) design of wetlands conservation policies that can safe guard and preserve habitats for wild breeding populations, however difference of opinions and methods of applications with requirements of local people in different areas ie: Sepik, Gulf or Fly will need to be considered.

c) opinions and uncertainty in policies are unavoidable and with two annual nests counts surveys in PNG (the Sepik Region), the analysis of data, evaluation of the economy and social aspects of use of the habitats to support people as well as crocodiles throughout the other wetlands can be applied to maintain the industry.

d) Exploitation of the crocodiles is currently proceeding and management (weather good or bad) based on scientific principals (weather good or bad) is already in practise. It is necessary to commence long term strategies for conservation of habitats.

8. Revised Legislation.

To ensure that the PNGs crocodile management programme is effectively implemented, revisions of the current legislation "The Crocodile Trade (Protection) Act. Ch.213, (1974) is currently in progress as part of the Strengthening Project under Species Management.

The current legislations covering the exploitation is:
(a) the (20"/51cm and 7"/18cm) belly widths and
(b) the traditional laws (land tenure)
as the need arises for tighter controls on harvesting of crocodiles with the Regulations enacted in 1980 and amended in 1986 to increase fees.

The review currently in progress with assistance from the Aus Aid project is to involve amalgamation of the existing provisions of the Crocodile Trade (Protection) Act with some provisions of the Fauna (Protection and Control) Act and might also include provisions of CITES legislation to accommodate new changes that are taking place in the industry.

That will also set in to motion redesigning applicable formats under the regulation of the Act, setting minimum standards of operations and providing for reasonable incentives for business.

When completed and gazetted its effectiveness will also be advanced by incorporating of recording and reporting procedures for licensing, harvesting, ranching and exporting operations.
This will enhance the competency of the management authority to adequately monitor resource utilisation and simultaneously provide accurate reports to CITES, CSG and other agencies.
The review also included enforceable penalties for sever violations.

9. 1995 a Review with recommendations.

The sub - review of PNGs programme in 1995 by Manolis resulted in two reports being produced. The reports covered operations at the C.porosus March 1995 and C.novaeguineae October 1995 surveys. The recommendations made in those reports were essentially the same however with additional informations relating from the C.novaeguineae, 95 survey.

The actions which the Management has taken to date includes:

1. The survey methodology which has been consistent and considered sound in searching sites and locating of nests.
2. Standardised data formats have been designed and are in use for this and future surveys for recording and transposing accurately the data.
3. All past data sets (15 Year programme) relating to overlays and reports have been reviewed and updated, thus the final data sets are presented in this report.
4. Sites that have been split have been updated with the latest review of data and that all sites have definite site names. Sites that have been separated by large distances have been dropped together with non productive sites which yielded no nests for the last 5 years. Variables of incomplete, false, and old nests have been recorded and checked for DEC,s reports.
5. All available ground survey data from previous years have been recorded on hard copies and computers.
6. All export data have been well recorded and are in hard copies and considerations are being given for development of software packages for harvest data storages.
7. Note appendices for NCMUs various data collections.
   Appendix 1. Aerial survey data format.
   Appendix 2. Updated crocodile traders purchase dockets.
   Appendix 3. Crocodile nests harvest data.
   Appendix 4. Ground surveys, night spotting format.
   Appendix 5. Appendix- commercial skins exports.
   Appendix 6. Appendix- commercial exports hornbacks

Conclusions.

It is evident that from the 15 year sample aerial monitoring survey PNG is currently maintaining its conservation and management objectives. Exploitation is being controlled although a lot more emphasis is still needed on enforcements of regulations. Population monitoring programme is still being conducted and expanded to other areas to be conducted at intervals as required. The trends of the nesting C.porosus is healthy and increasing as from 1988 in comparison to 1985 - 1988 when the population remained stable whilst the C.novaeguineae indicates declining although not significant require field studies. The present data considers that C.novaeguineae is safe as much of the inaccessible habitats are not being surveyed and hold unaccounted populations of crocodile and noting also that C.novaeguineae nests in the dry seasons (August to November, Cox 1985) it is susceptible to disturbances by human activities such as burnings. Such disturbances may force females to nests in more secluded, forested areas, where they would be poorly represented in the survey.

The much needed revenue from the crocodile resource comprises the component of the national budget and importantly the recognition of the swampland people as a means of social and economic development.

Continuation of the current activities and future development of the industry whilst conservation and management programmes should ensure the viability of the populations and the protection of the species complying with the objectives of the World Conservation Strategy.

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novaeguineae 1995 and 1996 replicate nest tables

Appendix I: Aerial survey data format.

TABLE 3.0 : REPLICATE NEST COUNTS OF C.novaeguineae IN THE SEPIK RIVER REGION, 1995 - 1996.

	1996					1995				
SITE	Active Nests		Habitat Type			Active Nests		Habitat Type		
	Total	Lake Fr	Scroll/Sw	OvOxbows	OvBarets	Total	Lake Fr	Scroll/Sw	OvOxbows	OvBarets
Japandai										
Lapangai										
Numahar										
Waimau										
Yambi Yauwe										
Kwasenam/ kangovei										
Biimba										
Nyali/Kanai										
Wihab										
Kwandimbe										
Nambahar										
Yigei										
Sopai										
Amer										
Wisowai										
Angauwi										
Wasui										
Khapar Brt										
Syar										
Yugwaikwa										
Kiskatamwen										
Kwaiyangur										
Kabat Brt										
Urufpwa										
Yessan Sc										
W Yessan Sc										
Kamiemu										
W Kamiemu										
Pwimakiyapa										
Ship										
Gaumbutauba										
Sop Brt										
Sop Scroll										
Wetok										
Wetok Ox Sc										
Kokobaguwa										
Ningyum										
Prembet										
Washkuk Brt										
Mapolu										
Yamanumbu										
Swamp SK 065										
Biaga Sc										
E Biaga Fr										
Kubkain Ox										
Kubkain Lag										
Kubkain Sc										
Keipi										
Bowami Lakes										
N Bowami Lak										
Hauna Levels										
W Hauna Level										
Oum Scrolls										
W Taun										
S Iniok										
N Iniok										
NE Iniok										
TOTAL										

APPENDIX II. CROCODILE TRADERS PURCHASE DOCKET

DOCKET NO: A 001352

TRADER : ____________________ LICENCE NO : ____________________

PROVINCE : ____________________ EXPIRY DATE : ____________________

DATE	PLACE CROCODILE WAS BOUGHT	DISTRICT	SELLERS LIC. NO IF HE IS TRADER	SELLERS VILLAGE	SPECIES		PLACE CAUGHT	LIVE	SKINS		AMOUNT PAID	COMMENTS
					FW	SW		Length(cm)	BW(cm)	Grade		

APPENDIX III : CROCODILE NEST HARVEST DATA SHEET

Crocodylus ____________________ Survey Date : ____________

DATE	NEST SITE	NEST NO #	GPS CO-ORDINATES	CLUTCH SIZE	VIABLE EGGS	DEAD EGGS	FIELD REMARKS					
							Temp (oC)	Est. Age	Days at Ambunti	Mean Length (mm)	Mean Width (mm)	Mean Weight (gms)

	CLUTCH SIZE	VIABLE EGGS	DEAD EGGS
TOTAL			
MEAN			
STD DEV			
PERCENTAGE OF TOTAL			

APPENDIX IV GROUND / RIVER SURVEYS - CROCODILE NIGHT SPOTTING DATA

PROVINCE : ______________

DATE	TIME HRS	LOC AREA	RIVER / LAKE	MAP REF	HABITAT	SPECIES			SIGHTINGS			TAG NUMBER		MEASUREMENTS				REMARKS
						FW	SW	U.KWN	HATCH LINGS	<2M	>2M	T	L	TL(cm)	SV(cm)	BW(cm)	WT (g)	

APPENDIX

FORM

Export of crocodile skins by (exporter).....................from (port).....................to (destination).....................

Date of shipment: / /19

Method of shipment:..

(a) Value as per Export Entry (actual value): K ________ ____

(b) Management Levy: K ________ ____

(c) Export Levy: K ________ ____

(* see notes on reverse)

OFFICE USE ONLY

1. Name of Exporter:..
2. CE..
3. Permit No.:..
4. Importer:...
5. Total No. Skins ....
   FW ....SW ....
6. Total No. cm ....
   FW ....SW ....

FRESHWATER SP. Tag Nos.:..

BW (cm)	1	2	3	TOTAL SKINS	TOTAL CM
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
TOTAL					

SALTWATER SP. Tag Nos...

1	2	3	TOTAL SKINS	TOTAL CM

Appendix VI

APPENDIX

.M 'HORN BACK

Export of crocodile skins by (exporter) . . . . from (port) . . . . to (destination) . . . .

Date of shipment : ____/____/19__

Method of shipment : . . . .

(a) Value as per Export Entry (actual value) : = K ______.___

(b) Management Levy : = K ______.___

(c) Export Levy : = K ______.___

(* see notes at bottom)

OFFICE USE ONLY

1. Name of Exporter: . . . .
2. CE . . . .
3. Permit No.: . . . .
4. Importer: . . . .
5. Total No. Skins = ...
   FW = ... SW = ...
6. Total No. cm = ...
   FW = ... SW = ...

FRESHWATER SP. Tag Nos.: . . . . SALTWATER SP. Tag Nos.: . . . .

Hg (cm)	1	2	3	TOTAL SKINS	TOTAL CM	1	2	3	TOTAL SKINS	TOTAL CM
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
TOTAL										

* NOTES

Management Levy = Total No. cm x *A x 15%, Collected by DEC

Export Levy = Total No. cm x *B x 5%, Collected by DoFP, Bureau of Customs

*A = Declared market value as gazetted under Crocodile Trade (Protection) Act, Chapter 213: = K 0.45 per cm

*B = Declared market value as gazetted under Customs legislation: = K 3.00 per inch

All tags are CITES recognized and referred to as 'CITES tags'

CROCODILE EGG HARVESTS AS AN EFFECTIVE CONSERVATION TOOL: THE PAPUA NEW GUINEA EXPERIENCE 1985 - 1996

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Introduction

The conservation aspect of the crocodile management program in Papua New Guinea depends heavily on sustained utilization of the wild resource: a multi-faceted harvest of two "classic" species, the New Guinea freshwater crocodile Crocodylus novaeguineae and the often sympatric saltwater (= Indo-Pacific) crocodile C. porosus. Skins from the controlled hunting of juveniles and young adults still comprise the majority of skin exports, and provide the highest share of resource derived income to local hunters. However, since the 1970s, capture of small juveniles for coastal ranching schemes has supplied an increasingly important segment of the harvest. In 1985, a third form of utilization, wild egg collection, was introduced in the middle Sepik River region. Although unexpectedly beset with opposition from some local communities, egg harvests have evolved, in the village domains where conducted, as the consolidating force for conservation of wild stocks.

This paper describes the establishment of egg harvests in PNG, some of the trials, travails and triumphs involved in the process, and the current need to expand the program to other crocodile producing areas of the country.

Conceptualization

Some of the most successful crocodile management programs (e.g. Louisiana and Florida in the USA, Northern Territory of Australia, Zimbabwe) emphasize, or solely rely upon, wild harvested eggs as the basic stock for ranching schemes. Incorporation of egg harvests in PNG similarly offers a number of advantages over live harvests for both conservation and commercial interests:

- As an ecologically K-selected species, resident crocodilians are presumed to exhibit high egg mortality in the wild (>50%). Because live juveniles harvested in PNG are beyond the critical first six months when mortalities are highest, eggs represent a much more expendable component of the population; wild stocks are therefore less likely to be impacted adversely.

- Because the harvest is conducted by personnel of the National Crocodile Management Unit (due to the special care involved with handling and transport of eggs), there is greater control of harvest numbers; this allows appropriate quotas to be set, and promotes their enforcement.

- Egg collection is a more efficient activity, requiring much less hunter effort than capture of dispersed juveniles. Routine monitoring of nesting areas, and in some cases nest site identification, can be accomplished during the course of hunter-gatherer forays.

- Although handling and transport of eggs requires particular caution, eggs come in small, durable packages (a thick shell and membrane) that are highly cost-effective to transport; unlike hatchlings and yearlings, eggs do not suffer from the stress of translocation.

- If young eggs are utilized, ex situ incubation at optimal temperatures permits the programming of improved growth rates, manipulation of sex, and (possibly) greater fecundity.

- Egg harvests assist monitoring of wild populations, as trends in population status can be inferred from clutch characteristics (e.g. size/ mass); fluctuation in the peak nesting period can be more accurately tracked from embryo ageing (or estimates based on egg band coverage) than visual assessment of nests.

- Cash payments for eggs to local landowners provide an economic incentive to reduce nest exploitation for eggs and breeding females, the latter being the key cohort for in situ conservation.

Baseline data on the nesting biology of the two crocodilians in the Sepik, including interactions with local communities, was provided by a preceding five year investigation (Cox 1985). Combined with analyses of data from aerial nest counts during 1980-1984, this knowledge of nesting parameters enabled the potential costs and benefits of egg extraction to be gauged quantitatively. One important finding was that at least 35% of surveyed C. porosus and a deduced similar proportion of C. novaeguineae nests in the middle Sepik were harvested for human consumption (Hollands 1985; 1986). Of remaining nests, losses to flooding (ca. 5%), non-human predation (5-10%) and other causes of embryo mortality (ca. 10%?) were more difficult to calculate and likely underestimated (perhaps substantially), because some flooded nests could not be relocated after initial discovery by hunters, and collection of most clutch data were limited to the early and middle parts of nesting seasons (Cox 1985). Therefore, it was surmised that >60% of eggs of each crocodilian failed to produce hatchlings.

Although villagers readily admitted that crocodile eggs were not as appetizing as other available eggs (e.g. megapode, cassowary, chicken) they were nonetheless prized, particularly by elder hunters. Consumption was often ritualized by a community feast, where young eggs were boiled, and the large embryos of older ones skewered and roasted. During periods of severe highwater other wild eggs are reportedly difficult to obtain, and crocodile eggs may be an important temporal source of protein in some communities (Cox 1995).

Substitution of crocodile eggs with chicken eggs, to defray any possible culinary or dietary loss, plus a cash payment, were considered sufficient to effect a change in consumption habit. Coincidentally, the principal commercial crocodile ranch in PNG, Mainland Holdings Pty. Ltd. of Lae, was integrated into a large-scale poultry operation, and could frontload eggs cheaply into the harvest region on air charters sent there to ship out crocodile eggs or live crocodiles.

Most important, by 1985 Mainland Holdings had utilized production from their C. porosus breeding stock to attain proficiency in the techniques of egg incubation and rearing of hatchlings. The company also possessed ample capacity for additional eggs and rearing stock. In fact, of all crocodile farms and ranches operating in PNG at that time, only Mainland Holdings could satisfy the criteria of processing eggs from a large scale harvest.

Program design and establishment

As initially designed (Hollands 1985), a helicopter used in conjunction with aerial nest counts was chosen over ground transport as the means to collect clutches. Helicopters offer the advantages of rapid conduct and control over handling and transport. Flight time devoted to harvesting would be paid for by Mainland, and placement time from outside the Sepik pro-rated accordingly. This arrangement reduced the overall cost of aerial croc surveys to government, while harvest labor was provided free to Mainland.

A cost of kina 2.50 (= US$ 3.25 in 1985) per C. porosus egg was estimated to position the helicopter and conduct a drop-and-retrieval at nests during the course of aerial counts. Transport to Mainland and incubation costs added ca. K 2.00 per egg. According to the calculated cost limit, this left K 0.50 per egg as the initial purchase price, which local communities agreed to accept.

By 1992, the actual cost of harvesting in the field was calculated at K 2.75 per egg for C. porosus (Cox and Genolagani 1992), which with depreciation of the kina is ca. 25% less than the 1985 estimate. Efficiency of transport to Lae, a high hatching rate, and depreciation has allowed the egg price to increase steadily over the years, to K 1.50 in 1988, K 2.50 in 1992, and K 3.20 in 1996.

C. porosus has been the species of choice owing to its higher commercial skin value and faster growth on ranches. In addition, a clutch size of >50% compared to C. novaeguineae substantially reduces the cost of collection in the wild. However, the majority of the skin trade in PNG (ca. 70%) is comprised by C. novaeguineae; thus in order to strengthen in situ conservation of this species, and further improve income generation for local communities, commercial ranches have been encouraged to harvest eggs of both species.

After nests are harvested, landowners can check clutch and viability counts at the base of operations in Ambunti, but it has been infeasible for them to accompany the harvest team, or for the helicopter to detour to villages for inspection of clutches. At the end of the survey, the Ambunti based wildlife officer travels on patrol to participating villages to disburse egg payments, discuss the results of the nest counts and harvest, and elicit future participation.

Ground-based harvesting with canoes was investigated in 1990 and 1992. The method was found to reduce costs and enhance safety compared to aerial collection, but to be more effective and applicable on a wide scale, requires substantial advance planning and coordination at the field level. Even then, availability of local guides and canoes cannot be assured. Although logistically more difficult and time-consuming, it appears advantageous for two reasons to incorporate (or possibly re-orient) the egg harvest to ground-based execution. In lieu of higher aerial costs, a bonus of K 2.00 - 2.50 could be offered for each ground harvested egg. Furthermore, direct participation of landowners allays any suspicion regarding the number of viable eggs harvested, while substantially remunerating them for their harvest effort. Such a scheme would be better suited for freshwater crocodiles due to the greater incidence of concealed nests, many of which are accessible, albeit with difficulty, to Sepik hunters.

A C. novaeguineae egg harvest in 1996 may be an ideal opportunity to re-assess ground harvesting, but this would require extensive preparatory patrols in July and August, and subsequent coordination patrols in early October before the start of aerial nest counts. Timing of initial nest searches or the start of ground harvesting is critical to avoid possible nest abandonment should a substantial number of clutches not yet be laid.

Experimentation with Global Position System (GPS) technology in 1994 and 1996 promises improved efficiency for both ground and aerial extraction. Because all counted nests are plotted with site coordinates of ± 50 m accuracy (using a Garmon 5000 GPS), nests can be relocated quickly. A hand held Magellan 2000 unit also aids efficient follow-up ground harvesting of easily accessible nests. However, the greatest benefit of GPS may be that, based on the initial conduct of nest counts, a route can be plotted and flown exclusively for egg collection. Such harvest flights should further reduce - perhaps substantially - aerial costs, although if some nests cannot be located, or personnel cannot be drop and retrieved, mid-air adjustment will be required to incorporate alternate sites.

Harvest priority was initially assigned to nests that were assessed as prone to flooding or predation. Whereas the first condition is still prioritized, the latter referred to heavily utilized nesting areas where no particular village exerted exclusive use or ownership. It was believed there was a high risk that clutches in these nests would be taken for food if not harvested. In practice, harvests in these areas led to controversies over who should receive payments, and complaints regarding the program. It was then decided to drop sites of disputed ownership from the harvest regime. However, the potential returns from egg sales induced resolution of disputes, and with nest protection so widely adopted since the early 1990s, harvests have resumed.

Priority has also been given to the most supportive landowners, and collection of at least one nest from the domain of each cooperating village, so as to disseminate the economic benefits and involve as many communities as possible.

The number of nests harvested from each survey location currently depends on the number of active and successfully hatched nests counted (with a take of ≤50% as a guideline), count history (general trend in nest numbers in the recent past), and most important, whether or not local landowners approve of the harvest, including in recent years their request for more intensive harvesting.

Landowners have agreed to allow unharvested nests to hatch, but if these were subsequently raided for eggs, it was initially understood that the clan domain would be excluded from future harvests. In practice, the agreement has proven infeasible to monitor because funds have not been available for replicate nest counts to determine hatching success, and in some instances people from other villages or clans have been alleged to raid nests. However, at present, this may be a moot point of concern given the indication of nearly total nest protection

One important tradeoff has been accepted: the preference for young clutches. Even with careful handling, translocation is risky, and the timing of aerial nest counts for peak nesting means that most clutches are at an advanced stage of development, past the critical periods of sex determination and setting of growth rates. However, harvests comprised of older eggs do offer the advantages of reduced length (and therefore cost) of incubation and a higher hatching rate. Even if young eggs could be collected before the surveys, this would probably bias the nest counts, as trails to harvested nests would tip off the spotter to their presence and confuse assessment of human predation.

Harvests were suspended in 1990, 1992 and 1994 due to opposition from communities downriver from Ambunti, and certain provincial politicians who sought to make an election issue of the harvest. The 1994 C. porosus harvest was carried out in selected areas after villagers proposed a biannual harvest to ameliorate possible hatchling depletion. However, with the numbers of captured young remaining high, and the loss of cash income increasingly felt, participating communities expressed their wishes, and even demands, in 1995 for renewed annual harvesting. In response, interventions from NCMU officials in early 1996 succeeded in obtaining the cooperation of those politicians who previously opposed the egg harvests, and the unanimous support afforded the March 1996 C. porosus harvest holds promise that the controversy is now largely resolved.

Collection methods

The methods of handling and transport of eggs have been discussed in various reports to Government (Hollands 1985; Cox et al. 1989; Genolagani et al. 1991; Cox and Genolagani 1992, 1994). In summary, clutches are quickly transferred from the nest to styrofoam coolers or cardboard boxes filled with rotting grass, with care taken not to rotate eggs. Containers are stored in the helicopter or motor canoe until return several hours later to Ambunti. Eggs are then unpacked, marked with permanent ink to indicate the top position, and data recorded on clutch size, egg length/width/weight, and viability (live, dead and infertile eggs). Non-viable eggs are discarded and remaining good eggs are subsequently repacked in boxes of decaying grass. Temperatures are monitored every few hours, and the eggs ventilated as necessary to maintain 32°C, until the harvest can be air freighted to a commercial incubator.

In some years, age and deduced laying date were estimated by sacrificing one egg and examining the embryo. Beginning in 1996, a more general but practical estimate is calculated from band width. These data are important for tracking fluctuations in peak nesting period, and their relation to environmental variables (e.g. seasonal water levels, burning of habitat).

During C. porosus harvests, the collection teams are composed of two members, one of whom performs the egg extraction, while the other guards him with a rake or canoe paddle and uses hand signals to communicate with the helicopter crew. Where nesting crocodiles are sighted on approach, or vegetation obscures their possible presence, the helicopter hovers closely at nests while the eggs are collected. During aerial clutch inspections in 1982-1983, a 12 gauge shotgun was carried for protection, but it was judged more of a threat from discharge while clambering in and out of the chopper, and slogging across floating mats, than attack from nesting crocodiles. It was replaced with a rake, which offers a wide surface for adults to bite into, but a sturdier long paddle was later found to be more effective.

During the C. novaeguineae harvest, a single member is usually dropped and retrieved in areas of multiple nest harvesting to reduce the higher cost of collection. C. novaeguineae is undocumented as responsible for any attacks on humans in Papua New Guinea, and of the ca. 185 attendant adults encountered on surveys and egg harvests, none have displayed aggressive behavior. However, the C. novaeguineae nesting period overlaps some C. porosus nesting (ca. 3-5%

of nests inspected; Cox and Genolagani 1992). For future harvests of C. novaeguineae nests, two member teams are planned for drop-and-retrievals.

Although harvest personnel have become increasingly conscious about safety considerations over the years, and incorporated additional precautions, aerial egg harvesting still contains elements of considerable risk. This is particularly so with C. porosus, which continues to annually attack and kill humans in the Sepik. Attendant crocodiles (assumed to be nesting females, although pairs of adults have been observed at nests; Cox and Genolagani, unpubl. data) have become bolder in recent years, probably as a result of reduced pursuit and disturbance by hunters. Of the 130-150 nests annually surveyed, 3-4 nest attendants commonly hold their ground (sic) with jaws agape, and one or two usually attempt to attack a closely approaching helicopter.

Harvest results and discussion

In conjunction with the aerial monitoring of nesting activity, seven C. porosus and three C. novaeguineae egg harvests have been conducted in the middle Sepik since 1985. Appendix 1 details the results of these collections.

Mean harvest intensity (number of harvested nests as a per cent of nests surveyed) has never exceeded one third of the total nest count (Figure 1), well below the 50% self-imposed quota. If ancillary rates of human predation are included, the take is still within or below the 30-35% of nests raided for eggs prior to inception of the egg harvest program.

The apparent incidence of C. porosus nest raiding plunged from 30-35% in the years before the egg harvest was adopted (1980-1985) to 3% when initially conducted in 1985 and 1986 (Hollands 1985,1986). However, it then inexplicably rose to levels of 7-12.5%, before dropping again in recent years (Figure 1). A spike in 1994 is mainly attributable to human predation in the Oum village domain (6 of 11 nests; Cox et al. 1994), which is the farthest point upriver that eggs are harvested.

Conversely, C. novaeguineae egg exploitation (see Figure 2) has remained low, even though relatively few harvests have been conducted, and none since 1990 (Figure 2). This could be due to the more secluded character of C. novaeguineae nesting, and hence more difficult detection of nests by hunters; the alleged seasonal availability of other wild eggs (Cox 1995), or other factors.

It is possible, particularly during initial years of conduct, that a substantial number of nests of either species was harvested for consumption after the surveys. However, current anecdotal evidence from a variety of local informants suggests that, if formerly so, this practice has declined dramatically. Of even greater significance, the devastating practice of setting hooks at nests has evidently ceased since the late 1980s (pers. obs).

Clutch characteristics have yet to be analyzed thoroughly, but mean clutch sizes of harvests closely parallel those of pre-harvest ground studies by Cox (1985) for C. porosus: 59.5 (n = 203) vs. 59.2 (n = 88); and lower for C. novaeguineae: 33.1 (n = 128) vs. 35.3 (n = 175), possibly indicating increased recruitment or higher turnover in the nesting population of the latter species.

Figure 1. Human predation and commercial harvesting of Crocodylus porosus nests in the middle Sepik River region, 1985-1996. Histograms show the relative intensity of seven egg harvests. No survey was conducted in 1987.

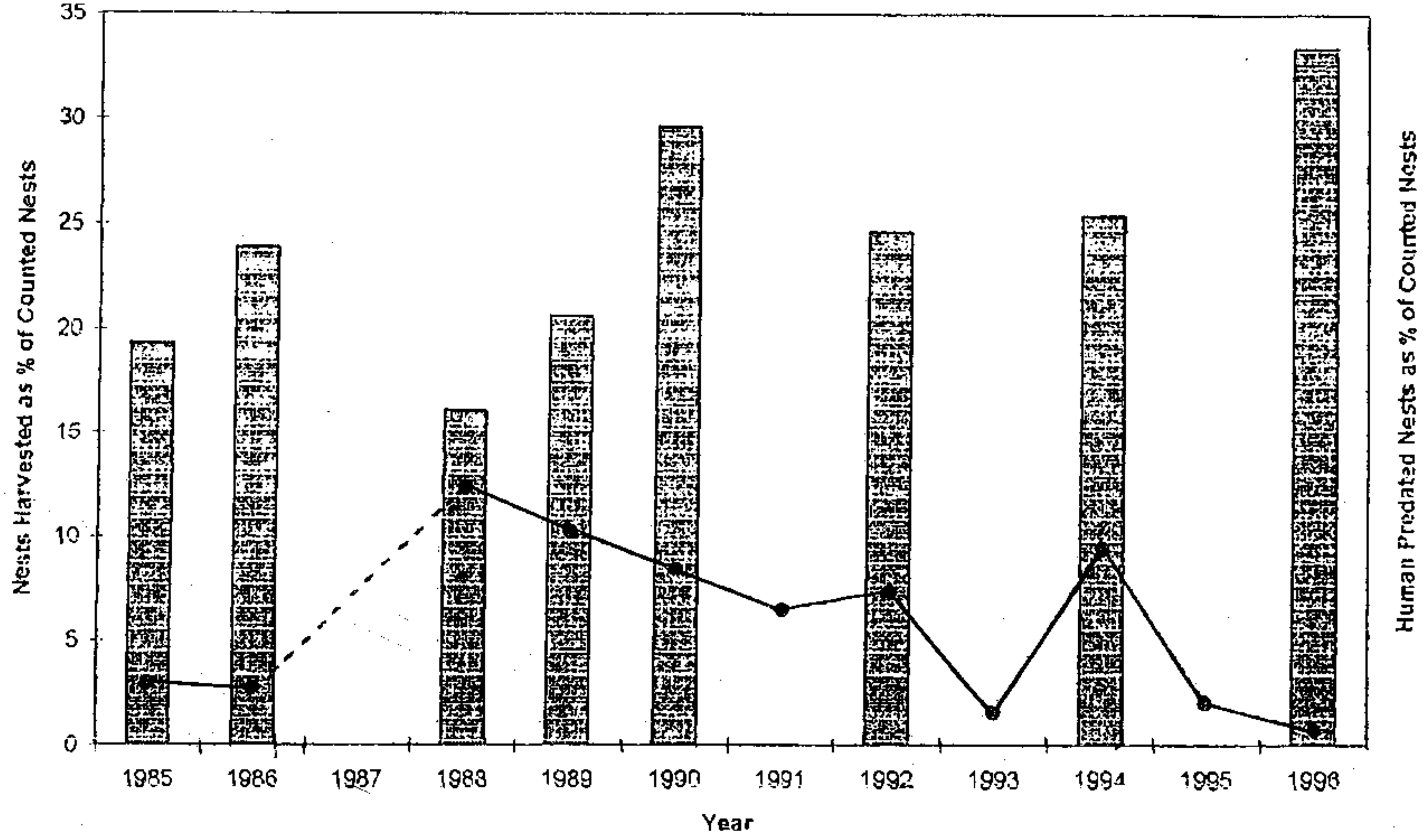
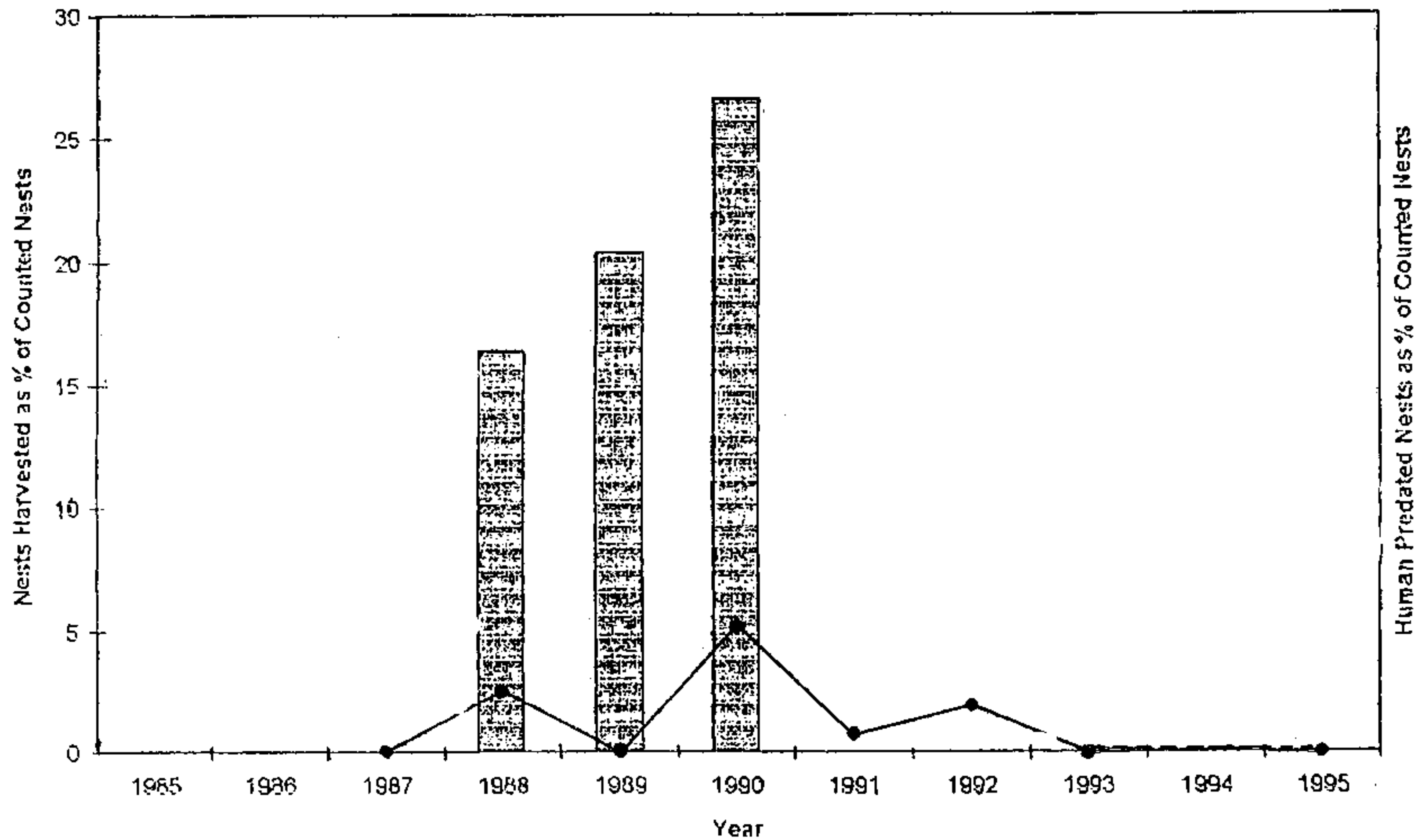


Figure 2. Human predation and commercial harvesting of Crocodylus novaequineae nests in the middle Sepik River region, 1985-1995. Histograms show the relative intensity of three egg harvests. No exploitation data exists for 1985 and no surveys were conducted in 1986 and 1994.



Detailed analyses of clutch size, egg mass and egg dimension may shed further light on the dynamics of Crocodylus populations in the Sepik, and as a monitoring tool, could provide a supplemental method to infer population status over time. This may be particularly valuable given the expense, logistical constraints and harvesting bias likely to be encountered with mark-recapture studies of hatchling survivorship and hatching success research. Furthermore, trends in clutch parameters would supplement the needed in-depth analysis of live and skin harvests to better ascertain the effects of egg harvests on local populations.

While in situ hatching rates have been difficult to assess (Cox 1985), available data from 1988 onwards suggests uniformly low rates of non-human predation and flooding at the time of the surveys (2.1% each factor for C. porosus [n = 1,103 nests]; 0.6% each factor for C. novaeguineae [n = 1,033 nests]), and are thus at variance with assumed high mortalities in the wild.

Ex situ hatching rates since inception of the harvests have ranged from 75.3 to 94.0 %, with a mean of 84.1% (n= 10,446 eggs; D. Wilkin, in litt. 16 May 1996), but exclude the 1990 C. novaeguineae harvest (<50%; G. Mitchell, pers. comm.), when the egg consignment was subjected to an extremely serious aerodynamic stall. Nevertheless, current techniques of egg handling, transport and incubation are evidently satisfactory.

Egg pricing

In 1992 the price for C. porosus eggs was increased to K 2.50 per egg. Since that time the PNG kina has depreciated by approximately 25%. Thus, an increase to K 3.20 per egg when harvests were resumed in 1996 largely offsets the depreciation and resulting inflated costs of local store goods.

Indications are that ranches could afford to raise the purchase price even higher, which would elicit additional support and further strengthen conservation incentives. With the ability of C. porosus to maintain its market value in recent years, a 25-40% price increase should not financially burden ranches, especially if instituted with the scale of economy involved in a harvest of ≥3,000 viable eggs. In fact, the additional expense may be recouped within 1-2 years by increasingly efficient harvest procedures, and with the adult population showing a trend of steady increase (Manolis 1995), promote even more intensive and efficient harvests in future years.

To reinforce the economic incentive of protecting active nests, and to avoid possible disputes regarding the number of viable eggs in a nest, payment could be made for entire clutches, instead of the current policy of paying only for viable eggs. This practice has occasionally left land owners disappointed, as they protected a nest with the assumption that it contained many viable eggs, only to hear that most were infertile or flooded out. As the mean viability of C. porosus eggs since the inception of harvests is 82.9% (n = 12,105; Appendix 1), an increase of 17% in procurement cost would be expected by paying for all eggs extracted.

Increasing the purchase price for C. novaeguineae eggs presents more of a challenge for commercial ranches. However, considering the level of profits still possible, continuing increases in production efficiency, ground harvesting potential, and the long-term benefits to industry, a higher price should be affordable. Fully including C. novaeguineae in the egg harvest regime is also consistent with management of the crocodile resource as a single unit in areas of species sympatry. This would not only strengthen conservation incentives for freshwater crocodiles, but further reinforce the value of intact habitat.

Community participation

Egg harvests must pay great heed to the land tenure system in PNG, as under organic law, traditional land owners exercise almost exclusive control of natural resources. For a long-term intervention to win local acceptance it must be tailored to the abilities, aspirations and resources of local communities, yet provide substantial short-term benefits.

Egg collection is well-tailored to the largely hunter-gatherer lifestyles of people in crocodile producing areas of PNG. Moreover, in the Sepik, an evolving routine of cash-and-kind payments, complemented by an extension campaign to inculcate the various benefits of the strategy, is actively persuading local people to act in their own economic interests as custodians of the resource.

At the current rate of K 3.20 per viable egg, a return of K 158 is realized for the average C. porosus nest. A comparison shows that a single harvest of eggs produces an amount of income that approaches the skin value of the female (assuming she is young enough to fall within the legal size limit). Local hunters and landowners know that females, if undisturbed, nest more or less annually for long periods, typically twenty years or more. Thus, by providing an alternative and greater source of income, the temptation to hunt adult females for their skins is effectively diminished, and a significant financial incentive exists for villagers to protect the 'goose that lays the golden egg'. Furthermore, because hunting methods away from nests are sexually non-discriminate, the protection incentive extends to adult males.

Harvested nests are usually limited to a few land owners in each village, but the elder in whose domain a nest is harvested will often divide the returns among those who have user rights over the nesting habitat, and thus extend the benefits and protection incentive to other members of the community.

How meaningful, though, are the returns? While the current, annual system-wide generation of US$ 5,000 from egg harvests provides insufficient income to in any way "develop" individual villages, with land owners as the driving force, the harvests increasingly function as a consolidating force behind conservation-oriented utilization of the local crocodile populations. This in turn underpins the sustained (and greater) returns from hunting and live capture.

Although a very high degree of nest protection is suggested by results of the most recent nest counts, a doubling or tripling of returns to local communities from resumed C. novaeguineae and more intensive C. porosus harvests would contribute even further to their socio-economic development, and greatly bolster incentives to protect habitat, which as frequent and extensive burning shows, remains poorly linked by local communities to conservation of crocodiles.

In the floodplain of the middle and upper Sepik, crocodiles are still the major source of income for most villages, and except for small scale felling of hardwoods, gold panning and smoked fish, competing economic opportunities are virtually non-existent. Although local people derive the basics for life from the swamps, cash is needed for new fishing nets, supplemental store goods, poll taxes, and school fees. It is the last item that was frequently cited as a main reason to resume the egg harvests. Villages upriver from Ambunti could no longer afford the K 80- 500 per year, and long-term improvement of the community's socio-economic welfare is often viewed as contingent upon sending students to national high schools or missionary institutes.

In identifying the reasons why the harvests have evolved to a successful stage, not to be discounted is the trust factor. People in the middle and upper Sepik have had a long association with NCMU/DEC personnel, particularly the Ambunti-based officer, who have been sympathetic and supportive of the plight of local communities. This has fostered trust, and in turn, the necessary cooperation to realize success. (Recall that people rely on the word of NCMU officers as to the number of viable eggs from their nests). Appropriate economic incentives are essential, but it takes people working hard and working together, in this case a tripartite effort of government, industry and local communities, to put them into action.

Egg harvests exemplify how crocodile management in PNG has advanced: From the nascent days when suspicion ruled, there were threats to shoot down the survey chopper if eggs were taken. Now, in 1996, the people of one village threatened to ban the aerial survey in their areas if eggs were <u>not</u> harvested.

Egg harvests, in combination with a sustained take of skins and young, are creating an additional spin-off that confers major and ultimate conservation value. Vast areas of lowland Papua New Guinea still feature an array of intact swamp habitats that are often regarded as inhospitable and "worthless". If, however, these habitats can be shown to have high productive value owing to optimally managed crocodile populations, then there is a powerful economic incentive to preserve them - and the spectrum of flora and fauna they comprise - rather than convert them for alternative production schemes. In other words, the economic value generated by sustained yield management allows habitat to effectively compete with other widely applied forms of land use such as forestry and agriculture (Webb 1991).

Expansion potential

There remains considerable scope to intensify and expand egg harvests in the Sepik region, as well as bring other river systems. Success of the egg harvest program in the middle-upper Sepik also provides impetus for expansion.

Fully protected nesting grounds, found almost exclusively in the Avatip village domain, include the current survey sites of Walmau, Lapangai, Numahar, Kangovel, most of Kwasenam, and Yambi Yauwe. Clearly, these should be incorporated into the program. Avatip leaders oppose the egg harvest and because of ancestral ownership claims, exert influence over the neighboring villages of Malu and Yau'umbak. The basis for their opposition is the belief that **<u>any</u>** egg harvesting will lead to a depletion in the number of young crocodiles available for live harvest, and over time reduce local crocodile populations.

Extension efforts are needed to re-approach village leaders and land owners in this area and explain the observable effects to date of harvesting, especially in relatively intensively harvested <u>C</u>. <u>porosus</u> sites upriver, where nest numbers are stable or increasing, and there is no indication of decline in the number of live crocodiles (Bagu, Swagap and Kubkain villagers, pers. comm.).

One way to win support for the program may be to propose a night count regime in a sequestered local lagoon (e.g. Numahar) to assess local population status prior to egg harvesting, then regularly replicate the night counts after harvesting has begun. Based on results of the surveys, the local trial harvest can be continued, expanded or dropped. If a more conservative approach is deemed necessary to persuade local landowners, the number of nests taken at the trial site can be limited to, say, 20-25% of the total.

Egg harvesting could also be expanded further downriver to the vicinity of Mindibit and Kandangai villages where relatively high nesting densities have been recorded. Program introduction in the Mindibit area should be facilitated by the prevalence of the Seventh Day Adventist church. Crocodile eggs are viewed as a dietary taboo and the Mindibit community is reportedly steadfast in not collecting or eating the eggs (G. Liversidge, local resident, pers. comm.).

Good potential also exists for expansion of ground-based C. novaeguineae egg harvests, both within the present survey area and further upriver. However, in order to be realized, the solid support of local communities and government councils must be gained well beforehand. This can be done only if the NCMU officer at Ambunti has the outboard motors, dinghies, fuel and spare parts to conduct regular patrols. Expansion to more remote areas such as the May, Yellow and Green rivers would be more expensive and demanding of time, but hunter-gatherers in these areas receive a much smaller, and disproportionate share of resource-derived benefits. They are therefore in more need of assistance, and arguably merit priority for socio-economic development programs.

Additional egg harvest potential is believed to exist in many areas outside the Sepik region. Foremost among these is the Ramu River where significant stocks of C. porosus reportedly occur, and protection of nests and breeding stock is said to be widely supported (S. Seeto, Madang crocodile rancher, pers. comm.). The proximity of commercial crocodile ranches at Lae and Madang improves the logistics of harvesting eggs in the Ramu.

C. porosus egg harvests also appear feasible in the middle Strickland River and coastal Gulf Province.

Appendix 1. Crocodile egg harvest data from the Middle Sepik River region, Papua New Guinea.

Crocodylus porosus

Year	nests harvested	% of nests surveyed	total no. of eggs	no. of viable eggs	per cent viable eggs	x clutch size
1985[1]	14	19.4	795	661	83.1	56.8
1986[2]	17	23.9	1061	859	81.0	62.4
1988[3]	13	16.1	793	647	81.6	61.0
1989[4]	20	20.6	1329	1198	90.1	66.5
1990[4]	29	29.6	1613	1324	82.1	57.6[a]
1992[5]	35	24.6	2066	1656	80.2	59.0
1994[6]	29	25.4	1726	1545	89.5	59.4
1996[7]	47	33.3	2722	2145	78.8	57.9
TOTALS	204		12,105	10,035		
x	25.5	24.9[b]			82.9	59.5[a]

a = (n = 203) one nest (HS 076) excluded as only a partial clutch of 20 eggs was delivered.
b = calculated as the harvested nest aggregate divided by the total number of nests surveyed (n = 819).

Crocodylus novaeguineae

Year	nests harvested	% of nests surveyed	total no. of eggs	no. of viable eggs	per cent viable eggs	x clutch size
1988[3]	33[c]	16.4[b,d]	996[c]	807[c]	81.0	32.1
1989[8]	48[c]	20.4[b,d]	1634[c]	1307[c]	80.0	34.0
1990[9]	47[c]	26.6[b,d]	1606[c]	1218[c]	75.8	34.2
TOTALS	128		4236[c]	3332[c]		
x	42.7	21.2[b,d]			78.7	33.1

c = excludes C. porosus nests: 1 in 1988 (SK 400) 46 eggs, 43 viable
1 in 1989 (SK 484) 71 eggs, 67 viable
2 in 1990 (SK 557/8) 134 eggs, 74 viable
d = excludes harvested nests that were not spotted on the aerial survey

Sources:
1 Hollands 1985.
2 Hollands 1986.
3 Cox et al. 1989.
4 Genolagani et al. 1990.
5 Cox and Genolagani 1992.
6 Cox et al. 1994.
7 Unpubl. data. DEC.
8 Genolagani et al. 1989.
9 Genolagani et al. 1991.

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FLORIDA'S ALLIGATOR MANAGEMENT PROGRAM AN UPDATE - 1987 TO 1995[1]

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I. INTRODUCTION

Alligators have been part of Florida's environment for thousands of years, and records of commercial exploitation of alligators in Florida date back to the late 1800's. Harvesting of alligators went unregulated through the early 1900's. However, in 1943, concerns about population declines in easily accessible areas stimulated establishment of a 4-foot minimum size limit (the first statewide alligator regulation) by the Florida Game and Fresh Water Fish Commission (Commission). In spite of this regulation, declines continued. In 1954, a statewide 6-foot minimum size limit was imposed, and eventually, in 1962, the legal alligator harvest season was closed. The closed season, however, did not stop wide spread exploitation because state laws were not effective in closing down a well established interstate network of illegal hide dealers. As a result, alligators were included on the first list of endangered species in 1967. In 1970, effective federal regulations were imposed through an amendment to the Lacey Act that outlawed interstate shipment of alligators taken illegally. This regulation gave enforcement officials the tool to effectively end the poaching era, and alligator populations in areas where declines had been observed made an impressive comeback (Hines 1979).

By the mid-1970's, alligator population surveys conducted by Commission biologists indicated that most populations were increasing rapidly (Kushlan and Kushlan 1980, Wood et al. 1985). At that time, the Commission was receiving 4,000 to 5,000 nuisance alligator complaints annually. In 1977, the status of Florida's alligator population was reclassified from endangered to threatened, by the U. S. Fish and Wildlife Service, following evaluation by the Commission's alligator research staff. This change in status allowed the Commission to initiate management of the nuisance alligator problem through harvest, resulting in our current nuisance alligator control program (Hines and Woodward 1980). The American alligator is currently listed under the Endangered Species Act as threatened due to similarity of appearance (Neal 1985).

In 1980, the Commission's alligator research staff began focusing its efforts on the impact of alligator harvests on wild populations. As a result of these investigations and subsequent experimental alligator harvests on selected wetlands, the Commission created an Alligator Management Program, later to become the Alligator Management Section (AMS) within the Division of Wildlife's Bureau of Wildlife Species Management.

The Commission's Alligator Management Program has developed around the premise that the economic value derived from wise use of Florida's alligator resource can provide economic incentives to conserve alligators

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[1] Prepared for the 13th Working Meeting of the Crocodile Specialist Group, IUCN, World Conservation Union, Santa Fe Argentina, May 11-17, 1996.

and preserve their wetland habitat. The expansion of management programs and growth of an industry dependent on the alligator resource provides a new constituency group to serve as advocates for wetland conservation. The major objectives of the AMS are to implement sustained alligator harvest programs while optimizing the economic, aesthetic, and ecological values of alligators as a renewable natural resource. By emphasizing these values, the Commission hopes to provide incentives for conservation of not only the alligator, but also the wetland ecosystems they inhabit.

II. THE PUBLIC WATERS ALLIGATOR HARVEST PROGRAM

ALLIGATOR HARVEST MANAGEMENT UNITS AND QUOTAS

Under this program, alligator populations are intensively managed on designated waterbodies ranging in size from 1,000 to over 100,000 acres. These Alligator Harvest Management Units (AMU's) are established by Commission Order and annual harvest quotas are established by order of the Executive Director. Table 1 lists the harvest quotas established for the AMU's each year since the program's inception in 1988.

AMU Selection

Biologists assigned to the Alligator Management Section review and recommend AMU's for establishment annually. Reconnaissance night-light surveys of candidate AMU's are done to determine if the areas may be suitable for harvest. The screening criteria used for evaluating areas for establishment include: 1) population estimates exceed 200 alligators greater than four feet in length (i.e., a population level that would be expected to sustain an annual harvest quota of 15 or more alligators), 2) residential development would not be expected to result in an unsatisfactory level of complaints related to hunting activities, and 3) other public uses of the area are compatible with harvest and the area does not include "protected" areas that cannot be effectively excluded. Although the AMS has not done a systematic search of all wetlands in Florida to identify potential AMU's, we believe we have included virtually all areas that meet these criteria.

Harvest Quota Criteria

The 1987 authorizing legislation for implementing the alligator management program set forth alligator study requirements (in 372.6678, F.S.). This statute requires studies of areas of the state to be opened to alligator collection to determine the number of alligators that can be removed without long-term adverse impacts. Experimental alligator harvests were conducted from 1981 to 1990 on selected areas throughout the state. In these studies, harvest quotas of 15% of the alligators greater than four feet in length resulted in trappers actually achieving an average annual harvest of 13%. Long term monitoring (also considered studies) of these and other harvested areas has shown that, in most cases, this harvest level is sustainable. The quota establishment protocol used in these studies, therefore, has served as the foundation for establishing harvest quotas on AMU's.

In establishing quotas, the number of alligators greater than four feet in length on each AMU is estimated by completing a statistical (regression) analysis of several years of night-light count data. The analysis statistically adjusts for changes in alligator observability resulting from annual differences in water temperature and water level (Wood et al. 1985). The quota is then established as 15% of the estimated number of alligators. An exception is made where harvest data from the AMU indicate that more than 13% of the six-foot and larger alligators have been harvested from the area in the past. In those cases, a reduced quota that is expected to achieve a harvest of less than 13% of the six-foot and larger alligators is established.

Criteria for Closing AMU's

Alligator population trends are monitored on each AMU using statistical (regression) analysis of alligators observed during night-light counts. A very conservative alpha level of .2 is used so as to improve the power of the test and increase the likelihood of finding a declining trend. When the analysis indicates a significant declining trend in the number of *four-foot and larger* alligators observed during night-light counts on an AMU, we recommend closure of that AMU. When the analysis indicates a significant declining trend in the number of *six-foot and larger* alligators observed during night-light counts on an AMU for a single year, quotas are reduced by

50%. If, after completing the following year's night-light counts, regression analysis still indicates a significant decline in the number of *six-foot and larger* alligators observed (i.e., declines for *two* consecutive years), we recommended closure of that AMU. The conservative criteria for closing AMU's is imposed to satisfy the social and political concerns in Florida rather than pure concern over adverse biological impacts. Such stringent criteria, consequently, may not de desirable in other regions where higher sustained yields are desirable. Hunting has been suspended on about 20% of AMU'S because of declining trends and about 10% of AMU's due to other causes, such as elevated mercury levels in alligator meat and temporary lake drawdowns as part of sport fisheries restoration and enhancement projects.

Tag and Permit Allotment

The number of alligator harvest tags issued to each participant is calculated by totalling the current year's quotas for those AMU's that were established in 1994 and dividing by 500. The quotient is then rounded down to the nearest whole number. This is generally 5 or 6. The number of permits to be issued for each AMU, consequently, is the AMU's established quota divided by this number. This rather complicated procedure helps to maintain stable revenues and prevent hunter overcrowding.

Following nearly a decade of hunting on AMU's, Division of Wildlife staff are currently reviewing the above AMU, quota, and tag allotment establishment procedures in light of research recently completed by the Bureau of Wildlife Research. Modifications to these procedures may be recommended based on the results of this review. We are considering changes that favor quota reductions over AMU closures in response to declining population trends. Further study into the effect that increased wariness, vegetative changes, and other factors have on alligator counts and population trends will also influence the protocol we use.

There is continued interest in providing greater "opportunity" to participate in alligator hunting under this program. Numerous possibilities have been suggested. For example, one of these includes establishing a five-day (September 1-5) "early season" harvest as part of the existing Alligator Harvest Permit Application, allow applicants to apply for the special opportunity hunt in addition to the regular hunt, issue one CITES tag with the permit and waive the validation fee. Numerous variations on this theme could be done at conservative levels with little concern over biological effect on many presently unhunted lakes, on closed AMU areas, on the WCA's where Hg contamination prevents commercial use of the meat, as county-wide quotas similar to the hatchling collection quotas, or, where suitable habitat exists, on some of the state Wildlife Management Areas that are generally managed for sport hunting of traditional game species. Because of the high license fee, increasing the number of participants also can greatly increase revenue. This increased revenue potential is attractive to the agency's administration, particularly in a time of rapidly shrinking conservation funds from other traditional sources.

The Commission's public waters alligator harvest continues to be an important component of the Alligator Management Program. It captures statewide, national, and international interest and provides an excellent opportunity to inform the public about the value of alligators and wetlands, while allowing participants to benefit from this renewable natural resource. Because of the high interest, we expect to continue to move toward increasing participation levels and program revenues.

Current Status

Alligator Management Section biologists completed surveys and recommended harvest quotas for 36 AMU's in 1995. Roughly 20,000 applications were distributed to the public, and 8,909 completed applications were returned to the Commission's Gainesville office by the June 1 application deadline. A total of 583 applicants were randomly selected to participate in the harvest. As a result, 565 applicants (97%) completed one of the 11 training and orientation programs offered at eight different locations throughout the state and purchased their alligator trapping licenses. The increase over 1994's participation rate of 93% is attributed to increasing hide prices.

The 565 qualified applicants were issued harvest permits and six alligator harvest tags each to harvest alligators during two, 15-day phases of the September harvest period. A total of 2,985 alligators (88% of the number of tags issued) was harvested. Table 1 summarizes alligator harvests on public waters from 1988 through 1995.

III. THE PRIVATE LANDS ALLIGATOR MANAGEMENT PROGRAM

Since a large percentage of Florida's wetlands are privately owned, conservation of alligator habitats on private lands is critical to the continued well-being of alligator populations in the state. The Commission has given landowners an incentive for maintaining these habitats by providing them an opportunity to manage and harvest alligators from their lands. To participate in the program, applicants must own or lease a parcel with a minimum of 1,000 acres of alligator habitat or with a minimum of 100 alligators greater than 4 feet in length. A group of landowners or authorized lessees may apply jointly provided the aggregate adjoining properties meet the minimum alligator habitat acreage or population requirements.

PRIVATE LANDS ALLIGATOR MANAGEMENT PROGRAM APPLICATION PROCEDURES

Private landa participants may choose from several available harvest options, depending on the acreage of alligator habitat on their properties and/or alligator population information provided to the Commission. Private landowners may elect to harvest alligators, hatchlings, and eggs from their properties. Applicants are required to seek the assistance of private consulting biologists to compile and verify survey information on the status of alligators and their habitat on property enrolled in the program.

Two general classifications of private lands participants exist: 1) those submitting habitat inventories that show the property has greater than 1,000 acres of alligator habitat, where both juvenile and adult harvests are permitted, and 2) those submitting only night-light surveys where only hunting (of non-hatchling alligators generally over four feet in length) is allowed; egg and hatchling collections are not allowed on property with less than 1,000 acres of alligator habitat.

Commission staff attempt to conduct on-site spot-visits to the property to check the habitat inventories, and night-light, nest and hatchling pod surveys submitted by private consulting biologists. These site-visits allow program staff to remain familiar with participants and conditions in the field, and to ensure that the information is accurate and the program remains credible.

Alligator Harvest Procedures

Only non-hatchling alligators less than 6 feet in length and alligators greater than 9 feet in length may be taken from May 1 through July 31, and non-batchling alligators may be taken from September 1 througb October 31. Alligators may be taken by the use of firearms during daylight hours; by live traps, set hooks (except from May 1 through July 31) and snares; baited, wooden pegs less than two inches in length attached to a hand-held restraining line; harpoons, gigs, and snatch hooks; manually operated spears, spearguns, gig-equipped bang sticks, crossbows, and bows with projectiles attached to a restraining line. The use of firearms other than bang sticks and gig-equipped bang sticks is prohibited from sunset to sunrise. Many of these methods are further described by McDaniel and Hord (1990). Alligators must be killed prior to leaving the property. An identifying alligator "harvest tag" (not a CITES-approved export tag) issued by the Commission must be locked through the skin of the alligator within six (6) inches of the tip of the tail immediately upon killing. The identifying alligator harvest tag must remain attached to the alligator hide at all times until the hide is validated by the Commission. The possession of any untagged alligator hide is prohibited.

An alligator harvest report form that identifies the source of the alligator must be completed by the permittee within 24 hours of taking each alligator and prior to any transfer to a permitted alligator processing facility. A copy of the alligator harvest report form must accompany the alligator hide at all times.

All alligator hides from private lands harvests must be validated. Hide validations are scheduled and conducted at private sites and at centralized locations by the Commission. Hides are measured, a CITES export tag is attached, and hide validation fees are collected. The validation fee for *hides* measuring greater than or equal to seven feet in length is $30.00 per hide. The validation fee for *hides* measuring less than seven feet in length is $15.00 per hide. Five dollars of the validation fee for each private lands alligator hide is returned to the industry through the Florida Alligator Marketing and Education Advisory Committee. The money is used to fund marketing and educational projects selected by a committee of industry representatives.

EGG AND HATCHLING INVENTORY AND HARVEST PROCEDURES

Private Lands Alligator Management Program applicants with parcels including more than 1,000 acres of alligator habitat who wish to harvest alligator eggs must submit an alligator habitat inventory and an alligator nest survey to the Commission by August 1 of each year. Those applicants wishing to harvest alligator hatchlings must submit an alligator habitat inventory and an alligator hatchling pod inventory by November 1 of each year.

Nest Surveys

Because alligator nests are often located in dense vegetation with extensive canopy cover, aerial nest surveys are generally conducted from a helicopter travelling at slow speeds (less than 30 m.p.h.). In some cases, however, a fixed-winged aircraft may provide reliable information if nests are located in "open" areas. To augment both survey techniques, ground searches may be used to locate nests constructed in very dense vegetation. Consulting biologists report the location of each nest on a map, assign the nest a number, and record the nest number and its status on a survey form provided by the Commission. Status of nests may be depredated, flooded, false, or good. Nest surveys, verified by Certified Wildlife biologists are submitted to the Commission. A nest quota is then established and the egg collection permit issued.

Hatchling Surveys

Hatchling pod surveys are most commonly conducted at night with the use of dim headlamps. Areas may be traversed by foot, canoe, or motorized boat depending on the amount and type of alligator habitat being surveyed. Pods are identifiable as a group of closely spaced animals (within a circumference of approximately 60 ft.) that are between 8 and 16 inches in total length. Pod inventories are reported by consulting biologists by recording the pod locations on maps and identifying the number of hatchlings per pod observed on a survey form provided by the Commission.

Egg and Hatchling Harvest Procedures

Eggs can be collected at the same time certified biologists conduct the alligator nest survey. The applicant must submit an alligator habitat inventory and a written request for an egg harvest permit including the name of the licensed alligator farmer designated to conduct the egg collection. The collection of eggs at the time of the survey is often less expensive and avoids egg losses caused by flooding and depredation that might otherwise occur while waiting for a permit to be issued.

Commission biologists assess the survey information provided by the applicant to determine the number of alligator eggs and/or hatchlings that may be collected. In general, a 50% harvest rate of nests or hatchling pods is recommended. Upon administrative approval of quotas, purchase of a farming license, and payment of alligator egg fees and/or hatchling tag fees, the Commission will issue a harvest permit and the appropriate number of alligator egg fee assessment records and/or hatchling tags to the designee. In general, the permittee will have 15 days from the permit issuance dates to collect eggs and 30 days to collect hatchlings. Alligator egg collection fees and alligator hatchling tags cost $2.00 and $5.00 each, respectively.

Harvest permits are issued to the applicant or his designee and identify the maximum number of eggs that may be collected and how many nests may be opened to achieve the quota. Any nest opened is assessed against the nest quota regardless of the number or quality of eggs contained in the nest. As a result, prior to opening a nest a judgment is made regarding the quality of the nest (e.g., does it appear to have been depredated or flooded). An Egg Fee Assessment Record must be completed and signed by the permittee to document all retained eggs on the day of collection and prior to transporting the eggs from the property or to a licensed farm. This record helps ensure that the Commission receives the proper fees for the eggs collected.

Alligator hatchling harvest permits identify the maximum number of hatchlings that may be collected from the permitted property. Only hatchlings measuring less than 9 inches in length from the tip of the snout to the rear margin of the cloacal vent may be collected. Each hatchling collected must be tagged with an alligator hatchling tag provided by the Commission. Permittees must maintain complete records of eggs and hatchlings taken. The permittee must complete and return to the Commission, within 15 days following collection, an alligator transfer document reporting the number of eggs or hatchlings transferred to or placed in alligator farm facilities. Alligator eggs or hatchlings taken under this program may only be transferred to eligible farms (i.e., those having a minimum of 2,000 square feet of rearing tanks), and may be retained for rearing by the applicant only if similarly permitted.

CURRENT STATUS

Participation in the private lands program increased from seven properties and 73,000 wetland acres in 1988 to a peak of 114 properties and over 360,000 wetland acres in 1995. Seventy-two properties encompassed more than 1,000 acres of alligator habitat, based on habitat inventories, and were issued 806 harvest tags; 2,460 additional harvest tags were issued to 47 of these permittees who provided supplemental alligator population surveys. On 42 additional properties, 1,789 harvest tags were issued based on verified alligator population surveys only. A total of 4,210 alligators was harvested.

Permits were issued for egg collection on 51 properties based on nest surveys conducted by certified wildlife biologists. Nest surveys were conducted simultaneously with egg collections under the supervision of a certified wildlife biologist on 17 additional properties. A total of 14,225 eggs was collected and transferred to eligible farms. No permits for hatchling collection on private lands were issued in 1995. Table 2 summarizes alligator harvests on private lands from 1988 through 1995.

IV. THE PUBLIC WATERS ALLIGATOR EGG AND HATCHLING COLLECTION PROGRAM

This program permits the collection of alligator eggs and hatchlings from public waters by licensed farmers who must meet specific requirements established by Commission rule. However, the number of farms allowed to participate is restricted due to the limited availability of eggs and hatchlings in the wild. The restricted access effectively guarantees continued access to a finite egg and hatchling resource and avoids diluting the availability of "raw materials" to farmers who have made significant capital investment in rearing facilities.

EGG HARVEST

Alligator Management Section (AMS) staff review and recommend alligator egg collection areas for establishment annually. Candidate areas are located based on staff familiarity with their region and suggestions provided by other personnel and the public.

The screening criteria used for evaluating new areas assess the costs and benefits of surveys and collections for the habitat in question, and are based on the minimum parameters associated with our previously established egg collection areas. These parameters require that the area is comprised of at least 1,800 acres of contiguous, non-forested alligator habitat, an average of seven or more nests are observed per aerial survey hour, and that the area would support a nest quota of at least 10 nests.

Commission biologists conduct aerial nest surveys by helicopter over each egg collection area and establish a collection quota of 50% of the non-depredated, non-flooded nests. Eligible farmers elect to participate in one-of-two egg collection groups and vote for an egg collection "coordinator." The Commission issues permits to direct and conduct egg collections on behalf of group participants to the individuals receiving the majority of the votes from eligible voting members in each group. The proportion of the total nest quota assigned to a collection group is proportional to the number of group participants. Each coordinator is solely responsible for making fee payments, informing participants in their group of permit requirements, ensuring that permit requirements are met, and equitably distributing eggs to the group's participants.

Egg collections are conducted under direct supervision of Commission biologists. All eggs collected each day are presented to Commission personnel for inspection and candling at a designated egg inspection site. The coordinator may select the eggs to be retained for which a fee of $5 per egg is assessed. All remaining eggs are surrendered to Commission personnel. A sample of these surrendered eggs is opened to monitor the percentage of live eggs that are discarded. In the event the participants in the collection group elect not to collect and utilize all the available egg resource allocated to their group, the surplus nest quota is assigned to the other collection group.

An additional, rather minor, source of eggs is the orphaned egg collection which was implemented in 1989. This allows the salvage of eggs from the oviducts and nests of female nuisance alligators that are harvested.

HATCHLING HARVEST

Hatchling collection quotas were established in 1987 based on the quantity and quality of alligator habitat in 65 of the state's 67 counties (political subdivisions). Quotas range from 50 to 350 hatchlings per county. Eligible farmers identify the total quota (number) of alligator hatchlings and the counties that they prefer on applications provided by the Commission. When more than one applicant selects the same county, assignments are made by random drawing. Farmers purchasing their hatchling tags at a cost of $10.00 each, are permitted to collect hatchlings from September 15 through October. Hatchlings are tagged by farmers immediately upon capture.

One-third of revenues generated from hatchling tag fees, by law, are dedicated to alligator husbandry research aimed at improving alligator rearing techniques. Husbandry research is administrated through a contract with the University of Florida veterinary school staff who are addressing nutritional problems, stocking densities, and reproductive performance. The vet school also provides technical assistance to the farmers with diagnosis and treatment of disease outbreaks. Work on this contract has been suspended due to the lack of legislative authorization to expend the revenues collected.

ALLIGATOR FARMING

Alligator farming has increasingly relied on wild egg and wild hatchling stock to support the continued growth of the industry. Captive propagation as a result of successful reproduction among the nearly 7,000 reported breeders (this includes replacement animals that are being grown to reproductive size and age) that are maintained in captivity seems to be remaining stable, yielding approximately 10,000 hatchlings annually. Farmers are no longer required to keep their records on hatch rates of captively produced eggs separate from those of wild collected eggs. So estimates for both are obtained from farmers who voluntarily report separate hatch rates.

The number of "licensed" farms and the number of "active" farms producing hides increased through 1991 and has since remained relatively stable. Alligator farm inventories peaked in 1992 at over 113,000 animals. Inventories have since hovered around 100,000 animals. The 1995 end-of-year annual alligator farm inventory reported 47 licensed farms and 24 active farms that used CITES tags for hides they produced. The farms reported holding a total inventory of 91,759 alligators on January 1, 1996. Farmers used a total of 27,346 CITES tags on farm reared hides in 1995, producing an estimated 123,057 feet of hides averaging about 28.6 cm wide and produced an estimated 150,769 pounds of meat. Hide prices generally increased from an estimated 1994 average of $3.42/cm to $4.11/cm in 1995; reported meat values also increased from approximately $4.00 to $4.50 per pound. The estimated gross value of farm hides and meat exceeds $3.6 million dollars as summarized in Table 3.

CURRENT STATUS

Public Waters Alligator Egg Collections - In 1995, 26 of the 29 permitted farms elected to participate in one of the two organized egg collection groups. Fourteen egg collection areas were established. A nest collection quota of 894 nests was established through aerial nest surveys conducted on 14 areas in early July by Commission biologists. A total of 880 nests were opened by farmers, yielding 796 viable nests (89% of the total available quota). A total of 30,586 eggs was collected; 23,050 (75%) of the eggs collected were retained by the two collection groups; and eggs were distributed to 21 of the 26 farms assigned to the two collection groups. Egg collection coordinators indicated that collection levels were up in 1995 due to improved economic conditions in the industry. Table 6 summarizes egg collections from 1988 through 1995.

Public Waters Alligator Hatchling Collections - In 1995, a total statewide hatchling collection quota of 10,200 hatchlings was established. Eight eligible farmers purchased tags and were permitted to collect hatchlings in 21 counties from September 15 through November 1. Hatchling collection remains relatively low, however, due to the farmers' preference for obtaining eggs. Table 7 summarizes public waters hatchling collections from 1988 through 1995.

V. THE NUISANCE ALLIGATOR CONTROL PROGRAM (NACP)

The Nuisance Alligator Control Program is administered by the Division of Law Enforcement through contracts between the Commission and alligator trappers. Approximately 40 private trappers are contracted to remove specific nuisance alligators. Individuals may call the Commission office in their region to submit complaints regarding nuisance alligators. The Commission will evaluate the complaint and determine if the alligator should be removed by a licensed nuisance alligator trapper (Hines and Woodward 1980, Jennings et al. 1989). This program permits the harvest of alligators that are determined to be a threat to the welfare of the public. The program has been an unwavering success, hence, it has remained virtually unchanged since its 1978 inception.

In 1995, the Commission received 13,615 complaints. This was another record number of complaints from the public for the third consecutive year. Forty nuisance alligator trappers were issued over 10,000 permits and tags and removed nearly 5,000 nuisance alligators (Table 8). The gross value of nuisance alligator hides and meat produced is approximately $1.7 million.

All hides from nuisance alligators must be validated. Hide validations are scheduled and conducted at private sites and centralized locations by the Commission. Hides are measured, a CITES export tag is attached, and hide validation fees are collected. The validation fee for *hides* measuring greater than or equal to seven feet in length is $30.00 per hide. The validation fee for *hides* measuring less than seven feet in length is $15.00 per hide. Five dollars of the validation fee for each nuisance alligator hide is returned to the industry through the Florida Alligator Marketing and Education Advisory Committee. The money is used to fund marketing and educational projects selected by a committee of industry representatives.

VI. ALLIGATOR PRODUCTION VALUES AND PROGRAM REVENUES

The gross value of alligator hides and meat produced from farm and wild harvested alligators has averaged over $3.5 and $3.3 million, respectively during the past five years (Table 3 and Table 7). The revenue generated from these programs has averaged over $418,000 annually (Table 8). The gross value of hides and meat from wild alligators harvested in 1995 was estimated at over $5.2 million. Tag fees paid by program participants generated approximately $467,145 in revenue to the Commission.

VII. OTHER ALLIGATOR MANAGEMENT PROGRAM ACTIVITIES

Important components of all harvest programs were strict documentation and tagging requirements that ensured tight control of harvests. All hides taken from the wild (including nuisance alligators and alligators harvested on public waters and private lands) were validated with Convention on International Trade in Endangered Species (CITES) tags to identify them as legally taken hides for the international market. By rule, $69,345 of hide validation tag fees (on alligators taken from private lands and nuisance alligators) was dedicated to fund alligator marketing activities though the Florida Alligator Marketing and Education Advisory Committee. Additionally, $7,519 of hatchling tag fees was expended for alligator husbandry research.

The Alligator Management Section completed various projects in addition to implementing the major program components described above. Section biologists conducted surveys to continue monitoring statewide alligator population trends. The Section actively supported programs to educate the public about the important role the alligator plays in Florida's wetland ecosystems and how successful alligator management programs can reach beyond alligator populations to benefit all species of wildlife dependant upon wetlands. Section biologists involved in these educational efforts at fairs, public meetings, and in classrooms also stressed the urgent need for wetland conservation at a time when wetlands are disappearing too rapidly from Florida's landscape.

Educational programs were supplemented and supported by distribution of informational brochures about the life history and biology of alligators and how Floridians can safely coexist with them. Also, to support public education efforts, the Alligator Management Section utilized a portable exhibit to present an overview of alligator management in Florida. The exhibit is used by Commission staff to tell the story of alligator management in Florida at public meetings, alligator industry meetings, conferences, professional meetings, fairs and expositions, schools, and Commission offices across the state.

VIII. DISCUSSION AND CONCLUSIONS

Each alligator program element seems to spawn its own group of individuals that promote alligator conservation in a slightly different way. The following exemplify some of the positive conservation spinoffs that result from the sustained use of Florida's alligator resource.

Trappers, both nuisance alligator trappers and those hunting alligators on private and public lands are actively involved in improving the image of alligators. Their public contacts heighten public awareness of alligators and their special value. They also provide positive public education in promoting the sustained use concept as a means of conserving alligators. Alligator trappers, particularly nuisance alligator trappers, have regular contact with the public who often view alligators as a threat or in an otherwise negative light. Nuisance alligator trappers serve as public educators in their one-on-one public contact. They generally attempt to show the public the importance of having alligators in the wild, explaining the alligators role in the environment, their aesthetic and scientific value as well as the commercial value. Thousands of people views toward alligators are positively influenced by nuisance alligator trappers serving the double role as environmental educators.

Private lands participants invariably involve a trapper or farmer leasing the alligator resource rights from a landowner. The lease arrangements are usually based on sharing the income from hide, meat and egg sales with the landowner. Such an income sharing arrangement has proven to be a very powerful alligator conservation tool. The landowner sees the direct link between the number of alligators and eggs taken on his land and the economic returns. Landowner attitudes have, in many cases, changed from viewing alligators as a liability or threat toward workers and livestock on their lands to a valuable economic commodity that is now diligently guarded. Landowners have an increased regard for alligators and their wetland habitat. Although, admittedly, most other more intensive land uses have more profit potential than alligator harvests, the alligator related income is often only part of other natural resource income sources that, as a whole can be considerable. Private landowners have a more positive attitude toward alligators as well as toward the Commission, relative to other government regulators. Because of the positive experiences made possible through this program, landowners now view the Commission as a partner in this progressive and rational program of sustained use.

Alligator ranchers are the farmers that rely on wild eggs and hatchlings as the raw material for their commercial success. As a group, they have millions of dollars invested in facilities for growing alligators that come from Florida's natural areas. The loss or degradation of alligator habitat that has a direct impact on the number of alligator eggs produced is a matter of grave concern to these ranchers. Funding for the state personnel and programs that are necessary to make these resources available to the ranchers is important to them. The large sums of investment capital that is required to build alligator rearing facilities has attracted businessmen that frequently have powerful political ties and influence. These political ties have frequently provided the direct avenue to high level political offices, influencing policies that affect wetlands and securing adequate program funding. The ranchers have also been instrumental in promoting the legislation and funding favorable to the alligator industry's needs.

Revenues collected from license and tag sales have provided an enduring source of funds during years of otherwise meager government support for new and existing programs. This relatively stable revenue base ensured that the participants did not suffer from cuts to programs and services that victimized other programs. Relying on this "user-tax" approach to funding the program enabled the Commission to obtain the legislative authority to hire the biologists necessary to operate the program.

The biologists assigned to the AMS have developed considerable expertise and knowledge of Florida's alligator resource. This cadre of professionals are a pool of credible alligator conservation advocates, that would otherwise be absent without the broad management program and revenue that emanated from the sustained use of our alligator resources. The individual biologists, armed with the expertise and information garnered from a decade of alligator management, frequently serve as advocates of alligator and wetland conservation. They often work with the industry and the conservation community toward this end, for example on agricultural issues, water management and wetland restoration projects. This cadre of professional wildlife biologists remain alert and ready to counter any actions that may hinder and obstruct the stewardship of the alligator resources that has been entrusted to the Commission.

Wide fluctuations in the market for alligator products, particularly the sharp decline experienced in the early 1990's, compelled the alligator industry to cooperatively address industry growth. The industry promoted the adoption of requirements for using a portion of the tag fee for alligator marketing and education programs. The revenues collected from certain alligator tag fees has provided a source of funding for this initiative. The organization of elements within the industry bas been an inherent outgrowth of the need to work cooperatively toward a common end. Two recent industry organizations have evolved having a primary goal relating to public education.

The American Alligator Council was established in July 1993, as an umbrella organization representing all facets of the alligator industry. The council provides a forum for addressing current alligator industry issues and it serves as a vehicle for implementing cooperative efforts to promote industry growth. Their primary objective seems to be carrying out marketing initiatives that focus on the positive benefits of sustainable use. Funding from Florida's program in conjunction with monies from Louisiana and other granting sources, provides much of the support for this organizations efforts.

A grassroots organization that has recently surfaced is the American Alligator Cycle of Protection. This organization is dedicated solely to educational projects. They have worked on projects for promoting public safety and living with alligators, ensuring that a positive public sentiment toward alligators is preserved, elementary school curriculum aimed at teaching the sustainable use story and its merits for alligators. They are banking on reaching youngsters as the best means of ensuring a sustainable alligator industry in years to come. Virtually all of their funding has come from the private sector grants and donations as well as considerable volunteer efforts and industry contributions.

These examples clearly demonstrate that a new constituency of benefactors has evolved from the alligator program that are, in fact, giving of themselves and their pocketbooks to promote wise use of this natural resource. Early skeptics that questioned the likelihood that commercial exploitation could have positive conservation benefits have likely been persuaded by these tangible actions, or they must otherwise remain in denial.

In summary, all of these programs allow us to manage alligators on a sustained yield basis and recognize them as an ecologically, aesthetically, and economically valuable renewable natural resource. Revenues generated through user-fees provide funding for alligator management and research. Most importantly, the economic value gives user groups a vested interest in the welfare of wild alligator populations. Therefore, beneficiaries become political advocates for wetland preservation, which ultimately conserves habitat not only for alligators, but for a wide variety of Florida's wildlife. The protection and recovery of the American Alligator is touted as a conservation success story in U.S. wildlife conservation chronicles; the epilogue will likely be a wide recognition that sustained use of alligators has the greatest conservation benefits.

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Table 1. Public waters harvest summary, 1988-1995.

	1988	1989	1990	1991	1992	1993	1994	1995
Applications Submitted	5,855	20,163	10,122	15,311	12,085	7,380	6,859	8,909
Permits Available	238	229	189	188	176	500	500	583
Permitted Applicants	230	222	177	186	143	405	464	565
Licensed Agents	203	218	162	178	268	697	799	894
Alligator Management Units	25	29	29	29	32	32	32	36
Alligator Harvest Quota	3,435	3,405	2,835	2,820	2,640	2,500	3,000	3,498
Harvest Tags Issued	3,375	3,330	2,655	2,790	2,145	2,025	2,784	3,390
Number Harvested	2,988	3,031	2,502	2,408	1,491	1,571	2,302	2,985
Percent of Quota Harvested	87%	89%	88%	85%	56%	63%	77%	85%
Average carcass length (ft)	7.6	7.7	7.9	8.5	7.9	7.9	7.9	8.1

Table 2. Private lands alligator management summary, 1988-1995.

	1988	1989	1990	1991	1992	1993	1994	1995
Properties	7	21	35	104	73	63	84	114
Acres of alligator habitat	61,150	159,000	174,000	311,263	300,455	263,500[a]	286,579[b]	360,745[c]
Harvest tags issued	225	700	1,276	2,099	1,592	1,999	3,619	5,055
Total alligators harvested	180	577	1,117	1,600	875	1,523	2,872	4,210
Average carcass length (ft)	NA	7.7	7.1	7.8	7.6	7.7	7.6	7.6
Eggs Collected	567	1,038	2,701	4,078	1,968	998	6,944	14,225
Hatchlings Collected	72	160	160	51	0	0	16	0

[a] Habitat inventories were submitted for 54 properties.
[b] Habitat inventories were submitted for 56 properties.
[c] Habitat inventories were submitted for 72 properties.

Table 3. Estimated value of alligator farm harvests in Florida during 1977-95. Note: figures are provisional.

Year	Licensed Farms	Active Farms	Hides Produced	Total Ft. Hides	Ave. Size Length (ft.)	Ave. Size Width (cm.)	Hide Prices /lin. ft.	Hide Prices /belly cm	Hide Value	Meat Prod. (lbs.)	Meat Price	Meat Value	Total Value
1977	4	0	0	0					$0			$0	$0
1978	4	3	335	2,345	7.00	44.5	8.17	1.40	$19,159			$0	$19,159
1979	4	2	220	1,430	6.50	41.3	11.47	1.96	$16,402			$0	$16,402
1980	4	1	89	534	6.00	38.1	11.86	2.03	$6,333	1,349	4.50	$6,070	$12,403
1981	6	2	284	1,704	6.00	38.1	18.37	3.14	$31,302	4,304	5.00	$21,521	$52,824
1982	10	2	244	1,464	6.00	38.1	22.42	3.84	$32,823	3,698	5.00	$18,490	$51,313
1983	13	2	184	1,012	5.50	34.9	9.24	1.58	$9,351	2,054	5.00	$10,269	$19,620
1984	19	4	738	4,059	5.50	34.9	18.24	3.12	$74,036	8,238	5.00	$41,189	$115,225
1985	26	12	1,339	7,365	5.50	34.9	20.59	3.52	$151,635	27,962	5.00	$139,810	$291,445
1986	30	14	3,921	21,566	5.50	34.9	22.72	3.89	$489,968	58,107	5.00	$290,535	$780,503
1987	40	19	6,479	35,635	5.50	34.9	31.52	5.40	$1,123,199	69,997	5.00	$349,985	$1,473,184
1988	48	20	7,529	41,410	5.50	34.9	32.50	5.56	$1,345,809	71,099	5.00	$355,495	$1,701,304
1989	48	23	16,385	81,925	5.00	31.8	35.56	6.09	$2,913,253	128,379	5.00	$641,895	$3,555,148
1990	58	24	20,007	100,035	5.00	31.8	38.18	6.54	$3,819,336	130,490	4.50	$587,205	$4,406,541
1991	58	31	18,092	90,460	5.00	31.8	31.82	5.45	$2,878,437	135,342	4.50	$609,039	$3,487,476
1992	56	32	33,219	166,095	5.00	31.8	16.00	2.74	$2,657,520	182,401	4.00	$729,604	$3,387,124
1993	55	32	38,505	173,273	4.50	28.6	12.00	2.05	$2,079,270	212,292	4.00	$849,169	$2,928,439
1994	48	32	37,113	167,009	4.50	28.6	20.00	3.42	$3,340,170	204,618	4.00	$818,470	$4,158,640
1995	47	24	27,346	123,057	4.50	28.6	24.00	4.11	$2,953,368	150,769	4.50	$678,458	$3,631,826
Total			212,029	1,020,375					$23,941,372	1,391,098		$6,147 %^U^\	^S+ 088,577
5-yr Ave	53	30	30,855	143,979	4.70	29.8	$20.76	$3.55	$2,781,753	177,084	$4.20	$736,948	$3,518,701
Average					5.44	34.6	$21.37	$3.66			$4.69		

Active Farms: Farms that produced hides that were subsequently tagged with CITES tags.
Hides Produced: Number of hides that received CITES tags.
Total Ft. Hides: Calculated from (Hides Produced * Ave. Size (ft.)).
Ave. Size - Length: Average total length from interviews with farmers and dealers.
Ave. Size - Width: Converted from ave. length based on a conversion factor of 6.0 cm belly width per linear ft.
Hide Prices: Based on interviews with farmers, dealers, and tanners.
Meat Produced: During 1985-92, derived from farm reports. Before 1985 and after 1992, derived from estimated weight of alligators (Woodward

Table 4. Egg collection summary, 1988-1995.

	1988	1989	1990	1991	1992	1993	1994	1995
Participating Farms	22	29	29	28	27	25	26	26
Collection Areas	3	5	7	7	14	14	14	14
Nest Quota	146	296	271	506	708	926	786	894
Nests Collected	145	284	253	450	465	368	687	880
Eggs Collected	5,707	9,956	8,605	14,522	17,460	13,346	24,653	30,586
Eggs Retained	4,302	7,895	6,594	9,735	13,945	9,017	16,803	23,050
Live Eggs Surrendered[a]	27%	21%	29%	5.4%	12.4%	53%	31%	19.5%

[a] Commission staff examine a sample of the collected eggs that are culled by farmers. The figures reported represent the percentage of examined eggs that were viable.

Table 5. Hatchling collection summary, 1988-1995.

	1987	1988	1989	1990	1991	1992	1993	1994	1995
Eligible Farms	20	20	20	30	30	28	30	30	21
Permittees	20	20	20	21	10	3	7	11	8
Counties Permitted	55	63	57	62	20	6	11	17	21
Hatchling Quota	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200
Hatchlings Collected	3,908	4,172	4,959	4,820	1,944	330	1,437	535	1,605

Table 6. Summary of Florida's Nuisance Alligator Harvests from 1977 to 1995.

Year	Complaints Received	Permits Issued	Tags Issued	Alligators Harvested	Alligators Harvested/ Complaint	Meat Yield (in pounds)
1977	709[a]	--[b]	--[b]	535	0.75	
1978	4,914	2,346	3,124	1,871	0.38	
1979	4,639	2,486	3,321	1,679	0.36	3,617
1980	4,024	2,216	2,856	1,590	0.40	36,907
1981	4,931	2,622	3,318	1,871	0.38	58,656
1982	6,124	3,209	3,826	2,169	0.35	50,911
1983	5,955	3,003	3,550	1,871	0.31	53,528
1984	7,289	3,536	4,272	2,201	0.30	71,262
1985	6,432	6,187[c]	6,187	3,023	0.47	90,100
1986	6,018	5,458	5,458	3,049	0.51	95,568
1987	7,288	6,618	6,618	3,853	0.53	110,625[d]
1988	10,305	7,978	7.978	4,464	0.43	121,297[d]
1989	9,867	7,076	7,076	4,263	0.43	116,000[d]
1990	9,950	7,787	7,787	4,053	0.41	97,712[d]
1991	11,965	8,297	8,297	4,228	0.35	n/a
1992	10,480	7,880	7,880	3,564	0.34	82,735[d]
1993	12,089	9,032	9,032	4,019	0.33	96,858[d]
1994	13,431	9,812	9,812	4,632	0.34	115,911[d]
1995	13,615	10,171	10,171	4,931	0.36	106,382
TOTALS	150,025	105,714	110,563	57,866	0.39	1,308,069

[a] Complaints from an 11-county area.
[b] Permits and tags were issued in conjunction with a pilot study and were not comparable to 1978-present data.
[c] Beginning in 1985, only one tag was issued per permit.
[d] Estimated meat yield.

Table 7. Estimated value of wild alligator harvests in Florida during 1977-95. Note: these figures are provisional.

Year	Tags Issued	Gators Harvested: Nuisance	Public	Private	Total	Success %	Hides Prod.	Total Ft. Hides	Ave. TL (ft.)	Hide Prices: /lin. ft.	/belly cm	Hide Value	Meat Prod. (lbs.)	Meat Price	Meat Value	Total Value
1977		535	0	0	535		708	4,196	5.93	$15.43	$2.64	$64,738	0		$0	$64,738
1978	3,124	1,871	0	0	1,871	60%	1,556	11,005	7.07	$8.17	$1.40	$89,876	0		$0	$89,876
1979	3,321	1,679	0	0	1,679	51%	0	0				$0	3,600	$4.00	$14,400	$14,400
1980	2,856	1,590	0	0	1,590	56%	3,562	25,112	7.05	$11.47	$1.96	$287,939	36,900	$4.50	$166,050	$453,989
1981		1,871	350	0	2,221		2,732	19,179	7.02	$18.37	$3.14	$352,285	66,650	$5.00	$333,250	$685,535
1982		2,169	379	0	2,548		748	5,354	7.16	$22.42	$3.84	$120,060	60,900	$5.00	$304,500	$424,560
1983		1,871	277	0	2,148		2,261	16,045	7.10	$9.23	$1.58	$148,122	62,400	$5.00	$312,000	$460,122
1984		2,201	271	0	2,472		4,325	32,409	7.49	$18.24	$3.12	$591,101	83,500	$5.00	$417,500	$1,008,601
1985		3,023	1,052	39	4,114		2,689	20,219	7.52	$20.59	$3.53	$416,383	134,700	$5.00	$673,500	$1,089,883
1986		3,049	1,121	76	4,246		5,206	39,113	7.51	$22.72	$3.89	$888,548	135,000	$5.00	$675,000	$1,563,548
1987		3,853	1,016	0	4,869		5,320	39,847	7.49	$35.99	$6.16	$1,434,057	150,600	$5.00	$753,000	$2,187,057
1988	11,578	4,464	2,988	180	7,632	66%	7,632	59,606	7.81	$45.15	$7.73	$2,691,207	228,960	$5.00	$1,144,800	$3,836,007
1989	11,106	4,263	3,031	577	7,871	71%	7,871	60,685	7.71	$46.25	$7.92	$2,806,700	236,130	$5.00	$1,180,650	$3,987,350
1990	11,718	4,053	2,502	1,117	7,672	65%	7,672	59,151	7.71	$58.04	$9.93	$3,433,131	230,160	$4.50	$1,035,720	$4,468,851
1991	13,186	4,228	2,408	1,600	8,236	62%	8,236	65,311	7.93	$41.97	$7.18	$2,741,123	247,080	$4.50	$1,111,860	$3,852,983
1992	11,617	3,564	1,491	875	5,930	51%	5,930	45,839	7.73	$23.91	$4.09	$1,096,008	177,900	$4.00	$711,600	$1,807,608
1993	13,031	4,019	1,571	1,523	7,113	55%	7,113	55,410	7.79	$20.71	$3.55	$1,147,547	213,390	$4.00	$853,560	$2,001,107
1994	16,215	4,488	2,302	2,872	9,662	60%	9,662	75,750	7.84	$35.30	$6.04	$2,673,978	289,860	$4.00	$1,159,440	$3,833,418
1995	15,531	4,752	2,985	4,210	11,947	77%	11,947	94,262	7.89	$39.18	$6.71	$3,693,178	358,410	$4.50	$1,612,845	$5,306,023
Total		57,543	23,744	13,069	94,356		95,170	728,494				$24,675,981	2,716,140		$12,459,675	$37,135,656
5-yr Ave	13,916	4,210	2,151	2,216	8,578	62%	8,578	67,315	7.84	$32.21	$5.51	$2,270,367	257,328	$4.20	$1,089,861	$3,360,228
Average									7.43	$27.40	$4.69			$4.65		

Success %: Some years (no data) were not comparable because tags were issued after alligators were killed.
Hides Sold: Hides receiving CITES tags. Includes hides resulting from confiscations and research.
Total Ft. Hides: Actual footage during 1977-87, calculated as (Total Hides * Ave. TL) after 1987.
Ave. TL: Based on actual length data from hide validations.
Hide Prices: Actual hide prices during 1977-87. Estimates of price for average size (7.5 ft.) alligator based on trapper and dealer interviews after 1987.
/belly cm.: Calculated from (price/lin. ft. / 5.842)
Hide Value: Actual price received during 1977-87. Calculated as (Total Ft. Hides * Hide Price) after 1987.
Meat Sold: Estimated from Woodward et al. 1992 (approx. 30 lbs. per 7.5' gator).
Meat Price: Derived from trapper reports.

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Table 8. Revenue Projections by Program Element.

Year	Program Element				Total
	Public	Private	Nuisance	Farm	
1988	$ 142,350	$ 5,917	$108,208	$ 97,340	$ 353,815
1989	142,175	17,020	103,786	126,610	389,591
1990	114,900	34,677	99,166	123,270	372,013
1991	115,600	51,018	103,016	96,061	365,695
1992	86,425	36,287	88,408	90,548	301,668
1993	175,375	40,709	98,418	73,655	388,157
1994	213,500	89,160	111,904	105,365	519,929
1995	260,575	140,812	120,000	132,750	654,137
Totals	$1,250,900	$415,600	$832,906	$845,599	$3,345,005

Hind-foot track length: a method for determining the size of American Alligators[1]

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[1]Presented at the 13th Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of IUCN at Sante Fe, Argentina, May 1996

INTRODUCTION

Most techniques utilized for estimation of population parameters for crocodilians require that the animal be directly observed. For example, size estimates of crocodilians observed during night light counts have been based on the relationship between total length and snout length (Chabreck 1966, Murphy 1977, Woodward and Marion 1978, Messel et al. 1981, Webb et al. 1983, Taylor and Neal 1984, Brandt 1989). Size class estimates also have been made from direct observations of basking alligators (*Alligator mississippiensis*)(Thompson and Gidden 1972), and alligators that were color marked by size as determined from capture and direct measurement (Brandt 1989, Woodward and Linda 1993, Rhodes and Wilkinson 1994). Photographic techniques have been used to estimate crocodilian size (Choquenot and Webb 1987, Stewart 1988). Indirect methods of estimation, such as track measurements, have been evaluated for gharials (*Gavialis gangeticus*) (Singh and Bustard 1977), and nesting saltwater crocodiles (*Crododylus porosus*) (Webb et al. 1977).

Platt et al. (1990) determined the relationship between hind-foot length and snout-vent length of 39 female alligators harvested in southeastern Louisiana, and the relationship between hind-foot length and track length from five captive juvenile alligators. They found that hind-foot track length did not differ from actual hind-foot length, and that hind-foot length was a good predictor of female alligator snout-vent length. They noted that their trials were conducted with young alligators (approximately 2 years of age) and accuracy may differ for larger individuals. We compared the relationship of hind-foot measurements with snout-vent length and total length of alligators in coastal South Carolina.

METHODS

During May-September 1993 and May 1994, alligators were live captured and released as part of several studies on the Santee River Delta of coastal South Carolina. Dorsal total length (TL), snout, ventral snout to rear of vent (SVL), vent, ventral tail, and neck, torso, and tail girth were measured to nearest 0.1 cm. Sex (Chabreck 1966) and weight were also recorded. Hind-foot length (HF) was measured from the first single extended scute posterior to the heel to the anterior end of the middle toe, not including the nail. Hind-foot track lengths were measured at capture sites when clear tracks were present and compared to HF lengths of captured animals. Animals were grouped by sex (M or F) and size (<>120 cm TL).

Relationships among TL, SVL, and sex were explored utilizing linear regression to determine the best overall predictor of alligator size from HF and track measurements. Determination of the predictor chosen for recommendation was made by examination through standard statistical indicators and ease of use by field personnel.

RESULTS AND DISCUSSION

We captured 248 alligators comprised of 132 males:116 females; 162 of which were >120 cm (Table 1; Figure 1). Total length ranged from 31.3 cm to 382.8 cm. We regressed TL and SVL on HF for all animals with only a linear term. Total length best described the data in this first model (adj r^2 = 0.97; CV = 9.21; $P < 0.0001$).

Table 1. Means (cm) and standard errors for morphological measures of South Carolina alligators.

Group	Sex	n	TL	SE(TL)	SVL	SE(SVL)	HF	SE(HF)
All	Both	248	174.4	9.7	89.0	7.0	15.3	2.8
All	F	132	162.3	9.2	82.2	6.6	14.3	2.7
All	M	116	188.1	10.1	96.8	7.4	16.4	2.9
Adult	Both	162	231.1	7.8	118.7	5.8	20.0	2.2
Juvenile	Both	86	67.6	4.9	33.2	3.4	6.3	1.5

However, due to heterogeneity of variances in a given body measurement and HF between alligators <120 cm and >120 cm, we were unable to accept this model. We were able to fit a loglinear model with a quadratic term that satisfied all assumptions (adj $r^2 = 0.98$; CV = 1.82; $P < 0.0001$) (Figure 2):

$$\log\ (TL) = 3.20 + 0.17\ (HF) - 0.0028\ (HF)^2$$

A separate model was constructed which satisfied all assumptions utilizing only data from animals >120 cm (adj $r^2 = 0.97$; CV = 8.8; $P < 0.0001$). The following equations would be applicable for animals >120 cm:

$$SVL = 8.386 + 6.346\ (HF)$$

$$TL = 2.36 + 11.42\ (HF)$$

or a ratio of approximately 11.5:1 TL:HF. For most field applications a ratio of 12:1 TL:HF would probably suffice. For animals <120 cm, an approximate ratio of TL:HF was 10.4:1.

Alligator tracks have been shown to differ very little from actual foot size in experimental situations (Platt et al. 1990), and in our field observations. If so, this method could be valuable in estimating size of alligators which cannot be estimated directly. Female alligators routinely leave tracks around their nest sites (pers. obs.), but require concentrated effort to capture and measure directly. The relationship between HF length and SVL or TL can be used to accurately estimate size of female alligators at most sites where capture and direct measurement is impractical. Additionally, capture operations that target particular size alligators using passive traps, ie. walk through snare design (Wilkinson 1994), would be enhanced where HF track length could direct efforts toward specific size individuals.

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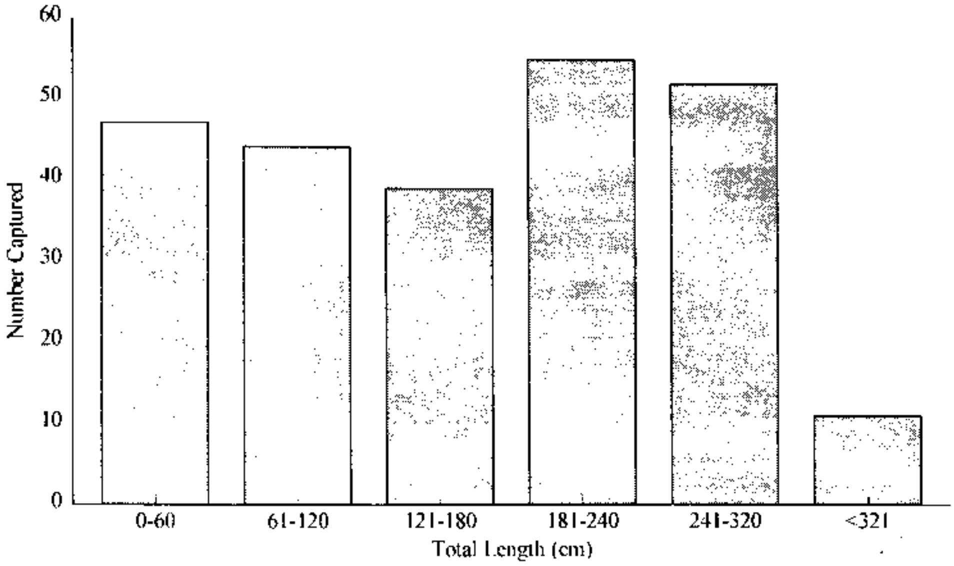

Figure 1. Size distribution of all alligators captured in coastal South Carolina during 1993-1994.

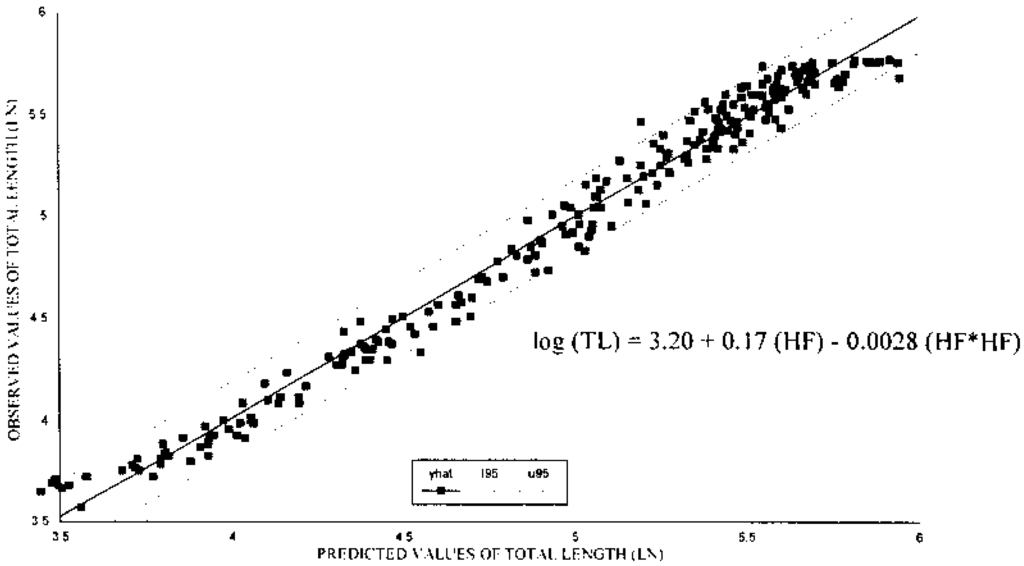

Figure 2. Observed vs. predicted values for a regression of hind-foot length on log (total length) for all alligators captured in coastal South Carolina during 1993-1994 (yhat = predicted line. l95 and u95 = 95% CI on yhat).

RETENTION RATES OF METAL TAGS IN STOMACHS OF AMERICAN ALLIGATORS

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American alligators (*Alligator mississippiensis*) are often marked for later identification by attaching monel tags to the webbing of the feet (Rootes et al. 1991). Alligators are very cannibalistic; and if a marked alligator is eaten by another alligator, the web tags are retained for period of time in the stomach of the predator alligator after the marked alligator is digested (Delany and Abercrombie 1986, Rootes and Chabreck 1993). Material in an alligator's stomach that is not digested such as hair, feathers, fish scales, wood, plastic, and metal is eventually regurgitated (Chabreck 1996); however, the length of time that different materials remain in the stomach will vary.

The presence of a web tag in an alligator stomach indicates that the alligator has consumed another alligator, and the number of tags present in stomachs indicates predation rates. However, because tags from depredated alligators are eventually lost from the stomach, information on the rate of tag retention in the stomach must be available if predation rates based on the presence of tags are to be determined.

The objectives of this study were to determine the retention rate of tags in stomachs of alligators and to compare retention rates between alligator size classes.

METHODS

The study was conducted in LaFourche Parish, Louisiana, on the 20,235-ha Golden Ranch Plantation (GRP) approximately 33 km southwest of New Orleans. A 4,200-ha intensive study area was located on the northwestern portion of GRP. The study area was located in freshwater marsh (Chabreck and Linscombe 1978) and consisted of approximately 50% open ponds and 50% marsh. Pond depths ranged from 30-90 cm. The intensive study area contained 23 km of canals that were approximately 3 m deep and 15 m wide and approximately 25 km of ditches about 1 m deep and 2 m wide.

Marked baits were used to determine the length of time that tags remain in the stomach of an alligator. Numbered monel web tags (1 cm long) and steel washers (serially numbered using a metal stamp) were attached to a chicken leg used as bait and placed in the study area. Marked baits were set out on lines suspended 0.2-0.3 m above the water similar to the method used by alligator hunters, except that no hook was used and the string was light enough to break when the bait was taken by an alligator.

Washers were 4 cm in diameter, a size that prevented their passage through the stomach and facilitated their detection in the stomach of an alligator that had taken a marked bait. Two tags and one washer per bait were used during 1991. Four tags and one washer per bait were used during 1992. Eighty-three baits were set out between May and August 1991. In 1992, 100 baits were set out during April, June, and August for a total of 300 baits. Baits were spaced about 100 m apart, set out a night, and checked at sunrise the following morning. Tag numbers and washer numbers were recorded at each site, as well as the date each was taken.

Stomachs were collected from alligators captured during commercial harvests held on GRP in September 1991 and 1992. During 1991, 455 stomachs were collected; 419 were collected in 1992. Alligators were captured by trappers using baited hooks. Legal restrictions limited the harvest to alligators >1.22 m total length (TL). Only harvestable size (>1.22 m TL) alligators were assumed to be cannibalistic.

All harvested alligators were marked with a numbered harvest tag, and the date, TL, weight, and sex of each animal was recorded. After each animal was skinned, its stomach was removed and the contents were visually inspected to determine if they contained web tags or washers. Stomach contents also were radiographed with standard X-ray equipment to locate washers and tags not found during visual inspections.

RESULTS AND DISCUSSION

To test the hypothesis that tag retention rates were the same for large and small alligators, we grouped the predator alligators by size class (<2.13 m TL and ≥2.13 m TL). During 1991-1992, 383 marked baits were taken by alligators. Tags and washers from baits were recovered from stomachs of 49 (5%) of 874 harvested alligators. The daily tag retention rate for predator alligators <2.13 m TL (0.9975, Table 1) was greater than (X^2=44.30, 3df, P=<0.01) the daily tag retention rate for predator alligators ≥2.13 m TL (0.9909, Table 2). Retention rates did not differ among the 4 bait hanging sessions (<2.13 m TL:X^2 = 1.39, 3 df, P = 0.708; ≥2.13 m TL:X^2 = 1.64, 3 df, P = 0.650). The frequency of baits with 0 through 4 tags retained was compared to the expected number using a chi-square test and assuming a binomial distribution. Results indicated that the tags were not lost independently of each other (X^2 = 25.79, 4 df, P <0.01). Therefore, we could not adjust predation rates based on the number of tags recovered.

Between May and August, 1991, 83 marked baits were taken by alligators. Of these, five washers and five tags were recovered from stomachs of alligators taken in the September 1991 harvest. Five alligators consumed these items; all were males and average 2.17 m TL. Six washers and six tags from the 1991 tagged baits were recovered from stomachs of six alligators harvested in September 1992. The alligators that consumed these baits were also males and averaged 1.62 m TL.

In 1992, we used 300 baits and all were taken by alligators. We recovered at least one item (web tag or washer) from 71 of the 300 baits. A total of 184 tags and 45 washers were recovered from the stomachs of alligators taken in the 1992 harvest. Of the alligators that consumed the baits, 34 were males and averaged 1.92 m TL; 4 were females and averaged 1.80 m TL. Of the tags recovered, 58 were from the April 1992 baiting session, 48 were from June 1992, and 72 were from August 1992.

Rootes (1989) conducted similar studies at Lacassine National Wildlife Refuge (NWR) in Southwestern Louisiana and found that 79.3% of 92 tags ingested by alligators were retained after 39.7 (±3.6) days; however, he did not find a difference in retention rates by different size alligators. If tag retention rates were constant, then the daily retention rate reported by Rootes would be 0.9942 and consistent with our results.

We failed to show that loss of an individual tag was independent of the loss of another tag in the same stomach. This was caused primarily by results from one stomach. An alligator 2.62 m TL had consumed at least 7 baits, because 7 washers were found in its stomach. However, only 1 of 28 monel tags on the baits was present in the stomach. When sorting stomach contents, we noted that tags were often contained in balls of hair. The balls of hair are not digested and must be regurgitated. If a predator had consumed one or more fur-bearing animals such as nutria (*Myocastor coypus*) or raccoon (*Procyon lotor*) just prior to or just after eating a tagged alligator, it may be more likely to lose the tag than a predator that had no hair in its stomach. This may account in part for the lower tag retention rate of larger alligators that consume more fur bearers than are consumed by smaller alligators (Wolfe et al. 1987).

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Table 1. Retention rate of monel web tags in stomachs of alligators <2.13 m TL taken in the 1992 harvest on Golden Ranch Plantation, LaFourche Parish, Louisiana.

Bait session	A No. of tags eaten	B No. of tags recovered	C Ratio of tags recovered	D No. of days retained	E Daily tag retent. rate	F Exp. ratio tags retained	G Exp. tags retained	X^2
Formula			(B/A)		$C^{1/D}$	E_5^D	F/A	$\frac{(B-G)^2}{G}$
May 1991	12	6	0.417	295[a]	0.9969	0.491	5.88	0.134
April 1992	56	46	0.804	150	0.9985	0.687	38.50	1.097
June 1992	52	43	0.827	90	0.9987	0.799	41.53	0.051
August 1992	68	59	0.868	40	0.9975	0.905	64.53	0.104
Weighted Average					E_5 0.9975			
Total								1.387

[a]31 May 1991 - 16 September 1992 minus 180 days for winter 1991-1992.

Table 2. Retention rate of monel web tags in stomachs of alligators ≥2.13 m TL taken in the 1992 harvest on Golden Ranch Plantation, LaFourche Parish, Louisiana.

Bait session	A No. of tags eaten	B No. of tags recovered	C Ratio of tags recovered	D No. of days retained	E Daily tag retent. rate	F Exp. ratio tags retained	G Exp. tags retained	X^2
Formula			(B/A)		$C^{1/D}$	E_5^D	F/A	$\frac{(B-G)^2}{G}$
May 1991	60	12	0.200	150	0.9893	0.254	15.22	0.679
April 1992	8	5	0.625	90	0.9948	0.439	3.51	0.630
June 1992	16	13	0.812	40	0.9948	0.794	11.10	0.326
August 1992	68	59	0.868	40	0.9975	0.905	61.53	0.104
Weighted Average					E_5 0.9909			
Total								1.636

POST-BREEDING HABITAT USE BY THE AMERICAN ALLIGATOR

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Habitat use by American alligators (*Alligator mississippiensis*) has been reported by numerous authors based on casual observations, night lighting counts, and radio telemetry. Casual observations fail to provide quantitative data on habitat use, and night lighting counts often are biased because alligators are more conspicuous in certain habitats and some animals may be wary and difficult to approach (Woodward and Marion 1978). Most studies on radio-collared alligators contained small sample sizes and involved animals that were captured and released in what may have been a previously established activity range (Rootes and Chabreck, 1993a). The purpose of this study was to determine if sex and size classes of alligators harvested by baited hooks (Palmisano et al. 1973) differed among marsh (< 50% open water), pond (> 50% open water), and canal habitats during the post-breeding period in late summer.

METHODS

The study was conducted on the 12,869-ha Lacassine National Wildlife Refuge in southwestern Louisiana. A 6,478-ha permanently flooded impoundment located within the refuge served as the principle study site. The impoundment, referred to as Lacassine Pool, consisted of floating freshwater marsh interspersed with shallow ponds and canals. Dense, emergent stands of maidencane (*Panicum hemitomon*), bulltongue (*Sagittaria lancifolia*), and spikerush (*Eleocharis* spp.) dominated the marsh. Ponds were 0.3-1.0 m deep and contained submerged and floating plants including watershield (*Brasenia schreberi*), fanwort (*Cabomba caroliniana*), coontail (*Ceratophyllum demersum*), American lotus (*Nelumbo lutea*), and fragrant waterlily (*Nymphaea odorata*). Canals were approximately 6 m wide, 3 m deep, and contained no vegetative cover.

In September 1988, a commercial alligator harvest was held in Lacassine Pool. Alligators were captured by contract trappers using hooks baited with beef lungs and suspended 0.2-0.3 m above the water's surface. On selected days trained observers accompanied trappers on their morning rounds. A total of 622 overnight baited hook sets were examined during the study. As alligators were removed from the sets, they were marked with a numbered harvest tag. Observers classified the habitat at each capture site into one of the three habitat types. Prior to removal from the refuge, the total length (TL) of each alligator was measured along its dorsal surface, and its sex was determined by cloacal examination (Chabreck 1963).

Legal restrictions limited the harvest to alligators > 1.20 m TL. Palmisano et al. (1973) reported that the baited hook harvest method was biased toward adult alligators

(> 1.82 m TL). However, because the same capture method was used in all habitats, the number of alligators of each size class captured in each habitat was indicative of the relative abundance of the size class within the habitat and allowed for comparisons among habitats. Chi square contingency tables (Steel and Torrie 1980) were used to test the null hypothesis that the capture rate of adult males, adult females, and juvenile alligators did not differ among habitat types.

RESULTS AND DISCUSSION

During the study, 124 alligators were harvested for an average capture rate (number captured per 100 sets) of 19.9% (Table 1). Eighty percent of the alligators harvested were adults. Joanen et al. (1984) examined 2,800 alligators harvested in Louisiana over a 5-year period and reported that 76% were adults. The capture rate of adult male alligators averaged 9.2% in Lacassine Pool and differed among habitat types ($X^2 = 7.59$, 2 df, $P = 0.02$). The capture rate in marsh habitat was 2.2 times greater than in canal habitat and 1.8 times greater than in pond habitat (Table 1), This was in contrast with the report by Joanen and McNease (1972), that 79% of the adult male alligators were found in canals during late summer in Louisiana. Also, Goodwin and Marion (1979) stated that 76% of the recorded locations of adult male alligators were in open lake habitat during the summer in Florida.

Table 1. Number of alligators captured and capture rate by sex and age classes in canal, marsh, and pond habitats in Lacassine Pool, September 1988.

		Captures (N)			Capture rate (%) [a]		
Habitat Types	Baited hook sets (N)	Adult males	Adult females	Juveniles	Adult males	Adult females	Juveniles
Canal	263	18	8	6	6.8	3.0	2.3
Marsh	140	21	17	2	15.0	12.1	1.4
Pond	219	18	17	17	8.2	7.8	7.8

[a] Capture rate is the number of captures per baited hook set expressed as a percentage.

The capture rate of adult females averaged 6.8% in Lacassine Pool and differed among habitat types ($X^2 = 12.54$, 2 df, $P = 0.01$). As with adult males, the capture rate of adult females was greatest in marsh habitat (Table 1) and was 4.0 times greater than the capture rate of adult females in canal habitat and 1.6 times that of pond habitat. Hines et al. (1968) and Joanen and McNease (1970) reported that adult females were more abundant in marsh habitat. Joanen and McNease (1970) stated that 96% of the locations of radio-collared adult females during the late summer post-hatching period were at dens in marsh habitat.

Our findings that the capture rates of adult male and female alligators were greater in marsh habitat in Lacassine Pool in late summer indicate that adults of both sexes were more abundant in marsh habitat at that time. Our findings are in agreement with the report by Hagan (1982) that 95% of the locations of radio-collared adult male and female alligators in North Carolina were in dense marsh and swamp habitat in late summer and early fall. In fact, he noted that dense marsh was heavily used at all times of the year and open water areas were not preferred by either sex at any time of the year. However, Hagan (1982) indicated that canals within dense marsh areas may have been used during the breeding season but the precise location of alligators could not be determined.

The capture rate of large juvenile alligators averaged 4.0% with the greatest capture in pond habitat ($\underline{X}^2 = 12.38$, 2 df, $\underline{P}$ 0.01). The capture rate in pond habitat was 5.4 times that of marsh habitat and 3.4 times that of canal habitat. McNease and Joanen (1974) reported that immature alligators avoided marsh habitat during summer and fall and were commonly found in canals and ponds. Their study was in estuarine emergent wetlands (Cowardine et al. 1979), and ponds in that habitat did not contain floating-leaved and emergent aquatic plants as found in ponds in Lacassine Pool. The use of pond habitat by juvenile alligators in Lacassine Pool was thought to be related to predator avoidance. Selection by smaller alligators of habitat that offers concealment and escape from larger alligators may provide a means of avoiding cannibalism (Rootes and Chabreck 1993b). The use of deep, open water areas by immature alligators in the study by McNease and Joanen (1974) suggests that cannibalism may not have been as prevalent in estaurine wetlands as in Lacassine Pool (Rootes and Chabreck 1993b). Wolfe et al. (1987) noted that where nutrias (*Myocastor coypus*) and muskrats (*Ondatra zibethicus*) were abundant, they were important in the diet of large alligators. McNease and Joanen (1977) found that the mammals were taken in substantial numbers by large alligators in their study area.

Use of pond habitat in Lacassine Pool by juvenile alligators also may have been related to prey availability. Juvenile alligators in southern Louisiana prey extensively on crustaceans (Giles and Childs 1949, Chabreck 1971, Wolfe et al. 1987), which may be more available to alligators in shallow ponds than in marsh and canal habitats in a freshwater system. In the estuarine wetlands, as studied by McNease and Joanen (1974), resources used by immature alligators may have been more available in deep water habitats in summer and fall (Chabreck 1971).

The distribution of adult male and female radio-collared alligators as noted by Joanen and McNease (1970), Joanen and McNease (1972), Goodwin and Marion (1979), and Hagan (1982) may have been a function of where the animals were captured and the nature of their traditional home range. Goodwin and Marion (1979) noted that winter movement of alligators in Florida may have been biased because alligators may have selected winter den sites prior to attachment of radio collars. Fourteen of fifteen radio-collared adult female alligators monitored on Lacassine Pool between June 1988 and June 1989 (Rootes and Chabreek 1993a) spent most of their time in marsh habitat. However, all 14 were captured and released in marsh habitat. The one female that spent considerable time in pond habitat was captured and released in pond habitat.

ACKNOWLEDGMENTS

We are grateful for the assistance of personnel of the U. S. Fish and Wildlife Service, Louisiana Department of Wildlife and Fisheries, and Louisiana State University Agricultural Center.

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Population Studies of American Alligators (*Alligator mississippiensis*) Inhabiting a Reservoir: Responses to Long-Term Drawdown and Subsequent Refill

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ABSTRACT: A 6 m drawdown of an 1100 ha reservoir in South Carolina, USA in 1991 continued to have an effect on the reproduction of resident alligators through the summer of 1994 when reservoir refill began. Clutch sizes in 1994 were reduced by 10.9 %. Body condition of hatchlings, as evaluated by weight/length relationships, was also lower during the period of drawdown than before. Nest depredation may have been reduced during drawdown however, providing some compensation for negative impacts upon clutch size and hatchling condition. Changes in numbers of alligators, as counted by night eyeshine censuses, could be explained by changes in visibility due to variation in emergent macrophyte cover along the reservoir shoreline. Within years, eyeshine counts varied between regions of the reservoir in proportion to the amount of available shoreline but not in proportion to the area of open water. Radiotelemetry studies showed movements of alligators varied between sexes and between drawdown vs. post-refill conditions. Only males moved long distances between regions of the reservoir, and only during the drawdown period. Alligator movements were generally reduced following refill. Wintering behavior during periods of exceptionally cold weather following refill followed expected patterns. Par Pond formerly served as a nuclear reactor cooling reservoir, and its sediments contain elevated concentrations of mercury and some radionuclides. Although no changes in mercury or radiocesium concentrations in alligator tissues could be related to the drawdown or refill, reservoir filling has been shown to enhance mercury bioavailability at other locations. This suggests the potential for increased mercury uptake by alligators in future years following refill. In general, this reservoir alligator population seemed highly resilient to any major negative impacts associated with reservoir drawdown and refill, with the exception of the flooding of nests and drowning of 14.6 % of the eggs in six nests studied. Such losses could be avoided by altering the timing of reservoir refill to avoid periods when eggs are incubating. An understanding of the basic ecology and natural history of any resident population of crocodilians is essential to minimizing detrimental impacts on these animals, as a result of reservoir management programs.

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INTRODUCTION

The alligator population in the 1100 ha Par Pond reactor cooling reservoir (Figure 1) on the U.S. Department of Energy's Savannah River Site (SRS) near Aiken, South Carolina, USA has been studied intensively over 25 years (Murphy 1977, 1981; Brisbin 1982; Brandt 1989, 1991; Brisbin *et al.* 1992). Early studies emphasized the movements and behavior of these alligators in response to thermal gradients in the reservoir due to heated effluents from one or two operating nuclear production reactors (Murphy 1977, 1981; Brisbin 1982). Later studies focused on population size, structure and reproduction, including changes in these parameters following the termination of all thermal inputs to the reservoir in 1987 (Brandt 1989). During this intervening 20-year period, the Par Pond alligator population more than doubled from an estimated 110 to 266 individuals. There was a concurrent shift in population age structure from a high proportion of large adults in 1972-1978 to a high proportion of juveniles in 1986-1988 (Murphy 1977, 1981, and Brandt 1989, 1991, respectively). Although there was no change in sex ratio during these years, the change in age structure was accompanied by an increase in reproductive output from an average of 2.3 to 4.0 nests per year (Brandt 1989, 1991).

Information concerning crocodilians now using reservoir impoundments worldwide (Alcala and Dy-Liacco 1989) now include reports of endangered species (Thorbjarnarson 1992). Whitaker and Whitaker (1989) for example, indicate that the last wild population of *Crocodylus siamensis*, one of the world's most critically endangered crocodilians, is now limited in its distribution to a single reservoir in Thailand. These facts indicate the importance of information on crocodilian responses to changes in reservoir hydrology, particularly in light of the need to periodically alter water levels in reservoirs for various management purposes. Between early July and mid-September 1991, the Par Pond Reservoir water level was lowered approximately 6 m to allow repair of the retaining dam (Figure 2). This was the largest change in water volume since the reservoir was created in 1958. The long-term stability of water level had resulted in extensive beds of submerged and emergent aquatic vegetation, particularly within the 6 m depth contour (Parker *et al.* 1973; Smith *et al.* 1986). The 1991 drawdown reduced the surface area of the reservoir by approximately 50%, and killed the aquatic macrophytes above the 6 m depth contour. The 526 ha of exposed mud flats that resulted (Figure 1) were quickly colonized by terrestrial old-field vegetation.

Ecosystem changes caused by the drawdown created concerns for the reservoir's resident alligator population and its reproductive output. Although subsequent studies showed that three alligator nests initiated before drawdown all hatched, the lack of emergent vegetative cover along the shoreline of the lowered reservoir and the concentration of larger alligators suggested that young alligators could be particularly vulnerable to predation from larger conspecifics, largemouth bass (*Micropterus salmoides*), and the increased numbers of wading birds attracted to the reservoir following drawdown (Brisbin *et al.* 1992). This same study also showed that several alligators left the reservoir following drawdown. Two of these were later killed in smaller nearby impoundments, presumably by larger alligators already resident in these habitats. However, more alligators were counted in night eyeshine censuses conducted after drawdown than before (Brisbin *et al.* 1992); this was thought to result from increased animal visibility along the exposed shoreline of the lake.

Radio-tracking of adult alligators following drawdown indicated sexual differences in movement behavior; males moved extensively throughout the lowered reservoir and outnumbered females by 2:1 among those animals that left the reservoir. In colder weather, long-distance movements ceased and nearly half (6/13) of the telemetered alligators spent the winter in open water along a < 300 m length of the northern shoreline of the drawndown reservoir's West Arm. In late January 1992, the discovery of an adult female alligator with several small juveniles in an elaborate ring-shaped underground den located at the former (full pool) shoreline, confirmed that not all of the post-drawdown alligator population was wintering in open water habitat (Brisbin *et al.* 1992).

Par Pond reservoir refill began in August 1994 by allowing a "passive refill" to take place as the result of natural rainfall events. In December 1994, active pumping of water from the Savannah River was initiated and full pool was attained by January 1995 (Figure 2). The present paper describes the results of Par Pond alligator population studies through the latter portion of the 3-year drawdown (September 1991 through August 1994), and through the subsequent refill and post-refill periods (August 1994 through March 1996). Using techniques similar to those employed in previous research, we (1) used night eyeshine surveys to infer changes in population numbers and distribution in the reservoir, (2) sought to identify changes in reproductive effort in the population, (3) used telemetry studies to follow the movements and distribution of individual alligators in the reservoir and, (4) studied the alligators' wintering behavior following reservoir refill.

Sediments in Par Pond contain elevated levels of mercury, radiocesium and other radionuclides. After drawdown, the Par Pond reservoir system was designated as a waste site under terms of United States (CERCLA) environmental legislation (Hickey et al. 1993). This created special concern for pollution monitoring and mitigation. Therefore, we also assessed the potential for Par Pond alligators to accumulate contaminants such as the gamma-emitting radionuclide cesium-137 (^{137}Cs) and mercury (Hg), throughout the period of reservoir drawdown and refill. We also report here the results of a pilot study to determine the rate and pattern of ^{137}Cs increase in the tail muscle of two captive alligators that were fed fish collected from the Pond B portion of the Par Pond reservoir system where elevated levels of this contaminant occur (Brisbin 1989; Whicker *et al.* 1990).

MATERIALS AND METHODS

Study Area:

The Par Pond reservoir is located in South Carolina within the Upper Atlantic Coastal Plain. It was created in 1958 by impounding an area containing several natural streams. The reservoir is located on the SRS, a 750 km^2 reservation that was closed to public access in the early 1950's. Winter temperatures at this site, which represents the northernmost inland extension of the alligator's range in this part of the southeastern United States, averaged 4.9, 4.6 and 4.9 °C in December, January and February, respectively, between 1971-1981 (Brisbin *et al.* 1982). Jenkins and Provost (1964), Murphy (1981) and Hillestad and Bennett (1982) provide more detailed information concerning the climate, topography, flora and fauna of the SRS.

The major subdivisions of the Par Pond reservoir system (Figure 1) include four regions of Par Pond itself and two smaller reservoirs located to the north. All received heated effluents from one or two operating nuclear production reactors prior to 1987; since that time, all thermal inputs have ceased. Further details concerning the history of reactor operations and the thermal gradients in this reservoir system are provided elsewhere (Parker *et al.* 1973; Gibbons and Sharitz 1974). The responses of Par Pond alligators to these thermal gradients were described by Murphy (1977, 1981) and Murphy and Brisbin (1974).

Night Eyeshine Counts:

Eyeshine counts were conducted from an airboat on nights with reduced wind and wave action to maximize alligator visibility. The entire periphery of the reservoir was surveyed during each census. We attemped to use, as much as possible, the same techniques as used by Murphy (1977, 1981) and Brandt (1989,1991). Eyeshine counts during the predrawdown period, as reported by the above authors, were made on 18 nights in 1972, on 15 nights in 1973 and in 1980 (n = 1), 1982 (n = 1), 1987 (n = 19), and 1990 (n = 15). During the period of lowered water level, eyeshines were determined during separate nights in 1991 (n = 6), 1993 (n = 7), and 1994 (n = 6). After refill, eyshines were counted on 11 nights in 1995. To determine yearly population trends, data were pooled for each year on a monthly basis and a mean was calculated if more than one survey was done in a month.

To determine if water surface area and shoreline lengths affected alligator distribution, chi-square tests were used to compare the mean number of alligators observed in each region of the reservoir vs. what would be expected based on surface area or shoreline available in that region. This was done for two drawdown years (1993-94) and one year after refill (1995). Tests were performed separately for available shoreline and surface area as well as separately for each year. For each year, data were pooled on an annual basis during the peak summer months (June-August) and a mean was calculated

Reproductive Studies:

As in previous years, direct searches of locations known for previous nesting activities proved to be the most effective means of locating alligator nests. Searches of the entire reservoir shoreline by boat and foot for nests were not undertaken. The development of dense vegetation along the reservoir's exposed mudflats made it necessary to employ aerial surveys for nests with fixed-wing aircraft. However, it was not possible to derive reliable, quantitative estimates of annual reproductive efforts in the entire alligator population, since aerial nest surveys of the lake shore may have missed nest locations concealed by shrubs or tree canopy. Determinations of the fates of nests in 1993-1994 were made by visiting them at 1-2 week intervals and more frequently when hatching was about to occur. These visits produced information on nest dimensions, clutch sizes, hatching success and inferred causes of mortality for each nest studied. Nests were either opened during incubation or estimates of clutch sizes were made after hatching by summing the number of unhatched eggs and the minimum number of empty eggshells and/or eggshell membranes found at the nest site.

Hatchlings were captured as soon after hatching as possible. Most were weighed on a laboratory balance ($\pm$ 0.1g), but a few were weighed in the field on a spring balance ($\pm$ 0.5g). Total length was measured ($\pm$ 1.0 mm) and they were then marked with tail scute notches and/or toe clips and released immediately. Hatchling data from the predrawdown period was taken from six of the ten nests reported by Brandt (1989), selecting data from those young that were most likely to have been measured within ten days after hatch. All 1994 hatchlings (measured during drawdown) were captured within a week of hatching. To determine if drawdown had an effect on the weight of hatchling alligators we used two-way analysis of covariance (ANCOVA). Reservoir status (predrawdown vs. drawdown) and an among-female dummy variable were the independent variables, and hatchling length was the covariate. Nests occurring in the same location of the reservoir both before (1981-1988) and after drawdown (1993-1994) were considered to have resulted from the same female, because of known nesting site fidelity. Hatchling data from 11 nests (6 predrawdown, 5 post-drawdown) representing 9 females, were used in this analysis.

Capture and Radiotelemetry:

Adult alligators were captured using a modified version of automated baited trip snares (Murphy and Fendley 1975; Murphy *et al.* 1983), using the same general techniques as Brisbin *et al.* (1992). Captured alligators were measured, sexed by cloacal examination and equipped with a radio transmitter weighing less than 250 g. Transmitters were mounted directly on the alligator's neck with stainless steel wire through holes drilled in the dorsal nuchal scutes. Alligators were provided with coded tail scute notches for individual identification on recapture in the event of transmitter loss; they were then released at the site of capture immediately after transmitter attachment.

Telemetered alligators were relocated during daylight hours from a small boat, and their positions were plotted on a map of the reservoir digitizied from engineers' drawings and reduced to fit on a 39 x 50 cm paper. Attempts were made to relocate each telemetered alligator at monthly intervals. Throughout the 2-year period covered by this report (April 1, 1994 through April 1, 1996) a total of 157 locations were made of 18 telemetered alligators (9 males/9 females).

Telemetered alligators were only rarely located visually; most relocations were concealed underwater locations. It was thus not always possible to immediately determine whether given animals were alive at the time of a relocation or whether the transmitter had fallen off. Therefore, unless subsequent evidence of movement occurred, no relocation data were used from any transmitter when its location did not change for more than two months during warm weather periods when alligators would be expected to be active. In addition, efforts were made to locate telemetered alligators in the early morning hours of exceptionally cold winter days, particularly when thin ice formed along the edges of the reservoir.

Contaminant Studies:

Mercury concentrations were determined in various tissues of Par Pond alligators. Where possible, samples of blood and dermal scutes were obtained from live-trapped individuals. Collection of these samples did not permanently harm the alligators, and they were released after sample collection. Blood was obtained from the post-cranial sinus, and dermal scutes from the dorsal region of the tail. In some cases, alligators were found dead, usually either by drowning after trapping, or as a result of hostile encounters with other alligators. Additional tissues, including liver and muscle, were obtained from dead individuals where possible. Tissues were individually stored in polyethylene bags or in glass vials and frozen until analysis.

Total mercury was determined by either gold-foil amalgamation with conductivity detection (using an Arizona Instruments Jerome 511 Mercury Analyzer), or by cold-vapor atomic fluorescence (CVAF; using a Brooks-Rand Model 2 Analyzer). Instruments were calibrated before use with NIST (U.S. National Institute for Standards and Technology) traceable standards, and the calibrations verified at periodic intervals. Before analysis, solid tissues were freeze-dried to determine moisture content, then digested by heating in a 1:1 mixture of HNO_3 and H_2O_2 in covered teflon vessels. For quality assurance, about 20 % of the samples analyzed consisted of reagent or digestion blanks, spiked material, replicates, or standard reference materials of known mercury content (purchased from the National Research Council of Canada). Further details of the analytical procedures and the quality assurance results may be found in Yanochko *et al.* (in press). Most mercury concentrations measured in Par Pond alligators have been reported in Yanochko *et al.* (in press). Here, we report mercury levels in additional tissues collected since the previous study was completed, and present a reanalysis of the data to attempt to detect changes in mercury concentrations associated with the refill of the reservoir.

The radionuclide contaminant of primary concern in the Par Pond reservoir system is ^{137}Cs (Brisbin 1989) so radiological assessments of alligators were confined to this particular isotope. Both the isotopes ^{134}Cs and ^{137}Cs were released into the Par Pond reservoir system, with the last releases over 20 years ago. The present contribution of ^{134}Cs to the total radiocesium burden was considered negligable, because of the short (Ca. 2 yrs.) physical half life of this isotope.

Since gamma emissions from radiocesium incorporated into an animal's body tissues can be detected externally, whole-body burdens of radiocesium can be quantified in living alligators by the use of field gamma counting techniques developed for deer by Rabon and Johnson (1973) and Wright and Splichal (1973). In adapting these techniques for use on adult alligators (total length > 1.5 m), lead brick shielding was erected to reduce background gamma counts. Gamma-ray photons in the range 550-760 KeV were detected by a NaI crystal (Eberline SPA-3) positioned about 10 cm above the midline of the dorsal surface of the base of the alligator's tail. Radiocesium tends to concentrate in muscle, so the large muscle mass at the base of the tail was selected for evaluation. Emissions were recorded by a portable, battery-powered gamma detecter (Eberline ESP - 1 Smart Portable). While counts were being recorded, the alligator was restrained beneath the detector and on top of a layer of 5.5 cm-thick lead brick shielding. Counts were recorded for 10 minute periods. On the same day, additional 10 minute determinations were made of an aqueous cylindrical phantom of known radiocesium concentration. This phantom approximated the diameter of the base of the alligator's tail at the point beneath the midpoint of the detector, and was used to estimate detector efficiency. By taking advantage of the tapered shape of alligator tails, gamma counts from various sized alligators (total length 1.5 - 3.5 m) could be compared to counts from the same phantom. By sliding the alligator anteriorly or posteriorly, the portion of the tail beneath the counter window could be made to closely approximate the 9.4 cm diameter of the phantom. Ten minute counts of background radiation were also recorded.

Gamma counting yields of the above field procedure were estimated by repeating these procedures on the amputated tails of five adult alligators that died or were found dead during this study. After field gamma counting, a 10 g sample of tail muscle was dissected from each of these tails at the position beneath the field counter window. The radiocesium contents of the muscle samples were determined using a Packard model 5530 auto-gamma counter using procedures described in detail by Colwell *et al.* (1996). Breifly, 550 - 760 KeV gamma photons were counted during a 30 minute period, yielding $\sigma < 5\%$. Counts were made of standards of similar geometry to estimate counter efficiency, and 30 minute background counts were made at regular intervals. Average minimum detectable concentrations ranged from 1.053 to 2.916 pCi/g wet weight of muscle, depending on the size of sample used (Currie 1968). A regression analysis was used to determine the relationship between field determinations of alligator tail pCi/g and alligator wet muscle pCi/g (Figure 3). Five alligators were used in this model, three of which were collected before refill began. The regression analysis was used to estimate radiocesium concentrations in the tail muscle of 7 additional alligators captured alive from Par Pond.

Radiocesium was also measured twice per year in tails of two captive alligators, fed on an exclusive diet of fish (mostly largemouth bass) collected from Pond B on the SRS. These fish contained elevated levels of radiocesium (about 190 pCi / g fresh muscle in fish the size used here; Whicker *et al.* 1990). Each alligator was offered as many contaminated fish (approximate length = 25 cm) as it would consume once per week, and although records were kept of the acceptance vs. rejection of food, no attempt was made to quantify actual amounts of radiocesium intake. The two alligators measured 1.40 m and 1.89 m in total length and showed no detectable body burdens of radiocesium when they were placed in this feeding study in 1986 and 1990, respectively. Both had been captive-reared from eggs taken from a wild population in Louisiana. Animals were housed throughout the study in separate indoor tanks measuring 5m x 1.5 m, equipped with basking platforms and filled with flow-through water 33 cm deep. Year-round air temperatures in the building varied from 23.9 - 29.4 °C and water temperatures varied from 19 - 21 °C. The two alligators were exposed to natural photoperiod through a translucent roof. Feeding ceased annually in the late fall months (usually November - December) and resumed the following spring (usually March). Radiocesium measurements were usually made after feeding stopped in the fall and again before feeding resumed the following spring (Figure 4).

RESULTS AND DISCUSSION

Population Numbers:

As reported by Brisbin *et al.* (1992), eyeshine counts of alligators in Par Pond were higher in 1991 after the initiation of drawdown than in preceding years. Monthly means from July through October 1991 exceeded the upper 95% confidence interval for all counts from 1972-1988, prior to drawdown (Figure 5). In 1993 and 1994, when the reservoir water level was low, counts between March and June also remained higher than during the predrawdown period. From July through August/September of these years, counts began to fall within the range of those from the predrawdown period. Counts in 1995 following refill were all similar to the predrawdown range from March through July. In August and September of 1995, counts actually began to fall below the predrawdown range (Figure 5). Similar monthly patterns in counts were evident in all years, with low numbers of alligators seen in March, and numbers increasing to maximum values in late May and June. Thereafter, numbers generally declined through late summer and fall in all years.

The monthly and yearly patterns of eyeshine counts described above probably do not reflect changes in the alligator population size within Par Pond. Instead these patterns likely resulted from changes in eyeshine visibility resulting from temperature dependent alligator activity and changes in the amount of emergent macrophyte cover in the reservoir. Thus, as also discussed by Murphy (1981) and Brandt (1989), monthly increases in counts in all years from March through June probably reflected increases in alligator activity as seasonal temperatures increased. The higher numbers of alligators counted during early reservoir drawdown in 1991 versus the predrawdown period were likely due to rapidly falling water levels. This produced a new shoreline that was denuded of all macrophyte cover, thus assuring that nearly all alligators active in the reservoir, including juveniles, were counted in the surveys late in that year (Brisbin *et al.* 1992). In 1993 and 1994, emergent macrophyte cover became progressively established throughout the drawndown reservoir, undoubtedly decreasing the visibility of many active alligators. Following refill in 1995, this decrease in alligator visibility likely became more pronounced as the reestablished shoreline cover was augmented by flooded terrestrial vegetation including young pines (*Pinus* spp.) and willows (*Salix* spp.).

We tested the suitability of alligator density indices based on shoreline lengths versus surface areas of reservoir regions (Figure 1) using eyeshine data. Chi-square test results based on night eyeshines during both drawdown and refill years indicated that alligators were equally distributed around each region of the reservoir based on available shoreline. However, chi-square tests revealed that there were significant differences in alligator distribution based on surface areas of each region (Table 1). These findings suggested that crocodilian density estimates based on shoreline perimeter rather than surface area may be the more appropriate choice when determining distributional responses in a reservoir system.

The various environmental factors that contribute to variability in alligator visibility during night eyeshine surveys have been discussed by Woodward and Marion (1978) and other authors. Pacheco (1996) moreover, has shown that in some crocodilian populations the proportion of individuals sighted on night eyeshine surveys can also vary with population density. As the surface area and amount of available shoreline habitat in Par Pond underwent contraction and expansion with water level drawdown and refill, the density of alligators in the reservoir increased and decreased correspondingly without any change in the number of alligators present. These findings suggest that night eyeshine census data such as that presented in Figure 5 cannot be considered to unambiguously document temporal trends in the population size of alligators in the reservoir. However, such count data can be used to clearly establish minimum numbers of alligators present at a given time in the reservoir; in those terms, there is no evidence of any dramatic change in the Par Pond alligator population size through the period of reservoir drawdown and refill. Although Brisbin *et al.* (1992) documented the departure of several marked alligators from Par Pond shortly after drawdown in 1991, the night eyeshine survey data presented here can offer no evidence of a decrease in population numbers resulting from the reservoir drawdown (Figure 5).

Reproduction:

The effects of changing water levels upon alligator reproduction were determined for six nests found along the reservoir's shoreline in the late summer of 1994 (Table 2, Figure 6). Since passive refill did not begin until August 1994 and these nests were initially constructed in the late spring of that year, their clutch sizes and investment per egg represent reproductive effort under conditions of full drawdown, while their hatching success reflects the effects of refill activities. In these regards, the characteristics of these nests (Table 2) and their clutches (Table 3) may be compared directly to similar information for the Par Pond alligator population prior to drawdown, as reported by Brandt (1989).

Clutch size of female Par Pond alligators in 1994 averaged 43.5 ± 2.9 (SE) eggs and was significantly lower than the average clutch size of 48.8 ± 1.3 (SE) reported by Brandt (1989) for eight Par Pond nests examined between 1981-1988, prior to drawdown (Two-sample t-Test with equal variance: $t = 1.81$; $P = 0.041$; $df = 10$). Additionally, adjusted least-square mean hatchling weight was significantly different between predrawdown (50.7 ± 0.4 (SE) g) and drawdown years (43.7 ± 0.4 (SE) g) when controlling for differences among breeding females in hatchling condition and structural size differences among hatchlings (by ANCOVA; $F = 117.57$; $P < 0.0001$; $df = 1$). This reduction in clutch size and hatchling weight likely reflected reduced body condition or stress upon females nesting during drawdown. Changes in hatch rates due to frequency of nest depredation could however, counteract the negative effect of the drawdown-related reduction in clutch size, provided that survival of the drawdown hatchlings was not compromised by lower hatchling weights.

In 5 of 6 nests found in 1994, the nest was located on substrate within the area that had been exposed by the reservoir drawdown. One nest built during drawdown (N6) was found on what was an island when the reservoir was at full pool. As such, most nests were located in more open herbaceous habitat than before drawdown (Table 2). Prior to drawdown, most nests were constructed in more wooded habitat where they were vulnerable to predators (Murphy 1981), especially raccoons (*Procyon lotor*). Brandt (1989) for example, reported the depredation of 25% of eight nests studied at Par Pond prior to drawdown. However, none of the nests observed in this study showed any evidence of predation.

Although flooding related to rising water levels in the reservoir caused the complete destruction of one nest in 1994, and caused an overall average loss of 30.6 % of eggs produced (Table 3), the minimum known hatch rates (based on marked hatchlings) from the eggs that were not flooded in nests N1, N2, and N3 were 65.9, 41.7 and 42.1 %, respectively (mean = 49.9 %). These values were similar to those reported by Brandt (1989) for predrawdown nests for which minimum hatch rates averaged 48.3 ± 9.1 % (SE) and ranged from 22 to 76%. Examination of the dimensions of the 1994 nests and their egg chambers (Table 2) suggested no obvious size differences between nests which experienced flooding mortality during refill versus those which did not. Impacts from rising water levels were more likely a function of location and topography where the nest was built, rather than how it was constructed. There was also no evidence that any later additions or alterations were made to the nest structures by the attending females in response to rising water levels. These observations emphasize the importance of timing reservoir filling so that it does not begin between the time of nest initiation and subsequent hatching.

The results of this study and those of Brandt (1989) for the predrawdown period, show that the factors discussed above (i.e., depredation rates, flood losses) are essentially self-cancelling with respect to the possible net effects of reservoir drawdown upon numbers of hatching alligators produced. The decisive drawdown effect on alligator reproduction may therefore be the survivorship of hatchlings that may have been disadvantaged by low hatching mass. Future work should focus on recaptures of this cohort of hatchlings to determine if their survival is lower than those from earlier nests.

Wintering Ecology:

The behavior of four telemetered adult alligators (one male/three females) was studied in Par Pond during periods of particularly cold winter weather in December, 1995 and January/February, 1996 - one full year after the reservoir had been refilled to full pool stage. Three of these alligators were located in the reservoir's North Arm, while one female (#860) was found on the eastern shore of the Main Lake region (Figure 6). Each of the two females in the North Arm (##810 and 970) spent colder periods in underground dens with submerged mouths opening into small (20-30 m diameter) pools of water. Each pool was located about 20-30 m inland from the reservoir's original shoreline. The den entrances were similar in appearance, with each pool representing an enlargement of a natural stream drainage. With night-time low temperatures in the range of 0 to -12 °C and occasional thin fringes of ice forming on the den pools, both females were consistently located during the day directly beneath the pools' surrounding shorelines, about 0.5 to 1.5 m inside den entrances. The extent of these den structures could not be determined, but at no time was either of these females radio-tracked as extensively underground as was the case with a wintering Par Pond alligator that occupied an extensive ring-shaped underground den described by Brisbin *et al.* (1992). Otherwise, both of these winter dens were similar to those described for alligators in other parts of their range (Kellogg 1929; McIlhenny 1935; Hagan *et al.* 1983).

The third female studied during cold periods (#860) may also have occupied a winter den although no entrance was ever found. This female was continually located deep in the narrow channel of a small tributary to the reservoir. Radio signals indicated a location about 7 m upstream from the reservoir shoreline, at a point where the channel was about 2 m wide, 1.5 - 2.0 m deep,and had steep overhanging banks with a tangle of fallen trees and submerged logs.

The only male studied during cold winter weather (#950) remained in more-or-less open water, always within the periphery of the refilled reservoir's shoreline. Unlike the females, this male regularly changed positions between days - often by 100 m or more, while remaining in the eastern terminus of a cove containing standing dead macrophyte cover along the fringes The behavior of this male alligator was similar to that reported for large male alligators studied by Brisbin *et al.* (1982) in the Pond B reservoir (Figure 1). Those authors followed large male alligators which also remained within the open waters of that reservoir and occasionally emerged to bask during warmer daylight hours - even during the coldest periods of winter. Goodwin and Marion (1979) also documented winter basking near den sites by Florida alligators. In their study, winter basking was observed when daytime temperatures were at least 16 °C. During the period of reservoir drawdown, 6 of 13 telemetered alligators (both sexes) spent the winter months within the open water of the reservoir, along a stretch of exposed northern shoreline of the West Arm (Brisbin *et al.* 1992).

Movements and Distributions:

Descriptions and general summaries of the movements of the 18 alligators followed by radio telemetry in this study are presented in Table 4. Only one of these alligators (female #860; Figure 6) ever left the reservoir, moving over the main dam shortly after the period of active refilling and spending over a month in the bottomland floodplain forest to the south of the reservoir. In mid-April 1995, this female returned to Par Pond and was located near a small tributary entering the eastern shore of the Main Lake - the location from which it subsequently never moved and where it later spent the winter (Figure 6).

Although the number of telemetry relocations and duration of radiotracking varied greatly between individuals (from three relocations over two months to 22 relocations over two years), these differences were not related to the extent of movement of given individuals. Female #810 for example, showed no movement over a period of 18 months with 22 relocations, while the only two instances of long-distance movements (i.e. between arms of the reservoir) were shown by alligators (##353 and 390) that were each followed for only two months or less with only three and four telemetry relocations, respectively.

Extent of movement rather seemed to be related to sex and the stage of reservoir drawdown/refill (Table 4). The only two alligators that showed long-distance movements between reservoir arms were both large males followed during the period of drawdown. The two alligators that showed no movements (##810 and 970) were both females, one of which (#810) was tracked from the drawdown period through reservoir refill and for over a year into the post-refill period. The association of these females with winter den pools is described above (see Wintering Ecology; Figure 6).

Following the completion of reservoir refill, Par Pond alligators moved less than during the drawdown period (Brisbin *et al.* 1992 and this study). No telemetered alligators, including two large males measuring in excess of 3.50 m, made any long-distance movements between reservoir regions after refill completion, even though 86 alligator-months of radiotracking were logged during this period (Table 4). Moreover, only one of nine alligators studied after refill showed moderate (within a region of the reservoir) movement, with the other eight showing either limited or no movement at all (Table 4). These limited movement patterns following refill were even less than those exhibited during the predrawdown period (Murphy and Brisbin 1974; Murphy 1981). The latter studies however, were conducted during the time of heated reactor inputs to the reservoir, and much of the long-distance movement by alligators between regions of the reservoir at that time seemed to be in response to thermal gradients created in the reservoir. No telemetric study of alligator movements in Par Pond was conducted after the cessation of thermal inputs and before reservoir drawdown. Thus, it is not clear whether the post-refill reduction in movement as shown by the present study (Table 3) should be considered "normal" for such a reservoir population under conditions of no thermal input.

Contaminant Studies:

Mercury was detectable in all tissues from all alligators that we analyzed. Among tissues, mercury tended to be highest in liver (Table 5). Additionally, blood mercury concentrations in Par Pond alligators averaged 2.2 ± 0.4 (SE) μg/g wet mass (Yanochko *et al.*, in press). We analyzed total mercury, ratber than attempting to determine whether the mercury accumulated in these animals was methyl mercury, or some other chemical species. However, a number of studies have documented that virtually all of the mercury accumulated by fish and other aquatic organisms is methylated (Greib *et al.* 1990; Bloom 1992), so it is reasonable to assume that methyl mercury is the form accumulated by these alligators. Methyl mercury is not readily excreted, so it accumulates over time in organisms. Because of this accumulation, methyl mercury concentrations tend to increase with trophic level, and the highest concentrations in a food web are usually found in top-level predators (MacCrimmon *et al.* 1983; Kidd *et al.* 1995). Large, long-lived predators like alligators might thus be expected to accumulate high levels of mercury when inhabiting contaminated environments. In fact, both Hord *et al.* (1990) and Yanochko *et al.* (in press) found high concentrations of mercury in alligators inhabiting the Florida Everglades, an area suffering from severe mercury pollution.

The mercury that accumulates in aquatic organisms can come from several sources. Local point sources, such as mining activities, metal smelters, incinerators, chemical industries or pulp and paper mills can be important in some situations. However, there is growing recognition that mercury pollution represents a global environmental problem. Many of the above-mentioned point sources also contribute to a global atmospheric mercury pool, resulting in increased mercury deposition over large areas. Mercury has been measured in precipitation at a variety of geographic locations, and the amounts input in this fashion are sufficient to explain the elevated mercury concentrations detected at some locations far removed from any local sources (Mierle 1990; Fitzgerald *et al.* 1991). The exact source of the mercury accumulating in alligators and other biota in Par Pond is not known, but much of it may have originated from industries on the Savannah River, which serves as a water source for Par Pond. Mercury releases from these industries have been greatly reduced since the 1970s. Additionally, some atmospheric input may be occurring, although mercury in precipitation near Par Pond has not been measured.

Most of the mercury detected in precipitation is in the form of inorganic species (Lambourg *et al.* 1995; St. Louis *et al.* 1995), as is much of the mercury discharged by industrial point sources. However, the mercury accumulated by aquatic organisms is mostly methyl mercury. The processes controlling the methylation of mercury therefore appear to be the key variables influencing mercury uptake and accumulation by organisms. Previous studies have shown that methylation is enhanced in flooded soils

(Porvari and Verta 1995), and in water under conditions of low pH and dissolved oxygen and high dissolved organic carbon (Winfrey and Rudd 1990). These conditions occur when a reservoir is constructed, and a number of studies have documented increased concentrations of mercury in aquatic organisms accompanying reservoir formation (Bodaly *et al.* 1984; Jackson 1988). Reservoir drawdown and refill mimics reservoir formation in many important respects, including the flooding of dry soils and the inundation and decomposition of terrestrial vegetation. Therefore, we reasoned that mercury levels in resident organisms such as alligators would increase after Par Pond was refilled. However, we were unable to demonstrate a statistically significant difference by analysis of variance in mercury content of three tissues of alligators sampled before and after refilling (Table 5). For liver, $F = 0.62$, $P = 0.62$; for muscle, $F = 4.0$, $P = 0.07$; and for scute, $F = 1.99$, $P = 0.17$. There may be some time lag before changes in mercury bioavailability produce detectable effects at the highest trophic levels, or our results could reflect the relatively small sample sizes available for internal tissues after the refill. We plan to continue sampling to detect any changes in mercury concentrations associated with water level changes in Par Pond.

The regression model (Figure 3) showed that radiocesium body burdens in the tail were highly predictable from radiocesium in wet muscle ($r^2 = 0.974$). However, the limited data available to develop the model (n=5) suggests that these model parameter estimates should be considered with caution. Using this regression equation, tail counts were transformed to pCi radiocesium /g wet muscle. A total of twelve samples were used to determine if radiocesium concentrations in wet muscle differed from the prerefill period compared to after refill. Four samples taken before refill (including both drawdown and predrawdown periods) averaged 12.85 ± 2.33 (SE) pCi/g wet weight of muscle (range = 8.28 - 16.95 pCi/g) and did not differ significantly from eight samples collected after refill from alligators whose tail muscle averaged 10.10 ± 0.56 (SE) pCi/g wet weight (range = 7.60 - 13.00 pCi/g; by Wilcoxson two-sample test: $z = 0.594$; $P = 0.55$; df = 10).

Two captive alligators fed contaminated Pond B fish accumulated radiocesium (Figure 4). Radiocesium levels were expected to decrease during winter periods of inactivity (shaded lines, Figure 4) and increase during periods of active feeding. Exceptions occurred in this pattern however, and these anomalies probably were artifacts resulting from improper positioning of the tail beneath the counter. In neither animal did these radiocesium uptake curves attain final levels that would warrant an analysis with asymptotic uptake models (Brisbin *et al.* 1990). Rather, these uptake curves indicated that more than 80 months would be required to attain an equilibrium of radiocesium body burden in the tail muscle of alligators in the 1-2 m size range. Since approximately 5 biological half-lives are required before the attainment of such a steady-state asymptote, the biological half-life of radiocesium in alligator tail muscle must be greater than 16 months. Previous studies of radiocesium elimination in a variety of vertebrate species by Reichle *et al* (1970) and Staton and Brisbin (1974) demonstrated that biological half-life was positively correlated with body size, as well as significantly longer in poikilothermic than in homeothermic species. In comparison, the maximum biological half-life recorded for radiocesium in snakes was 430 days (Staton and Brisbin 1974). Since we estimated a biological half-life of at least 16 months for alligators, the 3-year duration of the Par Pond drawdown was likely insufficient for resident individuals to attain any new equlibrium levels of radiocesium that might result from a change in radiocesium availability. Our results comparing radiocesium levels in predrawdown and post-refill alligator muscle indicated no significant differences existed and thus further support the notion that the biological half-life of radiocesium in alligators is relatively long. Radiocesium levels accumulated by the captive alligators were higher than levels determined for Par Pond animals since they were fed fish from Pond B, where radiocesium contamination levels of biota are known to be higher than in Par Pond (Potter *et al.* 1989). If the ratio between muscle and whole-body radiocesium concentrations is the same in Pond B alligators as in American coots (*Fulica americana*) studied by the latter authors, the muscle levels attained by the two captive alligators (Figure 4) would be equivalent to whole-body burdens of as much as 16 pCi/g live weight. This level is similar to those reported by Brisbin (1989) for three hatchling alligators from Pond B, whose whole-body burdens averaged 13.2 $\pm$ 1.1 (SE) pCi/g live weight.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

The results of this study along with those of earlier studies of alligators at Par Pond suggest some of the possible consequences of drawdown and refill of reservoirs upon resident crocodilian populations. Alligators are quite capable of surviving a partial reservoir drawdown, with some individuals even continuing to live, winter and reproduce in the same general area of the reservoir as they occupied before the drawdown. This seems to be particularly true of resident adult females occupying sites with traditional winter dens and associated remnant pools of water formed (possibly by the alligators themselves) in associated tributary streams which continue to flow during the drawdown period.

There was evidence of stress upon individual alligators immediately following the partial reservoir drawdown; some alligators left the reservoir and/or were killed by larger conspecifics as the shrinking reservoir surface area and shoreline caused resident alligators to come into more direct social contact and conflict (Brisbin *et al.* 1992). We have also presented some limited evidence to suggest that such stress upon resident females may continue to result in reduced clutch sizes several years after drawndown water levels had stabilized at the lowered levels (Table 2). This reduction in clutch size however, may possibly be compensated for by a reduction in nest depredation. Any assessment of the effects of reservoir management practices upon alligator reproduction and recruitment must consider the effects upon survivorship of young alligators during their first years of life. Such data is presently lacking, although by inference, loss of young alligators to predators such as largemouth bass and wading birds must certainly have been high during the first 1-2 years after drawdown. Hatchlings were observed occupying newly-exposed shoreline habitat that was devoid of any protective emergent cover (Brisbin *et al.* 1992). The significant reduction in the body weights of hatchlings from drawdown versus predrawdown nests further suggests that even in the absence of increased vulnerability to predation, survivorship of young and subsequent recruitment to the adult population were possibly reduced by reservoir drawdown.

One of the most important aspects of reservoir management is clearly the timing of the refill process. This study demonstrated a loss in alligator reproduction when refill caused water levels to rise during the summer months, thus flooding nests and drowning eggs. If refill could be delayed until mid to late fall after eggs had hatched, or be undertaken during the winter or early spring before nests are built, such nest flooding could be avoided. Furthermore, management options that shorten the drawdown period would likely benefit resident alligators by reducing breeding stress on females and social stress on the entire population. For example, the reduced movements of alligators following refill suggests a reduction in social stress occurred within the population concurrently with the increase in the amount of shoreline habitat and/or cover available to the individuals in the population.

Although we were unable to detect a change in alligator mercury concentrations associated with the refill of Par Pond, this may have been due to relatively small sample sizes. Increasing the sample size in the future should address this possibility. Meanwhile, there is ample evidence to suggest that reservoir formations, or large changes in reservoir water level over a time frame of one or more years, result in conditions that enhance the methylation of mercury. This results in increased mercury concentrations in organisms, especially those feeding at higher trophic levels. In light of this consideration, elevated mercury concentrations might be expected in alligators or other crocodilians inhabiting newly formed reservoirs, or those that have experienced larger fluctuations in water level.

Mercury in edible tissues of Par Pond alligators sampled before refill was about 1 ppm on a wet mass basis, assuming a water content of 75 % in muscle. After refill, a smaller sample of alligators had a muscle concentration of about 2 ppm on a wet mass basis. While no standard has been set for maximum tolerable concentrations of mercury in alligator meat, the U.S. Food and Drug administration has set a human consumption advisory limit of 1 ppm for fish, and some nations use a more conservative level of 0.5 ppm. Thus, most Par Pond alligtors would be near or above mercury concentrations considered safe to eat on a regular basis. This is not a problem at Par Pond, unless contaminated alligators leave the reservoir and the SRS on their own. Public access to the SRS is restricted, and alligators from this reservoir are not harvested for consumption by humans. However, these results do suggest that mercury may be a potential concern in the meat of crocodilians inhabiting reservoirs in other areas, where they may be used for food.

Finally, a number of the findings of this study may also be applicable to concerns for other crocodilian species residing in managed reservoirs. We caution though, that particular consideration should be given to differences between the temperate climate of this study area versus the less seasonal tropical climate of habitats where most of the world's other crocodilian species occur. This could be particularly important for example, with regard to such issues as the timing of reservoir refill and its potential to flood nests and thus negatively impact reproduction. A thorough understanding of the basic ecology, breeding biology and other natural history aspects is therefore indispensable to the planning of any reservoir management program aimed at minimizing possible impacts upon resident crocodilians and their future well-being.

ACKNOWLEDGMENTS

These studies have been supported by a contract (DE-AC09-76SROO-819) between the University of Georgia and the United States Department of Energy. Earlier studies of the Par Pond alligators by Thomas Murphy and Laura Brandt laid the basis for much of this later research. Data for predrawdown alligator hatchling weights was provided by Laura Brandt. Field work was supported by the assistance of Jack Epps, Andrea Koch, Warren Stephens, Jason Stout, Strom Thurmond, Jr., and Howard Zippler. Mercury analysis was supported by Gina Yanochko, Joan Garibaldi and Patricia Shaw-Allen. Ward Whicker and Thomas Hinton provided helpful advice regarding the design and operation of radiocesium counting equipment and Andrea Koch helped in the field collection of radiocesium data under the support of an Applied Health Physics Fellowship from the Science/Engineering Division of the Oak Ridge Institute for Science and Education. John J. Mayer and Robert Kennamer provided assistance and advice with data analyses and presentations, and critical comments on the manuscript.

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Table 1. Distribution of American alligators in the Par Pond reservoir of the U.S. DOE Savannah River Site during drawdown (1993-94) and after refill (1995).

Region[a]	Surface Area [b] / Shoreline Perimeter [c]				Mean Number of Alligators [d]		
	Drawdown		Refill		Summer [e]1993*	Summer 1994*	Summer 1995*
Main Lake	209 ha (44.1)	10819 m (23)	298 ha (30.9)	7197 m (12.3)	15 (17.6)	17.5 (20.2)	7 (15)
North Arm	120 ha (25.5)	10202 m (34.9)	301 ha (31.3)	27433 m (46.7)	25.3 (29.7)	34 (39.3)	19.4 (41.5)
Hot Arm	55 ha (11.69)	15449 m (17.7)	114 ha (11.9)	9136 m (15.6)	19.6 (23)	15 (17.3)	9.6 (20.5)
West Arm	89 ha (18.76)	7818 m (24.4)	250 ha (26.0)	14998 m (25.5)	25.3 (29.7)	20 (23.1)	10.8 (23.1)

[a] As shown in Figure 1.

[b] Numbers in parentheses show percentage of the total reservoir surface area for drawdown and refill conditions.

[c] Numbers in parentheses show percentage of the total reservoir shoreline perimeter for drawdown and refill conditions.

[d] Numbers in parentheses show percentage of the mean number of alligators counted.

[e] Summer means were determined by pooling alligator counts from the months of June, July and August.

* Asterisks indicate that the mean number of alligators observed in each region differed significantly ($p < 0.05$) from what would be expected, as determined by Chi- square tests based on the surface area of the reservoir. Chi-square tests were also performed based on shoreline perimeter of each region and no significant differences were found.

Table 2. Characteristics of five[a] American alligator nests constructed at the Par Pond reservoir of the U.S. DOE Savannah River Site, while the reservoir was drawndown 6 m during the summer of 1994. Passive refill of the reservior began in August 1994 (Figure 2), resulting in the flooding of some of the nests. Nest locations are indicated in Figure 6.

Nest	Dimensions (cm) Length/Width/Height	Distance to Water[b] Horizontal (m) / Vertical (cm)	Depth to Top of Clutch	Egg Cavity (cm) Length/Width/Height	Comments
N1	190 / 170 / 56	- 1.65[c] / - 19[c]	23	30 / 32 20	Located in a 3.0x2.8m clearing in wetland vegetation (*Eleocharis* spp., *Scirpus* spp. , *Salix* spp., *Sagittaria* spp). Bottom layer of eggs was underwater when nest was first checked on August 29.
N2	169 / 155 / 49	0 / - 10[e]	--[d]	--[d]	Located in wetland vegetation. Water 10cm deep had flooded the base of the nest when first checked on August 29. Could not open egg cavity because of fire ant (*Solenopsis invicta*) infestation.
N3	180 / 140 / 21	0 / 0	19	30 / 26 /21	Located in a 2.4x2.0m clearing in cattails (*Typha latifolia*), and rice cutgrass (*Leersia oryzoide*). Water had risen to the base of the nest, but no eggs were in water when first checked on August 29.
N4	200 / 190 / 49	1.35 / 34[e]	35	31 / 33 / 22	Located next to a stream in a 4.0x3.6m clearing in a mixture of old-field terrestrial and wetland vegetation. 1.5m pines near nest. Nest had been opened by female when first checked on August 30. Hatchlings were found and marked.
N5	220 / 170 / 35	0 / -21[c]	13	33 / 34 / 19	Located in a 2.9x3.9m clearing in wetland vegetation. Nest was submerged in water to within 6 cm of the top of the mound and all eggs had already drowned when first checked on September 7.

[a] Nest measurements not recorded at nest N6 because female destroyed nest when it was opened to remove young.

[b] Distance to the drawndown reservoir shoreline on the first day checked, unless otherwise noted.

[c] Negative values indicate flooding of the nest by rising water levels.

[d] Nest could not be opened because of fire ant infestation.

[e] Distance to a tributary stream flowing into the reservoir. Nest was located within the area encompassed by the reservoir's former full pool shoreline.

Table 3. Productivity and fates of six American alligator nests constructed at the Par Pond reservoir of the U.S. DOE Savannah River Site. Nests were constructed and eggs laid in the spring of 1994 while the reservoir was drawndown 6m, and hatching occured during August - September 1994 while passive refill was underway as indicated in Figure 2. Nest locations and characteristics are given in Figure 6 and Table 2, respectively.

Nest	Clutch Size[a]	Eggs Drowned (% of clutch)	Hatchlings Marked (Minimum % Hatch)[b]	Hatch Date
N1	48	7 (14.6)	27 (56.3)	Between August 29 and September 7
N2	39	15 (38.5)	10 (25.6)	September 8
N3	38	0 (0)	16 (42.1)	September 8
N4	--[c]	0 (0)	18 (--)[c]	Before August 26
N5	49	49 (100)	0 (0)	--
N6	--[d]	--[d]	24 (--)[d]	Before September 12
Means (SE)	*43.5 (2.9)*	*14.2 (9.1)*	*15.8(4.0)*	
% Means (SE)		*30.6 (18.7)*	*31.0(12.1)*	

[a] Minimum estimated number of eggs.

[b] Based on total clutch size.

[c] Nest hatched before clutch size could be determined; no drowned eggs found.

[d] Pod of newly hatched young found; nest destroyed by female in opening.

Table 4. Characteristics and movement behaviors of American alligators carrying radio transmitters in the Par Pond reservoir of the U.S. DOE Savannah River Site during periods of long-term reservoir drawdown and refill. Drawdown and refill schedules are indicated in Figure 2.

Alligator I.D.	Sex	Total Length (m)	Dates Telemetered		Reservoir Stages [a]	No. of Locations	Movement Behavior [b]
			Start	Finish			
3790	M	3.62	April 1994	May 1994	D	3	LM
390	M	2.80	April 1994	June 1994	D	4	DM
730	M	3.92	April 1994	June 1994	D	5	MM
690	M	3.51	April 1994	May 1994	D	2	LM
630	M	3.27	April 1994	June 1994	D	4	LM
353	M	2.74	April 1994	May 1994	D	3	DM
233	M	2.54	April 1994	June 1994	D	5	LM
252	F	2.04	April 1994	Aug. 1994	D	6	LM
369	F	2.59	April 1994	Feb. 1995	DR	5	MM
930	F	2.27	Aug 1994	Feb. 1996	DRP	19	LM
810	F	2.21	Aug 1994	Feb. 1996	DRP	22	NM
313	F	2.56	Nov. 1994	Feb. 1996	RP	5	LM
860	F	2.82	Aug. 1994	Feb 1996	RP	20	DR/NM [c]
950	M	3.58	July 1995	Feb. 1996	P	11	LM
4790	M	3.62	Aug. 1995	Feb. 1996	P	6	LM
970	F	2.41	July 1995	Feb. 1996	P	14	NM
271	F	2.44	June 1995	Feb. 1996	P	12	LM
230	F	2.65	June 1995	Feb. 1996	P	11	MM

[a] D = drawndown resevoir; R = refilling reservoir; P = post-refill period.

[b] NM = No movement: continually found within a radius of 100 - 200 m; LM = Limited movement: continually found in the same cove and/or adjoining portions of the reservoir shoreline; MM = Moderate movement: continually found in the same arm or region of the reservoir; DM = Distant movements: extensive movements between arms or regions of the reservoir; DR = Departed from Par Pond reservoir.

[c] Alligator departed from the reservoir and then returned to a location from which it subsequently did not move.

Table 5. Tissue mercury concentrations (µg/g dry mass) in American alligators from the Par Pond reservoir, U.S. DOE Savannah River Site, before and after the reservoir was refilled. Data are presented as means ± standard errors, with n for each given in parentheses.

	Liver	Muscle	Scute
Before Refill	15.30 ± 2.65 (11)	3.87 ± 0.44 (13)	5.84 ± 0.90 (18)
After Refill	12.09 ± 7.77 (2)	8.05 ± 4.43 (3)	3.97 ± 0.98 (17)

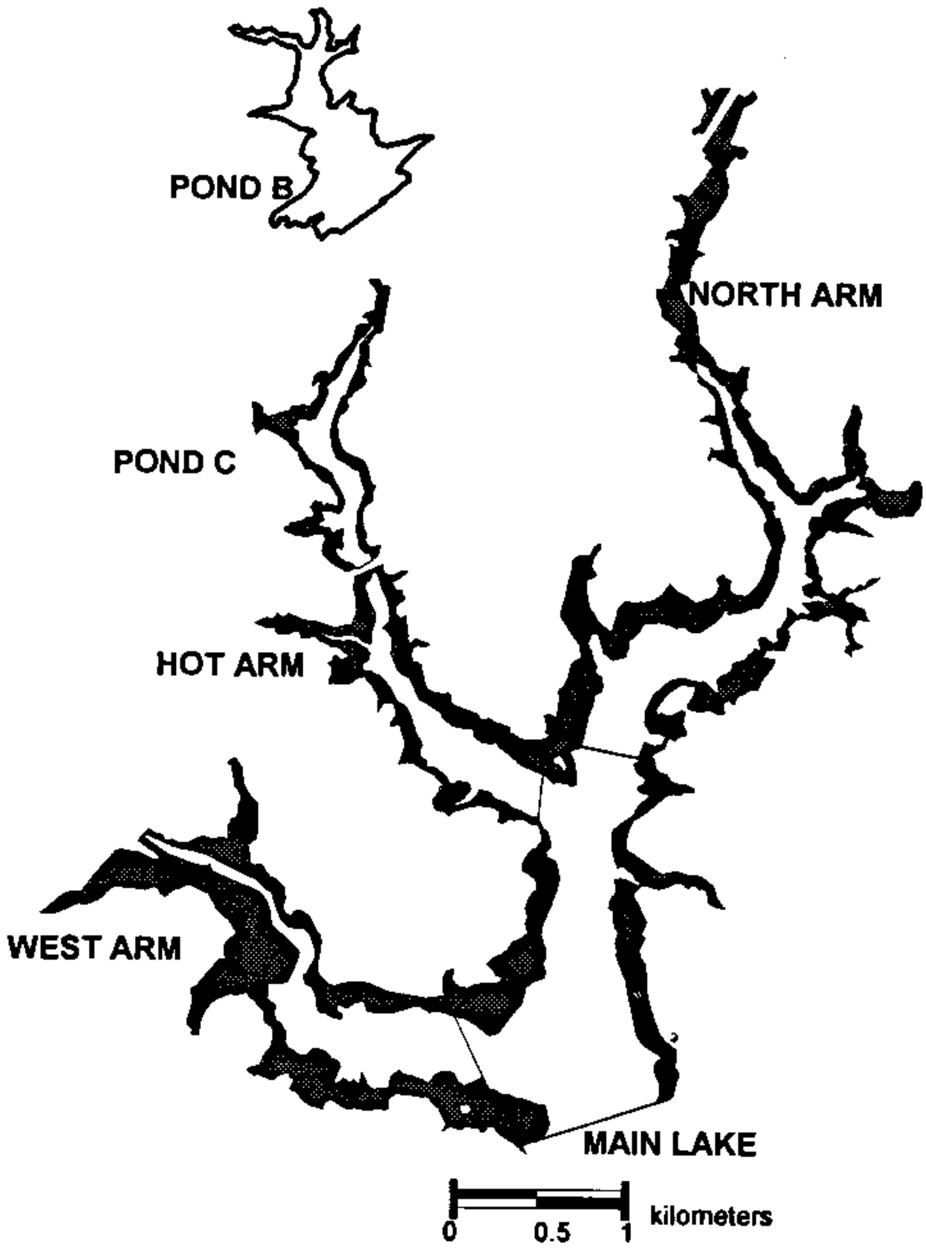

Figure 1. Map of the Par Pond, Pond B, and Pond C reservoirs of the U.S. Department of Energy's Savannah River Site. Regions of the Par Pond reservoir are delineated with black lines and grey areas indicate bottom sediments which were exposed during a reservoir drawdown between the summer of 1991 and winter of 1994-95 (see Figure 2). Drawn from Brisbin *et al.* (1992).

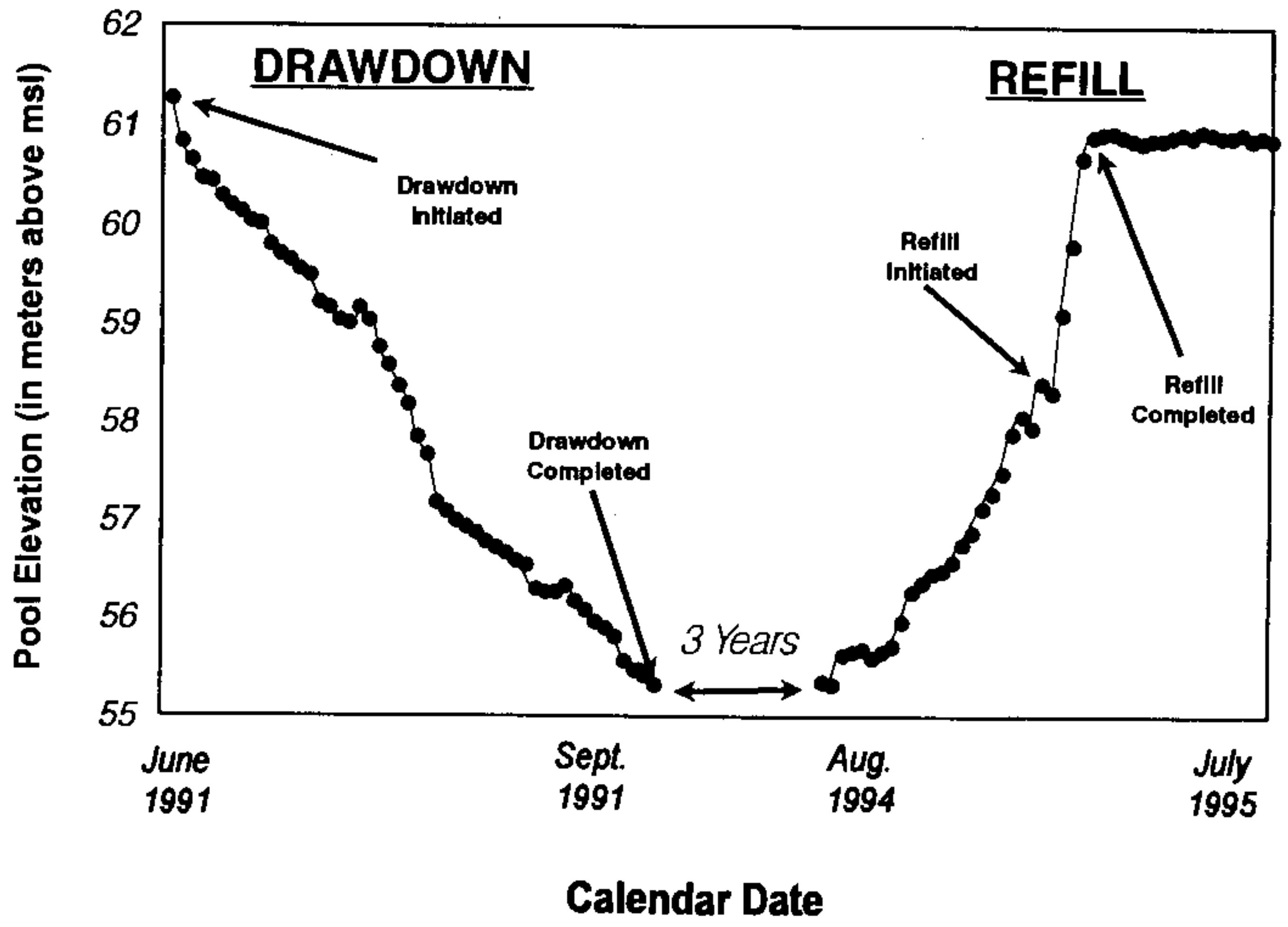

Figure 2. Water level changes during the drawdown and subsequent refill of the Par Pond reactor cooling reservoir on the U.S. Department of Energy's Savannah River Site. Water levels are reported as meters (m) above mean sea level (msl).

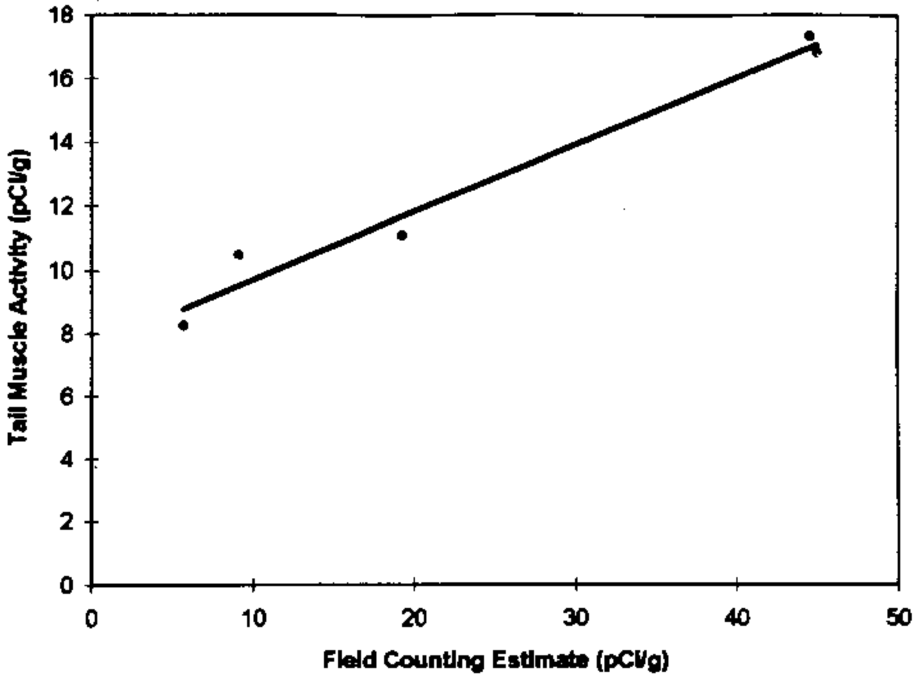

Figure 3. Regression analysis used to predict radiocesium concentrations in the tail muscle of large adult American alligators, as determined by laboratory analysis in a gamma well counter (vertical axis), from field estimates of radiocesium concentrations in the same animals, as determined by the counting of gamma emissions above the base of the tail (horizontal axis). The regression was defined by the equation: pCi/g fresh weight tail muscle = 0.21 (field estimate of tail pCi/g) + 7.6 ($r^2 = 0.973$).

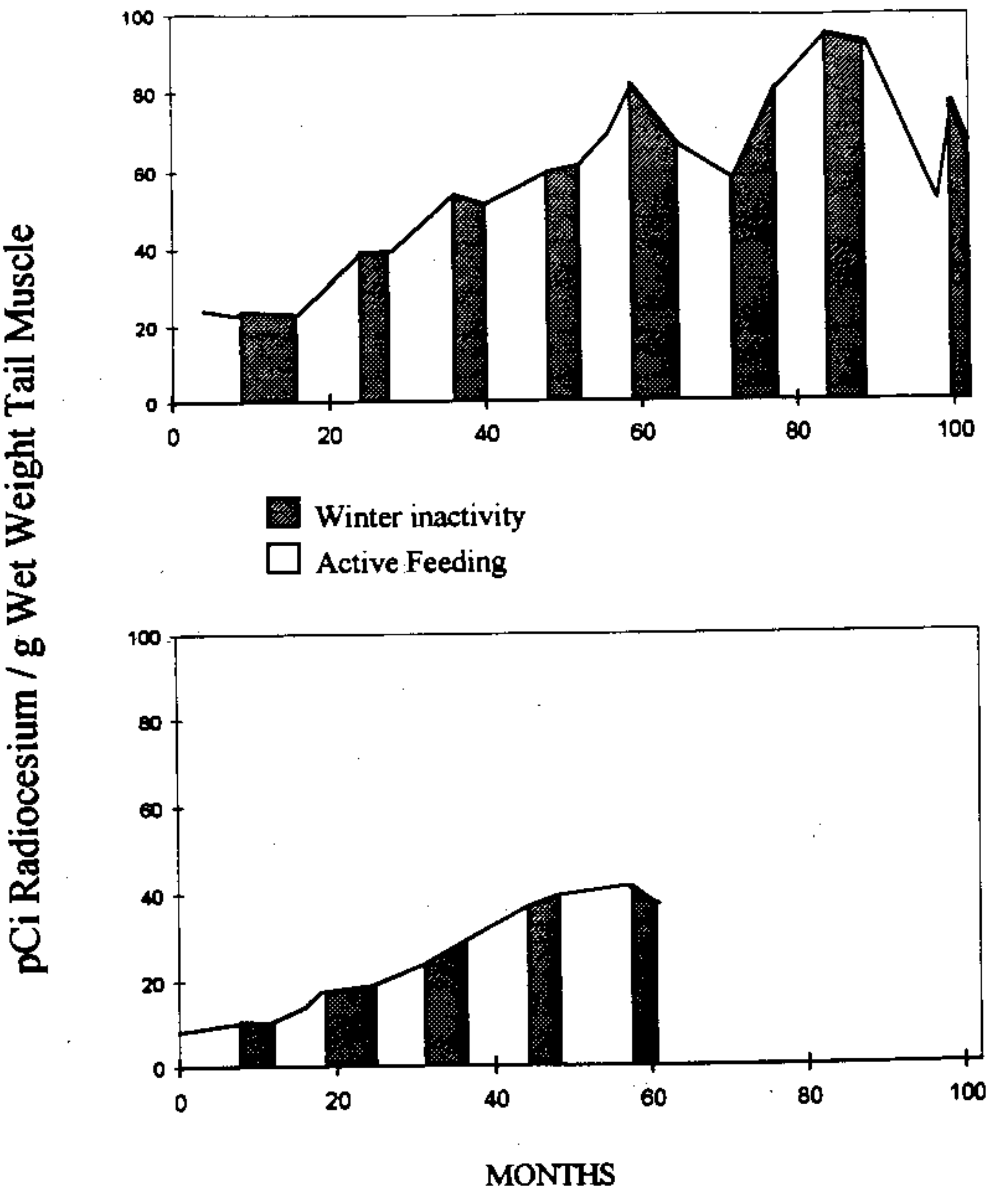

Figure 4. Increases in the estimated concentrations of radiocesium in the tail muscle of two captive American alligators which were maintained on a diet of fish from the Pond B reservoir of the U.S. Department of Energy's Savannah River Site. The fish show elevated levels of radiocesium as a result of feeding in contaminated food webs (Whicker *et al.* 1990). Shaded areas represent periods of winter inactivity when the alligators would not accept food, while unshaded areas represent periods of active feeding during warmer months. At the beginning of the study, the individuals shown in the upper and lower graphs measured 1.40 m and 1.89 m, respectively. Radiocesium levels were determined by the use of field gamma counting techniques, and the application of a regression equation (Figure 3) to predict isotope concentrations in the tail muscle.

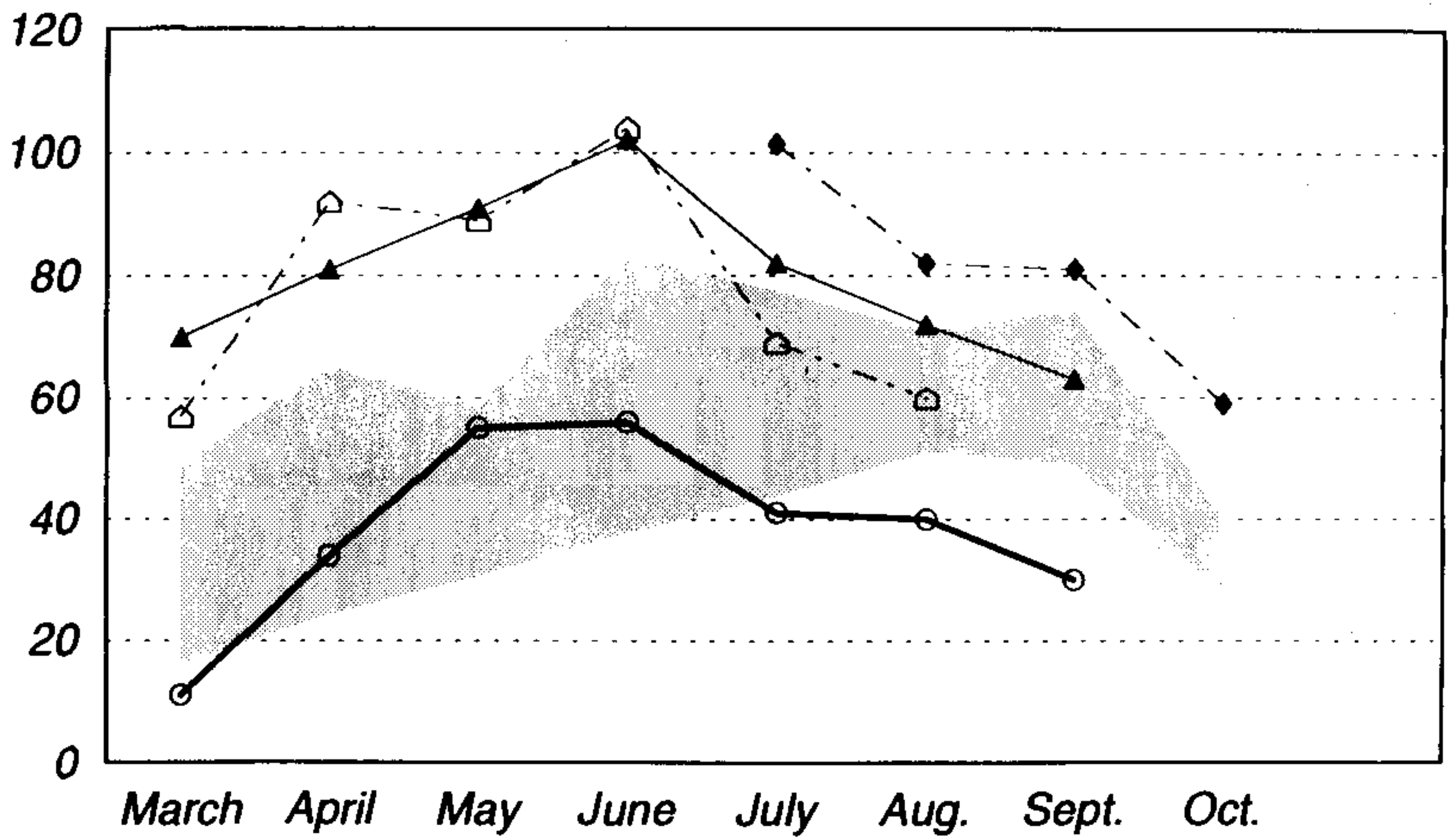

Figure 5. Monthly averages of night eyeshine counts of American alligators in the Par Pond reservoir before, during and after the reservoir's partial drawdown and refill between the summer of 1991 and the winter of 1994-1995. The shaded area represents the 95% confidence interval about all survey counts made prior to the drawdown (n = 69). These include surveys made between 1972-1990, including those made by Murphy (1977) and Brandt (1989). Solid diamonds indicates 1991 surveys made while the drawdown was in progress (Figure 2; n = 6). Solid triangles and open pentagons indicate survey counts made during 1993 - 1994 while the reservoir was in a partially drawndown state (n = 7 and 6) respectively. Open circles indicate survey counts in 1995 following completion of refill (n=11). Each point represents the mean of all surveys made during a given month in each year.

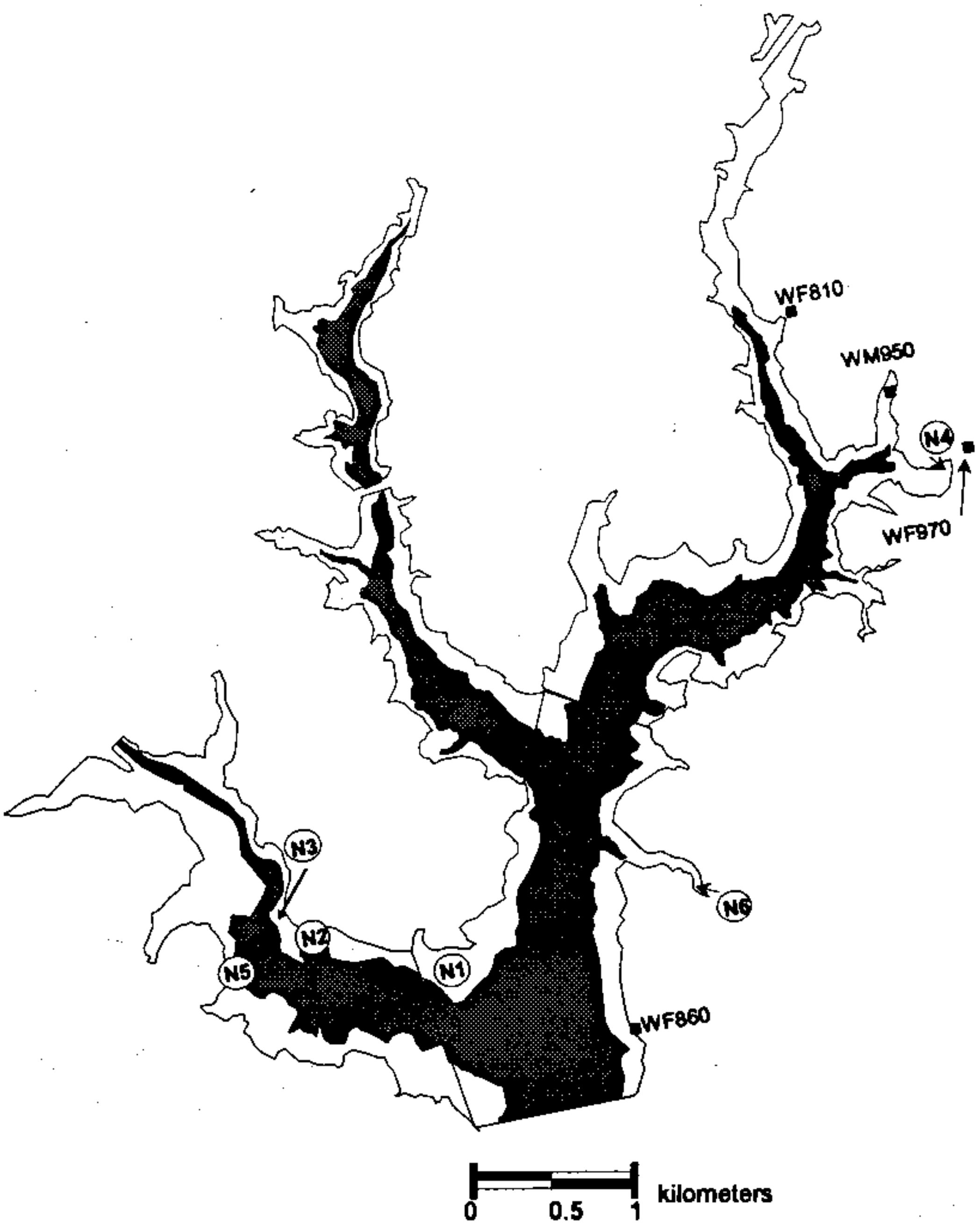

Figure 6. Wintering locations of one male (WM) and three female (WF) alligators and locations of American alligator nests (N1 - N6) at the Par Pond reservoir of the U.S. DOE Savannah River Site. Number codes following WF and WM designations refer to I.D. numbers as shown in Table 4, and nest designations are as in Tables 2 and 3. Nests were studied in the summer of 1994 and wintering locations from December 1995 through February 1996.

Misconceptions of Fourth and Fifth Grade Students About Alligators

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ABSTRACT: As part of the author's doctoral dissertation, questionnaires were administered to 99 fourth and fifth grade students in three west central Florida elementary schools in April 1995. Questionnaires contained both multiple choice and free-response items concerning various alligator topics. Misconceptions about alligators were shown to be numerous, supporting the need for formal education about alligators.

INTRODUCTION

The purpose of this investigation was to determine common misconceptions about alligators held by 99 central Florida fourth and fifth graders. Since alligators are common in the southeastern United States, residents of those areas must be educated about alligators in order to minimize potential dangers as habitat encroachment continues. An important part of educating the public involves the determination of misconceptions prior to formal instruction. Through the use of a fifteen item researcher-developed questionnaire, common misconceptions were determined.

METHODS

Student surveys were administered by four student teachers to 99 fourth and fifth grade "average" students in three elementary schools located in west central Florida. Two of the schools were public elementary schools located in rural areas which contained a majority of students designated as low socioeconomic status. The third school was a parochial school located in a coastal, urban area of west central Florida, and the majority of its students were designated as middle class. Table 1 summarizes the composition of the subject groups.

TABLE 1. Number and gender of subject groups.

	GROUP 1	GROUP 2	GROUP 3	GROUP 4
SEX				
Male	N=16	N=12	N=13	N=13
Female	N=10	N=13	N=8	N=14

For this study, a researcher-designed survey instrument was used to determine misconceptions about the following parameters: alligator range, diet, locomotion, behavior, protection laws, size and age, economic uses, safety, comparison of alligators to crocodiles, and ecological niches. Both multiple choice and open response questions were used. The instrument was reviewed by four elementary teachers and three university faculty members prior to administration. Also involved were two representatives of the AACOP who were consulted for the accuracy of the content of the questions.

Data were descriptive. For determination of misconceptions, student responses to the surveys were summarized for all four classes. Frequency of responses, for both correct and incorrect choices, were summarized and tabled. In addition, free responses, when made, were also summarized and tabled.

RESULTS

Table 2 summarizes the frequencies of responses by 99 students to the first survey question "Circle the names of the states that you think alligators live in." Responses, from most frequent to least frequent, were as follows:

TABLE 2. Summary of student responses to question one "Circle the names of the states that you think alligators live in."

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
New York	M	2	2	1	0
	F	2	4	0	1
Texas	M	7	7	2	5
	F	4	6	1	8
Illinois	M	4	4	1	1
	F	3	2	0	0
California	M	4	4	3	5
	F	6	4	3	7
Mississippi	M	14	7	11	11
	F	6	9	7	5
Louisiana	M	4	3	9	11
	F	1	8	6	3
Indiana	M	9	2	5	1
	F	2	8	1	1
Georgia	M	10	5	10	4
	F	5	8	5	7
Alabama	M	8	5	9	6
	F	4	6	6	5
Arizona	M	2	5	2	2
	F	4	4	3	4

Mississippi (70); Georgia (54); Alabama (49); Louisiana (45); Texas (40); California (36); Indiana (29); Arizona (26); Illinois (15); and New York (12). Free responses to the second part of question one "Please write the names of any other states you can think of," from most frequent to least frequent, were as follows: Florida (83); Colorado, Africa, and Asia (3 each); North Carolina, Mexico, Wyoming, Michigan, Minnesota, and Delaware (2 each); USA, Ohio, Georgia, Miami, Seattle, Chicago, Kentucky, Connecticut, Tennessee, Alaska, Tanzania, and Australia (1 each).

Table 3 summarizes the responses of 99 students to survey question number two "Please circle the places in Florida where you think alligators have been found." Responses, from most frequent to least frequent, were as follows: swamps (95); lakes (85); alligator farms (80); everglades (79); zoos (76); rivers (66); ponds (62); canals (54);

TABLE 3. Summary of student responses to question two "Please circle the places in Florida where you think alligators have been found."

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Swamps	M	16	9	13	13
	F	10	12	8	14
Zoos	M	11	8	9	12
	F	7	14	4	11
Lakes	M	15	9	11	11
	F	8	12	8	11
Ditches	M	5	2	8	7
	F	3	7	3	7
Neighbor-	M	4	1	0	5
hoods	F	1	0	2	2
Canals	M	7	4	10	8
	F	1	6	6	12
Beaches	M	2	1	1	4
	F	1	3	1	1
Ever-	M	10	7	14	13
glades	F	6	10	8	11
Roadways	M	3	3	1	2
	F	0	5	2	1
Swimming	M	4	1	1	2
Pools	F	0	1	2	1
Golf	M	3	1	3	8
Courses	F	1	1	3	3
Rivers	M	13	8	7	11
	F	5	12	3	7
Ponds	M	13	6	12	8
	F	6	9	3	5
Alligator	M	14	7	9	12
Farms	F	8	13	8	9

ditches (42); golf courses (23); roadways (17); neighborhoods (15); beaches (14); and swimming pools (12). Free Responses to the second part of survey question number two "Please write the names of any other places" were as follows: parks (10); Busch Gardens (4); school, Sea World, back yards, houses, and sewers (3 each); Indian reservations, oceans, springs, aquariums, woods, lakes, sewage pipes, and marshes (2 each); wrestling, packs, Africa, wetlands, Gatorland, neighborhoods, fairs, shows, streams, cages, amusement parks, national parks, Sunken Gardens, and tunnels (1 each).

Table 4 summarizes the responses of 99 students to survey question number three: "Please circle the kinds of food which large alligators like to eat." Responses, from most frequent to least frequent, were as follows: fish (90); duck (68); person (50); turtle and bird (46 each); snake (44);

TABLE 4. Summary of student responses to question three "Please circle the kinds of food which large alligators like to eat."

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Fish	M	14	9	13	12
	F	8	13	8	13
Bear	M	3	2	0	2
	F	1	3	1	1
Panther	M	2	2	2	2
	F	1	3	3	1
Dog	M	8	3	4	5
	F	4	4	3	4
Cat	M	7	3	1	5
	F	5	5	1	1
Squirrel	M	3	7	3	5
	F	2	6	3	1
Person	M	9	9	6	4
	F	6	8	2	6
Turtle	M	8	3	9	8
	F	6	6	1	5
Snake	M	9	5	5	4
	F	6	7	4	4
Frog	M	8	3	5	7
	F	3	8	3	6
Calf	M	7	4	3	9
	F	5	6	2	3
Duck	M	12	7	10	9
	F	6	10	5	9
Bird	M	6	4	11	9
	F	4	6	3	3
Marsh-	M	0	2	2	0
mallow	F	0	4	1	1

frog (43); calf (39); dog (35); squirrel (30); cat (28); panther (16); bear (13); and marshmallow (10). Table 5 summarizes free responses to part two of question three "Please write the names of other alligator foods." Responses included both animal and plant food sources, and the size of the food items varied from as small as an insect to as large as a moose. The most frequent response was "meat" (5). Several of the remaining responses included animals not found within alligator range: zebra (3); sea lion; squid; hippos; moose; antelope; parrot; and lion. Some responses were food items which could be purposely fed to alligators: bread (3); chicken (2); gator food; pork chops; cat food; steak; handouts; and dead rats.

TABLE 5. Free responses to part two of question three "Please write the names of other alligator foods."

FREQUENCY/RESPONSE		FREQUENCY/RESPONSE	
5	meat	1	little kids
3	bread	1	insects
3	zebra	1	moose
3	other gators	1	crabs
3	grass	1	baby deer
3	deer	1	dead rats
3	antelope	1	goat
2	lizard	1	beaver
2	chicken	1	dead animals
2	rabbit	1	baby
2	rats	1	otters
1	sea lion	1	shrimp
1	gator food	1	mice
1	dog food	1	cat food
1	pork chops	1	steak
1	lima beans	1	parrot
1	cow	1	lion
1	squid	1	handouts
1	hippos	1	algae
1	eggs	1	snails
1	eels		

Table 6 summarizes the responses of 99 students to survey question number four "Please circle the ways an alligator can travel." Responses, from most frequent to least frequent, were as follows: swimming (96); walking (85); running (47), and jumping (1). Free responses to part two of question number four "Please write down any other ways an alligator can travel" were as follows: crawling (8); floating (4); diving and waddling (3 each); gliding, rolling, riding in the back of a car, chasing, jogging, and in a zoo cage (2 each); floating, scooting, creeping, laying, slithering, hopping, sneaking, riding on another gator's back, in zoo trucks, sliding a little, going through pipes, being picked up and moved, and on hands (1 each).

TABLE 6. Summary of student responses to question four "Please circle the ways an alligator can travel."

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Swimming	M	16	9	13	13
	F	10	13	8	14
Walking	M	16	9	10	11
	F	8	12	7	12
Running	M	7	3	6	9
	F	5	6	3	8
Jumping	M	0	1	0	0
	F	0	0	0	0

Table 7 summarizes the responses of 99 students to survey question number five "Do you think an alligator can run faster than you?". Responses, from most frequent to least frequent, were as follows: yes (52); no (26); and don't know (18). Table 8 summarizes free responses to part two of question number five "How fast do you think an alligator can run?". The most frequent responses were "10 mph" and "20 mph" (6 each). The remaining responses varied from as slow as 2 mph to as fast as 86 mph.

Table 9 summarizes the responses of 99 students to survey question number six "Does an alligator breathe air?". Pretest responses, from most frequent to least frequent, were as follows: yes (85); don't know (9); and no (3).

TABLE 7. Summary of student responses to question five "Do you think an alligator can run faster than you?"

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Yes	M	9	4	7	11
	F	3	7	4	7
No	M	5	2	4	1
	F	3	4	4	3
Don't	M	2	3	2	1
Know	F	4	2	0	4

TABLE 8. Summary of free responses to question five "How fast do you think an alligator can run?"

FREQUENCY	RESPONSE	FREQUENCY	RESPONSE
6	10mph	1	fast as a dog
6	20mph	1	way fast
5	40mph	1	slow
4	15mph	1	they can't
3	25mph	1	fast as a horse
3	35mph	1	fast as a bike
3	30mph	1	very slow
2	60mph	1	almost as fast as a cheetah
2	50mph		
2	45mph	1	slow yet fast
2	5mph	1	faster than me
2	2mph	1	really fast
2	3mph	1	a little fast
2	10-15mph	1	40-50mph
1	2-5mph	1	12mph
1	86mph	1	3-4mph
1	65mph	1	55mph
1	25-32mph	1	5-10mph
1	28mph		

TABLE 9. Summary of responses to question six "Does an alligator breathe air?"

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Yes	M	16	7	12	13
	F	9	12	5	11
No	M	0	2	0	0
	F	1	0	0	0
Don't Know	M	0	0	1	0
	F	0	2	3	3

Table 10 summarizes free responses to part two of question number six "Please write why you chose your answer." The most frequent response (8) was that every living thing needs air. Seven students referred to "coming on land" as a reason to breathe. Four students incorrectly stated that alligators are mammals, and three correctly stated that alligators are reptiles. Five students cited the lack of gills as a reason for breathing air; Ten students mentioned "nose," "nostrils," or "lungs" as reasons for breathing air.

TABLE 10. Summary of free responses to part two of question six "Does an alligator breathe air? Please write why you chose your answer.".

Yes, Alligators Breathe Air Because:

They're Reptiles:

1. They're reptiles and reptiles breathe air (2).
2. They're reptiles and animals have to breathe.

They're Mammals:

3. It's a mammal (4).

They Come Out of Water:

4. They come on land (7).
5. An alligator has nostrils above the surface (4).
6. They come up every few minutes (3).
7. If alligators go out of water then they have to.
8. When the alligators come on land to sun they breathe.
9. Sometimes he is up, and sometimes he is down.
10. Alligators would not walk on land.
11. They have two holes at the edge of their nose.
12. They breathe like us when they're out of water.
13. They always come up for air when I see them.
14. It likes to keep its nostrils above water plus they don't have gills.
15. It always stays on top of water.
16. When they come out of water they would die if they didn't breathe air.
17. Every time I see an alligator its nose is sticking out.
18. An alligator can live in and out of water.
19. In some books it says alligators can only stay under for two hours.

They Need Air:

20. Every living thing has to be able to breathe air (8).
21. They are living things and they need air (7).
22. I seen (sic) one breathe air.
23. They can hold their breath long, but they still need air.

TABLE 10 (cont.)

24. For oxygen.
25. If it breathes under water it might drown.

They Have Breathing Structures:
26. He has a nose (2).
27. An alligator has nostrils.
28. They have lungs, not gills.
29. It has a nose, everything needs air.
30. Because it has lungs.
31. It has a nose, not gills.
32. They don't have gills like fish.
33. I don't see any gills on an alligator.
34. It does not have gills.
35. They do not have gills.

Others:
36. I know it (3).
37. He'll probably die or still stay alive with the water.
38. If I said no they would not be alive.
39. It's a living thing.
40. You see air bubbles when they swim.
41. It's alive.
42. It will die if it doesn't.
43. I just know that alligators can.
44. They do.
45. It's like a person. It can stay under long though.
46. I've studied alligators before.

No, Alligators Do Not Breathe Air Because:
1. They can't breathe with a nose.
2. When I went to a place I saw a big alligator stay under water for a long time; If they don't breathe they'll die.
3. It doesn't in water.

I Don't Know If Alligators Breathe Air Because:
1. I never studied them.
2. I have not done any research on this animal.
3. I never really learned about them.
4. They might breathe water.
5. I don't know.

Table 11 summarizes responses of 99 students to survey question number seven "Do alligators dig holes in the ground?". Student responses, from most frequent to least frequent, were as follows: yes (48); no (26); and don't know (22).

TABLE 11. Summary of student responses to question seven "Do alligators dig holes in the ground?".

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Yes	M	11	4	10	6
	F	4	2	7	4
No	M	1	3	1	5
	F	5	8	0	3
Don't Know	M	4	2	2	2
	F	1	3	1	7

Table 12 summarizes responses of 99 students to survey question number eight "Are alligators endangered species like manatees are?". Student responses, from most frequent to least frequent, were as follows: no (39); yes (35); and don't know (23).

Table 13 summarizes free responses to part two of question number eight "I chose my answer because....". The majority (18 out of 35) of the "no" comments reflect the notion that there are many alligators in existence. Two comments reflect the notions that having "alligator season" or being "made out of stuff" signify an abundance of alligators. Out of 31 reasons given for choosing "Yes," seven respondents referred to the "shooting," "hunting," or "killing" of alligators; Seven respondents made references to "hearing" from a person or a show that alligators are endangered; Six respondents believed that there are not many alligators remaining; Five respondents associated endangerment to human consumptive uses of alligators or their parts; Two respondents believed that alligators were "endangered" due to pollution/habitat destruction; and two respondents implied that endangered animals are pictured on "earth shirts" or are placed in zoos.

TABLE 12. Summary of responses to question eight "Are alligators an endangered specie like manatees are?".

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Yes	M	5	5	5	5
	F	1	5	4	5
No	M	6	3	7	4
	F	5	6	3	5
Don't Know	M	5	1	1	4
	F	4	3	1	4

TABLE 13. Summary of free responses to part two of question eight "Are alligators an endangered specie like manatees are? I chose my answer because....".

No, Alligators Are Not Endangered Species Because:

There are Many of Them:

1. There are a lot of them around (8).
2. I see a whole lot of them (4).
3. They're all around the country.
4. There are a lot of them left in the world.
5. I see so many all the time.
6. I see a lot of alligators.
7. I have seen a lot in my area.
8. I live in Florida and I see a lot of them.

People Hunt Them or Use Them:

9. They have alligator season.
10. People kill them for their skins and food.
11. Some alligators get eaten or made out of stuff.
12. I see many of them in alligator farms.

I Heard or Saw That:

13. I found out in school.
14. I have seen shows about alligators.
15. I heard that alligators have come back.
16. I've seen a lot more alligators than crocodiles.

Others:

17. I don't think they are.
18. They are not.
19. I just know that they are.
20. Manatees get killed a lot.
21. Their backs help them.
22. Alligators breathe air and water.
23. I have not seen any Save the Alligator signs.
24. They were but not any more.

Yes, Alligators Are Endangered Because:

They're Aren't Many:

1. People kill them a lot (5).
2. There aren't that many (3).
3. You don't see them anymore (2).
4. Most alligators are becoming shoes and suitcases (2).
5. People use alligators for skin.
6. A lot of people take their teeth, skin, and they kill them before doing anything to them.
7. Many die from pollution.
8. A lot of people have purses and wallets made from alligators.
9. The swamps are being killed out and that's their habitat.

TABLE 13 (cont.)

I Heard or Saw That:
10. I remember hearing that (2).
11. My mom's a teacher and she's studying endangered species and the alligator is one of them.
12. I have a page about them.
13. I think I remember hearing that alligators are one of the most endangered animals.
14. They said it on National Geographic.
15. They are on the endangered species list.
16. I remember watching a show about that.
17. I hear it from parks and the news.

Others:
18. He bites people.
19. I know its right.
20. If people are putting them in zoos they are endangered.
21. On my earth shirt it has an alligator on it.
22. For a nest.

I Don't Know If Alligators Are Endangered Because:
1. I am not really sure (2).
2. I really don't know because I don't study alligators.
3. They are really just protected.
4. I don't know if they're being protected or not.
5. I think they're good and because some of them I know.
6. They might be and they might not be.
7. I have not seen the endangered species list in a while.
8. There are a lot of alligators.

Table 14 summarizes the responses of 99 students to survey question number nine "How old do you think an alligator can get? Please circle one." Student responses, from most frequent to least frequent, were as follows: 25 years (31); 50 years (30); 50+ years (24); and 10 years (13).

Table 15 summarizes the responses of 99 students to question number ten "How long do you think an alligator can get, from the tip of its head to the tip of its tail? Please circle one." Student responses were, from most frequent to least frequent, as follows: 20+ feet (46); about 15 feet (43); and about 10 feet (8). The respondents who chose "20+ feet" may be confusing alligators with crocodiles.

Table 16 summarizes the responses of 99 students to survey question number eleven "What can people use alligators for? Please circle all of your answers." Student responses, from most frequent to least frequent, were as follows: wallets (85); meat and purses (83 each); shoes (72); hunting (44); hides (40); and pets (30).

TABLE 14. Summary of student responses to question nine "How old do you think an alligator can get?".

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
10 Years	M	2	0	1	3
	F	0	4	1	2
25 Years	M	4	1	2	6
	F	4	4	3	7
50 Years	M	7	3	7	3
	F	2	4	1	3
50+ Years	M	3	5	3	1
	F	4	2	3	3

TABLE 15. Summary of student responses to question ten "How long do you think an alligator can get...?"

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
ABOUT 10'	M	0	1	2	1
	F	2	0	1	1
ABOUT 15'	M	8	4	8	6
	F	3	7	2	5
20'+	M	8	4	3	6
	F	5	7	5	8

TABLE 16. Summary of student responses to question eleven "What can people use alligators for?".

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Meat	M	15	8	13	9
	F	9	13	7	9
Hides	M	10	4	4	5
	F	7	4	3	3
Pets	M	5	5	1	4
	F	4	8	0	3
Shoes	M	10	6	10	8
	F	8	10	7	13
Wallets	M	13	7	12	12
	F	9	11	8	13
Purses	M	14	6	12	12
	F	8	10	8	13
Hunting	M	9	5	7	4
	F	5	8	2	4

Table 17 summarizes free responses to part two of question eleven "Please write down any other uses for alligators." Table 18 summarizes the responses of 99 students to survey question number twelve "Which of these could be hurt or killed by an alligator? Please circle all of your answers." Responses, from most frequent to least frequent, were as follows: man (89); child (86); dog (82); cat (77); snake (73); calf (67); and turtle (59).

Table 19 summarizes free responses to part two of question twelve "Please write down anything else that could be hurt or killed by an alligator." Out of 89 written responses, variations of the following occurred: aquatic animals (30); mammals other than humans occurring in alligator range (25); humans (9); animals which do not occur in American Alligator range (8); animals that occur in crocodile range (5); and insects (4). The most frequent response was "fish" (17).

TABLE 17. Summary of free responses to part two of question eleven "Please write down any other uses for alligators."

1.	Boots (8).	21.	Teeth and feet.
2.	Belts (7).	22.	To kill.
3.	Coats (5).	23.	Boots and to stuff them.
4.	Suitcases (4).	24.	Outside of clothes.
5.	Zoo attractions (4).	25.	Meat.
6.	Necklace (2).	26.	Skin.
7.	Teeth (2).	27.	Seat belts.
8.	Souvenirs (2).	28.	Gator carpet.
9.	Jackets (2).	29.	Footballs.
10.	Bags (2).	30.	Clothes.
11.	Decorations (2).	31.	Gloves.
12.	Blankets (2).	32.	Entertainment.
13.	Bed spreads.	33.	Card holders.
14.	Trophies.	34.	Hats.
15.	Jacket & book bag.	35.	A design maybe.
16.	Handbags.	36.	Shows.
17.	Wrestling.	37.	Heads for collectors.
18.	To stuff them and mount them.	38.	They sometimes are used to hunt for other animals.
19.	Show cases and stuffed things.		
20.	Carving utensils.		

TABLE 18. Summary of student responses to question twelve "Which of these could be hurt or killed by an alligator?".

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Dog	M	13	6	12	11
	F	9	10	8	13
Cat	M	14	6	12	11
	F	8	8	6	12
Child	M	14	9	12	11
	F	8	11	8	13
Calf	M	11	5	11	11
	F	7	10	5	7
Snake	M	14	5	12	10
	F	7	12	5	8
Turtle	M	9	3	12	10
	F	6	7	6	6
Man	M	15	9	11	12
	F	8	13	8	13

TABLE 19. Summary of free responses to part two of question twelve "Please write down anything else that could be hurt or killed by an alligator."

These Could Be Hurt or Killed By An Alligator:

1. Fish (17).
2. Birds (13).
3. Duck (6).
4. Rabbit (4).
5. Deer (4).
6. Anything (4).
7. Bear (3).
8. Zebra (3).
9. Frog (3).
10. Woman (3).
11. Horse (2).
12. Antelope (2).
13. Squirrel (2).
14. Babies (2).
15. Most living things (2).
16. Bobcat.
17. Fingers.
18. Lamb.
19. Sheep.
20. Mice.
21. Bats.
22. Tiger.
23. Roach.
24. Mostly anything without a shell and smaller than it.
25. Animals.
26. Goats.
27. Water Creatures.
28. Armadillo.
29. Pig.
30. Hamster.
31. Cow.
32. Chicken.
33. Turtle.
34. Eel.
35. Rat.
36. Elk.
37. Stingray.
38. Wolf.
39. Teacher.
40. Food.
41. People.
42. Gator.
43. Ant.
44. Indians.
45. Fly.
46. Butterfly.

Almost any other animal.

Table 20 summarizes the responses of students to survey question number thirteen "Is an alligator and a crocodile the same thing? Circle one." Responses of 99 students, from most frequent to least frequent, were as follows: no (76); don't know (14); and yes (7). Students who chose "no" cited differences in teeth, noses, darkness and roughness of skin, aquatic habitat, species, and sex (see Table 21).

TABLE 20. Summary of student responses to question thirteen "Is an alligator and a crocodile the same thing?".

	SEX	GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
Yes	M	3	0	0	1
	F	1	2	0	0
No	M	11	8	13	12
	F	6	9	8	9
Don't	M	2	1	0	0
Know	F	3	3	0	5

TABLE 21. Summary of free responses to part two of question thirteen "I chose my answer because...".

Yes, An Alligator And A Crocodile Are The Same Because:

1. They are the same.
2. They are.
3. I just know alligators and crocodiles are the same.
4. A crocodile has a pointed snout and alligators don't.

No, An Alligator And A Crocodile Are Not The Same Because:

1. They are different.
2. You can tell them apart by their teeth.
3. I know the differences between a crocodile and an alligator.
4. A crocodile is a girl and an alligator is a male.
5. They're just not.
6. Crocodiles live in saltwater.
7. Crocodile has a long nose and an alligator doesn't.
8. I knew it.
9. Crocodiles have a darker and rougher skin.
10. Their noses are different.
11. Crocodiles are different species.

Table 22 summarizes student responses to question fourteen "Do you think that alligators are good for our environment?". Student responses, from most frequent to least frequent, were as follows: Yes (50); No (18); and I don't know (31). Of the reasons for choosing "yes," 21 out of 42 students made references related to food chain or population control; Four students mentioned economic uses for alligators, such as food; And "circle of life" was mentioned by three students (see Table 23). Of the reasons for choosing "no", 9 out of 15 responses contained "hurt" or "kill"; One respondent mentioned poisoning from eating alligators which ate poison. One response "they need water to survive" may be due to increased awareness for water conservation as a result of local water supply problems. Six students provided reasons for choosing "I don't know"; Four of those made references to food chain or eating.

TABLE 22. Summary of student responses to question fourteen "Do you think that alligators are good for our environment?".

		GROUP 1 N=26	GROUP 2 N=25	GROUP 3 N=21	GROUP 4 N=27
	SEX				
Yes	M	10	5	8	8
	F	3	8	3	5
No	M	3	1	3	3
	F	3	2	1	2
Don't	M	3	3	4	2
Know	F	4	4	4	7

TABLE 23. Summary of free responses to part two of question fourteen "I chose my answer because....."

Yes, Alligators Are Good For Our Environment Because:

They Help Control Other Populations:

1. They eat things if there is a large population (3).
2. They kill some of the bad things (3).
3. They control the plant population (2).
4. They help control the fish (2).
5. They kill other animals and help our ecosystem.
6. Because they eat snakes.
7. It eats things like snakes and tigers so they can't hurt us.
8. It eats almost anything.
9. They eat snakes and keep water clean.
10. It is part of the food chain and it kills snakes that could hurt us.
11. They can get rid of animals that are pests.
12. They can kill things that are bad for the environment.
13. They eat things in the water that are bad.

They are Part of the Food Chain:

14. Food (2).
15. It is part of the circle of life (2).

TABLE 23 (cont.).

16. It is part of our food chain (2).
17. If we didn't have alligators the food chain would break.
18. I ate some last night.

Others:

19. I knew it.
20. They clean up places.
21. I like alligators.
22. They are neat animals.
23. It is a good use for a lot of things.
24. They might be bad but they're good.
25. I like to study about them.
26. They are living things.
27. They help us therefore they can help the environment.
28. They are one of God's animals.
29. My mom says so.
30. It is our mascot and it is the right environment here.
31. They are nature.
32. Children of the future would like to see them.
33. They are happy.

No, Alligators Are Not Good For Our Environment Because...:

They Are Dangerous:

1. They can hurt you (3).
2. Because they can kill you (2).
3. They eat flesh!
4. They kill a lot and that is bad.
5. They can hurt things that we need.
6. They are bad and mean.

Others:

7. Alligators can ruin our world and we don't want that to happen.
8. What if it ate some poison and we ate it we would get poisoned.
9. They need hot, dry, damp climate.
10. They eat animals and those animals may become extinct.
11. Alligators don't do anything.
12. They need water to survive.

I Don't Know If Alligators Are Good For Our Environment Because:

1. Sometimes they are good, sometimes they are bad.
2. It kills and sometimes it is good that it kills.
3. I've never seen an alligator doing anything.
4. They hurt a lot of things but they are part of life.
5. They eat snakes and children.
6. What part of the food chain it is in.

Table 24 summarizes free responses to question fifteen "What should you do if you see an alligator near you? Please write your answer." Out of 92 responses, the most frequent (52) included the word "run"; Of those responses, 15 mentioned "zigzag," "swerving," "squiggly," or "side to side," all of which are potentially dangerous actions. Remaining responses included the following: moving slowly (21); telling someone (14); avoiding it (4); and interacting with it (4). Fear of alligators was implied in 84 of the 92 responses.

TABLE 24. Summary of free responses to question fifteen "What should you do if you see an alligator near you?".

If I Saw An Alligator Near Me I Would:

Get Away:

1. Run (15).
2. Run zigzag (12).
3. Run for your life (2).
4. Get away (2).
5. Climb a tree (2).
6. Run squiggly because alligators cannot run squiggly.
7. Run swerving.
8. Run side to side as fast as you can.
9. Run up a tree.
10. Climb.
11. Run to the nearest house and if there isn't one just run quick!
12. Run, don't feed it!
13. Run if I were next to a house or jump a fence.
14. Run as fast as you can and never look behind.
15. Stay clear of its path. If you are near its nest one thing to do--RUN!
16. If it looks mad run, if not just look at it.
17. Scream then run or faint!
18. Scream and run
19. Get as far away as you can.
20. Get out of there or stay calm.
21. Leaf (sic).

Tell Someone:

22. Run and get help quick!
23. Run or call for help.
24. Run as fast as I could and go find an older person and make sure everyone hears me say there's an alligator so don't go over there.
25. Run, yell, scream, call an adult.
26. Run and call the zoo or something.
27. Tell an adult and call animal control.
28. Tell someone or just run.

TABLE 24 (cont.).

29. You don't get close to it. If you see one get an adult fast, and someone will call the alligator farm and get it.
30. Stay away and tell an adult so little kids don't go by.
31. Go to my mom.
32. Tell my parents.
33. Call Mrs. Fagan because they are gator hunters.
34. Call animal control.
35. Call the animal patrol (sic) and stay away from it.

Move Slowly:

36. Walk away slowly (6).
37. Walk away and don't do anything to it.
38. Walk slowly away so it won't see you.
39. Walk backwards slowly.
40. Try to walk slow away from it.
41. Just slowly back off.
42. Back up slowly or get eaten.
43. Take off slowly, then run!
44. Stand still and walk back slowly then run.
45. You should back up and walk away.
46. Walk away.
47. Stay away because they are dangerous.
48. Stay real still like a log.
49. Stand really still or run.
50. Stand still.
51. Don't feed it or run.

Avoid It:

52. Stay away.
53. Don't go over there.
54. Leave them alone.
55. Don't bother it.

Interact:

56. Remove it, if not it might hurt someone.
57. Feed it.
58. Get a gun and point it at the alligator.
59. Get a shotgun and chase it.

CONCLUSIONS AND RECOMMENDATIONS

Misconceptions about alligators do exist. The primary reason for doing this study was to determine misconceptions common to fourth and fifth graders in three central Florida schools. Since there are approximately 6.7 million acres of wetland habitat occupied by alligators in the State of Florida (AACOP, 1993), and since the FGFC (1991) claims there are nearly 10,000 alligator-related complaints annually, the American Alligator is obviously quite common. When the factor of potential danger to humans is also considered, alligator education in Florida's public schools should be mandatory. Fortunately, the AACOP is currently working on a curriculum project to meet this need.

Alligator education is a topic which could easily be integrated into various subject areas across the curriculum, from kindergarten through high school. Math, history, social studies, reading, and science could easily include alligator lessons, while at the same time valuable safety lessons could be taught. Similar curricula involving manatees and panthers have already been used and have been quite popular with teachers and students.

Further research is recommended, particularly with respect to the identification and eradication of misconceptions. Additional studies in the following areas are recommended: Determination of both student and teacher misconceptions; Identification of the sources of common misconceptions; Determination of the effects of teacher misconceptions on the effectiveness of teaching; Relationship between teacher experience level and their effectiveness in changing misconceptions; And determination of teachers' perceptions of student misconceptions.

For more information concerning complete analyses of this research or copies of the questionnaire, please contact the American Alligator Cycle of Protection (AACOP).

Application of the new IUCN Criteria to crocodilian status evaluation.

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Introduction. One of the most widely used products of the IUCN- World Conservation Union is the Red List of Threatened Animals (formerly Red Data Books) which provides a simple list of species evaluated into categories of threat of extinction. The evaluations of species status are provided by the Specialist Groups of IUCN Species Survival Commission. In 1994, IUCN introduced a new system (IUCN 1994) for Specialist groups to evaluate the categories into which species should be placed. The new criteria were developed after several years of consultation and revision, in an attempt to provide criteria that were i. Objective and based on quantitative data; ii. that were simple; iii. that would apply to all (or at least most) taxa; and iv. that would be sufficiently flexible to accommodate the very great differences between species. The new criteria are based on a theoretical concept elaborated by Mace and Lande (1991) which uses population and distribution data of a species to evaluate the probability of a species becoming extinct in immediate, ecological or longer term time frames. Species with a high probability of extinction in the immediate future are considered to be in Critical danger of extinction, while species whose probability of extinction is low or only becomes significant over very long time frames are said to be of Low Risk (of extinction) and a series of categories between these extremes are defined (Fig 1.). An additional set of categories provides for various other contingencies such as extinct, extinct in the wild or surviving only as a result of conservation action (Fig. 1).

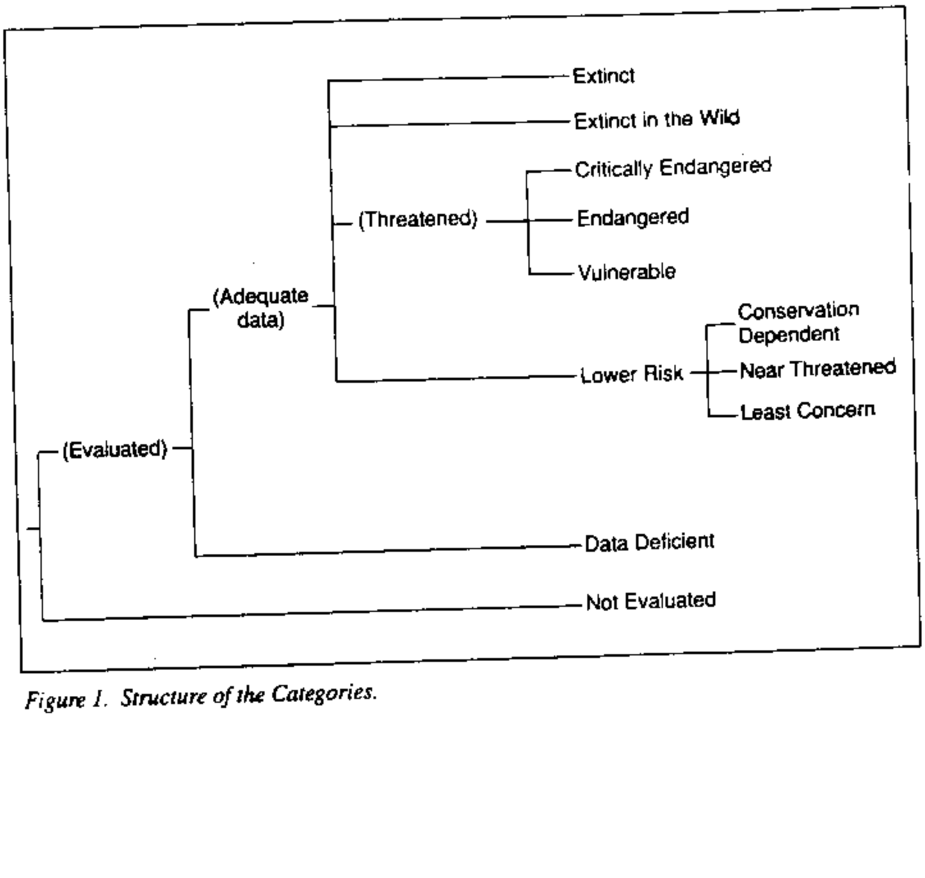

Figure 1. Structure of the Categories.

A set of quantitative decision criteria are given to allow the evaluation of each species based on the information available. The kinds of information required are population trends over time, distribution patterns and trends, numbers of breeding adults, and combinations of factors (levels of exploitation, competition from feral species, habitat loss) that are thought to increase the probability of extinction. A simple hierarchical decision tree is followed to arrive at the category that best fits the data for the species, Table 1.

Application of this decision tree requires some care and familiarity with the definitions and operations of the criteria. For example, population sizes are described as reproductive adults, not total numbers; distributions are defined as either area of occupancy (actual habitat area) or as extent of occurrence ('range' or 'distribution' in the more usual biological sense, see figure 2) and rates of population decline can be judged over absolute (10 years) or species specific (3 generations) periods. The document 'IUCN Red List Categories' 1994 must be consulted for a full description of the criteria and definitions.

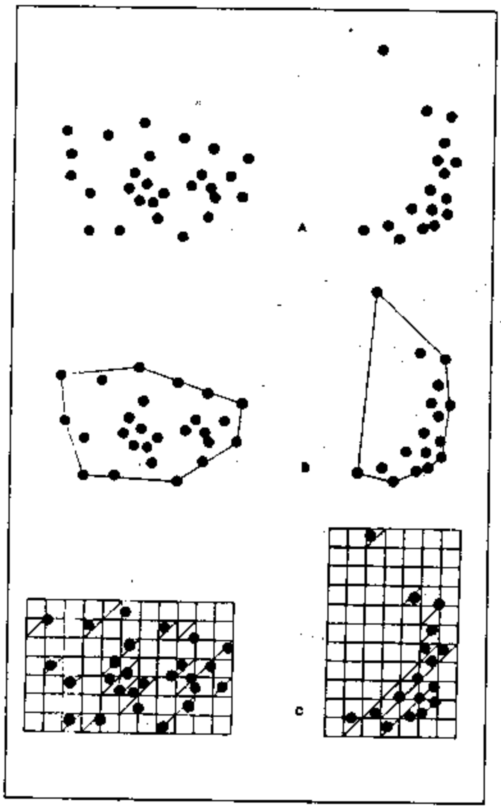

Figure 2. Two examples of the distinction between extent of occurrence and area of occupancy. (a) is the spatial distribution of known, inferred or projected sites of occurrence. (b) shows one possible boundary to the extent of occurrence, which is the measured area within this boundary. (c) shows one measure of area of occupancy which can be measured by the sum of the occupied grid squares.

The Crocodile Specialist Group was asked to provide a first attempt at reclassifying crocodilian species under the new criteria in August of 1995 and a preliminary list was developed and appears in the revised CSG action plan (draft 1995). However it was thought valuable to refine these evaluations using the concentration of expertise available among CSG members at the 13th Working meeting. At a workshop held on 14 May 1996 an introduction to the new criteria was presented and then working groups of experts formed to evaluate several Latin American Crocodilian Species with the new criteria.

Table

Summ ry of new IUCN Categories and Criteria

Use any of the A-E criterion	Critically Endangered	Endangered	Vulnerable
A. Declining Population			
population decline rate at least	80% in 10 years or 3 generations	50% in 10 years or 3 generations	20% in 10 years or 3 generations
using either (1) population reduction observed, estimated, inferred, or suspected in the past or (2) population decline projected or suspected in the future.			
based on	a) direct observation b) an index of abundance appropriate for the taxon c) a decline in area of occupancy, extent of occurrence and/or quality of habitat d) actual or potential levels of exploitation e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.		
B. Small Distribution and Decline or Fluctuation			
Either extent of occurrence or area of occupancy	≤ 100km2 ≤ 10km2	≤ 5000km2 ≤ 500km2	≤20000km2 ≤2000km2
and 2 of the following 3:			
(1) either severely fragmented: or known to exist at # locations	"(isolated subpopulations with a reduced probability of recolonization, if once extinct) =1	≤5	≤10
(2) continuing decline	any rate	any rate	any rate
in any of the following:	a) extent of occurrence b) area of occupancy "c) area, extent and/or quality of habitat" d) number of locations or subpopulation e) number of mature individuals		
(3) fluctuating	>1 order/mag.	>1 order/mag	>1 order/mag
in any of the following:	a) extent of occurrence b) area of occupancy c) number of locations or subpopulations d) number of mature individuals		
C. Small Population Size and Decline			
Number of mature individuals	≤250	≤2500	≤10000
and 1 of the following 2:			
(1) rapid decline rate	25% in 3 years or 1 generation	20% in 5 years or 2 generation	10% in 10 years or 3 generations
(2) continuing decline and	any rate	any rate	any rate
either (a) fragmented	all sub-pops ≤50	all sub-pops ≤250	all sub-pops ≤1000
or (b)	all individuals in a single sub-population		
D. Very Small or Restricted			
Either (1) # of mature individuals	≤50	≤250	≤1000
or (2) population is susceptible	(not applicable)	(not applicable)	area of occupancy <100km2 or # of locations <5
E. Quantitative analysis			
Indicating the probability of extinction in the wild to be at least	50% in 10 years or 2 generations	20% in 20 years or 5 generations	10% in 100 years

Results.

Crocodylus moreletii working group.
Participants: Jose Juan Perez, Beatrix Figueroa, Luis Sigler, Franciso Leon, Fabricio Andrade, Jose Carlos Rodarte, Gabriel. (Mexico)

Crocodylus moreletii was tentatively assigned to the Data Deficient category in 1995 however the working group was able to bring forward a large amount of unpublished information on the species status in Mexico and drew the following conclusions. Based on the New Criteria of IUCN *C. moreletii* is a species with **Low Risk, (LR)** of extinction. The population is confidently thought to number in excess of 10,000 mature individuals in the wild distributed widely around the Gulf of Mexico. None of the other criteria to qualify the species for Vulnerable or higher category is thought to apply. The working group considered that the subcategory **Conservation Dependent** might apply to this species as its continued survival may be dependent on the success of efforts currently underway to establish management and conservation programs.

Crocodylus acutus working group.
Participants: Alfredo Arteaga, Gustavo Hernandez (Venezuela); Miguel Rodriguez, Gerardo Abadia, Mario Fernandez Orjuela, Leonardo Orjuela, Maximiliano Ambrosio (Colombia); Francisco Castillo (Mexico); Andreas Schubert (Dominican Republic); Hugo Caracha (Bolivia); Ana Maria Trelancia (Peru); Graciela Folis, Alejandro Traccia (Argentina)

Over its total range the group considered *C. acutus* to qualify for the category of **Vulnerable (VU)** based on criteria A. 1. a & c. "Population reduction of at least 20% in the last 10 years based upon direct observation and the observed decline in area of occupancy". The species is known to be extirpated from areas of its former range, and to remain in highly fragmented isolated populations over much of its distribution. Populations are known to be small and depleted in Honduras and Nicaragua. Data are lacking for important parts of the range (Peru, Ecuador, Colombia, Panama,). Substantial populations are thought to remain in Belize and Cuba and small, isolated but relatively secure populations remain in USA, and Jamaica.

The working group went on to evaluate the status in the range states as follows:

Venezuela, Endangered (A 1 a. Decline of 50% in 10 years)
Dominican Republic, Endangered (A 1 a. Decline of 50% in 10 years)
Haiti, Critical (A. 1.a. decline of 80% in 10 years)
Colombia, Data Deficient (little information but the habitat is fragmented)
Peru, Data Deficient
Ecuador, Data Deficient
Costa Rica Data Deficient but possibly Vulnerable
Mexico, Vulnerable (A.1.a & c as above with an estimate of between 300 and 3,000 adults).

Recognising the need for continued coordination between their diverse national efforts this group formed an ad hoc task force on *C. acutus* to remain in communication following the 13th working meeting.

Caiman latirostris working group.
Participants: Tomas Waller, Patricio Miccuci (Argentina); Luciano Verdade (Brazil)

The status of *C. latirostris* as **Low Risk (LR)** was confirmed due to large and healthy populations known in Argentina. However, the depleted status of the species in southern Brazil, largely due to habitat loss was recognized. Detailed information from Bolivia, Paraguay and Uruguay is not available but the species is thought to be at the margins of its range in these countries.

Melanosuchus niger working group.
Participants: R. Da Silviera, W. Magnusson (Brazil); E. Pachon, M. Rodriguez (Colombia); G. Webb (Australia).

New information on the distribution and densities of *Melanosuchus niger* in Brazil (Mamamirua area) Colombia and Ecuador, reported at the 13th Working Meeting , and general reports of apparent recovery of the species in many areas of its range caused the group to initially evaluate the species as **Low Risk (LR).** However, difficulty was encountered by this group in applying to the new criteria to the known/inferred population history of the species. *M. niger* was reported anecdotally to be extremely abundant throughout the Amazon system during the early years of colonization and is thought to have suffered a drastic decline due to over exploitation in the period of 1930 -1950. It was unclear to the group whether the very large declines of the past (3 generations), or the recent modest recovery (over the last 10 years) was of more importance in evaluating the current status. It appeared to this group that while the species has been extirpated from areas of its former range, and is unlikely to ever return to the abundance of the past, that there was a strong expectation that individual populations occupying very large areas could be confidently assigned to be low risk of extinction. The application of sustainable use strategies to these remaining populations is thought to have very good potential for ensuring their long term survival.

In general discussion all the groups agreed that all the species of *Caiman* and *Paleosuchus* were **Low Risk LR**. The only possible exception was the subspecies *Caiman crocodilus apaporiensis* whose status, both taxonomically and from a conservation perspective, is uncertain.

Venezuelan and Colombian representatives agreed that *Crocodylus intermedius* is correctly assigned to the **Critical (CR)** category based on criteria A.1.c. (a decline of >80% in the last 3 generations) and C. 2 a. (Adult wild population of >250 individuals and continuing decline with severely fragmented habitats).

Conclusions. It was clearly useful and relatively easy to apply the new criteria to crocodilian species of Latin America. The groups, with little prior experience of this system, quickly adapted the available information to the IUCN criteria decision tree and made conclusions that were accepted as useful and accurate. No serious dissatisfaction with the process or the criteria and categories themselves were expressed. Some difficulties were experienced in adopting the correct interpretations of the definitions and most groups formed preliminary conclusions that were subsequently modified after deeper thought and analysis. The exercise of applying concrete criteria, and reporting the results in reference to quantitative evaluations was novel, but acceptable.

The status evaluations arrived at are consistent with current expert opinion within the CSG and appear to reflect quite accurate conservation situations for the species. The system has some deficiencies. The application of trend data over different time scales allows quite different conclusions (see *M. niger* above) and the system is not very sensitive to regional differences in widely distributed species (for example the apparently critical situation of *C. acutus* in Haiti is masked by the overall status). The Data Deficient category is unsatisfying, but a useful indication of where additional information is needed. Overall the workshop was considered a success and the application of the IUCN criteria to other species of crocodilians is recommended. The results of this workshop will be integrated into the CSG input to next round of species evaluations for the IUCN Red List.

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Trade Workshop
Report prepared by D. Ashley, Trade Group CSG

During the 13th Working Meeting of the CSG in Santa Fe, Argentina a Trade Workshop was convened to discuss issues concerning trade in crocodilians. The concept and format for this workshop were developed by Vice-Chairman for trade Kevin Van Jaarsveldt and Deputy Chairman Y. Takehara and Don Ashley during the Hong Kong Leather Fair in April. The objective was to provide a regular venue for the discussion of trade issues during CSG working meetings and provide an opportunity to exchange information as well as discuss trade-related topics in more detail.

A longer term goal was to provide a forum through the CSG Trade Group to encourage cooperation between regional trade associations to better educate the public and promote sustainable use as a benefit to both people and wildlife. It is important to emphasize this effort through the CSG Trade Group is not to suggest the CSG should be directly promoting the industry. Only that it should provide the opportunity for trade representatives to discuss a wide range of topics that updates, informs and encourages more trade participation in the sustainable use strategy.

An overview of the International Alligator Crocodile Trade Study (IACTS) was presented and discussed.

Table 30. Minimum net trade in classic crocodilian skins reported in CITES annual reports
* Gross exports from the USA

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Total
*A. mississippiensis**	21519	20718	33278	45184	51838	77810	125483	146829	160986	218477	902,122
C. acutus	106	573	27	4	1	59					770
C. cataphractus	2030			149	1193	570	554	464	76		5036
C. intermedius											0
C. johnsoni	157			824	1274	794	988	884	1863	3661	10,445
C. niloticus	6115	9378	18480	22974	27526	41097	39701	46324	71083	95358	378,036
C. novaeguineae	29156	43027	33938	37890	34728	42993	47674	32165	26408	22503	350,482
C. palustris				3			3				6
C. porosus	5358	6497	5752	7166	10042	15928	13036	14590	12648	18781	109,798
C. moreletii	4	1	1	244	18	4	1				274
C. rhombifer									0	0	0
C. siamensis	800	351	605	981	2050	1713	2808	1400	102	23	10,833
C. gangeticus											0
T. schlegelii											0
Total	65,245	80,545	92,081	115,419	128,670	180,968	230,248	245,082	273,167	358,803	1,767,802

World trade in Classic crocodilians reached 358,803 hides in 1993. The alligator (A. mississippiensis) continues to represent 60 percent of this classic supply (218,477 hides) and the nile crocodile (C. niloticus) has taken over second place in production with 95,358 hides in 1993. [1] Together, the U.S. and Africa produced 313,835 classic hides or 87 percent of total world production in 1993.

The supply of alligators is ‹ pected to continue to increase through 1995 with an estimated tal of 225,000-250,000 available to market by 1996. Some of the ɜak production in 1993 was caused by the sale of inventoried stock during the significant market decline in 1992. However, egg collections in 1994 and 1995, plus a wild harvest in Louisiana, Florida and Texas that averages at least 35,000 hides a year, virtually guarantees annual production of almost a quarter million alligators per year in the near term.

The supply of nile crocodile also continues to increase, with Zimbabwe leading the way. About 53 percent of total nile crocodile exports (50,356 hides) originated in Zimbabwe with South Africa exporting 13,982 hides. Both countries are expected to increase further in 1994-95 (Zimbabwe through ranching and South Africa through captive production), as are other African countries including Kenya, Tanzania, Uganda, Zambia and others. [2]

[1] See discussion on nile crocodile trade data which may reduce this number by 5 percent.

[2] Difficulties in estimating world trade in nile crocodile in 1993 underscore the need for standardized reporting by importing and exporting countries. An unintended consequence of universal tagging may be the loss of some verifiable trade data if reports lump hides as well as other parts (backskins, etc.) into one category.

Based only on production estimates from these two species (alligator and nile crocodile) world trade in classic skins will soon surpass the historic peak of about 500,000 hides a year reached in the late 1950's and early 1960's. Unless there is another serious market decline like 1992, the half million classic hide mark will be reached in the 1995 to 1997 period.

The freshwater crocodile (C. novaeguineae) declined again in 1993 for the third straight year to 22,503 hides or 6 percent of total classic production. This is a significant reduction from the 20 percent share this species represented of classic production in 1990 when more than 47,000 hides were in trade. There are several reasons for this decline, including emphasis in Papue New Guinea on rearing the more commercially valuable C. porosus and the voluntary moratorium on exports from Indonesia which may have affected C. novaeguineae production from this region even before it was implemented in January, 1994. Indonesia has the resource to produce exports of C. novaeguineae similar to those of PNG (particularly from Irian Jaya) and has had a CITES quota of 25,000 since 1991. Once remaining management, reporting and regulatory concerns are addressed in Indonesia a combined production with PNG of about 50,000 C. novaeguineae a year is possible, based on historical data. However, this species remains behind the saltwater crocodile, nile and alligator in trade value of species producing more than 15,000 hides a year.

The trade in the saltwater crocodile C. porosus has increased for the third consecutive year to 18,781 hides in 1993. While it accounted for only 5 percent of total classic trade it remains the most desirable and valuable of all classic hides. PNG produced 8,529 hides (45 percent) and Australia exported 6561 hides (35 percent). A similar case for potential production of C. porosus in Indonesia in the same range as PNG and Australia can be made. That would easily mean at least 25,000 C. porosus available to the market if all three countries continued to gradually expand production of the saltwater crocodile.

The other classic species in trade, C. johnsoni (3661 hides) and C. siamensis (23 hides) only make up 1 percent of the total classic trade. However, the number of siamese crocodiles in trade (C. siamensis) will significantly increase when the 1994-95 trade data is available. While it is true some of the farms in Thailand downsized during the 1992 market crisis and others became zoological attractions, farm stocks of siamese crocodiles are increasing. The captive production potential of the siamese crocodile may exceed the South African production of nile crocodiles in a few years, and certainly has the capacity to produce more than 15,000 hides a year.

In the table below, I've summarized the actual production of classic hides in trade during 1993 and estimated the level of trade possible, if not expected, by 1997:

	1993	by 1997
A. mississippiensis	218,477	250,000
C. niloticus	95,358	125.000
C. novaeguineae	22,503	50,000
C. porosus	18,781	25,000
c. johnsoni	3,661	5,000
c. siamensis	23	15,000
TOTAL	358,803	470,000

In addition to the likeihood of underestimating the production of the alligator and nile crocodile if world markets remain relatively stable the next two years, the addition to the market of some production of C. moreletti, C. rhombifer or C. acutus is almost certain. And so is the production of a half million classic hides a year by 1997 or before.

While the Black Caiman (Melanosuchus niger) is not strictly considered a classic, it is considered almost so in terms of trade value. With the approval of the Ecuador program in 1994, subject to a zero quota until approval of its management plan, additional supply of the Black Caiman can be expected in the next few years.

Table 20. Reported countries of origin of *Caiman crocodilus* skins derived from CITES annual reports, 1983-1991

Origin	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Argentina	8262	1668	1200	6000	54226	5654	1110	3831	105		
Bolivia	43500	15325	171457	27352	24182	166164	13915	11039	2768	2724	4
Brazil		835					7	265	30	233	7523
Br Virgin Is			8000								
Colombia	188094	108334	54644	35161	40708	82233	31168	91386	129521	208669	477606
Costa Rica	12				2000						
Ecuador								2			
El Salvador	27982	174947	207644	118602	20066	7375	8268	938	2106	4	106
France	28		4135		1			6			
F. Guiana	7887		489								
Germany	15			197					50		
Guatemala		116234	349685	26288	12851	33341	8587	2513	12	13	
Guyana	1130	72950	108408	41350	47905	76824	49289	10503	6556	6496	2886
Haiti	55										
Honduras		41705	59466		7907	15865	40	2001			799
Hong Kong				6					16		
Indonesia	530			379	267				1		3
Italy	300			50	632			140	194	44	
Japan	13		1940					6			
Korea, Rep.					409						313
Mexico		1			1		2				1300
Nicaragua		1	246	210	863	100	75	15050	24720	21014	14121
Nigeria					187						
Panama	85155	18378	23845	253	66	76	210	353			
PNG						4269			5	7	
Paraguay	909303	700028	212273	143635	45357	53707	11725	642	6		5806
Peru	235			2855							1
Singapore				15867	105393	37413					3659
S. Africa	4	1			183	150					15
Spain			4								
Suriname	39				1		1				
Switzerland		1076									
Taiwan		152		1133	1382						
Thailand			1								
UK	5151		154						759		
USA	3200			635	972		8			28	3013
Venezuela		3487	125566	128095	73990	224630	170347	204206	117687	123594	87314
Vietnam									400		
Zimbabwe		28									
Unknown	85906	79398	113711	58134	24891	86944	2176	41	822	47549	44378
TOTAL	1366401	1334548	1442868	606202	464440	794765	296917	342922	285758	410375	648847

While there is always speculation and sometimes reports of increased illegal trade whenever a new species is added to Appendix II, there is little current evidence of any organized illicit trade in Black Caiman. This does not mean some local stockpiling doesn't occur (this happened with the alligator in the early seventies when first reports of an experimental season were released). But access to a world market that is currently implementing universal tagging and strengthening CITES reporting requirements, does not seem likely. However, regional efforts to insure the protection of Black Caimen populations in all countries is necessary when Ecuador and presumably other range states reinstate trade.

The trade in caiman C. crocodilus is very difficult to quantify compared to classic hides due to reporting differences and estimates the last ten years that have ranged from 300,000 to 1.4 million per year based on available trade data. Net imports (based on reported countries of origin) in 1993 were 648,847 hides, with the majority of the skins originating in Colombia (74%) and Venezuela (13%).

Since skins from unknown countries of origin (more than 40,000 skins in both 1992 and 1993) are the third leading supply of caiman in trade, current reporting is inadequate. In addition to seizure in 1992 of one lot in Paraguay of 50,000 illegal hides and another the same year in the Netherlands Antilles of 85,000 hides, indicates that some unregulated trade has continued through the period of this report.

Actual trade in caiman is probably at least one million hides per year based on an estimate that at least 40 percent of the total trade is still unregulated and that the historical ratio of caiman to classic skins in trade is three or four to one.

While caiman trade from Brazil was only 7,523 in 1993, the registered 75 ranches there and the most significant habitat and populations for the species in all South America assures that level of production will rise significantly the next several years. As more legal trade enters the market, there will be some offsetting with current estimates for unregulated or unreported trade, but projections of total caiman production of 1.2 million to 1.5 million hides by 1997 is possible.

Combined then, classic and caiman trade could reach 2 million hides a year by 1997 and likely will reach those levels by the year 2000 unless a precipitous decline in the market occurs as happened in 1992. It is not only likely these levels of production are necessary to support and encourage sustainable use of crocodilians throughout the ranges of species that can be commercially managed as renewable natural resources, but in fact more than this total can be sustainably produced.

The situation with caiman is comparable to where the classic trade was ten years ago when management programs were being simultaneously developed in several countries. Considering the complexity of implementing these management programs for caiman, establishing guidelines for trade and regulating activities in numerous jurisdictions, remarkable progress is being made. The removal of CITES reservations on caiman by Singapore and the cooperation it has provided to insure legal trade is significant. Colombia, Venezuela and Brazil all have significant stakes in the legal trade, which historically has provided the competitive impetus to divert trade to legal supplies. It will not happen overnight with caiman, any more than it did with classics, but the trend is definitely moving in a positive direction.

Interestingly, both caiman and classic trades have a common stake in the continuing improvement of trade reporting and regulation. Public perception and acceptance of sustainable use will be based on the integrity and viability of programs for all species. Sustainable use must provide equal benefit to commerce and conservation, and significant levels of unreported trade or poorly regulated programs will adversely affect the entire trade.

Primary importing countries for crocodilians continue to be those historically important in Europe (France, Italy and Switzerland), Asia (Japan) and the United States. However, Singapore is emerging as a major importer of both classic and caiman skins and other Pacific Rim countries with expanding manufacturing bases for leather products (i.e. Taiwan, Korea, Thailand, Hong Kong and China) are expected to increase imports as trade and markets expand.

The implementation of universal tagging and improved implementation of CITES requirements in many countries will enhance regulatory control of the trade in raw hides and leather. When the caiman trade can reach the same level of compliance and reporting as the classic trade, these initiatives will prove sufficient to control the management of crocodilian resources. Further efforts to require marking or tagging of manufactured products will not be necessary and are counter productive to expanding markets as well as supporting sustainable use programs in all countries with commercially viable species and management plans.

While there was a downsizing of the trade as a result of the 1992 economic crisis, actual production levels in all species will prove to have significantly increased when 1994 and 1995 data is available. The challenge in the next century will be to actually market what research, management and regulation has produced through the sustainable use of crocodilians.

The negative advertising campaign by World Wildlife Fund (WWF) at Heathrow Airport also described in the IACTS Report was discussed. The consensus was to support the recommendation reached by the Steering Committee to write a letter of objection to WWF and suggest the issue be brought up at the next WWF General Assembly for discussion. Specifically, conservation organizations that discourage the purchase of wildlife products should exclude crocodilians (in name or picture) from their promotional materials.

Several regional representatives presented overviews of efforts to better promote sustainable use and educate the public to its benefits. They include Papua New Guinea (cooperative film with National Geographic), Colombia (information packets on caiman management programs), Thailand (various promotional programs to educate tourists and others about sustainable use) and the U.S. (point-of-sale materials, airport displays and cooperative advertising programs).

The general recommendations of the participants in the trade workshop were to:

1) Continue regular trade workshops during CSG Working Meetings;

2) Continue the IACTS Project and provide a consistent review and monitoring of world trade in crocodilians.

3) Contact the World Wildlife Fund and other conservation organizations that discourage the purchase of wildlife products and request that crocodilians not be included in their campaigns;

4) Improve cooperation between regional trade associations and form an international task force to better coordinate activities.

5) Identify the Asian/Pacific Rim market as a priority for promotion and expanded market opportunities;

6) Correct Hong Kong's negative airport display and lack of positive sustainable use information on crocodilians;

7) Discuss a standardized format for customs brochures with CITES and adopt a strategy for distribution;

8) Accept CITES offer to participate in more trade fairs where they can independently explain their role as well as that of sustainable use as a conservation tool;

9) Consider the development of a universal trademark for crocodilian products in trade;

10) Encourage more promotion of sustainable use and the expansion of consumer markets for crocodilian products as essential for management programs to be economically viable.

While research, management and regulatory efforts affecting crocodilian conservation should continue, greater emphasis must be put on promotion and marketing of the products produced through sustainable use. Soon there may be not enough customers worldwide to support all the sustainable use programs at economically viable levels. The conclusion of the trade workshop was to implement a more coordinated, focused and ongoing international effort to help insure the sustainability of the market as well as the crocodilian resources.