CROCODILES

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of the Species Survival Commission of IUCN
Manaus, Brazil, September 12-17 2010

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Foreword

The 20th biennial Working Meeting of the IUCN SSC Crocodile Specialist Group (CSG) was held in Manaus, Brazil, on 13-17 September 2010. It was attended by 200 participants from 27 countries. Since the first meeting in 1971, the biennial CSG Working Meetings have been forums in which crocodilian conservation action around the world has been both initiated and assessed for nearly four decades. This meeting, hosted by Brazil, was both successful and illuminating. Brazil successfully had their Black Caiman population transferred from Appendix I to Appendix II at CITES CoP14 (2008), and is now experimenting with sustainable use programmes to benefit local people. All attendees were interested in way in which Brazil's program is developing.

The CSG is very extremely grateful to State Government of Amazonas, Secretaria de Produção Rural (SEPROR) and Institute for Sustainable Development of Agriculture and Forestry of the State of Amazonas (IDAM), which hosted the meeting. The Organizing Committee consisted of Sônia Canto, Sônia Alfaia, Paula Mafra, Ana Paula Batista (SEPROR), Bill Magnusson (INPA), Ronis da Silveira (UFAM), José Max Dias Figueira, Leandro Lopes de Souza, Bianca Abecassis (IDAM), and Bruno Pereira Regis. Together with their support staff, did a marvelous job in preparing and running a wonderful meeting. The Deputy Eron Bezerra and Dr. Edson Barcelos, believed in the success of the event from the outset, and their support is greatly appreciated. Current Secretary Dr. Ferdinando Barreto managed resources directly with Governor Omar Aziz, to whom we are grateful.

The meeting would not have been possible without the generous financial support provided by the major sponsors: Bank of Amazonia (printing of certificates, badges, etc.); the Sustainable Amazon Foundation (simultaneous translation); and, DueDesign, who created the logo of the 20th Working Meeting.

The Working Meeting itself was preceded by the CSG Executive Committee meeting, and then by the CSG Steering Committee meeting, which as usual was open to all participants.

It addressed a wide range of current CSG priorities, particularly in Brazil, China, Mexico, Paraguay and Egypt. The development of a crocodilian capacity building manual, and broadening the CSG membership were two priorities. The effect of the global financial crisis on crocodile conservation and management was examined, as regardless of whether programmes are based on sustainable use or not, government budgets for conservation are being reduced. Lake Mesangat wetlands in East Kalimantan, the last remaining habitat for Siamese Crocodiles in Indonesia, were discussed in depth. The spread of oil palms into the immediate lake area is a matter of great concern, and the CSG would like to encourage Indonesia to nominate Mesangat as a RAMSAR site of international significance. The CSG has completed a morphometric study of caimans in Colombia, which provides the quantitative tools for predicting the size of caiman from which skins and leather products have been derived. The goal was to assist Colombia and the Parties to CITES in their efforts to ensure compliance with Colombia's size limits.

For the many people who work on crocodilians around the world, the biennial CSG Working Meetings are an important event. Working with crocodilians requires a special effort by special people. Crocodilians live in remote and inhospitable places, where access is difficult. Because they range in weight from less than 50 g to over 500 kg, catching and handling is always a challenge - not to mention the personal risks involved. In the eyes of the general public, it is often a thankless task, because crocodiles are truly viewed as being "wicked" by most people. Not so amongst CSG members. The CSG Student Research Award Scheme was established after the last CSG Working Meeting to encourage students to work on crocodilians: over 30 students have now benefited from the scheme.

CSG Working Meetings, bring together an exceptional array of talented people, from all around the world. For most of them, the time and travel involved is a significant personal

cost. The major reward is the ability to share one week with like-minded people, equally passionate about crocodilians. It recharges often tired batteries, stimulates interest, fosters camaraderie, creates new friendships, puts new faces to names, provides a genuinely sympathetic ears for discussion of problems, and most important, provides an opportunity to pass on new results and findings.

The core business of CSG is to help the IUCN and SSC achieve their conservation missions with crocodilians. This involves a raft of different CSG initiatives and activities in different countries, some simple others immensely complex. They are all addressed openly within the Working Meetings. As the complexity of the world expands, so the "biopolitics" of crocodilian conservation becomes more challenging. But the CSG adapts well. We do an exceptional job, usually quickly, honestly, transparently and by consensus. That we do it largely as volunteers, with very few paid staff, is remarkable in its own right.

An important key to the success of the CSG is that its membership includes representation from a great diversity of different stakeholders. We can look at the same problem through many different eyes. Particularly important are members representing the international crocodile skin industry. They keep us focused on attainable goals, make sure our concerns about trade are valid, and offer sound advice and a wealth of experience when required.

The proceedings of the 20th Working Meeting of the CSG will once again be a unique compendium of current information on research problems in crocodilian conservation, management and sustainable use, and innovative approaches to solving them. It will serve as both a source and reference book for members.We take this opportunity to thank the organizing committee for their efforts in getting the proceedings published in a timely way.

Prof. Grahame Webb, Chair
Crocodile Specialists Group

20th CSG Working Meeting Summary

The 20th Working Meeting of the IUCN-SSC Crocodile Specialist Group (CSG) was held in Manaus, Brazil, from 13-17 September 2010, and was preceded by a CSG Steering Committee meeting on 12 September.

The meeting was hosted by the State Government of Amazonas, Secretaria de Produção Rural (SEPROR) and Institute for Sustainable Development of Agriculture and Forestry of the State of Amazonas (IDAM), and the CSG is extremely grateful to them.

The Organizing Committee consisted of Sônia Canto, Sônia Alfaia, Paula Mafra, Ana Paula Batista (SEPROR), Bill Magnusson (INPA), Ronis da Silveira (UFAM), José Max Dias igueira, Leandro Lopes de Souza, Bianca Abecassis (IDAM), and Bruno Pereira Regis.

Together with their support staff, they did a marvelous job in preparing and running the meeting. The Deputy Eron Bezerra and Dr. Edson Barcelos, believed in the success of the event from the outset, and their support is greatly appreciated. Current Secretary Dr. Ferdinando Barreto managed resources directly with Governor Omar Aziz.

None of this would have been possible without the generous financial support provided by the major sponsors: Bank of Amazonia (printing of certificates, badges, etc.); the Sustainable Amazon Foundation (simultaneous translation); and, DueDesign, who created the logo of the 20th working meeting.

The CSG Chairman Professor Grahame Webb welcomed around 200 participants from 27 countries (Australia, Argentina, Bolivia, Brazil, Canada, China, Colombia, Cuba, Denmark, Egypt, France, Germany, Guyana, Hong Kong, Ireland, Italy, Japan, Malaysia, Mexico, Mozambique, Netherlands, Panama, Papua New Guinea, South Africa, United Kingdom, USA, Venezuela) to the meeting. CSG working meetings, held every two years, are the primary international meeting dedicated to crocodilian conservation, management and research. They have become the major forum for discussion of conservation issues, presenting new findings and new directions, and the 20th meeting was no exception.

A number of important issues were addressed by the CSG Steering Committee prior to the working meeting, including the critical situation with *Crocodylus siamensis* and *Gavialis gangeticus*. Important initiatives such as a Capacity Building Manual were also advanced by the Steering Committee.

At the 4-day Working Meeting, a range of topics were covered by oral presentations organized into discrete sessions: Management Programs; Populations; Genetics; Disease; Human Dimension; Markets; Conservation; Reproductive Biology; General Biology; and, Physiology. A Poster session also saw a diverse range of topics being covered.

The CSG's Veterinary Science (Paolo Martelli), Zoos and Community Education (Kent Vliet) and Human-Crocodile Conflict (Richard Fergusson) groups also met during the course of the meeting. The deliberations of each of these groups are summarised at the end of the Proceedings.

No CSG meeting would be complete without the various social activities. The welcome function featured folk music by IMBAUBA (Regional Tree), and traditional dancing by Boi Bumba. At the farewell dinner at the Fellice Restaurant, participants partied to the sounds of a local rock band.

The auction once again proved to be a popular event, and auctioneer Carlos Piña worked the record sum of $US4087 out of his audience. Thanks are extended to all those people who contributed items to the auction, and of course to those who dug deep into their pockets to buy them. Auctioned items included two of the late John Thorbjarnarson's framed photographs of an Orinoco Crocodile and a Chinese Alligator. Funds collected from the auction funds will be

used to assist the CSG's efforts to list Lake Mesangat, in Kalimantan. Indonesia, as a RAMSAR site.

After considerable deliberation, Robinson Botero-Arias of Brazil was awarded the Castillos Award for his contribution to crocodilian biology, management and conservation in the Latin American region. Robinson was a popular recipient among the Latin American participants.

On the last day, participants had the opportunity to go on a field trip, and travel by ferryboat to the Bem Vindo, Tiwa Amazonas Ecoresort, located on an island in the Negros River. An enjoyable, relaxing day was spent lazing around the pool, enjoying the local cuisine, beverages and wildlife.

Host, Sponsors and Donors

Host Organizations

· State Government of Amazonas, Secretaria de Produção Rural (SEPROR)
· Institute for Sustainable Development of Agriculture and Forestry of the State of Amazonas (IDAM)

Organizing Committee
· Sônia Canto (SEPROR/IDAM) - President
· Edson Barcelos (SEPROR)
· Bill Magnusson (INPA)
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Major Sponsors
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· Secretaria de Estado da Produção Rural - SEPROR
· Institute for Sustainable Development of Agriculture and Forestry of the State of Amazonas – IDAM

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We are very grateful to the following people and/or organizations for their financial and in-kind support of the meeting:
· Instituto Nacional de Pesquisas da Amazônia - INPA
· Universidade Federal do Amazonas - UFAM
· Bank of Amazonia - BASA
· Sustainable Amazon Foundation - FAS
· DueDesign

Our thanks also go to the ORCAL PLANET TOUR, the host company, which followed through on the planning for the event until the final implementation, even under considerable difficulties at times, believing that the event would be a success

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Foto 1: Brazilian officials and CSG members were present at the Opening of XX Working Meeting of the Crocodile Specialist Group

Foto

Foto 2: Dr. Edson Barcelos (Scientific Coordinator) with Graham Webb and Alejandro Larriera

Foto 3: Specialist around the world came to Manaus to participate of XX Working Meeting of the Crocodile Specialist Group

Foto 4: Opening cerimony at Studio 5 – Manaus / Amazonas

Foto 5: Participants who work on crocodilians around the world came to Manaus to attend the event

Foto 6: Tom Dacey and Charlie Manolis

Foto 7: Many posters were presented at XX Working Meeting of the Crocodile Specialist Group

Foto 8: Graham Webb, Sonia Canto, Luis Antonio Bassetti and Alejandro Larriera

Foto 9: Field Trip at Tiwa Amazonas Ecoresort, located on an island in the Negro River, to have a relaxing day

Foto 10: The view of the Tiwa Amazonas Ecoresort

Foto 11: Relaxing day

Foto 12: Party Night at Fellice Restaurant

Foto 13: Participants partied to the sounds of a local rock band at Fellice Restaurant

Foto 14: Party Night at Fellice Restaurant

Foto 15: Party Night at Fellice Restaurant

Foto 16: Group shot in the end of the event

ANALYSIS OF DIGESTIVE TRACT IN *MELANOSUCHUS NIGER* AND *CAIMAN CROCODILUS*.

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Crocodilians are top carnivores and feed on a wide variety of aquatic and terrestrial prey. The objective of this study was to analyze the morphology of the digestive tract of *Melanosuchus niger* and *Caiman crocodilus* and to provide a better understanding of the digestive processes in these Alligatoridae species. Caimans were collected between August 2008 and February 2010 in the Piagaçu-Purus Reserve. We sampled a total of 12 *M. niger* (79.0 cm-156.7 cm SVL) and 23 *C. crocodilus* (47.2 cm-104.6 cm SVL). We also examined stomach contents and found plant material, mollusks, and a monkey foot in *M. niger*; and plant material, fish, crabs, spiders, snakes, mollusk and a mammal tooth in *C. crocodilus* stomachs. For both species we studied the morphology of the tongue, esophagus, stomach, small (SI) and large (LI) intestines. The esophagus is a tubular organ with internal longitudinal and rectilinear pleats, which develops into an undulated pattern caudally. The stomach is a muscular organ with mucous folds. It has three regions: cardiac, initial and short region near esophagus. The stomach body is the largest portion, and the pyloric atrium is characterized by a small dilatation in caudal region of the organ. Through the pyloric sphincter only liquids pass, because it is a very narrow passage. The SI is long and rolled, composed by duodenum, jejunum and ileum. Duodenum is located in an anterior and on dorsal part of stomach just after pyloric atrium. We observed differences on internal surface of SI, where *M. niger* presented an rearrangement with "honey-combed" folds and a longitudinal zig-zag pleats. *Caiman crocodilus* presented longitudinal zig-zag pleats in the whole organ. The LI is a short organ with longitudinal folds on its internal surface. Presence of distensile folds in the esophagus indicates the capacity to swallow large prey.

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ANATOMIA DO TRATO DIGESTÓRIO DE JACARÉ DO PANTANALCRIADO EM CATIVEIRO.

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Conhecido como jacaré do pantanal, o *Caiman yacare* é um réptil que apresenta alto potencial zootécnico evidenciado pelo crescente incremento de criações comerciais no Estado do Mato Grosso. Embora algumas informações sobre os diferentes segmentos do trato digestório estejam disponíveis na literatura para essa espécie, trabalhos anatômicos descritivos conspícuos geralmente se referem a outros crocodilianos. Neste contexto, o trato digestório de 20 jacarés do pantanal foi coletado, fixado, dissecados e descritos quanto a sua anatomia. A cavidade oral apresenta-se alongada no sentido crânio-caudal. O palato duro constitui o teto da cavidade oral e é formado pelos ossos incisivo, maxila e palatino, cuja mucosa que o reveste tem aspecto rugoso conferido por inúmeras estruturas arredondadas. A língua é achatada dorso ventralmente, seu formato acompanha o da cavidade oral e participa na formação do assoalho desta cavidade. A faringe é um segmento músculo-membranoso que conduz o alimento da cavidade oral para o esôfago. O esôfago, tubuloso e muscular, inicia-se caudalmente à faringe em posição mediana e se estende até o estômago na cavidade celomática. O estômago apresenta-se saculiforme e susceptível a mudança de forma e tamanho conforme seu grau de repleção, sendo sua mucosa intensamente pregueada e glandular. O intestino delgado é constituído pelo duodeno (parte descendente e ascendente) e jejuno (segmento repleto de circunvoluções). Macroscopicamente não foi possível identificar o íleo e o ceco. O cólon está fixado a esquerda do plano mediano junto ao teto da cavidade celomática. O fígado apresenta-se constituído por dois lobos de formato cônico, achatado dorso-ventralmente e unidos por um istmo. O lobo esquerdo localiza-se ventralmente ao estômago, e o lobo direito parcialmente sob o estômago e as alças intestinais. A vesícula biliar apresenta-se digitiforme localizada na superfície caudal do lobo direito do fígado, entre o estômago e o duodeno. Conclui-se que os achados macroscópicos são consonantes com o hábito alimentar da espécie e semelhante a de outros crocodilianos já descritos.

DESCRIÇÃO MACRO E MICROSCÓPICA DE FÍGADO DO JACARÉ DO PANTANAL *Caiman yacare*

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O fígado é a maior glândula nos vertebrados, com funções exócrinas e endócrinas, diretamente relacionado a hábitos alimentares e acúmulo de glicogênio, está localizado na cavidade peritonial sobre o estômago e com formato piramidal, sendo que a porção delgada fica localizada na parte cefálica do órgão enquanto que a base fica disposta caudalmente, recobrindo as vísceras. O órgão não é lobulado como em mamíferos, fato recorrente para a literatura disponível para répteis. Cortes histológicos longitudinais revelaram que os hepatócitos estão dispostos enfileirados ou formando estruturas acinosas, os mesmos possuem núcleos descentralizados com abundância de eucromatina. Sob a coloração de PAS, o citoplasma dos hepatócitos cora-se intensamente, o que indica grande acúmulo de glicogênio. Sob a coloração de picrossirius, identifica-se, uma cápsula de fibras colágenas, enquanto que as demais fibras colágenas estão distribuídas no entorno dos vasos, duetos, pequenas trabéculas e delgadas tramas de sustentação fibrilar no entorno dos hepatócitos. Entre os hepatócitos são identificáveis capilares sinusóides contendo eritrócitos e granulócitos. Sob a coloração de Rosenfeld, alguns desses granulócitos apresentaram grânulos esféricos eosinofílicos, enquanto que outros apresentaram grânulos afilados (bastonetes) com coloração de parda a marrom escuro. Disperso pelo parênquima do órgão, foram encontradas frequentemente células com morfologia compatível a de melanomacrófagos, com núcleos descentralizados ou periféricos e diversos grânulos esféricos com coloração variando de amarronzado a enegrecido. Dispersos pelo fígado, havia concentrações de células com morfologias compatíveis a de linfócitos ou trombócitos ativos (round shaped). Portanto, o fígado de *C. yacare* difere por não apresentar lóbulos, possuir melanomacrófagos dispersos e não organizados em centros melanomacrofágicos e, por fim, apresentar aglomerados de linfócitos/trombócitos em diversos pontos do órgão.

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HISTOLOGIA DE INTESTINO DE JACARÉ DO PANTANAL *(Caiman yacare* DAUDIN, 1802) CRIADO EM CATIVEIRO.

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A criação de animais silvestres em cativeiro pode ser considerada como uma das alternativas para evitar a extinção de espécies ameaçadas, tendo em vista que pode ser passível de exploração e assim, protegida da degradação (caça, destruição do habitat, etc). Foram *Colhidas amostras de* dois cm de cinco regiões (duodeno ascendente, duodeno descendente, jejuno, íleo e intestino grosso) dos intestinos em 16 animais, de ambos os sexos, com massa corpórea entre 6 e 7 kg., comprimento focinho-cloaca (CFC) entre 59 a 67 cm. e comprimento total (CT) variando de 107 a 128 cm. As amostras foram fixadas em Bouin e conservadas em solução de Mac Dowell. A inclusão foi realizada em parafina e cortes semi-seriados de 4 um de espessura foram obtidos e corados pela hematoxilina-eosina. A mucosa do intestino apresentou estrutura clássica e vilosidades intestinais revestidas por epitélio simples colunar com microvilosidades e células caliciformes. A histometria apresentou uma relação média entre lâmina própria e comprimento do epitélio de 1:8 e espessura de mucosa variando de 23 um para intestino delgado e 11 um para intestino grosso A frequência de vilosidades variou de 11 para intestino delgado e 6 para intestino grosso. O estudo histométrico da mucosa intestinal consistiu da mensuração dos comprimentos do epitélio e da lâmina própria, da espessura da mucosa medida em três (3) vilosidades intestinais e da frequência das vilosidades, através de programa de análise de imagem acoplado a um microscópio binocular. Houve diferenças significativas nos parâmetros analisados entre os segmentos do intestino delgado e o intestino grosso. Quando os parâmetros são analisados entre os animais, aparece diferenças significativas nos parâmetros testados, principalmente no jejuno. Concluímos que os intestinos delgado e grosso do jacaré do pantanal apresentam estrutura semelhante ao de outros vertebrados.

REPRODUCTIVE BIOLOGY OF *CAIMAN CROCODILUS* AT PIAGAÇU-PURUS RESERVE, CENTRAL AMAZONIA.

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Caiman crocodilus has a wide distribution in basically all habitats throughout the Amazon Basin. The aim of this study was to describe the reproductive biology of *C. crocodilus* in the Central Amazon, where it is strongly influenced by hydrological cycles. Between 2008 and 2010, we sampled a total of 18 females and 34 males in the Piagaçu-Purus Reserve. All captured individuals were sexed and measured (SVL-cm). We removed the reproductive tract to be measured and weighed; afterwards it was fixed in 10% buffered formalin and proceeded for routine histology. Gonadossomatic index (GSI) was calculated as the ratio between combined gonad mass and total somatic mass multiplied by 1000. The logistic model was fitted to data to determinate the minimum maturation size, which was assumed to be when the SVL where 50% of individuals are mature. Male GSI shows seasonal cycles with spermatogenesis peaks from early June to August (0.9±0.4). The reduction of GSI (0.3±0.2) is related to the reduction of testis activity between September and December. After December the testis is quiescent. Males (50%) are physiologically mature at SVL= 59.0 cm (SE±0.5), but 95% are not reproductively active until the SVL=63.4 cm (SE±0.4). Follicle growth and vitellogenesis peaks occurred from June to July. Ovulation and mating occurred from June until August. Females mature at the minimum size of SVL= 61.0cm (SE ±0.71), and 95% of females were mature at SVL= 64.0 cm (SE ±0.39). The data is in agreement with a previous study of a larger sub-species in the Pantanal region of Brazil.

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REPRODUCTIVE BIOLOGY OF *MELANOSUCHUS NIGER* IN PIAGAÇU-PURUS, AMAZONAS, BRAZIL

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The Black caiman (*Melanosuchus niger*) is the largest crocodilian in the Amazonia. They occur in floodplain habitats and their biology is strongly influenced by the river flooding pulse. How this factor influences the species reproductive cycle must be understood to support their conservation and management issues in the Amazon Basin. The aim of this work was to describe the reproductive biology of *M. niger* in a varzea flooded forest. A total of 12 females and 15 males were collected from 2008 through 2010 in the Piagaçu-Purus Sustainable Development Reserve. All captured individuals were sexed, measured (SVL-cm) and weighed. The reproductive tracts were removed and fixed in 10% buffered formalin and saved for routine histology. The logistic model was fitted to the data to determinate minimum maturation size, considered as the SVL where almost 50% of individual were mature. Follicle growth and vitellogenesis occurred from June to August when water level was falling. Ovulation occurred from end of August through September. Spermatogenesis peaks were in early May through June, and testis activity was reduced after July. Apoptotic spermatozoa were observed in seminiferous tubules and a small amount in epididymes during dry season. After December no spermatozoa were observed. Females reach sexual maturity at SVL= 102.7 cm (SE±0.38); 95% of females were mature at SVL= 110.2 cm (SE±0.99). Males are physiologically mature (50%) at SVL= 91.2 cm (SE±0.41), but because of social factors they are not reproductively active. Active males (95%) were mature at SVL= 96.3 cm (SE±1.25).

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REPRODUCCIÓN Y COLECTA DE HUEVOS DEL CAIMÁN DEL ORINOCO (*Crocodylus intermedius*) EN EL SISTEMA DEL RÍO COJEDES, VENEZUELA.

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RESUMEN

El caimán del Orinoco *Crocodylus intermedius*, ha sido considerado como uno de más amenazados del mundo, dado sus bajos niveles poblacionales y reducida distribución geográfica. Una de las razones por las que se ha retardado la recuperación de sus poblaciones, es la pérdida de huevos debido a crecidas repentinas del río y por depredación humana y animal. En el presente estudio, evaluamos el estado y éxito reproductivo de la especie en dos sectores del sistema del río Cojedes (20,7km): Caño de Agua-Confluencia río Sarare (CA-CS) y Merecure-Caño Amarillo (M-CAM), área que mantiene la población reproductiva más grande conocida de la especie. Entre febrero y mayo de 2009, estimamos el hábitat reproductivo de la especie en 1,25 playas/km; el sector CA-CS presentó el mejor hábitat para anidación con 3,38 playas/km. Así mismo, evaluamos la temporada reproductiva mediante el conteo de nidos y grupo de crías, encontrando una abundancia de 1,30 nidos/km. De los 27 nidos encontrados, a ocho les colectamos la totalidad de sus huevos (n=368) y los trasladamos a un área bajo vigilancia, para su incubación en nidos artificiales. Adicionalmente, georreferenciamos y dejamos en las playas en condiciones naturales cinco nidos como control. Los nidos colectados mostraron en promedio 49,5±7,0 huevos. El éxito de eclosión en los nidos colectados osciló entre 7,5 y 75,5%, mientras que en los controles entre 0 y 70,7%; la eclosión de los nidos colectados fue del 53%, mientras que los nidos control fue de 36,4%. La población mínima de cocodrilos reproductivamente activos es de 42 individuos, concentrados principalmente en Caño de Agua-Confluencia Sarare (61.9%), esta situación convierte al Sistema del río Cojedes en área estratégica para el mantenimiento y persistencia de la especie; así como en un área ideal para la aplicación de un programa de rancheo de huevos y crías, donde se involucren distintos sectores de la sociedad, para incrementar la producción de neonatos y nutrir las poblaciones silvestres con la intención de conservar la especie.

ABSTRACT

The Orinoco crocodile *Crocodylus intermedius,* has been considered one of the most threatened the world, given their low population levels and reduced geographical distribution. One reason that has slowed recovery their populations is the loss of eggs by the river and flash floods human and animal predation. In this study, we evaluated the status and reproductive success of the species in two sections of the Cojedes River System (20.7 km): Caño de Agua-Confluencia río Sarare (CA-CS) and Merecure-Caño Amarillo (M-CAM), an area that maintains the population reproductive largest known of the species. Between february and may 2009, we estimate the breeding habitat of the species on 1.25 beaches/km; CA-CS sector had the best habitat for nesting with 3.38 beaches/km. We assessed the breeding season by counting nests and young group, finding an abundance of 1.30 nests / km. Of the 27 nests found, eight were collected all their eggs (n=368) and moved to an area under surveillance, for incubation in artificial nests. Additionally, geo-referenced left on the beaches in natural conditions and five control nests. Nests showed on

average collected 49.5±7.0 eggs. The success of hatching in nests collected ranged between 7.5 and 75.5%, while in control between 0 and 70.7%, the hatching of nests collected was 53%, whereas control nests was 36.4%. The temperature average incubation in nests collected was 31.7 ± 2.4. The crocodiles minimum population is 42 reproductively active individuals, mainly concentrated in CA-CS (61.9%), a situation that makes the Cojedes River System in strategic area for the maintenance and persistence of the species, others as an ideal area for implementing a eggs ranching and hatchlings program, which involve different sectors of society, to increase hatchling production and nourish populations wild, with the intention of conserving the species.

INTRODUCCIÓN

El caimán del Orinoco (*Crocodylus intermedius*) fue una especie abundante en caños y ríos de la región llanera de Venezuela y Colombia hasta comienzos de siglo XX. Después de la explotación excesiva de la especie entre la décadas de los 1920 y 1960 del siglo pasado, las poblaciones del caimán del Orinoco quedaron severamente reducidas o incluso eliminadas en toda su área de distribución (Medem 1983, Seijas 1998). Desde finales de la década de los 80, se han llevado a cabo trabajos que evalúan aspectos reproductivos de *C. intermedius* en poblaciones silvestres venezolanas, como los realizados en el sistema del río Cojedes (Ayarzagüena 1987, González-Fernández 1995, Seijas y Chávez 2002, Navarro-Laurent 2007 y Ávila-Manjón 2008), el río Capanaparo (Thorbjarnarson y Hernández 1993a y b, Llobet 2002); el río Manapire (Jiménez-Oraá *et al.* 2007) y el sistema caño Macanillal-Laguna La Ramera (Antelo *et al.* 2010). También en Colombia se realizaron este tipo de estudios en los ríos Cravo Norte y Ele (Bonilla y Barahona 1999).

Aun cuando *C.intermedius* está protegida legalmente desde los años 70 del siglo pasado, y no obstante los esfuerzos realizados en Venezuela (declaratoria de áreas protegidas, fomento y restauración de poblaciones por medio de la liberación de individuos), las poblaciones de esta especie no han mostrado la recuperación que podría haberse esperado (Mendoza y Seijas 2007). Algunos factores afectan altamente sus poblaciones desde las primeras etapas de desarrollo, tales como recolección y saqueo de huevos para el consumo humano y para la venta de neonatos como mascota (Muñoz y Thorbjarnarson 2000), depredación de huevos y neonatos por fauna silvestre y pérdida de nidadas por inundaciones repentinas. En crocodílidos, este último factor pudiera provocar pérdidas de hasta más del 80% de las nidadas pre-eclosión (Ramírez-Perilla 1999). Es así, como por la rareza de la especie y su estatus de amenaza, en el presente trabajo evaluamos la temporada reproductiva y la colecta de huevos de *C. intermedius* como estrategia potencial para la conservación de una de las poblaciones de la especie catalogada como la más importante de toda su área de distribución (Seijas y Chávez 2000).

MATERIALES Y MÉTODOS

ÁREA DE ESTUDIO-. El estudio lo llevamos a cabo en dos sectores del Sistema del río Cojedes (SRC), Caño de Agua-Confluencia río Sarare (CA-CS 6,5km) y Merecure-Caño Amarillo (M-CAM, 14,2 km, Fig. 1) en los Llanos centrales de Venezuela. Los sectores estudiados se encuentran en la zona de vida definida como Bosque Seco Tropical, donde predominan principalmente dos tipos de formaciones vegetales tales como los bosques de galería y las sabanas antropizadas (González-Fernández 1995).

BÚSQUEDA Y COLECTA DE NIDOS-. Durante la temporada reproductiva del caimán del Orinoco en el año 2009, realizamos recorridos diurnos utilizando un bote de aluminio de 12' con motor fuera de borda de 15 HP. El primer recorrido lo realizamos en febrero, para la búsqueda de playas arenosas (hábitat reproductivo) y nidos para su colecta. En la búsqueda de nidadas, identificamos las playas con evidencia de haber sido utilizadas por los caimanes (presencia de huellas dejadas por las hembras cuando desovan). En estas playas, introdujimos

una vara fina de madera en la arena, en los lugares donde la vara se introducía con relativa facilidad, excavamos con el objeto de localizar nidadas (Pooley 1991).

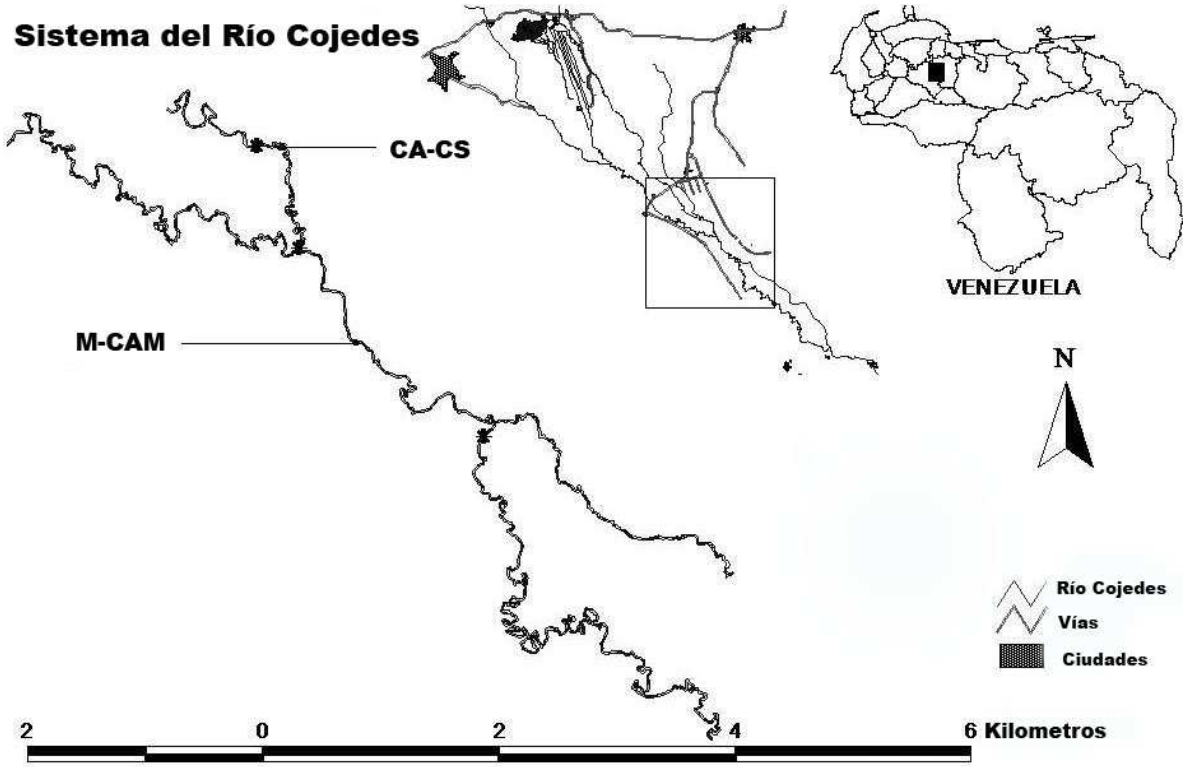

FIGURA 1. Localización geográfica de los sectores estudiados en el Sistema del río Cojedes en Venezuela. Asteriscos indican el comienzo y fin de los mismos.

A las nidadas encontradas, les colectamos los huevos en cajas de material aislante (poliestireno) y los cubrimos con material del mismo nido (arena y hojarasca), luego los transportamos con cuidado (evitando movimientos fuertes) al rancho Merecure, área con vigilancia y supervisión para su incubación, esta finca que forma parte del SRC, es un hato ganadero muy cercano al río (entre 4 a 5 km en bote y carro). Las cajas con los huevos las colocamos en nidos artificiales, los cuales consistieron en huecos excavados en el suelo, rellenados con arena del mismo río. Adicionalmente, dejamos un grupo de nidos en las playas en condiciones naturales para su seguimiento y control. Todos los nidos encontrados (colectados y control) fueron georreferenciados con un GPS.

ÉXITO DE ECLOSIÓN DE NIDADAS COLECTADAS Y NATURALES-. Una vez iniciada la temporada de eclosiones (mitad de abril y comienzo de mayo) realizamos recorridos diurnos y nocturnos para ubicar grupos de neonatos. La ubicación de estos grupos y el número de individuos que lo constituían permitió determinar tanto la ubicación original del nido o nidos (en el río, es posible encontrar agrupados individuos de más de una nidada). La estimación del número de nidos que podrían pertenecer a un grupo de crías en el río estuvo basado en el promedio de crías estimado por Seijas y Chávez (2002, $\dot{x}$=26,0±13,9). Es decir, si un grupo de crías presentaba más de 40 neonatos (número promedio más su desviación estándar), se asumió que el grupo contenía más de un nido.

TAMAÑO MÍNIMO DE LA POBLACIÓN REPRODUCTIVA-. El número de nidos identificados, lo tomamos como medida del número de hembras reproductivamente activas. El número de machos dominantes, lo estimamos de la siguiente manera: i) uno macho por cada hembra

nidificante aislada, ii) un macho por cada cuatro hembras en segmentos del río con nidos con una separación no mayor a 500m.

RESULTADOS

En los 20,7km del SRC estudiados, estimamos la abundancia de playas aptas para la reproducción de la especie en 1,25 playas/km. Para el sector CA-CS la abundancia fue 3,38 playas/km y en M-CAM fue 0,28 playas/km. Encontramos un total de 27 nidadas (nidos con huevos y grupos de crías), mientras que la abundancia y distribución de los nidos al lo largo del área fue 1,30 nidos/km. Particularmente en el sector CA-CS fue 3,07 nidos/km y por su parte en M-CAM fue 0,49 nidos/km.

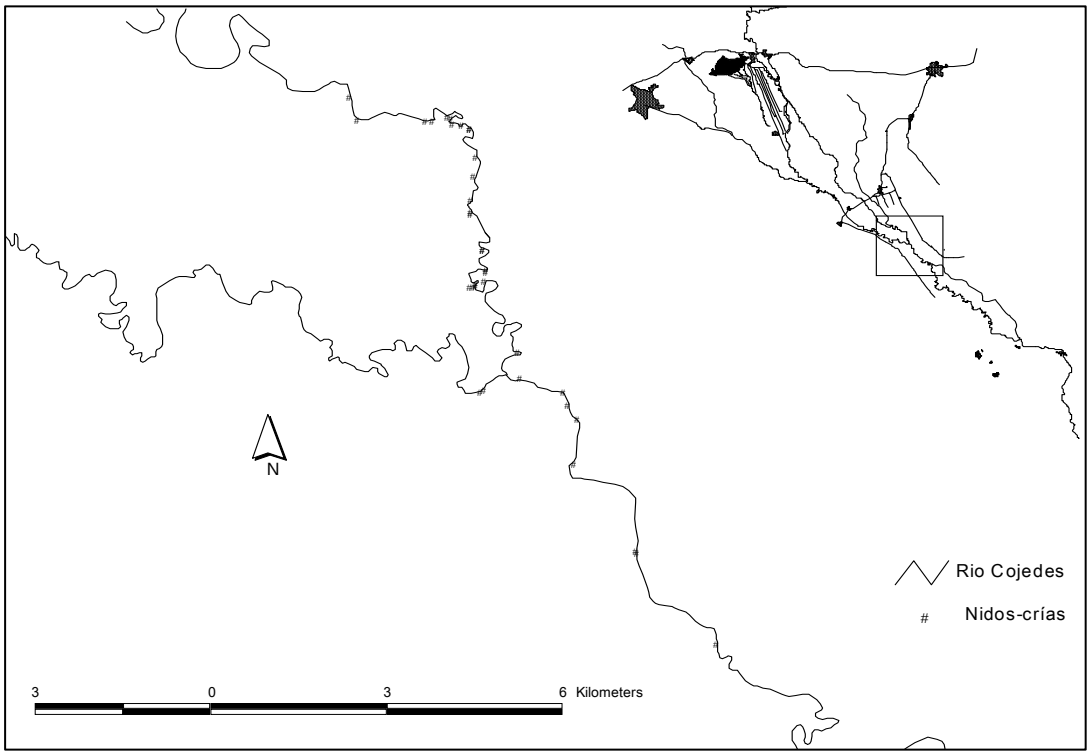

FIGURA 2. Distribución y abundancia de nidos de *C. intermedius* en los sectores estudiados en el Sistema del río Cojedes.

Del total de nidos encontrados (n=27), a ocho les colectamos la totalidad de sus huevos (n=368) para su incubación en nidos artificiales con la fin de evitar la perdida por depredación, saqueos e inundaciones repentinas. El promedio de huevos en los nidos colectados fue 49,5±7,0. Adicionalmente, dejamos cinco nidos en condiciones naturales en las playas en como control. El éxito de eclosión en los nidos colectados osciló entre 7,5 y 75,5%, mientras que en los control entre 0 y 70,7%; la eclosión de los nidos colectados fue de 53%, mientras que los nidos control fue de 36,4% (Tabla 1).

Tabla 1. Número de nidos de caimán del Orinoco estudiados en el Sistema del río Cojedes, Venezuela.

Nido	No. huevos	Huevos incubados	Crías producidas	Éxito de eclosión
Incubación artificial				
1	59	57	11	19,3
2	48	46	34	73,9
3	45	45	30	66,7
4	36	28	26	92,9
5	51	51	40	78,4
6	51	48	7	14,6
7	50	40	3	7,5
8	56	53	40	75,5
Total	396	368	191	51,9
Nidos control (incubación natural)				
9	49,5	0	0	0
10	49,5	0	0	0
11	49,5	0	32	64,6
12	49,5	0	23	46,5
13	49,5	0	35	70,7
Total	248	0	90	36,3

El número de huevos de los nidos control no fueron contados. Para el cálculo del éxito de eclosión utilizamos el número promedio de huevos de los nidos colectados.

Con base en el número de nidos identificados (como medida del número de hembras reproductivamente activas) y la relación de machos y hembras (aisladas y agrupadas), se estimó una población mínima de 42 cocodrilos reproductivamente activos en los dos sectores estudiados, la mayor parte de ellos (61,9%) en el sector CA-CS. Esta cifra representa un valor mínimo estimado del número de adultos presentes, puesto que no todas las hembras adultas nidifican cada año (Seijas 1998).

DISCUSIÓN

El SRC ha sido catalogado como el área que contiene la población más importante de la especie en toda su área de distribución (Seijas y Chávez 2002); sin embargo, en los sectores estudiados el hábitat reproductivo (playas o bancos) con condiciones óptimas para su nidación está disminuyendo. De las 2,1 playas/km estimadas por Seijas (1998), en el presente estudio sólo reportamos 1,25 playas/km. Esta situación es originada por la modificación del cauce y el patrón del flujo de las aguas, como producto de la construcción de infraestructuras para la retención y regulación del flujo del agua en las márgenes del río Cojedes; así como por la deforestación y el avance de la frontera agrícola, lo que origina cambios en la dinámica hídrica natural del río (Mendoza y Seijas 2007).

La densidad de nidos encontrados en los dos sectores estudiados en la presente investigación (1,30 nidos/km), es similar a los registrados por González-Fernández (1995), Seijas (1998), Navarro-Laurent (2007) y Ávila-Manjón (2008) (1,04; 1,03; 1,08 y 1,91 nidos/km, respectivamente) para estos mismos sectores.

El sector CA-CS sustenta el mejor hábitat reproductivo para los caimanes (Seijas 1998, Seijas y Chávez 2002, Navarro Laurent 2007, Ávila-Manjón 2008) debido posiblemente a las características físicas del sector, tales como la estrechez (en general menos de 12 m) y la presencia de numerosos meandros. Además, muchos de los bancos del río están cubiertos por bosques, el cauce del río presenta grupos dispersos de caramas y ramas de árboles caídos y las orillas del río están frecuentemente cubiertas por masas densas de mangle (*Alchornea castaneifolia*).

El número de nidos registrados en el presente estudio, es el segundo más alto reportado en el SRC (1,30 nidos/km) después del estudio del 2006 (1,91 nidos/km, Ávila-Manjón 2008). El SRC mantiene uno de los promedios más altos de abundancia de nidos (1,27 nidos/km), en comparación con otras áreas donde habita la especie, como por ejemplo en el río Capanaparo donde esta abundancia no supera los 0,36 nidos/km (Thorbjarnarson y Hernández 1993a). Esto convierte al SRC como área estratégica para el mantenimiento, persistencia y conservación de la especie y la segunda área más importante para la reproducción de *C. intermedius* en el mundo, después de la población del sistema caño Macanillal-Laguna La Ramera en el estado Apure, con 3,8 nidos/km reportada por Antelo (2008). Por otra parte, el número de hembras nidificantes (27) que encontramos en el SRC, es un valor alto si se compara con las cifras reportadas por Seijas (1998) y Ávila-Manjón (2008, 12 y 35 respectivamente) para los mismos sectores evaluados.

Por otra parte, el número promedio de huevos por nido (49,5 ± 7,0) que encontramos, fue mayor que los reportados previamente en el SRC por Ayarzagüena (1987), González-Fernández (1995), Navarro-Laurent (2007; 43,3; 42,0 y 41,2 respectivamente), así como para otras poblaciones silvestres del caimán del Orinoco en Venezuela, como la del río Capanaparo (Thorbjarnarson y Hernández 1993a y b), la del río Manapire (Jiménez-Oráa *et al.*2007) y la del Sistema Caño Macanillal-Laguna la Ramera en el Frío (Antelo 2008).

Con la colecta de huevos (rancheo) y manejo de nidadas, se ha demostrado que es posible lograr la recuperación y manejo racional de especies de crocodílidos que llegaron a estar al borde de la extinción. Varios autores han mencionado las ventajas de la incubación artificial tales como la eliminación de las pérdidas debidas a la depredación natural (Joanen 1969, Pooley 1973; Chabreck 1978), la cancelación de la mortalidad de los factores limitantes debido a las condiciones climáticas (Joanen y McNeese 1977; Chabreck 1978) y la protección de los huevos contra las inundaciones inesperadas de los río (Jiménez-Oráa *et al.* 2007).

Aunque la muestra es pequeña, con la presente investigación confirmamos que la colecta de huevos del medio natural para su posterior incubación artificial, puede contribuir a maximizar el éxito reproductivo de *C. intermedius*, ya que el éxito de eclosión fue mayor (53,5%) si lo comparamos con la incubación natural (36,4%, nidos control). La razón de estos resultados posiblemente se deba a la técnica de incubación utilizada, la cual es catalogada como rústica,

ya que requiere un bajo costo y se pueden aplicar cerca de los sitios de recolección (Barros *et al.* 2010) y en zonas de difícil acceso. Si se mejoran las condiciones de incubación es posible que se incremente el éxito de eclosión de las nidadas colectadas.

En el SRC la temporada reproductiva de caimanes del Orinoco varía de un año a otro, además la pérdida de nidos debido a las inundaciones puede ser casi total en algunas temporadas (Seijas *et al.* 2010b). Por otro lado, en los sectores evaluados también existen registros de perdida de nidos de la tortuga Terecay *Podocnemis unifilis* por las inundaciones repentinas en el año 2009, la cual fue de 15,4% según Hernández *et al.* (2010).

El SRC mantiene una población reproductiva importante para la especie, principalmente en los sectores que se encuentran más alejados de los centros poblados y de la actividad agrícola e industrial (CA-CS y M-CAM). De este modo, este estudio sustenta la importancia del SRC, como área estratégica para la persistencia y conservación del caimán del Orinoco, dado su alto potencial reproductivo, donde los esfuerzos de conservación de mayor importancia, estén enfocados en la protección de la especie *in-situ* (en el propio SRC).

Un programa de colecta de huevos y crías, ayudaría a incrementar el éxito reproductivo de la especie, con el fin de propiciar su el apoyo y continuidad al Programa de Conservación del cocodrilo del Orinoco en Venezuela; reforzar las labores de monitoreo de la población de cocodrilos y temporadas reproductivas; capacitar a los pobladores residentes cercanos al río para que asistan las labores de búsqueda de nidos y crías, apoyados a su vez de programas de educación ambiental y vigilancia contra la cacería furtiva.

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CHARACTERIZATION OF SERUM DIPEPTIDYL PEPTIDASE IV ACTIVITY IN THREE SPECIES OF WEST AFRICAN CROCODILES.

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Dipeptidyl peptidase IV is a ubiquitous peptidase with putative immune activity. We characterized DPPIV activity in the serum of three diverse species of west African crocodile: the African Dwarf crocodile (*Osteolaemus tetraspis*), the slender-snouted crocodile (*Mecistops cataphractus*), and the Nile crocodile (*Crocodylus niloticus*). Crocodylus niloticus serum exhibited the highest activities, followed by *Mecistops cataphractus* and *Osteolaemus tetraspis*. The serum DPPIV activity was measured within 5 min after the addition of the substrate for all three species, and exhibited linear accumulation of product for at least 180 min. In addition, the DPPIV activity in all three species was temperaturedependent, with a linear increase in activity with temperatures and peak activity at 40 °C. Crocodile plasma DPPIV displayed classical Michaelis–Menten kinetics, with Vmax values of 2.29-2.81 nmol/min, and Km values of 0.09-0.17 nM. The proteolytic activity was inhibited in a concentration-dependent manner by a specific DPPIV inhibitor, diprotin A, which indicates that the activity is probably due to the presence of DPPIV.

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COMPARISON OF SERUM PHOSPHOLIPASE A2 ACTIVITIES OF ALL KNOWN EXTANT CROCODYLIAN SPECIES.

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Serum samples from all 23 extant crocodilian species were tested for phospholipase A2 (PLA2) activity against nine different bacterial species. The data were used to generate a PLA2 activity profile for each crocodilian species, and the data were used to compare the activities of the three main lineages (Alligatoridea, Crocodylideae, and Gavalideae), the seven different genera, and to compare all of the 23 individual species. The data revealed that the three lineages of crocodylians (Alligatoridea, Crocodyloidea, and Gavaloidea) exhibited PLA2 activities toward nine species of bacteria that were statistically distinguishable. In addition, the PLA2 activities of crocodylians in a specific genus tended to be more similar to other members in their genus than to members of other crocodilian genera.

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EFFECTS OF SELENIUM AND VITAMIN IN *Caiman latirostris* HEMATOLOGIVAL VARIABLES

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At present, it is well known that antioxidant capacity of vitamin E protects unsaturated fatty acids of cell membranes against peroxidation and eliminate free radicais from normal cellular activity. Selenium is also an antioxidant and cofactor of the enzyme cytoplasm glutathione peroxidase, an enzyme related to the neutralization and elimination of free radicais oxygen that can alter cellular integrity. In addition, selenium is involved in protein transport and cofactor of several enzymes. Previous studies have shown that the phagocytic activity of neutrophils increased in animais with diets supplemented with vitamin E and selenium, thus facilitating the elimination of invading microorganisms. Similarly, addition of doses of vitamin E and selenium resulted in higher antibody production. An experiment was conducted to study the effect of supplementation with vitamin E and selenium on growth and immune system on *C. latirostris.* The study was performed with 36 animais (12 months old), food was provided *ad libitum* 6 days per week. Half of the animals(9 per replica) received the special diet enriched with selenium and vitamin E. At the end of the study, we compared weight, length, and hematological variables (white and red blood cells count, percentage of type of white blood cells, serum proteinograms, concentrations of different serum proteins, and activity of serum complement system).

ESTUDO COMPARATIVO DO HEMOGRAMA DE FILHOTES DE *Caiman crocodilus* E *Melanosuchus niger* NO PERÚ.

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Os estudos comparativos de parâmetros fisiológicos entre espécies são importantes para determinar o grau de similaridade ou diferença entre animais aparentemente semelhantes. Durante o mês de setembro de 2009 foram coletadas amostras sangüíneas de 22 filhotes de jacarétinga (CC) e jacaré-açu (MN), mantidos em cativeiro no Parque Zoológico Huachipa, na cidade de Lima-Peru. As amostras foram coletadas por punção do seno venoso pósoccipital e colocadas em microtubos com heparina lítio para o seu analise posterior. Foram avaliados todos os valores do hemograma completo. Nos resultados obtivemos valores de semelhantes em quase todos os valores, porem se encontraram diferencias significativas para os valores da linha leucocitária, com valores de 12854 ± 4810 para MN sendo estes superiores aos 6360 ± 2356 achados para CC, entretanto os valores de basófilos e plaquetas foram maiores em CC do que no MN. As diferenças encontradas entre ambas as espécies poderiam estar relacionadas à variação da resposta imune de cada espécie ou a diferenças relacionadas à resposta de liberação leucocitária induzida pelo estresse produzido no momento da contenção física dos indivíduos amostrados.

HEMATOLOGY AND BLOOD CHEMISTRY OF CAPTIVE ORINOCO CROCODILES (*Crocodylus intermedius),* AT THE DALLAS WORLD AQUARIUM, TEXAS, USA.

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In August and December 2008, blood samples were taken from a group of 55 Orinoco crocodiles (*Crocodylus intermedius*) raised in captivity, in order to determine the status of their health before exporting them to Venezuela for releasing them into the wild. 34 specimens were 30 months old and 21 were 18 months old, all females, clinically stables and with an average length of 1200 mm and weighed 4.37 kg. Diet consisted of calcium-dusted crickets, live fish, and "chicken flippers" six days a week. The crocodiles were placed on ventral recumbence, and the puncture area for the internal jugular sinus, was cleaned with alcohol. Blood was extracted using #23 needles and vacutainers. Samples were sent to the diagnostic lab to be automatically analyzed under calibrated techniques for reptiles. The results were as follows: Ht: 21.47%, Leucocytes: 8.65, Heterophils: 63.28, Lymphocytes: 29.62, Azurophils: 2.75, Eosinophils: 0.52, Basophiles: 3.71, Alkaline phosphatase: 109.94, ALT (SGPT): 23.86, AST (SGOT): 47.69, CK: 1207.8, LDH: 334.3, Albumin1: 1.25, Total proteins: 4.3, Globulin: 3.05, Cholesterol: 359, Glucose: 69.3, Ca: 11, P: 5.7, K: 5.6, Na: 152.3, A/G Ratio: 0.41, Uric acid: 3.4. This study is the first performed for this species.

ISOLATION OF MANNOSE-BINDING LECTIN PROTEINS FROM THE AMERICAN ALLIGATOR *(ALLIGATOR MISSISSIPPIENSIS)*

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Lectins are carbohydrate-binding proteins that play an important role in innate immunity by recognizing a wide range of common pathogen surface carbohydrates. C-type lectin proteins, a subset of lectins that require calcium for binding to target carbohydrate moieties, were isolated from serum of the American alligator *(Alligator mississippiensis)* using a mannan affinity column. The proteins were isolated by SDS-PAGE, and the total mass determined by MALDI-TOF. Results from these analyses showed that the protein was present in monomeric, dimeric, and tetrameric forms in vitro. The N-terminal sequence was determined by Edman degradation, and the complete sequence was ascertained using protease digestions coupled with MALDI-TOF/TOF mass detection. The sequence of the alligator lectin protein was aligned with mammalian and avian C-type lectins.

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ATTITUDES, KNOWLEDGE, AND RISK PERCEPTIONS ABOUT ALLIGATORS IN FLORIDA.

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As American alligator (*Alligator mississippiensis)* populations in Florida have recovered from depressed levels in the 1960's, human-alligator conflicts have increased. Maintaining populations of potentially dangerous wildlife species at levels consistent with human desires can be a challenge. The Florida Fish and Wildlife Conservation Commission's Alligator Management Program (FWC) has previously conducted surveys of public opinions about alligators, and the purpose of this study was to gauge current public attitudes, knowledge, attitudes and risk perceptions about alligators. In the summer of 2009, we mailed questionnaires to 2,600 randomly selected Florida households and 1,000 households that had reported a complaint about a nuisance alligator to FWC within the previous year. We received 1,175 completed questionnaires. Forty-four percent (n=510) of respondents reported having requested that a nuisance alligator be removed, while 56% (n=644) reported never having made such a request. We found differences between nuisance complainants and non-complainants in knowledge levels, attitudes, nuisance beliefs, and risk perceptions associated with alligators. Understanding the differences in these measures between groups can help FWC tailor management strategies for alligators in Florida.

EFFECTS OF WATER LEVEL, DISTANCE FROM COMMUNITY AND HUNTING EFFORT ON CAIMAN MEAT PRODUCTION.

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Caiman hunting in the Purus River is based on dried-salted meat bought by traders from Pará State. This trade represents one of the largest illegal exploitation on wildlife in the world. Between February and October 2008 we followed 31 caiman hunting events carried out in the northern portion of the Piagaçu-Purus Sustainable Development Reserve. Our main goals were to evaluate how the level of the Purus River, the distance from the community and trapping effort affected the production of caiman meat. We also wanted to record which caiman species is most hunted and the prices paid in the region for caiman products. Hunting events began between 11h43 and 17h31 and finished the next morning. All *Melanosuchus niger* and *Caiman crocodilus* captured were measured and weighed. Fresh meat mass was measured before hunters started the salt-dried process. The distance from the community to the hunting site was measured with a GPS. An index of trapping effort was obtained as the product of the number of hooks used and the period of time the hook remained armed in each hunting event. The level of water was considered to be the average level of the month from a data series of the last 20 years. The price paid for salt-dried caiman meat was obtained through interviews with local hunters. Multiple linear regression models explain 70% of fresh-meat mass variance. Water level showed a negative effect ($p= 0.005$), and distance from the community ($p= 0.003$) and trapping effort ($p< 0.001$) had positive effects on total meat obtained. The price paid for salt-dried meat ranged from US$ 0.60 to US$ 0.75 per kg. Caiman illegal hunting occurs throughout the entire year, indicating that the activity is economically important for local people. Information on caiman illegal exploitation is crucial to detect unsustainable trends to be avoided in a future caiman management program in the Amazonia.Financial Support: FAPEAM, SECT, Governo do Estado do Amazonas; WCS.

IMPACTS OF HUMAN INTERFERENCE ON PREDATION OF THE YACARE CAIMAN, *Caiman crocodilus yacare* NESTS IN THE BRAZILIAN PANTANAL.

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Mortality of eggs of crocodilians is a key issue for the understanding of their populations dynamics. Normally, identification of predators of eggs of crocodilians is made through indirect observations, such as tracks and signs left in the nest and/or in the eggs. In this study, we aimed to identify predators and evaluate the effect of the researcher-induced disturbance of nests in the mortality rate of eggs of yacare caiman, *Caiman crocodilus yacare*, in the Central Pantanal, Brazil. We installed camera traps in 30 nests during the 2009 nesting season and 11 camera traps during the 2010 nesting season. Of these 41 nests, we opened 35 to count and measure the eggs and we kept 6 nests undisturbed. In 29 occasions the female were present near the nest and therefore we captured them. All disturbed nests were completely predated, but 3 of the undisturbed nests remained intact and the eggs hatched successfully. The crab-eating fox, *Cerdocyon thous* (n = 15), coati, *Nasua nasua* (n=9), and tayra, *Eira barbara* (n=9), tegu lizard, *Tupinambis teguixin* (n = 2) were photographed eating eggs. However, other species of mammals were recorded near the nests (i.e. the giant anteater, *Myrmecophaga tridactyla*, the *Tayassu pecari*, the white-lipped peccary, and the feral pig, *Sus scrofa*). The human presence in the nesting area favored the high mortality of eggs.

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LIVING WITH PREDATORS: A FOCUS ON THE ISSUES OF HUMAN-CROCODILE CONFLICT WITHIN THE LOWER ZAMBEZI VALLEY.

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Abstract

Context. Human–wildlife conflict is a global problem and increasing worldwide as people and wildlife compete for limited resources. Conflict between people and crocodiles, especially in Africa, is recognised as a serious problem. The people of the ChiawaGameManagement Area are heavily dependent on the Zambezi River for several resources from potable water and irrigating fields to a source of food (subsistence and small-scale commercial fishing).

Aims. To assess the spatial and temporal scale of human–crocodile conflict (HCC) and identify associated factors, with a view to recommending mitigation measures.

Methods. A questionnaire survey and Zambia Wildlife Authority data were utilised to estimate the scale of HCC.

Key results. Between 2000 and 2009, there were 98 crocodile attacks on people, 62.2% were fatal. Most of the attacks occurred while canoe fishing (57.1%) and collecting water (29.6%). Crocodiles were disliked and seen as a 'problem' by the majority of the populace. Even though crocodiles are a charismatic mega-fauna species, being employed within the tourism industry had only a minor positive effect on people's attitudes. The area is an important location for crocodile egg and adult harvesting, although the local population gains no financial benefit.Anincrease in the number of boreholes in the villages was suggested by the local people as the primary mitigation measure, as well as the removal of crocodiles by various means.

Conclusions. Although people displayed an understanding of the risks of crocodile attack, very few actually employed mitigation techniques or utilised protective barriers when at the river. Increased water-access points (and their maintenance) in the villages would reduce people's dependency on the river. The negative attitude towards crocodiles is an issue that has to be addressed to allow successful implementation of long-term conservation strategies.

Implications. Understanding local people's attitudes towards wildlife is an important aspect within any conservation management plan.

Additional keywords: attack, attitudes, management, mitigation.

Introduction

Human–wildlife conflict (HWC) is a global problem, occurring in many countries where human and wildlife requirements overlap. As wildlife and humans increasingly compete for

limited space and resources, the severity and frequency of conflict increases (Madden 2004). The fate of many wildlife populations is dependent on coexistence with people. An understanding of the factors that shape the response to HWC by humans is essential for its prevention and mitigation (Manfredo and Dayer 2004). Conflict management has often focused on wildlife; however, alteration of human behaviour may be a more realistic option for long-term conservation plans (Baruch-Mordo *et al*. 2009). The evaluation of local people's tolerance thresholds and attitudes towards wildlife can have significant conservation implications (Manfredo and Dayer 2004; Romanach *et al*. 2007). If the fundamental issues of HWC are not addressed, conservation efforts lose stability and the support of local communities (Treves *et al*. 2006). Community involvement has been demonstrated to be a deciding factor in the success of management plans (Groom and Harris 2008). Such management plans, however, need to be adhered to by all parties so as to be successful (Infield and Namara 2001). One of the animals associated withHWCis the crocodile, once heavily persecuted and harvested in the 1950s and 1960s (Cott 1961). Successful conservation methods have increased wild crocodile populations, which in turn has been accompanied by an increase in 'problem' crocodiles (Letnic and Connors 2006). The issues involved with human–crocodile conflict (HCC) are a concern, especially in African countries where the Nile crocodile (*Crocodylus niloticus* Laurenti (1968)) is the cause of significant numbers of human and livestock fatalities (Aust *et al*. 2009; Dunham *et al*. 2010).

Crocodiles are keystone species and fulfil an important role within the aquatic ecosystem in which they occur (Mazzotti *et al*. 2009) and also have a significant economic value (Heykoop and Frechette 2001; Balmford *et al*. 2002). Although crocodile farms can ultimately be self-sufficient, they do require an initial wild stock if captive specimens are not available and crocodile ranching requires harvests of eggs from the wild population (Luxmoore 1992).

There are several factors involved with the Chiawa Game Management Area (GMA); it is a site of conservation importance, a location for people to settle and develop agriculture, a tourist destination, and a source of wild crocodile adults and eggs for the ranching industry. Developing a harmonious management plan that benefits all of the aforementioned participants as well as conserving the existing crocodile population requires accurate baseline data.

Some of the primary information forHCCanalysis in the lower Zambezi is available as Zambia Wildlife Authority (ZAWA) keeps records of HWC incidents. There is no direct incentive to report wildlife attacks to ZAWA; therefore, it is not expected that all attacks would be reported. The magnitude of human–crocodile conflict is a challenge to quantify, because it is difficult to obtain comprehensive data especially concerning attacks resulting in no harm which are rarely reported (Fergusson 2004).

The main objectives of the study were to (1) estimate the scale of conflict, (2) investigate spatial and temporal aspects, (3) identify associated factors, (4) assess local attitudes towards crocodiles and (5) ascertain likely solutions to HCC.

An important pre-requisite for managing HWC in a specific locale is to understand the attitudes to wildlife and patterns of conflict. Involving people at the local level in surveys and realising attitudes can assist in future long-term conservation strategies (Dickman 2010). The priority is to ascertain whether the conflict is a serious problem endangering wildlife or a threat to people. Local people are directly involved with all forms of wildlife interactions and often decisions concerning both them and wildlife are realised by people far removed from the actual 'problem areas' and with limited understanding of the circumstances. The

fundamental questions that require answering are ‘are the ‘problem’ wildlife really a problem’ and if so, what is the most practical compromise for the local community and the wildlife concerned. Quantifying the scale of the problem is one aspect and identifying the attitudes of the local community towards the wildlife concerned (e.g. prevention, mitigation) is important for long-term success.

Materials and methods

Study site

The Chiawa GMA is situated in the middle or lower Zambezi region of Zambia, hereafter referred to as the lower Zambezi, and is bordered by the Kafue River to the west and the Lower Zambezi National Park to the east (Fig. 1). The area has a distinct wet season from November to April, followed by a cool and dry season (May–July) and a hot and dry season (August–October). The Chiawa GMA is 2344 km2 and is divided (perpendicular to the River) into two sections by a game-control fence. Although HCC can and has occurred in many areas across the lower Zambezi, the study examined only incidents within the western GMA because this has the largest human population adjacent to the Zambezi River. The easternGMA‘Sanctuary area’ acts as a buffer zone between the western area and the Lower Zambezi National Park to the east. A population of ~20 000 people reside in 15 villages that border the lower Zambezi Road that parallels the Zambezi River. The villages are spaced at regular intervals between the Kafue River and the game-control fence. The wildlife in the western GMA are at a lower density than those of the eastern GMA. However, several species of large wild animals persist and potentially pose human– wildlife conflict. These include baboon (*Papio ursinus*, *Papio cyncephalus*), buffalo (*Syncerus caffer*), elephant (*Loxodonta africana*), hippopotamus (*Hippopotamus amphibious*), and Nile crocodile (*Crocodylus niloticus*). The Chiawa GMA is classified as an IUCN Category IV, defined as an area ‘to maintain, conserve and restore species habitat’ (IUCN 2010).

It is also part of the African Wildlife Foundation (AWF) Heartlands program which encompasses key landscapes, including national parks, local villages, government and private lands (Muruthi 2005; AWF 2010). GMA’s in Zambia were principally established to act as buffer zones around National Parks, although they also support hunting and photographic safaris, as well as limited settlement for local communities who are allowed to practice agriculture (ZAWA 2010). The lower Zambezi valley is dominated by flood plains, with rural communities making use of the fertile soils and access to water to grow food crops. Fishing is the other means of subsistence and small-scale commercial operations. Water is available in most villages from a manually operated hand pump known as a borehole. Local villagers pay ZMK 5000–20 000 per household per month (~US$1–4) to the headman for maintenance of the borehole.

Questionnaire surveys

The questionnaire included both open-ended and fixed response questions. The study proposal and methodology were reviewed and approved by the Ethical Review Process of Imperial College London. The household was chosen as the sampling unit, with only one respondent used from each household. Interviews were conducted between April and August 2009. These were carried out with a permanent resident representative of the household, lasted 30 min and all respondents were above the age of 18 years. Translators were used when required and no incentives or rewards were offered to the respondents. A total of 14 enumerators (two ‘western’ research team members and 12 ‘western’ volunteers) conducted the interviews. So as to reduce interviewer bias, each enumerator was given prior training which included an

explanation of the questionnaire and purpose of the survey, interview techniques and aspects of local culture. To reduce the possibility of any questions being misconstrued (Willgerodt 2003), all six translators that participated were interviewed and asked for feedback. Changes to the questionnaire were incorporated when necessary.

Fig. 1. The Lower Zambezi Valley. The study site is depicted by the rectangle in the western half of the Chiawa Game Management Area (GMA) in Zambia. Other abbreviations are safari area (SA) and open area (OA).

Statistical analysis

All statistical analyses were performed using R version 2.10.1. Respondents were asked for information concerning HCC. These crocodile-attack reports had to be disentangled because of the possibility of the same incident being reported by several different respondents. The data were cross-checked by correlating the name of the attack victim, age, sex, activity, location, date and severity of injury. ZAWA provided data detailing 44 crocodile attacks dating from 2000. The details regarding crocodile attacks (year, month, activity and outcome of incident) were assessed for accuracy by comparing the answers from respondents to the data of the identical incident recorded by ZAWA (assumed as being 'correct' because of it being reported immediately). This was then recorded as the percentage of respondents who gave the 'correct' answer.

The location of crocodile attacks (distance from the eastern Chiawa GMA gate) was used as an explanatory variable for the number of attacks, using regression analysis. Linear models were also used to examine the number of crocodile attacks as a response to the mean monthly temperature and rainfall. The year of attack was used as an explanatory variable to identify trends of attack rates through time. Seasonal variation in the pattern of attacks was examined

with ANOVA using the wet season (November– April), cool and dry season (May–July) and hot and dry season (August–October).

Categorical data (sex, age, time period of residence, employment) were initially analysed with contingency tables using Pearson's chi-square test (c2) or Fishers exact test (if one or more of the expected values were below 5) to determine the homogeneity of proportions with regard to crocodile attacks. A generalised linear model with Poisson error structure was constructed for the number of crocodileattack incidents that occurred. This was split into sex, the type of activity the victim was involved in before the incident (riverbank fishing, bathing, canoe fishing, crossing a footbridge, farming or water collection) and severity of the incident (fatal, injury or no injury). Saturated models were initially fitted which were then simplified to the minimum best-fit model, using an ANOVA with a chi-square test.

Linear models were used to ascertain the degree of correlation between the number of people in the village that collected water, as a function of the distance to the river and borehole reliability (to facilitate analysis, the respondents answers were assigned a numerical state from 1 = unreliable, to 4 = reliable). Similar analysis was conducted for the likelihood of a crocodile attack being reported using the incident outcome (1 = fatal, 2 = serious injury, 3 = minor injury, 4 = no injury) as the explanatory variable.

Demographic factors (age, sex, village rank, employment, employment within tourism, ownership of arable fields and/or livestock) were tested using Pearson's chi-square test (X2) as explanatory variables to explain variation in attitude to crocodiles.

Results

In total, 398 people were interviewed in the 15 villages. This varied from 17.5% and 90% of the households of each village (mean = 41.1%). Only five people refused to participate and these cases were due to the potential respondent being too busy and there was no animosity towards the enumerator. There were more female (68%) than male (32%) respondents.

Scale of HCC

A third of respondents (*n* = 126) offered information detailing 85 individual crocodile attacks. An additional 41 attacks were obtained from ZAWA data, including 10 found on both sets of data. The crocodile-attack data given by respondents were assessed for reliability, as details of past events are often difficult to recall accurately (Odinot *et al*. 2009). Recollection of the outcome of the incident (78% of respondents recalled the correct outcome) and the activity being undertaken (74%) were similar to theZAWAdata. Most respondents (83.6%) were able to suggest a year when the incident occurred, but only 21.9% of respondents could also suggest a month or a period of the year (wet or dry season). It was decided to use the data from 2000 to 2009, omitting 28 attacks pre-1999, or of unknown date, from the analysis.

During the previous 10 years (2000–09 inclusive), crocodiles attacked 98 people. The questionnaire survey accounted for 57 attacks, ZAWA data 31 attacks and 10 attacks were identified by both. Females accounted for 36 of the victims and 62 were male. The mean age of the victim was 39.2 years. Most of the incidents were fatal (62.2%), 31.6% resulted in an injury, 4.1% in no harm and 2.1% had an unknown outcome.

Approximately half of the attacks (53.1%) identified from the questionnaire survey were reported to an organisation such as ZAWAor the police. There was a correlation between the severity of the attack and the likelihood of it being reported ($r2 = 0.93$, $P = 0.02$, d.f. = 2); 31.6% of the fatal attacks were reported, 21.4% of the attacks resulted in a serious injury, 5.1% involved a minor injury and none of the attacks that resulted in no injury was reported.

Approximately half the households (45.8%) kept poultry (either ducks or chickens), 20.9% kept goats and 0.5% kept cattle. A quarter of the households (25.5%) that kept livestock experienced livestock depredation by a crocodile (70.4% goats and 27.7% dogs, 1.9% poultry); these incidents were infrequent, occurring from once a year to once in 10 years. Respondents witnessed 29.6% of the attacks, with the remainder being based on supposition. There were no reports of cattle being killed, with all being tended by a herd-boy.

Spatial and temporal aspects of HCC

Crocodile-attack incidents were consistent throughout the study site, showing no relationship to the distance (of the nearest village where the attack was recorded) from the eastern Chiawa GMA gate ($r2 = 0.01$, $P = 0.36$, d.f. = 13). There was no direct evidence for temperature ($r2 = 0.11$, $P = 0.30$, d.f. = 10), rainfall ($r2 < 0.01$, $P = 0.90$, d.f. = 10) or season (ANOVA $F = 1.462{,}9$ $P = 0.28$) influencing the likelihood of an attack (Fig. 2). The combined number of attacks (survey and ZAWA data) decreased between the years 2000 ($n = 12$) and 2009 ($n=7$) ($r2 = 0.41$, $P = 0.05$, d.f. = 8), although no attacks were recorded by ZAWA during the recent years of 2006, 2007 and 2009.

Factors associated with HCC

There was a significant gender effect and activity effect within the model ($c2 = 14.2$ $P < 0.01$, d.f. = 6). These ratios follow the sex biases for the various activities; of the canoe-fishing attacks, 90.3% involved men and of the water collection, 74.3% were women. The majority of attacks (57.1%) occurred while fishing from a canoe, which was an activity undertaken by a minority of the population (16.3%) (Fig. 3). The second-most dangerous activity was collecting water from the river (49.7% of households), accounting for 29.6% of the attacks. Most households (84.0%) had a borehole in a closer proximity than was the river, with the mean distance from a respondent's house to the nearest borehole being 411.3m (range 10–5000 m) and that to the river 1368.1m (range 100–6000 m). The reliability of the borehole decreased with an increase in the number of households in the village per borehole ($r2 = 0.57$, $P < 0.01$, d.f. = 13). As the reliability of the borehole decreased, the number of people that collected water from the river increased ($r2 = 0.42$, $P = 0.02$, d.f. = 12). Increasing distance between the household and the river had a negative effect on the number of people collecting water from the river ($r2 = 0.12$, $P = 0.03$, d.f. = 12).

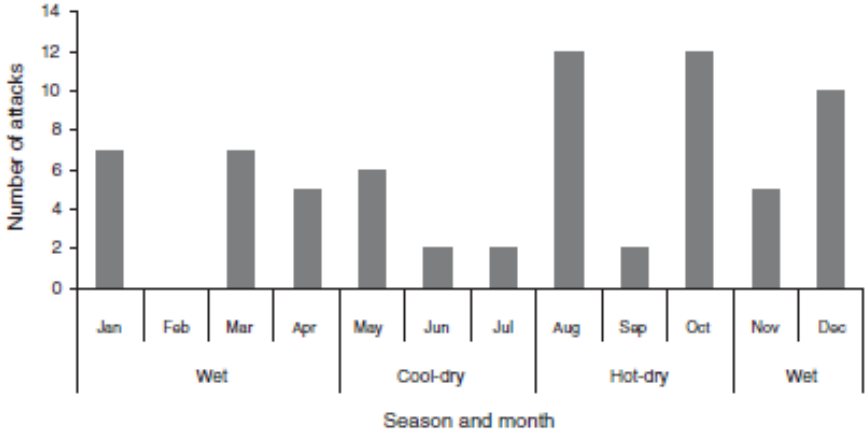

Fig. 2. Seasonal distribution of crocodile attacks that occurred in the Chiawa Game Management Area between 2000 and 2009 inclusive ($n = 98$).

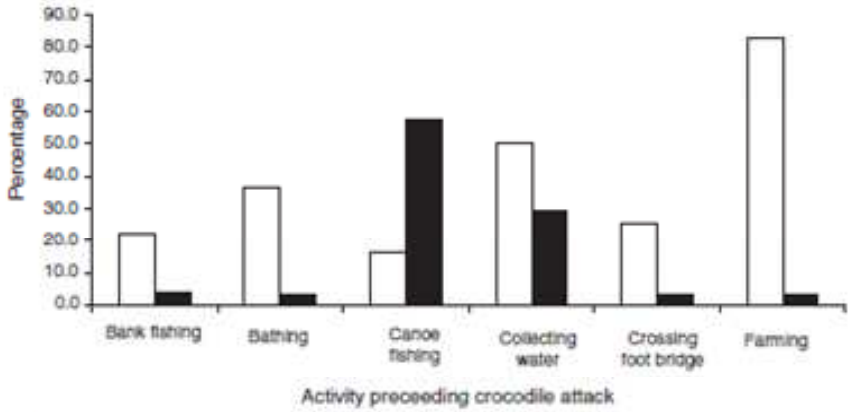

Fig. 3. Percentage of crocodile attacks ($n = 98$) between 2000 and 2009 (black bars) relative to the population involved in a particular activity (white bars, which exceed 100% because many households are involved with multiple activities) in the Chiawa Game Management Area.

Crocodile attacks were also recorded while individuals were engaged in agricultural activities (3.1% of the attacks). Most households were involved in some form of agricultural activity (83.2%), although the proportion of fields that actually border the river was not ascertained; therefore, the results may indicate this bias. A third (30.8%) of the households that cultivated crops had to cross a footbridge across a tributary of the Zambezi, which accounted for 3.1% of attacks. Approximately half (50.9%) was required to cross a footbridge during the rainy season and 49.1% all year round. The ZAWA data indicated that during the 10-year period, one crocodile was killed (during 2004) by ZAWA personnel.

Local attitudes towards HCC

Crocodiles were considered a problem by the majority of both women (92.9%) and men (89.1%). Only gender and employment within tourism had significant ($P < 0.05$) influences on some of the 'attitude towards crocodile' responses. The majority of households with both tourism and non-tourism employees regarded crocodiles as a problem, 80.4% and 97.3% respectively. However, of the 20 households that regarded crocodiles as either a benefit or a combined benefit and problem, 18 had a tourism employee. The main reason cited for

crocodiles being a problem was that they were dangerous (94.8%). Of the remaining minority that believed that crocodiles were beneficial, 3.0% suggested that crocodiles were important for tourism or economic reasons, 0.7% that they were important for conservation reasons, 0.7% that they were avoidable, 0.5% that they were important because God created them and 0.2% that they were important for aesthetic reasons.

Removing some or all of the crocodiles from the river was preferred by the majority of both men (78.3%) and women (88.1%) as well as by the households that had an employed person (whether they were employed within tourism 75.5% or not 91.8%). This varied from selective culling or removal of large and/or problem animals to complete eradication. Gender influenced the response to the suggestion of a monetary recompense for living alongside crocodiles, with 25% of women willing to accept a form of payment, although the majority cited that 'a financial incentive is not comparable to the loss of human life'. Men were twice as likely (49.5%) as women to consider a financial incentive to allow crocodiles to remain.

The majority of people (62.7%) believed that crocodiles could attack at any time of the day. Most people (65.2%) regarded the rainy season as the most dangerous period during the year, as opposed to the dry season by 5.0%. Approximately a quarter (26.4%) of people believed the whole year to be dangerous. A large proportion of people (81.7%) did not take precautions to prevent crocodile attack, only 38 households (18.3%) utilised a river fence on a regular basis.

Possible solutions to HCC

Respondents were given a choice of four organisations that should be held responsible for public safety; the government was suggested by 40.0%, conservation non-governmental organisations (NGOs) by 23.7%, the local community by 11.4%, the headman by 10.6%, all of the previously mentioned by 1.3% and 13.1% did not know. When asked what the best mitigation solution would be to prevent crocodile attacks, approximately half of the respondents offered a comment (n = 160). Mitigation measures suggested were as follows: additional boreholes (57% of respondents), removal of crocodiles (29%), river fences (7%), building more and improved bridges (4%), developing fish farms (2%) and bathing pools (1%). Other suggestions (not actual mitigation techniques) included avoiding the river (n = 5), education (n = 6), God creating everything and protecting people (n = 2), ZAWA being more involved with communities experiencing 'problem crocodiles' (n = 9).

Discussion

Human–crocodile conflict in Africa is a significant problem, with more fatalities reported than for other continents where crocodilians occur. People who live in areas where crocodiles occur run inherent risks when spending time at the river. Finding ways to save people's lives should be of paramount importance. Crocodiles are an ecologically and economically important species; therefore, it is important to resolve any negative relationships which may impede conservation or utilisation efforts. The present study identified the activities that precede crocodile attacks and quantified the attitudes of people towards crocodiles and mitigation methods. These data can be used as a framework for crocodile management, which should include public safety. The analysis revealed the complex nature of attitudes towards this charismatic species which is an efficient predator.

Scale of HCC

There was a discrepancy between the attack-incident data gathered using the questionnaire survey and the ZAWA data. It is possible that there was a lack of communication between the authorities to whom the crocodile incident was reported (e.g. Police, ZAWA patrol, village scout, village headman) and the ZAWA Chirundu office. Chirundu is ~16 km from the western edge of the GMA and therefore access for local people maybe an issue for the purpose of reporting a crocodile attack. The likelihood of reporting a crocodile attack increased with the severity of the incident. There were no attacks recorded by ZAWA that resulted in no harm being inflicted on the victim. Predators are more likely to return to an area where a previous attack has taken place (Treves *et al*. 2004). This highlights the importance of encouraging the local populace to report crocodile (and other animal) attacks to the relevant authorities. Livestock losses as a result of crocodile depredation were minimal, with goats being the main animal attacked, following the pattern of also being the predominant livestock. Crocodile attacks on humans appeared to outnumber those of livestock attacks. Any loss of human life is tragic and 9.8 attacks per year constitute 0.05% of the Chiawa GMA population. Human deaths that could have been avoided are deplorable and this figure represents only those people attacked by crocodiles. There are numerous other dangerous animals such as elephant in the area as well as the prevalence of life-threatening diseases such as HIV/AIDS and malaria. There is still a great deal of scope to realise the full extent of mitigatable fatalities.

Spatial and temporal aspects to HCC

It was thought that the rates of crocodile attack would increase towards the eastern section of the study site, which was close to the protected area and the increased number of crocodiles. However, the presence of large protected areas adjacent to (the Lower Zambezi National Park) and opposite (Hurungwe Safari Area) the study site may in fact have reduced the number of attacks because of an abundance of natural prey in areas of limited human density. These areas would also offer relatively undisturbed basking sites compared with the shoreline of the GMA.

Seasonal patterns of attacks by crocodiles on both livestock and people have been reported for Kenya and Namibia (Fergusson 2004) and for north-eastern Namibia, including a portion of the upper Zambezi River (Aust *et al*. 2009). During the dry season, it is assumed that more people (and livestock) would utilise the river to bathe and cool down. The warmer temperatures would allow crocodiles to be active during a greater portion of the day. These assumptions would lead to a hypothesis of an increase in attacks during the hot and dry months. The main peaks in the number of attacks did occur during 2 of the 3 months of the hot and dry season, whereas the third month had some of the lowest numbers of reported attacks. It is not known why September has some of the lowest numbers of reported attacks. The month and/or season were the most difficult aspect of the crocodile attack for respondents to recall accurately and this may be reflected in the results.

The number of crocodile attacks per year decreased from 2000 to 2009. More attacks were identified in recent years using the questionnaire survey. TheZAWAdata had more attacks recorded for the earlier years, with few or no attacks reported during the past 3 years. TheZAWAdata are reliant on ‘reported’ attacks, whereas the questionnaire survey revealed several attacks that were not reported. Only a small percentage of these were found within the ZAWA data. It is possible that the number of attacks is reducing each year, although the reasons are as yet unclear. One possible reason could be an increase in the number of boreholes, which would have reduced the number of people collecting water from the river.

Factors associated with HCC

The type of activity carried out at the river influenced the potential for a crocodile attack, with fishing from a canoe being recognised as the most dangerous because of the high incidence of attacks and the low proportion of the population involved. Fishing from a canoe has been recognised as a high-risk activity in other studies (McGregor 2005; Thomas 2006). Both fishing activities (canoe and bank) can place people in isolated areas and the associated activities of setting nets (wading in the river and along sandbars) and gutting fish (which can offer an olfactory cue to the crocodiles) may increase the risk of attack. If the individual is alone (as is often the case for fishermen), there is very little chance of the attack being either witnessed or for intervention from a third party. Not all of these incidents were visually confirmed and it should be noted that many of the canoes are often in a state of disrepair. It is not uncommon to see canoes being paddled and water being bailed out simultaneously. Very few of the local people can swim, and it is possible that some of these fatalities may be attributed to canoes capsizing or sinking from an encounter with a submerged obstacle or animal other than a crocodile (i.e. hippopotamus, *Hippopotamus amphibius*) and the individual drowning. The other activities in the order of potential risk of crocodile attack per year are collecting water, fishing from the bank, bathing and crossing foot bridges, which follow a pattern similar to the proportions of the local populace that are involved. The farming incidence of attack should be viewed as an underrepresentation; the actual river usage would depend on the location of the farm in regard to the river and irrigation method, neither of which was established.

Much of the literature concerning crocodile attacks reports the number of incidents in areas per year according to the preceding activity (Fergusson 2004; Caldicott *et al*. 2005) and some relates the data to human population size and proportion of the populace involved in that particular activity (Thomas 2006). This can be taken one step further by utilising the amount of effort per day for each activity. Some activities such as fishing from a canoe may consist of an entire day on the river, whereas collecting water may require only an hour at the most per day. Investigation into daily effort could yield informative results and elaborate on the ranking of activities in terms of the exposure to potential crocodile attack. This information becomes pertinent when assessing the activities for mitigation, especially when funding for conservation measures can be limited (Brockington and Scholfield 2010).

Local attitudes to crocodiles

On the whole, the majority of people viewed crocodiles as a problem, regardless of sex or employment within tourism. A higher proportion of women, however, was in favour of crocodile removal and a financial recompense was less likely to sway their point of view. Other studies have shown that women can express a higher degree of concern about potentially dangerous wildlife (Zinn and Pierce 2002). Men appear to have higher tolerance levels to crocodiles. The local tourism industry is biased to employing males and so there is a higher chance of males having a more sympathetic attitude towards wildlife because of previous experience. Tourism has been suggested as the solution to ensure positive human–wildlife relationships and, used in the correct way, can be beneficial, not only in raising awareness and tolerance levels for wildlife but in providing an economic incentive (Stronza and Pegas 2008). The interviews quantified whether the household had a tourism employee, not whether this was the respondent him/herself. We assume that because the family is benefiting from tourism they would be more predisposed to crocodiles; however, tourism have very little effect. It is possible that such ‘tourism’ respondents may be more predisposed to wildlife in general, but when singled out, the crocodile (because of its size and appearance) becomes a ‘problem’ animal. The type of tourism related job may also have an influence,

possibly the ‘front of house staff’ (e.g. managers, lodge guides) acknowledge the bigger picture of an ecosystem and the relevance of different types of wildlife because of their training and experience. The ‘back of house staff’ (such as e.g. cleaners, kitchen staff) may not appreciate such nuances. Subtle differences such as these require further investigation because a general increase in the awareness of the wildlife issue may have a decisive impact on the attitudes of employees who may be unaware that their employment is dependent on the large and potentially dangerous species that they would like to be removed.

Only one household was involved with a crocodile ranch, directly benefiting from the presence of crocodiles. Considering that several Zambian crocodile farms and ranches harvest crocodile eggs and adults in this area, there is potential for community involvement. Conservation strategies have often benefited from local participation which includes financial benefits for the local population that live alongside the wildlife (Frost and Bond 2008; Groom and Harris 2008). There are no crocodile farms located in the Chiawa GMA and only a minority of people will directly benefit because adult crocodile capture and egg collection require small teams with specialist training and operate only for a few months of the year. Trophy hunting and the collection of wild crocodile eggs and specimens is regulated by ZAWA who set the quota and price. The Zambian crocodile management plan stipulates that 50% of the proceeds from trophy hunting will be distributed with the local communities ‘...to assist in creating a positive attitude towards crocodiles’ (IUCN 2004). It also stipulates that 5% of wild-collected eggs, once hatched and reared to 1.2-m total length, should be repatriated to compensate for the initial off-take.Analternative strategy allows the crocodile farm to sell this percentage and pass the funds ontoZAWAfor use in crocodile conservation (Chansa *et al*. 2005). These sentiments are admirable if followed through but it is not known if or how these funds would be distributed to local communities. Therefore, it is difficult to increase tolerance levels through direct economic incentives.

Possible solutions to HCC

The majority of people felt that it was the responsibility of the Government to ensure the safety of the people of Chiawa GMA. A considerable number of people suggested that NGO’s should accept some of the responsibility. The reasons stated were that these were the interest groups that wanted conservation and therefore should take an active part in reducing the conflict between wildlife and people. Respondents believed that a crocodile attack could happen at any time of day and that the rate of attacks would peak during the wet season. Despite this knowledge, the majority of people did not use any form of mitigation while utilising the river.

The construction of more boreholes (and regular maintenance) in each village was the most widely suggested solution and would reduce substantially the proportion of the population that has to collect water from the River. Supplying every household with running water would be the ideal solution, but this is currently an unrealistic option in rural Zambia.

The removal of crocodiles was a widely suggested solution to reduce the number of attacks and has been cited as an effective technique in Australia (Nichols and Letnic 2008). The capture and relocation or removal of ‘problem’ crocodiles to a crocodile farm could have multiple benefits. The problem animal is humanely removed, the farm gains an extra breeding individual and ZAWA is seen to be following-up crocodile-attack reports. In conjunction with skilled capture teams, correctly identifying the ‘problem animal’ and not using as an excuse for excessive removals of large breeding females, capture and relocation poses a possible short-term solution. This will not necessarily reduce the potential for attack and, if not carried

out correctly, could infuse a false sense of security for certain areas until another ‘problem crocodile’ takes up residency.

Unfortunately there is very little that can be done to mitigate the risk of crocodile attack on people who fish using a canoe, other than dissuading participation, which would require an alternative option. The use of better canoes is a possibility, but will require initial investment and continued maintenance. This may not deter a crocodile attack or accidental drowning as a result of collisions with submerged obstacles or encounters with other animals. Human–crocodile conflict in the Zambesi Valley Mitigation measures to prevent or reduce crocodile attacks such as protective barriers at the river’s edge have been cited (Thomas 2006) as a solution, yet this has not been validated empirically. Although it is common sense that physical barriers at the river’s edge may reduce the number of attacks, there are also other factors that need to be considered. The barrier will require maintenance and corralling people into the same area may be problematic. This situation could change from a safe haven to a potentially high-risk area if the fence falls into a state of disrepair. There are only three protective barriers in the Chiawa GMA and these appear to be underutilised despite the potential benefits of using a mitigation measure that can be locally sourced, constructed and maintained. Only a small percentage of the respondents suggested the use of protective barriers as a mitigation aid.

The incidence of attacks while traversing a foot bridge could also presumably be reduced by a sturdier initial construction and building high enough to prevent the tributary flowing over the bridge at times of high water. Reducing livestock losses (at least from crocodiles) is possible by providing water for the animals in the village or using a shepherd to keep the animals away from the river and corralling them at night.

Although half of the respondents offered mitigation suggestions, a considerable number of people responded by saying that there was ‘nothing that can be done to prevent crocodile attack’. This fatalistic attitude indicates a type of resignation to the possibility of an attack happening, accepting that living in the GMA brings with it inherent and unavoidable risks.

The present study has provided valuable data and insights to the human–crocodile relationships in the Chiawa GMA. Crocodiles are a problem and there is currently very little mitigation effort. More boreholes and on-going maintenance would reduce people’s reliance on the river for water collection. A greater effort on follow-up, with the involvement of NGO’s and/or crocodile farms to capture and remove ‘problem’ animals would be beneficial, and could increase the likelihood of the local populace reporting attacks. An improved system of reporting would be helpful, such as monthly visits by ZAWA to villages to document HWC. It is important to determine all the incident locations, regardless of the severity of the injury so that attack ‘hot-spots’ can be identified and appropriate action implemented. The ideal way to prevent HCC is to avoid the river. This is not possible in areas such as the Chiawa GMA, where people rely on the river for a multitude of activities from social pastimes to the necessity of collecting water. The underlying dislike of crocodiles by the local population should be carefully considered. Unless this is changed, future conservation or mitigation measures may not be as effective as anticipated. There appears to be a disregard for safety and minimal understanding of crocodile behaviour and the potential ecological and financial benefits. Conservation and ecological-education and -awareness campaigns would benefit local people and could have a positive influence on people’s attitudes to wildlife.

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LIVING WITH THE NILE CROCODILE.

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For centuries people have defended their home, families and fields from marauding and potentially dangerous animals. Conservation measures have made this traditional response either illegal or socially unacceptable. Recent studies have highlighted the importance of developing schemes beyond protected areas in order to sustain viable populations of wildlife and to reduce the level of conflict. For these schemes to be successful it has been shown that the involvement of the local populace can be invaluable. Each house in 14 villages of the Chiawa Game Management Area (GMA) in Zambia, was approached and a request was made to a representative of the household (above the age of 18 years) to participate in a voluntary questionnaire survey. Each enumerator was accompanied by a translator. A total of 398 people were interviewed (~40% of the total households in the Chiawa GMA). A high proportion of people (69%) in the area are dependent on the river for one or more activities such as fishing, collecting drinking water, washing dishes/clothes or bathing. Each of these activities exposes that person to potential attack by a crocodile. Nineteen percent of households had a family member attacked, 66% of these fatal. Unsurprisingly, 92% of people deemed crocodiles to be a problem in the GMA, 85% if given the choice would prefer crocodiles to be removed. Forty percent of men, but only 23% of women, thought that some form of financial incentive would be acceptable to allow crocodiles to remain in the river. One of the main suggestions for mitigation was to increase the number of fresh water boreholes in each village. Most people (43%) hold the government responsible for mitigation measures. A substantial number (23%) suggested that NGO's should take a more active role as they are responsible for the conservation measures. An improved system of reporting attacks and investment into local infrastructure could assist in alleviating conflict.

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APPLICATION OF SKULL MORPHOLOGY TO CONSERVATION OF SYMPATRIC CROCODILIANS.

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Sympatric apex predators will compete for niche space, and it is accepted that interspecific competition between crocodilians increases with similarity in skull shape. Skull shape is an unadulterated form of evolution, representing a form of natural state prior to human interference and limited resources. With the application of such a natural state equilibrium to ecology of sympatric species, conservation initiatives can be better directed, minimizing negative effects to cohabitors.
We used landmark analyses on photographs of crania (n=159) in all extant crocodilian species (n=23) to determine interspecific overlap of cohabiting species. With that data, a morphospace analysis (adapted from Compton et al. 2007) was conducted to determine overlap within skull morphospace. This overlap was then applied to a simple equation for calculating available habitat for expanding populations.

Of five sympatric crocodilian pairs compared by skull morphospace analysis, four were indicative of realized niche segregation. *C. crocodilus* and *M. niger* - treated as a case study - had a 51% overlap in morphospace. Translated to niche segregation, for every one *C. crocodilus*, 0.852 *M. niger* would successfully cohabitate.

When we combined the morphospace results with a habitat availability model, based on home range, intraspecific overlap and abundance, we were able to estimate the maximum supportable number of crocodilians (3602.6) within the habitat (2810 km^2) while maintaining the natural state equilibrium between *M. niger* (1657.2) and *C. crocodilus* (1954.4). Ecology was compared within the hypothetical study, and areas of focus could be noted for reducing possible competition.

The application of natural state equilibriums, derived from skull morphospace analysis, to conservation plans of sympatric species would lead to a more focused action plan and enhance applied conservation ecology.

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BACTERIOLOGICAL QUALITY OF CAIMAN MEAT OF ANIMALS OF RESERVE FOR SUSTAINABLE DEVELOPMENT PIAGAÇU-PURUS, AMAZONAS.

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Introduction: In Brazil, the consumption of alligator meat is part of Amazon culture, yet there is no consensus on the Amazon best option for sustainable management. A work was carried out to evaluate the microbiological quality of meat of animals from nature reserve Piagaçu-Purus Sustainable development, to determine the best protocols for processing.

Methods: A total of 43 samples were analyzed, with the permission of IBAMA No.: 14498- 1. The animals were of species *Caiman crocodilus* (Spectaled Caiman), by using the code CC and *Melanosuchus niger* (Black Caiman), we use the code MN. The analyses were made in accordance with BRASIL, 2003. We evaluated the presence or absence of total coliforms and thermotolerant in VRBA and EC media; *Staphylococcus aureus* on BP and BHI; *Salmonella* in selenite and SS. We considered the criteria set by BRASIL, 2001 for determination of meat quality.

Results: Of the total meat analyzed, 33 (77%) were fit for consumption and 10 were disapproved (23%) and 16% (7 samples) disapproved by the criterion of evaluation of coliforms, 5% (2 samples) by the evaluation criterion of *Salmonella* and 2% (one sample) by the evaluation criterion of *S. aureus*. For the species *C. crocodilus* (25 samples), 80% were approved and 20% disapproved, and the Salmonella test: 8%, by *S. aureus*: no and the criterion of fecal: 12%. For the species *M. niger* (18 samples), 74.5% were approved and 25.5% disapproved, and none was disapproved by the *Salmonella* criterion, but 5.5% was the criterion *S. aureus and 22% according coliforms.*

Conclusions: the improvement of the sanitary quality of Caiman meat for human consumption is due to the inclusion of improvements in processing post-slaughter.

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CROCODILE MEAT FROM A PROTOCOL FOR THE SLAUGHTER IN APPLIED BASE FLOATING IN RESERVE FOR SUSTAINABLE DEVELOPMENT PIAGAÇU-PURUS

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Introduction: The concern with preserving the environment in the modern world justifies a tendency to trade for creation of productive chains socially just. At the Amazon Forest the Chains refer to the Sustainable Development Reserves and Extractive Reserves. In this context, adding value to products is essential in order to ensure no damage to the fishermen, provide affordable prices and consumer products safety.

Material and Methods: A float of 60 m2 with three environments: receiving, processing area and salting room, with a catchment system and water treatment simplified, was designed and built. The structure and flotation devices were made of metal and wooden floor painted with smooth, durable and waterproof. The tables were built with aluminum. As well as the wall of the salting room. In that area an insect screen of PP (polypropylene), and the lining in PVC (Polyvinyl chloride) were used. The slaughters were carried out according the protocols of ***the principies of Good*** Manufacturing Practices (GMPs) (Brazil, 1997).

Results: There were slaughtered and processed 33 **(*Melanosuchus niger)*** and 52 **(*Caiman crocodilus)*.** The meat was submitted to different process: salting, dry salting, smoking and protein concentrate. A small portion was kept in ice to verify the shelf life of the product in seven days. The meat was produced mostly (77%) according to the official requirements of health conditions (BRAZIL, 2001) and the characteristics required for technological processes.

Conclusion: It was possible to obtain good quality meat in a simplified structure in place. The improvement of the sanitary quality of meat for human consumption compared to the product illegally produced in that region is due to the inclusion of GMPs.

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COÍBA: RESEARCH AND EDUCATION PROGRAM FOR CONSERVATION AND MANAGEMENT OF CROCODILES.

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Coiba program is a Texas Tech University, Smithsonian Tropical Research Institute (STRI), and Crocodile Specialist Group (IUCN-SSC-CSG) initiative supported by The National Secretariai for Science, Technology and Innovation of Panamá (SENACYT) to create opportunities for field research at Coiba Marine National Park (CMNP) and to diffuse the knowledge globally. This program is aimed at developing three important steps. The first step is the establishment of long term research on ***Crocodylus acutus*** population structure and habitat use at CMNP using genetics and telemetry. This study offers research opportunities in ecological genetics, evolutionary ecology, and **in situ** biodiversity conservation and marine coastal habitat management using *C.* ***acutus*** as a model. The second step will focus on establishing a training program for researchers interested in developing field-based skills to work with salt water crocodiles. Additionally, basic genetic laboratory training will be offered to interested individuais. The third step, distance education, aims at establishing a global network where teachers, students, and researchers from around the world can perform real time virtual studies with the data provided by the telemetry project. We also plan to add this telemetry project to the STRI long-term project on coral reefs monitoring, migratory patterns of large pelagic species in the eastern Pacific, shark fishing, and marine reserve networks using internet platforms. Our project started in May 2009 with a budget of 65,000 US dollars supplied by SENACYT, STRI, TTU, and WCS. In the summer of 2009 A.H. Escobedo-Galvan (UNAM), and M. Vandewege (TTU) did field work in Coiba. Currently, we have three TTU students conducting their thesis work on population genetics and Island biogeography; L. Garcia, A. Bashyal, and B. Gross. On July 15, 2010 we offered the first telemetry workshop for this program to 15 researchers from throughout Central America. Based on these results, we present the utility of regional institution training on crocodile research and conservation and implicate a large community impact.

CONSERVATION AT THE WESTERN LIMIT – THE GAMBIAN CROCODILE PROGRAM.

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The Gambia represents the western range limit for slender-snouted and dwarf crocodiles. However, neither species had been reported in over 10 years (nearly 40 years in the case of slender-snouted crocodiles), and it was feared that threats like habitat alteration, hunting, and fisheries overexploitation had resulted in their extirpation. In order to confirm their continued presence in The Gambia, and ultimately work towards their conservation, the Croco's Ark Trust was established. The major goals of the Trust are to survey the presence, distribution, and abundance for all three crocodile species, work with the Dept. of Parks and Wildlife Management to develop the capacity to monitor and manage crocodile populations, and establish a captive population for ultimate reintroduction and augmentation of wild populations. Surveys conducted to date have revealed the presence of all three species, though in significantly low numbers and highly fragmented groups. Despite this, we have recorded evidence of reproduction and encouragingly heterogeneous demographic structure in populations of all three species. Both slender-snouted and dwarf crocodiles are most abundant in the River Gambia National Park, though they are patchily distributed further east where suitable habitat is available and anthropogenicthreats are minimal. Genetic analysis of dwarf crocodiles has revealed a moderately divergent lineage indicating long-term isolation from populations further east in theUpper Guinea biome. These analyses have also been used to identify captive stock in Europe that can be imported for use as founders in the breeding program. To date, the breeding facility has been constructed and a strategy for locating breeding stock has been devised. The priorities for the near future are to establish a crocodile monitoring plan for the country and to continue collaboration with the DPWM to implement it. This will include identification of key sites for reintroduction and the development ofcommunity-based education and conservation campaigns.

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CONSERVATION STATUS OF CROCODILIAN POPULATIONS ON THE CONFLUENCE OF NEGRO AND AMAZON RIVERS.

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During the last decade the conservation status of Amazonian crocodilian species changed quickly at regional and national levels, including the regulated international trade of skins. However, our scientific knowledge is basically defined from a few studies carried out in Brazilian protected reserves. We evaluated the caiman population status in a region located within 100 km from the confluence of Negro and Amazonas rivers, probably the area most impacted by human activity in Central Amazonia. We carried out spotlight surveys between June and October 2009 in four different localities to estimate abundance and size structures of caiman populations. We also captured some individuals to evaluate sex ratio and calibrate our size estimate. Physic-chemical parameters of water in the river sampled will be used to explain ecological characteristics of the study area. We counted 5,531 caimans over 211 km along 14 surveys. Caiman number ranged from 0.7 to 70.7 caimans/km of shoreline (mean = 21.5, SD = 26.4). We identified to species 855 caimans, which of 49.9% were Melanosuchus niger and the rest Caiman crocodilus. The snout-vent length (SVL) of 427 M. niger ranged from 22 to 200 cm, and for 427 C. crocodilus the $10 \leq SVL \leq 120$ cm. The sex ratio for M. niger was two males for one female and for C. crocodilus 1.4:1. No evidence of commercial hunting was recorded in the area. Abundances in black water system were similar to those found in the Anavilhanas and Jau National Parks, both located in the Rio Negro. Results from white water system were lower than the ones found in the Mamirauá Reserve and similar to those from Piagaçu-Purus Reserve where hunting is widespread through the entire year. Around 64% of the distance traveled and 96% of the caimans counted during surveys were in the Lago Piranha locality.

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CONTRIBUCIÓN DE LA UNIVERSIDAD JUAREZ AUTÓNOMA DE TABASCO EN LA CONSERVACIÓN DE LOS COCODRILOS EN MÉXICO.

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El estado de Tabasco en México se caracteriza por contener la mayor reserva de agua en forma de humedales dei País. Los recursos naturales de este ecosistema han sido utilizados en muchos aspectos en esta región, y el cocodrilo de pântano (Crocodylus moreletii) es uno de ellos. Símbolo de la cultura tabasquefia, el cocodrilo se encuentra distribuído en casi todos los cuerpos de agua someros dei estado de Tabasco, incluyendo aquellos que se encuentran dentro de las ciudades. Desde su formación en 1989, la División de Ciências Biológicas de la UJAT ha formado proyectos, programas y profesionales interesados en la conservación, uso y manejo sostenible de esta espécie. Uno de los elementos característicos de esta institución, fue la creación de un lago de 4 Has. disenado para la exhibición de los cocodrilos. Sin embargo, múltiples eventos frenaron en algún momento muchas de las actividades a realizar con los cocodrilos. En 2003 se desarrolla un plan de ajuste, remodelación y rehabilitación dei programa de reproducción de cocodrilo, y se realizan un número importante de eventos y actividades para fortalecer estas propuestas. Entre ellas se han ofrecido más de 9 cursos y talleres con tópicos sobre la cria en cautividad y evaluaciones de poblaciones silvestres, promoviendo la formación de personal capacitado en el manejo integral de los cocodrilos. Más de 200 estudiantes han participado en estos cursos, se destaca el número de estudiantes locales, sin embargo, también estudiantes de licenciatura y posgrado de diferentes universidades mexicanas adernas de productores interesados en la cria y manejo de los cocodrilianos. El intercambio también es importante por lo que se han realizado foros y estancias con investigadores y estudiantes para promover, difundir y colaborar en diferentes proyectos y programas de investigación en los estados donde se distribuyen espécies de cocodrilianos en México y en otros países.

Se agradece a la Dirección y coordinaciones de la DACBiol por los apoyos y facilidades otorgados para el desarrollo dei programa de conservación dei cocodrilo de pântano.

CROCODILIANS RANCHING PROGRAM IN ARGENTINA: TWENTY YEARS OF SUCCESS.

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Abstract:

The experimental ranching program began in Argentina in 1990 with the aim of monitoring and recovering the *Caiman latirostris* population in Santa Fe Province. The work was later extended to Chaco, Formosa and Corrientes Provinces, and the *Caiman yacare* populations were also added to the sustainable use project. Now, twenty years later, over 35.000 yearlings were released into the wild on their natural habitat, and the reproduction of many currently adult released females was recorded in the last 10 years. More than 100.000 caymans are reared in the different ranching operations all over the country for releasing and commercial purposes, and over 800 people are now working on the different stages of the program as eggs harvesters, rearing operations workers, processors, manufacturers and retailers.

The numerous benefits obtained from the application of ranching programs in crocodilians have been described many times. The mainstays of these programs are their economic, social and environmental contributions. The most tangible results are evidenced in the progressive increase in the number of nests identified as consequence of more local residents involved in the program on one hand, and the confirmed recovery of the Caymans populations during the last 20 years on the other.

Background:

The northern part of Argentina represents one of the southern-most limit of the distribution of the Broad-snouted Caiman (*Caiman latirostris*) and the Yacare Caiman (*Caiman yacare*). Both species are distributed throughout 9 Provinces (Formosa, Santa Fe, Misiones, Corrientes, Entre Rios, Chaco, Santiago del Estero, Salta, Jujuy) in Argentina, although *C. yacare* occurs in higher densities above the 30^{o} latitude and *C. latirostris* up to the 32^{o} latitude.

Listed in Appendix I of CITES, international trade in *C. latirostris* products was prohibited until the Santa Fe *C. latirostris* ranching proposal was approved at the 10th Conference of Parties to CITES (Zimbabwe, 1997). In 1999 it was incorporated to the program the Chaco Province, and finally, Formosa and Corrientes Provinces started with the production. The species *Caiman yacare* is already listed in the Appendix II of CITES.

The Ranching Program:

The sustainable use of wild animals and plants of commercial interest, leading to economic benefit and the stimulus of in situ conservation, clearly is, nowadays, the most realistic approach to conserving natural ecosystems. Currently, there are three different projects operating in Argentina, through Cayman ranching of the two species presents in the country.

Proyecto Yacaré began in 1990 with the aim of monitoring and recovering *C. latirostris* population in Santa Fe, Argentina, by means of the already mentioned management program. In this way, C. latirostris transfer to Appendix II under the Ranching Resolution of CITES was achieved at the COP CITES Meeting in Zimbabwe (1997), only for the Argentinean population. The releasing of more than 35.000 animals on its natural habitat makes it easier and frequent to observe liberated females that are in the reproductive stage. On the other hand, the production of skin and meat for the domestic and international trade turned our Caymans into a valuable resource for the local inhabitants. All these achievements and the number of scientific papers and human resources formation Turing the last 20 years, place Proyecto Yacaré as a model enterprise of management and conservation worldwide.

Community based conservation:

The experience from Santa Fe (also seen in Chaco and Formosa), indicated that most of the landowners are not interested in to directly obtain a profit from the programs. They appear more interested in the fact that people involved in the program do work on their land, and that they obtain good publicly from it, seen as an integral part of the conservation program. They have also gained an understanding that the drying of swamps also impacts negatively on cattle production in the long-term.

The situation is very different for the local inhabitants, that as employees of the cattle ranches, receive direct benefit from the program through payments for each nest (U$S 20) that they locate, mark, and sometimes harvest. Incentives have been created for the employees to not allow the killing of caimans, and to protect nesting areas, that in the past were regularly burned. Caimans now have a positive value to them. Between the all Provinces, there are about 800 peoples involved with the projects in one or another way.

Enforcement:

The enforcement of the national and international regulations in Argentina, is under the responsibility of the Dirección Nacional de Fauna y Flora Silvestre, which is also the CITES Management Authority in the country. All the projects are supported by a regular monitoring system annually carried out by crocodile specialist group members in the different provinces, through the standard night counts and the analysis of the annual egg collection. The national authority office is also in charge of the administration of the universal tagging system and the national tagging system, which imply a double tagging, the first one at the slaughterhouse, and the second one as CITES tag, before the exporting if so. As Argentina is a Federal Country, also the Provinces have its own regulations and controls on the activity, so the first step for every ranching operation, is to fulfill all the local requirements, before to ask for the national authorization.

Conclusions:

At the moment in the country there are seven ranching programs registered at the Federal government. Three of them works on an educational basis, with no commercial exploitation, they are run in Entre Ríos, Chaco and Corrientes Provinces. The commercial ranching programs are placed two in Formosa, one in Corrientes and one in Santa Fe. Programs located in Formosa, Corrientes and Chaco ranch on both species, *C. latirostris* (Broad-snouted caiman) and *C. yacare* (Yacare caiman); the ones in Santa Fe and Entre Ríos only collect *C. latirostris* eggs.

Considering all the ranching operations, the hatchlings production during this last season (summer 2010) was of 7,768 for *C. latirostris*, and 18,476 for *C. yacare*. The harvest of *C. latirostris* eggs during the last two seasons (Summer 2009 and 2010), was drastically reduced in Corrientes and Santa Fe provinces, and partially in Formosa, due to a severe drought in the area. Considering all programs together they collected about a 50% of the eggs collected on previous season.

In Table 1, we are showing the egg collection on this last season and the stock of animals older than one year in every Province.

TABLE 1

Species	C. latirostris	C. yacare	Total (both species)
Santa Fe (Hatchlings 2010)	**1,996**		**1,996**
Santa Fe (Stock I year and older)	**9,840**		**9,840**
Formosa (Hatchlings 2010)*	**1,036**	**17120**	**18,156**
Formosa (Total stock)*	**9,223**	**39541**	**48,764**
Corrientes (Hatchlings 2010)	**4,736**	**1356**	**6,092**
Corrientes (Total stock)	**12,793**	**6426**	**19,219**
Chaco (Hatchlings 2010)**			
Chaco (Total stock)**			
Total	**39,624**	**64,443**	**104,067**

***: Two ranching operations in Formosa.**

****: No information available**

Considering that in 1990 at the beginning of the program, we only harvested 10 Cayman nests with a total of 372 eggs, we can consider this as one of the most successful Sustainable Use programs in the Country.

ESTRATÉGIA DE MANEIO DE *CROCODYLUS NILOTICUS* EM MOÇAMBIQUE.

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Palavras Chaves: Benefícios do maneio do crocodilo; Conflito Homem-Crocodilo; Conservaçao de crocodilo; Criação do crocodilo em cativeiro; Maneio de crocodilo; Utilização sustentavel do crocodilo.

Abstract

O Crocodilo do Nilo (*Crocodylus niloticus*) é uma espécie que ocorre em quase todos os rios moçambicanos. Ainda não é conhecido o número exato de crocodilos que ocorrem no país mas estima-se que podem existir, só no rio Zambeze, mais de 78.900 crocodilos. Estimativas feitas em Agosto do ano 2009, durante a caça controlada de crocodilos adultos, indicaram a existência de uma média de 20 crocodilos a cada raio de 100 metros do rio Zambeze, cuja extensão é de 850.000 metros.

O crescente número de crocodilos nos rios moçambicanos, pode estar relacionado com a falta de caça controlada sistemática, desde 1975 à 2008. Este factor aliada ao assentamentos humano em áreas ribeirinhas, podem estar na origem do actual índice elevado de conflito Homem-Crocodilo. Cerca de 65% de mortes humanas são causadas por crocodilos, de um total de 100 por ano, em consequência de conflito Homem-Crocodilo. Este fenómeno de conflito Homem-Crocodilo em Moçambique fez com que o Governo adoptasse e implementasse política e estratégia para o maneio do crocodilo, com objectivos ecológicos e sócio-económicos, garantindo a utilização sustentável do *Crocodylus niloticus* por forma a promover a sua conservação e garantindo o retorno dos benefícios à comunidade local.

A estratégia de maneio de crocodilo visa a conservação sustentável da espécie, através de apanha de ovos e criação em cativeiro, obedecendo os princípios definidos, tanto na legislação em vigor no país como da convenção CITES (Convenão Sobre o Comércio Internacional de Espécies de Fauna e Flora Ameaçadas de Extinção).

Agradecimentos: Dr Richard Fergusson (CSG), Engenheiro Marcelino Foloma (Chefe do Departamento de Fauna Bravia), Senhor Sansão Mahanjane (CITES Management MZ) e Olavo Manhique (Jurista da Direcção).

Autobiografia do Autor

Paulo Barros, Biólogo de profissão, é funcionário do Ministério de Agricultura de Moçambique. Escreveu e publicou obras tais como: Em 2003: *Valor Económico da Biodiversidade na Reserva Especial de Maputo*, Tese de Licenciatura pela Universidade Eduardo Mondlane: Em 2008: *Contribuição das Fazendas do Bravio na Mitigação do Conflito Homem-Fauna Bravia em Moçambique* (apresentado na Conferência da CPLP sobre sobre a Áreas de Conservacão, realizado em Maputo); E em 2009: participou na recolha de dados para a elaboração da Estratégia de Gestão do Elefante Africano (*Loxodonta africana*) com Dr Russel Taylor e Dr Cornélio Ntumi.

Ex situ CONSERVATION PROGRAM OF THE ORINOCO CROCODILE *Crocodylus intermedius* AT THE DALLAS WORLD AQUARIUM, TEXAS, USA.

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With the goals of displaying an endangered species and promoting its conservation through education and captive breeding, The Dallas World Aquarium (DWA) imported a pair of adult Orinoco crocodiles (*Crocodylus intermedius*) from Venezuela in 1998. The crocodiles were 18 and 25 years old, and 10 feet in length. The female was older and longer than the male. Breeding started next season after arrival, but the clutch was lost. After some modifications in the exhibit including the basking/nesting area in 2002, the couple renewed their reproductive activity. The first hatchling was obtained in 2003 and since 2004; several hatchlings were produced, totaling 100 until 2008. The educational part of this project is achieved by media such as posters, fliers and post cards distributed in Venezuela and at the DWA, and a curriculum booklet that is given to the school groups visiting our facility. A weekly talk is performed every Saturday to our guests while the crocodiles are fed. In 2007, a small exhibit was built to display some of the baby crocodiles. Both the adult and baby crocodile exhibits, have interactive touch screens to show information about the species and its natural environment. Hatchling mortality has been less than 10%, especially in 2006, 2007 and 2008, and the hatchability has been higher than 90% on the average. The survival of the hatchlings has been almost 100%, allowing the DWA to send eleven crocodiles to other AZA institutions in the USA, in order to increase the captive and displayed population of the species. To support the conservation of this crocodile in Venezuela, the DWA supported a workshop in 2007, and in December 2008, fifty-three female crocodiles, 2-3 years of age, were sent to Venezuela for release in three rivers of the Orinoco basin. To our knowledge, this event represents the major crocodilian exportation from any zoo in the USA, for introduction into their natural habitat, hopefully to reproduce.

IMPACTS OF THE MARKET CRISIS OVER THE *Caiman yacare* PROGRAM, BOLIVIA.

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The Program of Use of Yacare (*Caiman yacare*) in Bolivia was developed from 1997 with the participation of indigenous territories, rural communities and cattle properties, under a model of harvests of mature males (individuals bigger than 180 cm of total length).Starting from the implementation of management plans the years 2007 and 2008 we registered better prices paid to the hunters, however the year 2009 the national prices of the skins were reduced to approximately half of their price with relationship to the previous year. This work analyzes the distribution of benefits along the productive chain of the Yacare and we evaluate the possible impact of the international crisis on the internal and external commercialization of products of *C. yacare*. Although the crisis has affected the trading prices among actors from the productive chain, the volumes of marketed skins didn't diminish. Despite the international crisis, we find that the market of crocodile skins continues having a positive gradient.

MONITORING CAIMAN POPULATIONS IN THE PIAGAÇU-PURUS RESERVE.

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3 *In memoriam*

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Melanosuchus niger and *Caiman crocodilus* are historically traded in the Amazonian varzea floodplain habitats. Recently the most intense illegal hunt of these species took place in the Piagaçu-Purus Sustainable Development Reserve, located in the Purus River, Central Amazonia. We have been monitoring caiman populations in this area since 2005. About 50 tons of salt-dried meat was commercialized annually only in the northern portion of Piagaçu-Purus Reserve. We have carried out standardized spotlight surveys in 82 water bodies and capture 162 individuals. Information gathered allowed us to evaluate relative abundances of the population (individuals/km of shoreline), size structure trends over the years, and sex ratios. We have also monitored nesting females and their clutches. Results show an increase in relative abundances for both species. The size structure of *C. crocodilus* presents a normal distribution with an increasing proportion of reproductive individuals (SVL > 60 cm). *Melanosuchus niger* population is recovering more slowly, and the proportion of adults (SVL > 100 cm) is still under 16% of total population. In general, the size structure of *M. niger* in the study area was different from the one found in areas without hunting; but the populations of *C. crocodilus* were similar between these areas, confirming the resilience of the species. These differences reflect the ecology of the species and suggest that dynamic population extrapolations from one area to another need to be done with caution.

Funding sources: CNPq 482034/2004-1 to RDS, WCS, Rufford Small Grants.

MONITORING PROGRAM OF MORELET´S CROCODILE (*Crocodylus moreletii*) MEXICO – BELIZE- GUATEMALA.

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ABSTRACT

CONABIO coordinates Morelet´s Crocodile Monitoring Program (MCMP) in Mexico, looking towards a trinational scope (MEX-GUAT-BEL). The aim is to provide information on a long term and periodic basis on conditions and trends of the main wild populations and habitat of *Crocodylus moreletii*. It included two phases:

1. Design: a Trinational Workshop (Mexico City, January, 2010) was held in cooperation with experts, authorities of the three countries and members of CSG-IUCN, reaching agreement on methods, periodicity, populations to be surveyed, coordination and equipment needs, and mechanisms to systematize and analyze information. Such agreements where compiled on a Procedures Manual for training and field work, published in June 2011 http://www.conabio.gob.mx/institucion/cooperacion_internacional/doctos/manualf_monitoreo_cocodrilo.pdf.

2. Implementation: agreements were signed between CONABIO and four institutions responsible for establishment and training of field teams, surveys and systematization of field data. CONABIO administrate the Database, which is accessible via internet to data providers. Field work initiated on 2011 and information is already available at the Database.

In March 8th-9th 2012 a Trinational Workshop on Evaluation of Results for Season 2011, will be held in Mexico City to analyze these first results, share lessons learned, identify improvement opportunities, and to plan for 2012 season.

MONITORING THE *PALEOSUCHUS TRIGONATUS* POPULATION OF A LARGE BRAZILIAN AMAZON URBAN FOREST FRAGMENT.

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Schmidt's (1928) statement on the lack of knowledge on the habits and distribution of the *Paleosuchus* remains true today. *Paleosuchus trigonatus* inhabits closed canopy small forest streams, occupying habitats different from all other sympatric Amazonian caimans. Long term studies following marked populations are crucial to understand the population dynamics of this and other sympatric species occurring in urban fragments in an ever-growing city. The UFAM campus is an Amazon *terra firme* forest fragment of almost 700 ha within the city of Manaus. It has been reduced by at least 40% of its former area during the last 40 years. However, it still represents one of the largest urban forest fragment in Brazil. Six sub-basins of small forest pristine streams occur in this area, most of these have their headwaters within the fragment. Ground spotlight surveys along the streams of the campus were undertaken between 2006 and 2009. Since January 2010 we are undertaking weekly surveys and a mark-recapture experiment. In these four months, we have captured almost 40% of all individuals involved in the research. Since 2006, we marked 89 *P. trigonatus*, of which 14% were recaptured at least once. The longest movement registered from recaptures was a hatchling (600 m straight-line in 63 days). Relative abundances in 2010 ranged from 2.0 to 9.5 ind/km of stream, excluding hatchlings. Size structure varied little since the beginning of the study. Most abundant size class was that corresponding to juveniles with $20 \leq SVL \leq 30$ cm. Six *Caiman crocodilus* individuals were captured in two polluted peripheral streams of the forest fragment. Probably this species do not colonize pristine closed-canopy forest streams. A long-term monitoring effort of these caiman species is a good opportunity to shed light on the ecological interaction between these two sympatric urban crocodilian populations.

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NATIONAL POLICIES FOR CONSERVATION AND MANAGEMENT OF *Melanosuchus niger IN* BRAZIL: SPECIES STATUS & MONITORING, RESEARCH AND CURRENT REGULATIONS.

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After years of protection, natural populations of black caimans (*Melanosuchus niger*) in Brazil have increased steadily. In 2003, the species was removed from the official Brazilian list of endangered species. More recently, based on a number of more comprehensive biological studies which indicated that the species has large and not fragmented wild populations and is widely distributed within its range, *M. niger* was downlisted to CITES Appendix II (CoP 14). The present paper describes some of the main outcomes achieved by the Brazilian Government, in collaboration with universities, research institutes and non-government initiatives in order to develop science-based conservation programs to promote the sustainable use of caiman products and to provide economic benefits for local Amazonian communities. Firstly, biological data obtained systematically in two strategic localities within the Brazilian Amazon are presented. This is followed by a brief description on the evolution of *M. niger* management program in the Brazilian Amazon, which includes the forms of management and the development of current legislation. Finally, the perspectives and main constraints affecting the program development are discussed.

Acknowledgements: The project is supported by RAN/ICMBio/MMA.

OBSERVATORIO DE PARTICIPACION Y EDUCACIÓN AMBIENTAL – ESTUDIODE CASO: CONSERVACION DEL *Crocodylus acutus* EN LA BAHIA DE CISPATAPOR COMUNIDADES LOCALES, SAN ANTERO, CORDOBA – Convenio CVS (Corporación Autónoma Regional de los Valles del Sinú del San Jorge) - MEN (Ministerio de Educación Nacional).

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El compromiso entre las autoridades ambientales y la comunidad de antiguos cazadores caimaneros" es la recuperación y estabilización de las poblaciones silvestres de caimanes de la Bahía de Cispatá, cobijados por los principios conservacionistas y apoyados por el monitoreo y la investigación científica. El grupo de antiguos cazadores (ASOCAIMAN) junto con actores locales institucionales y comunitarios avanzan en un proceso de cualificación de la capacidad ciudadana para la toma de decisiones en materia ambiental, con acompañamiento del Convenio MEN –CVS y a partir de la instalación de un Observatorio de Participación y Educación Ambiental, es decir, la experiencia de pasar de cazadores a conservacionistas, es el eje central que se toma como parte de la educación ambiental no formal. Las relaciones entre actores varían en sus características. Se aprecia la estrecha relación ASOCAIMAN – CVS, quienes lideran la implementación del proyecto. Se señala la articulación fuerte, particularmente de Asocaiman con el SENA y el grupo de comunicadores para el desarrollo sostenible y la articulación de la CVS con el MEN, SENA, Secretaria de Educación Municipal y Ministerio de Medio Ambiente. Se fortalecen los procesos de participación ciudadana de los actores relacionados con la conservación del *Crocodylus acutus* de la Bahía de Cispata en el marco de los procesos de ordenamiento ambiental de un territorio ubicado en el extremo sur del Golfo de Morrosquillo y su área de influencia, con jurisdicción de los municipios de San Antero, San Bernardo y Lorica. Se proyecta avanzar en la construcción participativa de la estrategia de articulación de las actividades turísticas en el Golfo de Morrosquillo, los planes de manejo en implementación en la Bahía de Cispata y Delta de Tinajones y de 2 Distritos de Manejo Integrado en el Dpto. de Córdoba.

O JACARÉ DE PAPO AMARELO (*Caiman latirostris*) COMO FERRAMENTA DE EDUCAÇÃO AMBIENTAL NA CONSERVAÇÃO DO COMPLEXO LAGUNAR DE JACAREPAGUÁ, RIO DE JANEIRO, BRASIL

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O crescimento urbano e a fragmentação de habitat são os principais fatores da redução de populações selvagens de crocodilianos no Brasil. No município do Rio de Janeiro, no complexo lagunar de Jacarepaguá é encontrada um dos últimos remanescentes de populações de jacarés de papo amarelo em áreas de proteção ambiental do município. Observamos que a expansão imobiliária desordenada tem aproximado cada vez mais os jacarés de populações humanas, e com isso, gerado desconforto e curiosidade. Para os moradores do bairro Recreio dos Bandeirantes e Barra da Tijuca, os jacarés são motivos de idolatração e medo. Palestras e orientações estão sendo realizadas a fim de educar e sensibilizar a população quanto à importância de conservação dos jacarés em ambientes naturais. O Programa de Educação Ambiental, realizado pelo Projeto Jacaré de Papo amarelo – RJ nas comunidades do entorno do complexo lagunar de Jacarepaguá tem como objetivo informar e alertar quanto à necessidade de conservação de seus ecossistemas aquáticos, fauna e flora local, utilizando o jacaré de papo amarelo como espécie bandeira e imagem carismática em palestras com crianças e adultos, em escolas, creches e durante o manejo e soltura dos animais. Através do uso de questionários é possível avaliar as crenças e preocupações da população humana quanto a aproximação dos jacarés, tais como jacarés se alimentando de animais domésticos durante seus passeios matinais à beira dos canais e das lagoas. Com o decorrer do tempo o Projeto Jacaré de papo amarelo-RJ visa alcançar a estabilidade no convívio entre as espécies e a conservação desse hábitat remanescente em lagoas urbanas onde ainda se mantêm populações naturais de *Caiman latirostris* no Rio de Janeiro. Suporte Financeiro: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Bolsa 76 a expansão imobiliária desordenada tem aproximado cada vez mais os jacarés de populações humanas, e com isso, gerado desconforto e curiosidade. Para os moradores do bairro Recreio dos Bandeirantes e Barra da Tijuca, os jacarés são motivos de idolatração e medo. Palestras e orientações estão sendo realizadas a fim de educar e sensibilizar a população quanto à importância de conservação dos jacarés em ambientes naturais. O Programa de Educação Ambiental, realizado pelo Projeto Jacaré de Papo amarelo – RJ nas comunidades do entorno do complexo lagunar de Jacarepaguá tem como objetivo informar e alertar quanto à necessidade de conservação de seus ecossistemas aquáticos, fauna e flora local, utilizando o jacaré de papo amarelo como espécie bandeira e imagem carismática em palestras com crianças e adultos, em escolas, creches e durante o manejo e soltura dos animais. Através do uso de questionários é possível avaliar as crenças e preocupações da população humana quanto a aproximação dos jacarés, tais como jacarés se alimentando de animais domésticos durante seus passeios matinais à beira dos canais e das lagoas. Com o decorrer do tempo o Projeto Jacaré de papo amarelo-RJ visa alcançar a estabilidade no convívio entre as espécies e a conservação desse hábitat remanescente em lagoas urbanas onde ainda se mantêm populações naturais de *Caiman latirostris* no Rio de Janeiro.

Suporte Financeiro: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Bolsa CAPES), Student Research Assistance Scheme (CSG)

PLAN DE ACCIÓN PARA CONSERVACIÓN DE BABILLA (*Caiman crocodilus fuscus*) EN COMPLEJO CENAGOSO B15, CORPORACIÓN AUTÓNOMA REGIONAL DEL SUR DE BOLÍVAR, M.A.V.D.T., ZOOCRIADERO COLOMBIAN CROCO LTDA. COLOMBIA.

Iván D. Palacios 1, Pablo Lagares John Jairo Gómez, Alexandra Tesillo2,. Renzo Zambrano3

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El objetivo es contribuir a la conservación y manejo sostenible de la babilla (*C. c. f.*) en jurisdicción de C.S.B. Este programa se encuentra ajustado al Plan Nacional de Conservación de cocodrilos de Colombia. Hace dos años se comenzaron a caracterizar poblaciones de Babilla en el sur del departamento Bolívar y también se caracterizó el hábitat (Ciénagas). Como resultados se obtuvo: Monitoreo de babillas en 993 km en las ciénagas: Mico: densidad 0,192 Ind/Km-l; Vieja: 0,16 Ind/Km-l. Matatigre: 0,011 Ind/Km-l. Se hallaron 32 Nidos en 88,5 Km-l es decir 0,361 nidos/K-l. El CSG Publicó la cartilla Juan and Lorenzo Now rescue the babilla; http://iucncsg.org/ph1/ modules/Publications/reports.html. Se establecieron criterios técnicos para seleccionar especímenes de acuerdo a las necesidades y se identificaron sitios para liberar y repoblar, se liberaron las primeras 800 babillas en las ciénagas Mico y Santo que hacen parte del complejo cenagoso Matatigre en el municipio Barranco de Loba. Estos serán monitoreados con participación de la comunidad, ex cazadores, ahora guías y operarios del programa de conservación. Para ejecutar este programa el zoocriadero Colombian croco, aportó el 26% del valor total, como cuotas de repoblación que puede pagarse en dinero y 74% por el Fondo de compensación del Ministerio de Ambiente. Anteriormente los cazadores extraían reproductores, juveniles, neonatos y huevos de babillas, los Invitamos a integrarse, recibieron remuneración económica (400 jornales) y capacitación en manipulación de huevos e individuos (pesajes, medición, marcaje, sexaje y registro de información). Los beneficios van desde Capacitación en Aspectos biológicos y Organización Comunitaria. (Pescadores, cazadores Mujeres, Adolescentes, Niños. Fortalecimiento institucional de la C.S.B. 121.
Se reconocieron líderes que conformaron grupos de trabajo asociativo, que han generado cambios de hábitos y actitud con miras al uso sostenible a mediano plazo mediante el permiso Caza Comercial o Zoocría mixta. De esta manera le podremos dar fin al Tráfico ilegal de esta especie en la región.

PLANO DE MANEJO COMUNITÁRIO DE JACARÉS NA VÁRZEA DO BAIXO AMAZONAS, PAE ARITAPERA, SANTARÉM-PA

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A região da Várzea nas proximidades do município de Santarém possui a pesca como atividade chefe da economia familiar, seguida pela pecuária, agricultura e atividades assalariadas. Nas últimas décadas, iniciativas de organização comunitária, acordos de pesca e, atualmente, planos de uso inseridos na proposta de regularização fundiária estão modificando a maneira de vida dos ribeirinhos. Novas regras estão sendo elaboradas para o uso dos recursos naturais dentro dos limites dos Projetos de Assentamento Agro-Extrativista (PAEs) a fim de proporcionar o desenvolvimento dos conselhos regionais e das associações comunitárias, aumento dos estoques pesqueiros e, por conseguinte, obter resultados favoráveis para a melhoria da qualidade ambiental da região. O manejo de fauna foi pensado como um componente a mais e o manejo de jacaré pareceu uma demanda local. O que foi inovador no projeto de fazer um plano de manejo informal de jacarés foi a iniciativa de fazer um plano de manejo comunitário, teoricamente integrado com os sistemas de co-manejo locais. A base comunitária deveria apoiar uma estratégia para captura de jacarés para controle e produção em comunidades onde hoje são os PAEs Aritapera e Tapará. Procuramos atender demandas comunitárias a partir de 2006, mas ao final, o plano de manejo informal se choca com as diretrizes políticas dos PAE (PDA, PU, PE) ao prever (involuntariamente) a comercialização de produtos e não apenas o controle, e retrata os interesses de apenas uma comunidade (Água Preta).

Apoio financeiro: MCT-CNPq-PPG7 Edital 048/2005 para JCBP, Instituto de Pesquisas Ambientais da Amazônia (IPAM)

PROJETO PILOTO PARA O MANEJO E CONSERVAÇÃO DE CROCODILIANOS NO ESTADO DO AMAZONAS.

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O Governo do Estado do Amazonas, desde 2003 teve a iniciativa de promover o desenvolvimento sustentável por meio da utilizaçào sustentável dos recursos naturais, como forma de desenvolver o Estado, e promover a geração de renda e emprego, em especial para comunidades tradicionais no interior do Estado. Um dos projetos trata em especial do aproveitamento comercial de um dos nossos maiores recursos e abundantes no Estado, que são os jacarés. O projeto piloto para o manejo de jacarés em Unidades de Conservaçào de uso sustentável no Amazonas, tem como espécies alvo os jacarés Açu (Melanosuchus niger) e jacaretinga (Caiman crocodilus crocodilus). O primeiro passo foi um abate experimental de 58 animais entre as duas espécies para definir algumas metodologias de abate e processamento e determinar o tamanho de abate dessas espécies. Após essa primeira fase experimental, outros abates com finalidade comercial foram realizados entre 2006 e 2008 na Unidade de Conservação Estadual Mamirauá. Vários foram os entraves encontrados e as dificuldades de comercialização dos produtos, como a carne e as peles, a inserção desses produtos no mercado foi e ainda é um dos nossos maiores desafios. Estes abates serviram para que, na medida em que se conseguiu vencer alguns obstáculos, o Governo e demais instituições parceiras desse projeto, pudesse tomar conhecimento do quanto ainda se tem que planejar e mensurar de forma objetiva, todos os aspectos que envolvem um projeto dessa natureza e com responsabilidade, para que se consiga obter bons resultados desse manejo que é tão esperado pelas comunidades locais.

PROMOTING THE DEVELOPMENT OF REGIONAL CROCODILIAN STRATEGIES A RECENT CASE OF GOOD PRACTICE FROM WEST AFRICA.

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1. Introduction

At the 18th Working Meeting of the IUCN/SSC Crocodile Specialist Group (CSG) held from 19th -23rd June 2006 in Montélimar, France and following in-depth discussion with the meeting organizers, the Chairman of the CSG decided to endorse and support, both technically and financially, a 1st regional meeting for West Africa. Holding such an inaugural meeting was considered to be useful in order to improve regional co-operation in crocodilian conservation and management in one of the least known tropical and sub-tropical crocodilian areas on our planet.

The CSG's 1st regional meeting for West Africa took place from 13th - 15th November 2007 as a result of the outstanding technical and financial support provided by the 'Ferme aux Crocodiles' in Pierrelatte, France. The meeting focused on Captive Management and Conservation of Crocodilians and was held at the transfrontier biosphere reserve 'Parque Régional de W' at Tapoa in the Republic of Niger. The agenda targeted specifically the needs of the West Africa region, where the Crocodile Specialist Group had not previously extended its activities. In addition, the new CSG initiative aimed to build up an entirely new forum to enable delegates from West African countries to meet and to exchange information about crocodiles and their management in the region.

In general, the two major objectives of the 1st regional CSG meeting were to:

- Strengthen sub-regional, regional and international cooperation on all crocodilian conservation issues; and
- Assess the aims and aspirations of countries in the region with regard to conservation, management and sustainable use of crocodiles, and where appropriate, the constraints preventing those goals from being achieved.

Furthermore, participants at the 1st regional CSG meeting discussed at length coordinated strategic issues, how to improve technical capacities, and to what extent the benefits derived from crocodilians could contribute, in the future, to improve the livelihoods of local communities in the region.

One of the major outcomes of this 1st regional meeting was the proposal by participants to develop a regional conservation and management strategy for crocodilians, which should consider the following issues:

- Elaboration of a common crocodilian conservation policy;
- Harmonisation of national legislation for crocodilian conservation and management;
- Development of actions for further research on the three crocodilian species occurring in the region;
- Strengthening human and institutional capacities for better management of crocodilians;
- Elaboration of information, education and communication programs for all stakeholders involved with crocodilians in the region; and
- Identification and improvement of existing captive management facilities and programs in the region.

2. The development of a regional crocodilian strategy

The CSG held its 2nd regional meeting for West Africa from 2nd to 6th March 2010 at the "Ranch du Gibier de Nazinga" in Burkina Faso, which was attended by over 40 representatives from 11 countries including 7 from the region.

Once again, the meeting brought together key players actively involved in crocodilian conservation and management in the region in order to consolidate the CSG's newly established regional forum for West Africa. The overarching objective of the meeting was to revisit the recommendations from the first regional meeting and establish a framework for a regional crocodilian conservation and management strategy (Jelden *et al.* 2010).

In order to focus the discussions at the workshop to develop a framework strategy, and based on the outcome of the discussions during the Tapoa regional meeting in 2007, several over-arching themes were identified by the organizational committee and the meeting was split into three working groups as follows: 'Legislation and Policy' (including international conventions and human-crocodile conflict); 'Science and Education' (including capacity building); and 'Sustainable Use and Management'. Each working group was given draft terms of reference in an attempt to guide their discussions towards drafting specific chapters of a regional strategy for crocodilian conservation and management.

The key elements for a regional strategy that were discussed and agreed at Nazinga (see **ANNEX 1**) can be summarised as follows:

- *Policy and Legislation.* Agreement was reached that new, crocodile-specific legal texts and actions were needed to ensure legal and sustainable management of crocodile populations across the region. Furthermore, harmonization between national, regional and international policies that applied to crocodile conservation and management was considered to be of major significance.

- *Science and Education.* Despite the fact that some research is already being carried out in a few countries in the region (e.g. Benin, Gabon, The Gambia), it was noted that similar activities should be initiated in other countries across the region in order to improve knowledge on all three crocodilian species and to facilitate better decision-making for their management and conservation. In addition, concerted environmental education campaigns targeting local communities living alongside crocodiles, as a first priority, are required. Finally, the nomination of national focal points for crocodile-

related activities could not only facilitate such educational initiatives but also assist to streamline and co-ordinate the various disciplines surrounding crocodile management and conservation.

- *Sustainable use and Management.* Given the current national and international (e.g. CITES Appendix I) protection of crocodiles in the region all commerce is effectively illegal. Uses are varied and include traditional medicine, bushmeat, trophy hunting, skin trade and ecotourism. Most of these commercial activities require clarification as well as a review of respective legislation. Where appropriate management strategies for the use of crocodiles are being developed and implemented, a wide stakeholder representation and involvement should be identified from the outset of any such use programs.

Each of the thematic working groups in Nazinga produced a feedback report, the contents of which have been used to produce a consolidated strategic document, incorporating all of the recommendations from the meeting. This consolidated strategy document underwent an in-depth review by the organizational committee and is the first document ever produced by the CSG for dissemination to a region that includes a set of recommendations embedded in a framework strategy applicable for all crocodilians in the West African region. The consolidated document (see English version in **ANNEX 1**) was circulated in July 2010 by the Ministry of Environment of the host country, Burkina Faso, to appropriate governmental decision-makers in the region for national review and appropriate implementation, taking into consideration both the overall recommendations in the document and the specific conservation and management needs of each country.

3. Discussion

Over the years several crocodilian management programs worldwide have been evaluated by the IUCN Crocodile Specialist Group. During these evaluation missions, on several occasions the CSG recommended that cross boundary co-operation was urgently needed in order to enhance conservation and management of shared transfrontier crocodilian populations.

During the 1992 CSG mission to Indonesia, the need to develop a management program consistent with the successful harvesting regime in Papua New Guinea, which operates in a practically identical environment with the same species and the same type of village level use, was a key recommendation. This recommendation focused in particular on the different legal size limits of large animals in the neighbouring countries, which provided incentives for cross-border laundering of illegally taken wild skins (Messel *et al.* 1992).

In addition, one key finding of a CSG team's 2005 review of Cambodia's management programme focused on trans-boundary cooperation and, in particular, the largely unregulated trade in live animals to supply the farming industry in neighbouring countries such as Thailand or Viet-Nam. The CSG review team concluded that a dialogue with neighbouring states, through a regional working group under an appropriate body (eg ASEAN wildlife trade initiative and/or Mekong River sub-regional CITES Working Group) should be established, to address regional issues and problems with *C. siamensis* (Jelden *et al.* 2005). Currently there

are efforts underway to organise a meeting in East & Southeast Asia to examine and review with all range states concerned the conservation, management and sustainable use of *Crocodylus siamensis* generally, and in particular, to look at priority conservation actions and at production systems, trade and compliance with international conservation legislation such as CITES.

Finally, during the recent 15th Conference of the Parties of CITES held in early 2010 in Doha, Qatar, the lack of regional co-operation became apparent with regard to a proposed downlisting of *C. moreletii*. If adopted in its submitted version, the proposal would have affected a shared *C. moreletii* population across all three range countries (i.e. Belize, Guatemala & Mexico). However Mexico's original proposal (http://www.cites.org/eng/cop/15/prop/E-15-Prop-08.pdf) to downlist all populations across the species range was not supported by its neighbouring range state Guatemala, due to a lack of in-depth coordination and consultation at all levels. Following bilateral consultations at the conference in Doha, an amendment was made to the original proposal such that the crocodile population of Guatemala was withdrawn, leaving only the transfer of the populations of Mexico and Belize to CITES Appendix II. This amended proposal was finally approved by consensus (http://www.cites.org/eng/cop/15/sum/E15-Plen-06.pdf).

Other examples from other crocodilian range states exist, and all of which document quite clearly the need for enhanced international co-operation and coordination where populations of crocodilian species are shared across national borders. If such transnational cooperation is improved, management and conservation of affected crocodilian populations will benefit significantly. Furthermore, lessons learned indicate that it is clearly advisable to undertake reviews before national crocodilian management programs are developed and implemented, to determine any positive and negative implications of such programs on other populations beyond the jurisdiction of the respective country. Such reviews could provide an avenue for further insights into potential unfavourable or even detrimental implications arising from an uncoordinated approach. Finally, if conservation action is viewed from an international context, obstacles and problems associated with new management programs would not have to be indentified separately by each country and, in addition, solutions to any such shortfalls could be more easily solved through co-ordinated transnational dialogue.

The common strategy being developed in the West African region for regional collaboration to conserve crocodilians can viewed at this stage as so far outstanding, as through CSG's involvement new conservation activities have started in some countries of the region underpinned with a common elaborated and agreed strategic approach. Furthermore the strategy offers general guidance on conservation and management for a strictly protected crocodilian resource. And finally the strategy has the potential to offer beyond the West African Region a readily available blueprint to other crocodilian regions to discuss and develop regional strategic approaches, in particular whenever crocodilian conservation issues are discussed on a bilateral or multilateral regional basis.

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ANNEX 1

FRAMEWORK STRATEGY

for the Conservation & Management of Crocodilians in West Africa

Background

Crocodiles are widespread in the West Africa region where they play important cultural and spiritual roles and are often deemed to be sacred and are venerated. Large concentrations of crocodiles are often found in sacred lakes and such beliefs and customs comprise an effective form of 'endogenous conservation'. Crocodiles provide a means of income across the region as they are used extensively for traditional medicines, as a source of protein (subsistence and commercial bushmeat), for artisanal (mainly) leather production and in ecotourism ventures.

This regional strategy framework document is the result of collaborative discussions between representatives from several countries in the region during the IUCN Crocodile Specialist Group's (CSG) 2nd regional workshop for West Africa at the 'Ranch du Gibier de Nazinga' in Burkina Faso. This meeting was held from the 2nd to 6th March 2010 and 37 participants attended the event from Benin (4), Burkina Faso (20), Chad (1), France (2), Gambia (1), Germany (1), Guinea (1), Madagascar (1), Niger (4), South Africa (1) and the United States (1). In addition, discussions had also taken place at the 1st regional workshop held in Tapoa, Niger in 2007.

The objective of the 2nd meeting was to develop a regional strategy for the conservation and management of crocodilians. This followed on from the outcome of the CSG's 1st regional workshop in Niger,[1] where it was suggested that in order to develop a regional strategy on crocodile conservation and management, the following should be considered and addressed:

- Elaboration of a common crocodile conservation and management policy;
- Harmonisation of national regulations for crocodile management;
- Strengthening of human and institutional capacities for better management of crocodilians;
- Consideration of other natural resource management plans that impact on crocodilians;
- Development of crocodilian monitoring and research;
- Elaboration of information, education and communication programs for all actors involved with crocodilians in the region;
- Strengthening of sub-regional, regional and international cooperation and collaboration on crocodilian conservation issues;
- Identification and improvement of ranching set-ups; and
- Mobilisation of necessary financial resources to implement the strategy.

These issues were consolidated into three main thematic groupings and discussed during working group sessions at the 2nd regional meeting under the following headings:

I Policy & Legislation (including international conventions);

II Science & Education (including capacity building); and

III Sustainable Use & Management.

The results of the working group discussions have formed the cornerstones of this regional framework strategy for conservation of crocodiles in West Africa.

The CSG's 'Status Survey and Conservation Action Plan (3rd edition, 2010; http://iucncsg.org/ph1/modules/Publications) provides guidance for practitioners, researchers and political decision-makers on management action required for the conservation of crocodiles. All chapters in the action plan, including those on the three crocodile species that occur in the West Africa region are updated and improved upon as new research and information becomes available. This regional strategy framework document aims to provide recommendations for policy, legislation, research and management actions that will ensure the conservation of crocodilians in the region.

2. Goal of the Strategy

This regional strategy framework is the result of collaborative discussions between representatives from several countries in the region during the CSG's 1st regional workshop held in Tapoa, Niger in 2007, and the CSG's 2nd regional workshop in Burkina Faso, 2010.

The overarching objective of this regional strategy is to contribute to a coordinated and enhanced **conservation and sustainable management of all crocodilian species in the West Africa region**. A number of initiatives or special activities were identified during the above mentioned regional meetings through a logical framework process which was deemed necessary to address the gaps identified and ensure that the regional strategy framework

[1] **http://iucncsg.org/ph1/modules/Publications/download/West_Africa_Subregional_Meeting_Summary_2007.pdf**

document will have a direct impact on the ground in the future. Some of the activities may be developed into projects and it is hoped that, as new information becomes available (i.e. population data, survey results, inventory of captive breeding centres, ecotourism potential, etc), national governments will adopt and adapt the regional strategy framework document to suit each country's specific management and conservation requirements.

2.1 Policy

In the event that crocodilian resources one day become a subject on the political agenda, in terms of both policy and legislation, a number of issues need to be resolved.

There is no specific policy regarding management of crocodilians in West Africa. However for the past forty years, international (CITES, RAMSAR, CBD), regional (CEDAO, UEMOA) and national (forestry, agricultural, fisheries, wildlife, water) policies regarding natural resource management have provided umbrellas for the development of coordinated policies among countries in the region. With regard to international Conventions, a process has commenced within the region to harmonise national policies most notably in terms of CITES, RAMSAR and the CBD.

2.1.1 Gaps

A number of shortcomings in the policy are evident, as indicated in the table in **Annex 1** of this document, such as:

(i) Duplication of policies;
(ii) Incompatibility between various national policies;
(iii) Weak public dissemination of national policies;
(iv) Lack of resources to apply policies;
(v) Weak involvement of civil society organisations;
(vi) Inadequate monitoring and evaluation of policies;
(vii) Poor promotion of the crocodile resource chain; and
(viii) Poor interpretation of data regarding policies affecting crocodiles.

2.1.2 Activities

(i) Ensure synergy between various international policies;
(ii) Redraft national policies. Identify inconsistencies between various national policies, ensure that international obligations are respected, secure participation of civil society and territorial groups, develop a national strategy and action plan for promotion and conservation of crocodiles, create a joint framework for management and conservation of crocodiles;
(iii) Develop a public awareness programme to disseminate information on national policies;
(iv) Request funding assistance from Ministry of Finance, PTF, NGOs and private sector;
(v) Encourage private sector to set up pilot crocodile farms/ranches/breeding centres, carry out exchange of experiences between the region and internationally, develop an Information-Education-Communication programme;
(vi) Put in place mechanisms for monitoring and evaluation of policies;
(vii) Identify and develop the value chain, carry out a market study; and
(viii) Analyse data collected and apply to improve crocodile-related policies.

2.1.3 Actors

Within each nation in the region, there is a country-specific attitude to crocodiles and their conservation and management. In general, however, in terms of policy development and implementation, the main actors will be the government agencies (Ministries of Fisheries, Environment, Agriculture, Forestry; Departments of National Parks, etc), the civil society (community based organisations, traditional healer associations, local authorities, etc), environmental NGOs and the private sector.

In addition, the countries in the region should work together to develop synergistic policies for crocodile conservation and management. Many of the countries face similar problems and issues and, of course, cross-border movement of crocodiles will naturally impact on the capacity of several states to manage the resource. The political and economic framework of ECOWAS (Economic Community of West African States) could provide a platform from which a regional strategy could garner support.

2.2 Legislation

Legal instruments regarding natural resource management exist at the international, regional (Algiers Convention, Maputo Convention) and national levels (forestry, agriculture, water, fishing, wildlife). All national legislation in the region places crocodilians in Appendix I of CITES, i.e. all crocodilian species in the region are fully protected. In general, this degree of legal protection has gone a long way to ensuring the conservation of populations of West African crocodilians. However, such integral protection is a handicap for certain forms of commercial exploitation of crocodiles. At present, most forms of consumptive use of crocodiles in the region are 'illegal' under national legislation.

2.2.1 Gaps

Several gaps and deficiencies in legislation exist in the region, which need to be addressed in the event that enhancing the value of crocodilians is placed on the political agenda within the region. **Annex 2** of this document provides a table showing the gaps and a number of possible actions to be taken in order to improve the situation.

International legislation:

(i) Limited to commercialisation of crocodiles (ranching / trophy hunting / ecotourism);
(ii) Little adherence of West African countries to the Maputo Convention; and
(iii) Incompatibility of national texts with international conventions and other agreements.

National legislation:

(i) Texts are inappropriate and not in context with the reality;
(ii) Texts are not developed in a participatory manner; and
(iii) Weak capacity to implement current legislation.

2.2.2 Activities

International:

(i) Carry out national status reports on crocodiles; review national legal texts with reference to CITES Appendix I listing requirements;
(ii) Encourage States to adhere to the Maputo Convention; and
(iii) Adapt national legal texts in accordance with international conventions and agreements.

National:

(i) Carry out a revision of legal texts;
(ii) Develop new texts in a participatory manner; and
(iii) Reinforce human, financial and material resources.

2.2.3 Actors

Revision of legislative texts requires inputs from various sectors of society, including researchers, State agencies, civil society, NGOs, International Organisations, and local authorities.

2.3 Research

Scientific research and education on crocodile conservation is taking place across the region. However, not every country in the region is carrying out the same level of investigations and studies need to be initiated to improve knowledge on all three species in the region, which would facilitate better decision-making for management and conservation.

2.3.1 Gaps

Several gaps in scientific research were identified during the CSG's 2nd regional workshop in 2010, including the following:

(i) Poor application by countries of available information on crocodiles;
(ii) Absence of molecular characterisation of crocodile species in West Africa;
(iii) Countries do not have geographical distribution maps for the West African crocodile species;
(iv) Poor understanding in the region of population dynamics of populations of the different crocodile species;
(v) Survey techniques are not uniform across the region;
(vi) Few wild crocodile management plans;
(vii) Insufficient knowledge regarding ethno-zoology and socio-cultural perceptions of crocodiles;
(viii) Countries do not have a crocodile focal point;
(ix) Absence within the region of databases and information on crocodiles secured by foreign researchers;
(x) Too few crocodile specialists in the region;
(xi) No West Africa crocodile research group exists in the region; and
(xii) No crocodile research centre exists in any of the countries in the region.

2.3.2 Activities

Analysis of the actions to take in order to promote and conserve crocodiles in West Africa led participants to identify the urgent need to appoint a key individual or focal point exclusively for crocodile issues, to be located in the Wildlife Departments of each country in the region in order to streamline the various disciplines surrounding crocodile management and conservation.

In order to achieve the objectives of the regional strategy, a number of actions need to be carried out with specific and defined results or outputs. The 2nd regional workshop adopted a logical framework approach and identified a number of actions, results and possible small projects or programmes for their implementation (see **Annex 3**). In addition, the participants from Benin, Burkina Faso, Chad, The Gambia, Guinea and Niger developed a series of actions to be carried out in the short- and medium-term, as shown in the table in **Annex 4**.

General Activities

The most urgent need in the region is a better understanding of the distribution and the size of crocodile populations of each species. To this end, it is imperative that surveys are carried out, together with the following activities:

- Ascertain the current state of knowledge of crocodile populations in each country;
- Keep track of the population dynamics of crocodiles;
- Create a network of universities from West Africa, using the AUF as a platform, for the management of crocodiles;
- Define survey methodology as well as the monitoring of human-crocodile conflict for all countries in the region in accordance with the CSG's accepted international standards;
- Use the IUCN/CSG web site as a central site for distribution of information on crocodiles in West Africa;
- Carry out typology analysis of crocodiles kept in captivity;
- Define a system to ensure synergy between researchers and policy makers; and
- Establish national research support for all conservation, management, legislation and policy actions regarding crocodiles.

Species-specific Activities

Species-specific research studies and activities that have been identified by the CSG and outlined in the CSG's 'Status Survey and Conservation Action Plan' (3rd edition, 2010) include the following:

C. cataphractus

(i) Re-assessment of IUCN Red Listing (high priority);
(ii) Assessment of population status throughout West and Central Africa (high priority);
(iii) Studies on ecology and population dynamics (high priority);
(iv) Studies on intra-specific systematic and population genetics (medium priority); and
(v) Studies on inter-specific relationships (low priority).

Osteolaemus tetraspis

(i) Surveys of status and distribution throughout West and Central Africa (high priority); and
(ii) Basic ecology studies on movement and population demography.

Crocodylus niloticus

(i) Assessment of wild crocodile populations in West and Central Africa (high priority);
(ii) Taxonomy of Central and West African populations (high priority); and
(iii) Reassessment of IUCN Red Listing.

2.3.3 Actors

Implementation of a scientific research and education strategy will involve a variety of different actors, including University students, researchers and scientific institutions, local communities living alongside wetlands, sacred lakes and protected areas, environmental NGOs, Protected Area staff, local and national administrative authorities, artisans working with crocodile products, and traditional healers using crocodile products in their treatments.

2.4 Environmental Education

During the CSG's 2nd regional workshop in 2010, delegates noted that crocodiles were not sufficiently incorporated into environmental education programmes in each country. Concerted environmental education campaigns targeting local communities living alongside crocodiles are needed in order to develop mitigation strategies against human-crocodile conflicts. They further considered that, in order to develop an 'Information, Education and Communication Strategy', television and radio should be used more pro-actively in raising environmental awareness, particularly as there was weak communication with riverine rural populations living in wetlands where crocodiles occur.

2.4.1 Gaps

(i) Crocodiles were not taken into consideration in existing environmental education programmes in any of the West Africa countries;
(ii) Television and radio were under-utilised as media for environmental awareness raising; and
(iii) Poor communication at the local level where communities live alongside crocodiles in wetlands.

2.4.2 Activities

(i) Organise study and exchange visits for rural populations living alongside crocodiles;
(ii) Develop specific Information-Education-Communication tools that can be used across the West Africa region;
(iii) Organise thematic games based on crocodiles for use in environmental education programmes at community level; and
(iv) Develop environmental education documentaries focusing on conservation and sustainable management of crocodiles.

2.4.3 Actors

In addition to those actors listed in 2.3.3 above, individuals from the media will be involved in carrying out this aspect of the regional strategy.

2.5 Sustainable Use

Two main forms of use exist in the region, which are not necessarily in harmony with national legislation protecting all crocodilians fully:

(i) direct value – i.e. crocodile skin, meat and trophy hunting, captive breeding or ranching (generally unofficial, unprofessional and frequently informal), traditional medicine and use of crocodiles for scientific purposes (research); and
(ii) indirect value – i.e. ecotourism, socio-cultural and customary use (in West Africa, this form of utilisation has a long history of tradition, is of enormous importance and products are traded without any form of legislative restriction), biodiversity conservation and scientific research.

Given the high costs associated with establishing direct value uses, primarily with regard to international trade in crocodile skins in accordance with CITES regulations, together with the difficulties finding markets for crocodile products, the onerous international skin quality standards, and the uncertain status of crocodiles in the region, it is recommended that indirect value uses would for the time being be the preferable way forward for the entire region.

2.5.1 Gaps

(i) Utilisation of crocodiles takes place in the region, despite the national legislative texts prohibiting any harvesting or use;

(ii) Shortage of technical skill in captive breeding of crocodiles;

(iii) Human-Crocodile conflict data is lacking;

(iv) Uncertain potential for trophy hunting of problem animals;

(v) Potential for Ecotourism ventures based on crocodiles is under-exploited; and

(vi) Lack of information on customary use of crocodiles per country in the region.

2.5.2 Activities

In the medium to long term, artisanal and pharmacological use, ecotourism options, ranching or captive breeding for reintroduction purposes, and a review of the CITES Appendix listings for the countries within the region in order to permit controlled, sustainable trade in crocodiles should be considered as possible means of enhancing the value of crocodile populations. The following activities should be considered:

(i) Artisanal and pharmacological utilisation. Given that the sale of crocodile-based pharmaceuticals has a long tradition in West Africa, despite a lack of legislation permitting such commercialisation, an in-depth evaluation of the current situation should be carried out. Following a review of national legislation (carried out in terms of 2.2.2 above) new legislation should be developed to permit legal use of crocodiles for

artisanal & pharmacological use, possibly based on problem animal control measures or through captive breeding operations.

(ii) Promote and encourage ecotourism ventures, which add economic value to crocodilians, in and around conservation sites. To offset the risk of human-crocodile conflicts, trophy hunting of dangerous individual crocodiles, or pro-active reduction of overpopulation, should be considered as a management tool.

(iii) Initiate a review and evaluation of crocodile populations and conservation efforts across the region with a view to downlisting crocodiles from CITES Appendix I to Appendix II.

(iv) Promote rearing of crocodiles through 'Ranching' and 'Captive Breeding' as a means to restoring wild crocodile populations in those countries where the species is highly threatened or endangered.

(v) Commence research on how to improve skin and meat quality to meet local, regional and international standards. Ensure participation of consumers (tanneries) and veterinarians (for health quality) in the research programmes.

The CSG's 'Status Survey and Conservation Action Plan' (3rd edition, 2010) recommends the following species-specific actions:

Osteolaemus tetraspis

(i) Evaluation of harvest sustainability in Gabon and the Congos; and

(ii) Determine the captive breeding potential of dwarf crocodiles.

Crocodylus niloticus

(i) Develop management programmes in those countries planning or implementing sustainable utilisation.

2.6 Management

Current management systems for wild crocodiles are virtually identical across the West Africa region, where countries face enormous difficulties applying laws and regulations in force. It is necessary to consider reforms in the internal procedures of national administrations. In general, the four pillars of management programmes are: (i) legislation & regulation; (ii) monitoring of wild populations; (iii) preparation of reports and evaluation of current management objectives; and (iv) strengthening controls and application of the legislation.

2.6.1 Gaps

Few, if any, of the countries in the region have specific management plans for crocodiles. Madagascar, although outside the West Africa region, does have a management plan for crocodiles.

2.6.2 Activities

The over-riding activity to be carried out is the development of national management programmes for crocodiles. Any such management programme should be based on certain basic principles and include the activities detailed below:

(i) Regular review of the effectiveness of a management programme should, if necessary, result in respective amendments of the programme objectives. Indicators should be defined for the programme against which success can be measured.
(ii) Coordination and communication between government administrations and management authorities (customs, national police, veterinary services, etc) should be set up or improved. The creation of a Crocodile Management Committee or Working Group should be considered, to assist with improving communication.
(iii) In addition to government agencies, other stakeholders from the scientific community and private sector are affected by crocodile management programmes. A framework should be established to ensure synergies with these other stakeholders. Multisectoral (economic, research, legal) consultations should be convened at national and regional levels to share common interests and concerns.
(iv) Establish scientific, administrative and legislative methods for management of wild and captive populations – in the event that wild crocodile populations are utilised, a scientific database should be created detailing population data, species present, distribution information, etc. Quotas could be set for any collection of juveniles and/or eggs with the option to release a certain number back into the wild. In order to guarantee a successful management programme, economic, social, cultural data should be considered, together with the political context of the relevant country.
(v) A key element for every management programme is to define the level at which the programme will be applied. It is important to control harvests from the wild, from breeding centres and at markets, from hunting, tanneries and traditional healers. Control measures required could include registration of traders, and auditing product movement through fiscal controls and audits. Particular attention should be given to cross-border populations. Collaboration and synergy should be established between control structures and stakeholders on the ground, as well as at international borders. Involvement of customs officials is required, as well as a working synergy between regional and international conventions.
(vi) Without adequate resources, management programmes cannot achieve their objectives and results. Resource users should be urged to make financial contributions through special taxes (collection permits, skin tagging, etc), which should be used to carry out activities under the management programmes.

Species-specific actions identified by the CSG's 'Status Survey and Conservation Action Plan' (3rd edition, 2010) include the following:

C. cataphractus
(i) Draft management plans to implement real-time protection (including monitoring and training).

C. niloticus
(i) Study of HCC impacts and mitigation and development of problem crocodile management programmes (high priority).

ANNEX 1 – POLICY GAPS AND ACTIONS PROPOSED IN THE SHORT (ST) AND MEDIUM TERM (MT)

Gaps	Actions	Actors	Time frame	Institutions	Risk	Indicators
A. INTERNATIONAL						
Duplication of Policy	Ensure synergy between various international policies	Regional Coordination Agencies + CSG/AOC	MT	States, IUCN, PTF, CSG/AOC, decentralised cooperation	Medium	Synchronised policies
B. NATIONAL						
1. Inconsistency between national policies	1. Identify inconsistencies between various national policies; redraft national policies; ensure that international obligations are respected;	Ministries Environment, Agriculture, Fisheries	MT	States, PTF and private sector, territorial and local communities	Institutional instability	Policies are reviewed
	2. Secure participation of civil society and territorial groups;					Support of civil society secured
	3. Develop a strategy and action plan for promotion and conservation of crocodiles;					Strategy and action plan documents exist
	4. Create a joint framework for management and conservation of crocodiles					Effective consultation network
2. Weak public dissemination of national policies	Develop a public awareness programme to disseminate information on national policies	States, civil society, territorial and local communities	ST	States, civil society, territorial and local	Poor knowledge/understanding of	Policies are diffused

				communities	crocodiles	
3. Lack of resources to apply policies	Request funding assistance from Finance Ministry, PTF, NGOs and private sector	States, civil society, territorial and local communities, and private sector	MT	States, civil society, territorial and local communities and private sector	Availability of partners and non-motivation of private sector	Resources are mobilised
4. Weak involvement of civil society organisations	Encourage private sector to set up pilot crocodile farms/ranches/breeding centres	State	ST	State + Civil Society + Private + CSG/AOC	Lack of transparency / fiscal pressure / bad governance	Pilot farms created
	Carry out exchange of experiences between the region and internationally	State + Civil society+ private sector + CSG/AOC				Exchange visits organised
	Develop an Information-Education-Communication programme	Etat + Société civile et secteur privé + GSC/AOC				IEC programme developed
5. Inadequate monitoring and evaluation of policies	Put in place mechanisms for monitoring and evaluation of policies	State + PTF + Civil Society + NGO	MT	State + PTF + Civil Society + NGO	Political and institutional	Effective monitoring put in place

					instability	
6. Poor promotion of the crocodile resource chain	Identify and develop the value chain	Private sector / State	ST	Private sector / State	Absence of market potential / environmental lobbying	Value chain promoted
	Carry out a market study					Market study available
7. Poor interpretation of data regarding policies affecting crocodiles	Analyse data collected and apply to improve crocodile-related policies	State + CSG/AOC + PTF	MT	State + CSG/AOC + PTF	Access to data	

ANNEXE 2 – LEGISLATION GAPS AND ACTIONS PROPOSED IN THE SHORT (ST) AND MEDIUM TERM (MT)

Gaps	Actions	Actors	Time Delay	Means	Risks	Indicators
A. INTERNATIONAL						
1. Limited commercialisation of crocodiles (ranching / trophy hunting / ecotourism)	Carry out national status reports on crocodiles	Research + State + civil society + NGO + IO + territorial communities +PTF	ST	Research + State + civil society + NGO + IO + territorial communities	Availability of resources	National status reports published
	Review national legal texts with reference to CITES Appendix I listing requirements	Research + State + civil society + NGO + IO + territorial communities +PTF				Legal texts comply with Appendix I of CITES
2. Little adherence of West African countries to the Maputo Convention	Encourage States to adhere to the Maputo Convention	Research + State + civil society + NGO + IO + territorial communities +PTF	MT	Research + State + civil society + NGO + IO + territorial communities +PTF	Nil	Countries accede to the Maputo Convention
3. Incompatibility of national texts with international conventions and other agreements	Adapt national legal texts in accordance with international conventions and agreements	Research + State + civil society + NGO + IO + territorial communities +PTF	MT	Research + State + civil society + NGO + IO + territorial communities +PTF	Nil	Legal texts are in accord with international conventions and agreements

B. NATIONAL						
1. Texts are inappropriate and not in context with the reality	Carry out a revision of legal texts Révision des textes	Research + State + civil society + NGO + IO + territorial communities +PTF	MT	Research + State + civil society + NGO + IO + territorial communities +PTF	Political instability / survey of texts not carried out	Legal texts are revised
2. Texts are not developed in a participatory manner	Develop new texts in a participatory manner	Research + State + civil society + NGO + IO + territorial communities +PTF	MT	Research + State + civil society + NGO + IO + territorial communities +PTF	Survey of texts not carried out	Legal texts are developed in a participatory fashion
3. Weak capacity to implement current legislation	Reinforce human, financial and material resources	Research + State + civil society + NGO + IO + territorial communities +PTF	MT	Research + State + civil society + NGO + IO + territorial communities +PTF	Mobilisation of resources	Capacity is built

ANNEX 3 SHORT, MEDIUM AND LONG TERM ACTIONS TO BE TAKEN REGARDING RESEARCH, EDUCATION AND CAPACITY BUILDING FOR THE WEST AFRICA REGION

Short-term actions	Medium-term actions	Long-term actions
- Ascertain the current state of knowledge of crocodile populations in each country - Create a network of universities from West Africa, using the AUF as a platform, for the management of crocodiles - Draft a questionnaire to collect information on crocodiles per country - Define survey methodology as well as the monitoring of human-crocodile conflict for all countries in the region in accordance with the CSG's accepted international standards - Use the IUCN/CSG web site as a central site for distribution of information on crocodiles in West Africa - Define a system to ensure synergy between researchers and policy makers - Establish national research support for all conservation, management, legislation and policy actions regarding crocodiles	Carry out typology analysis of crocodiles kept in captivity Evaluate the potential for crocodile-related activities in West Africa Carry out a technical-economic study of crocodiliculture in the region	Keep track of the population dynamics of crocodiles

ANNEX 4 SHORT AND MEDIUM TERM ACTIONS PER COUNTRY PRESENT AT CSG 2ND REGIONAL MEETING, BURKINA FASO

Country	Short-term actions	Medium-term actions
Benin	- Molecular characterisation of crocodile species - Human-crocodile interactions - Inventory and produce distribution map of crocodile	- Establish a pilot breeding centre for research under "Breeding of unconventional animal species" Programme (PEEANC) - Monitor crocodile population dynamics

Country	Short-term actions	Medium-term actions
	species	
Burkina Faso	- Update existing information on crocodiles - Inventory and produce distribution map of crocodile species - Molecular characterisation of crocodile species - Improve sacred crocodile sites at Bazoulé and Sabu.	- Human-Crocodile Interactions - Monitor crocodile population dynamics
Gambia	- Inventory and produce distribution map of crocodile species - Train National Parks staff	- Human-Crocodile Interactions - Establish a pilot breeding centre for *Osteolaemus* and *C. cataphractus* at Kartung
Niger	- Development of crocodile ponds - Inventory and produce distribution map of the crocodiles - Install a breeding centre on the island of Karey Kopto in Parc W	- Human-crocodile interactions
Guinea	- Survey crocodile populations - Improve the area of Baro as a site for crocodiles	- Establish a pilot breeding centre for research purposes - Monitor crocodile population dynamics
Chad	- Survey crocodile populations - Secure human and material resources - Train personnel	- Monitor crocodile population dynamics - Carry out molecular identification of the crocodile species

REDUCED EFFECTIVE POPULATION SIZE IN AN OVEREXPLOITED POPULATION OF NILE CROCODILES: MANAGEMENT ISSUES.

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Unchecked exploitation of wildlife resources is one of the major factors influencing species persistence throughout the world today. A significant consequence of exploitation is the increasing rate at which genetic diversity is lost as populations decline. Recent studies suggest that life history traits affecting population growth, particularly in long-lived species, may act to moderate the impact of population decline on genetic variation and lead to remnant populations that appear genetically diverse despite having passed through substantial demographic bottlenecks. In this study we show that the retention of genetic variation in a partially recovered population of Nile crocodile is deceptive, as it masks the reality of a significant decline in the population's effective size (Ne). Repeated episodes of unchecked hunting in the mid to late 20th century have today led to a five-fold decrease in the population's Ne. Using current census data (capture-mark-recapture and spotlight count data) we estimate the contemporary Ne/N ratio as 0.05 and, in light of quotas that permit the ongoing removal of adults, simulated the likely effects of genetic drift on extant levels of variation. Results indicate that even if the current effective size is maintained, both allelic diversity and heterozygosity will decline. Our findings have complex implications for longlived species and our management thereof; an emphasis on the retention of genetic variation alone, whilst disregarding the effects of population decline on effective size, may ultimately obscure the continued decline and extinction of exploited populations.

RESULTS FROM THE IMPLEMENTATION OF MANAGEMENT PLANS IN THE *Caiman yacare* PROGRAM, BOLIVIA.

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The Program of Use of Yacare (*Caiman yacare*) in Bolivia was developed from 1997 with the participation of indigenous territories, rural communities and cattle properties, under a model of harvests of mature males (individuals bigger than 180 cm of total length). From year 2004 management plans were developed in eleven indigenous territories, two protected areas and one Municipality. We analyzed the impact of the implementation of some of these management plans on the Program of Use of the Yacare, taking in count environmental, social and economic variables and indicators. Our results show that the managed populations didn't register negative impacts, being presented in some cases the increase in the proportion of mature males, the decrease of the hunt effort and the increase in the values of Capture per Unit of Effort (CPUE). From the social point of view, systems of agreements and conflict resolution were settled down among the actors of the Program improving the social sustainability of the use, as well as the development of local systems of control that diminished the illegal hunt over the specie. From the economic point of view, the leathers of yacare commercialized under management plans improved their price in the market between 200% and 300% of the price previous to the elaboration and implementation of the plans, and were carried out a more transparent distribution of benefits considering the hunters, local organizations, self monitoring systems and communal contributions. We consider that the management plans are impacting positively the National Program of Yacare, improving the sustainability of the hunting in the environmental, social and economic levels.

SOME CRITERIA USED FOR CAIMAN MANAGEMENT IN MAMIRAUÁ RESERVE.

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The Caiman Management Pilot Project of the Mamirauá Sustainable Development Reserve is an initiative coordinated by the environmental agencies of the government of Amazonas State, which is based on a favorable legal environment for the use of natural resources in protected areas. The project is justified by the caiman use for illegal meat trade and abundance of caiman. However, the absence of technical criteria and the lack of scientific study on the production chain and marketing strategies, coupled with the shortage of sanitary laws for hunting of non-traditional species have hindered the development and structuring of the project.

The most recent caiman hunting event occurred in December 2008. In these activities the Mamirauá Institute shares the responsibilities in the application of criteria related to the caiman extraction. Criteria involved the selection of hunting areas, evaluation of environmental variables, establishment of quotas between areas, and definition of the range of lengths for management or of the exclusion criteria.

Nocturnal surveys were conducted before and after of caiman hunting. Before extraction 468 caimans were counted in 52,3 kilometers (8,9 caiman/km); after the extraction, 234 caimans were counted in 49,5 kilometer (5,0 caiman/km).

The caiman captures were conducted in six nights, December 16-22 2008, resulting in an average capture of 43 caiman per night (SD = 24.7) and an average time of capture of 54 minutes per caiman. In total 257 individuals were captured (253 black and 4 spectacled caiman). The black caiman was the species of commercial interest in this event. The total length of the caiman captured ranged between 1.6 and 3.2 m, and 76 animals (30%) outsized the range established for extraction. We reported the capture of 35 females, representing 14% of all captured animals.

The Mamiraua Research Institute implemented a tracking system for monitoring the product (meat and hide) along the production and trade chains.

After this last caiman extraction, it became clear that the caiman management in Amazonas State must still be considered experimental, and requires further scientific, technological and meat marketing studies.

STATUS AND CONSERVATION OF CROCODILES IN GABON.

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West and Central Africa is the single most data deficient region for crocodilians in the world. Only a handful of surveys have been conducted over the last 20 years and virtually no intense studies on crocodilian biology, utilization, or management have been conducted. In recognition of this deficit, since 2006 the CSG has prioritized research and reconnaissance in the region. As part of this initiative, Gabon has been identified as a high priority zone due to a combination of the expansive, relatively intact ecosystems, low human population density, and preliminary data suggesting it is a stronghold for slender-snouted and dwarf crocodiles. Starting in December 2009, I have initiated nationwide surveys of crocodile populations that will continue through August 2010. Surveys to date have been conducted in the northern Gamba Complex N'gowe and N'dougou lagoons, including feeder rivers (N'gowe, Echira, Rabi, Bongo, Nyanga) and targeted sites like the Lourie Lagoon in Loango National Park. Slender-snouted crocodiles were the most abundant species encountered, ranging from 0.558 – 3.096 ind./km, though this species is limited in distribution to the freshwater, forested rivers and their mouths, not ranging further into coastal lagoons. Nile crocodiles were sparsely encountered, ranging from 0.0 – 0.529 ind./km., likely due to a combination of wariness and heavily depleted populations, and critical nesting sites for this species have been identified. Dwarf crocodiles appear to be abundant throughout; though developing a robust survey strategy for this species is logistically challenging and should be considered a top priority. Significant threats to all of these species include bushmeat harvest and incidental mortality through conflict with artisanal fisheries. Survey efforts will be expanded in the dry season (July – August) when we will assess targeted areas including the Evaro lakes region south of Lambarene, Dji Dji and Ivindo Rivers near Ivindo NP, Ogoué River near Lope and Minkebe NPs, and the Mpassa River near Plateau Bateke NP, amongst others. NGOs and Gabonese government agencies have prioritized crocodile management recently, and these are a critical first step to mitigating the bushmeat threat and developing protected areas for slendersnouted crocodile conservation.

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Mohamed bin Zayed Species Conservation Fund, Conservation, Food and Health Foundation.

STATUS OF WILD CHINESE ALLIGATOR *(Alligator sinensis)* CONSERVATION IN ANHUI.

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Chinese Alligator *(Alligator sinensis)* is endemic species and the first class of national protected animal, one of the 7 most endangered species among 23 species of alligator in the world. Anhui National Nature Reserve of Chinese Alligator *(Alligator sinensis)* is the last refuge and the only concentrated distribution area of the wild Chinese Alligators *(Alligator sinensis).* How to better conserve Chinese Alligators *(Alligator sinensis)* and stop the declining trend and maintain a stale population size and hence to gradually restore and increase the population is our first priority. Through continuous efforts to enhance conservation and adopt effective protection measurements, the living condition and habitat of Chinese Alligators *(Alligator sinensis)* has been improved in a certain extent.

1. Status of Habitat Protection of Chinese Alligators *(Alligator sinensis)*

Since intensive human activities and economic development, habitat of Chinese Alligators *(Alligator sinensis)* has been degraded and decreased continuously that caused wild population decline. Based on survey in past ten year, the wild population of Chinese Alligators *(Alligator sinensis)* was less than 150 in 1999 and less than 120 in 2005. How to prevent the wild population from extinction? The nature reserve had adopted a variety of effective protection measurements to maintain the wild population stable and gradually increase and achieved a welcome result. In accordance with the survey in 2009 and 2010, the number of wild Chinese Alligators *(Alligator sinensis)* has increased obviously, which is much higher than and census in 1999 and 2005. The wild population of Chinese Alligators *(Alligator sinensis)* is estimated up to 150 and has shown a stable increasing trend.

1.1 To protect, improve and enhance habitat quality. Habitat quality of Chinese Alligators (Alligator sinensis) mainly include: stable condition of the water; conditions of water and surrounding land and hiding vegetation; level of prevention from human disturbance; abundant prey etc. The nature reserve maintained the water area through reconstruction of dyke, assistance with local alternative livelihood as well as deduction of cutting vegetation and human disturbance. The nature reserve artificially put small fishes, snails and mussels etc into the water so as to increase the habitat quality in some extent that effectively enhanced the conservation of the habitat.

1.2 To enhance natural hatching. To stop artificial hatching with pick-up eggs and improve natural hatching by the alligators in the wild. To allow breeding-lay eggs-hatching-being born-growing up occurred in the wild. In addition, to strengthen protection measures during the natural hatching. There were 817 eggs from 34 nests laid within the nature reserve in 2003-2009. Of which 466 alligators were born naturally.

1.3 To adopt protection measures for young alligators. Most of the eggs can be successfully hatched by nature. However visible rate of the wild young alligators was very low based on field survey in the second year after birth. The survival rate is approved not high. According to relevant study domestically and abroad, the survival rate of fresh water alligators is only about 2%. In order to increase survival rate of the young alligators, some assistant protection measurements were implemented on the basis of no change of predatory and other behaviors, such as measures of preventing from predators, artificially dig holes to help young alligators spend cold winter, artificially feed with small fishes and shrimps to increase survival rate of young alligators. The protection measurements were adopted since 2005 to protect young alligators. The census in 2006-2009 showed the survival rate increased up to 60% and above. The assistant protection was approved very successful and efficient that may directly supplement and rejuvenate wild population of the alligators.

1.4 To conduct community participatory co-management and assist local economic development. The habitats of Chinese Alligators (Alligator sinensis) are almost located in rural areas where are closely associated with agricultural production. It is impossible to protect wildlife resources with only the manpower of the nature reserve. It is essential to co-work with the communities. Nowadays 15 rural townships from 5 counties/districts, 3 state-owned forestry farm, 2 water conservancy management committees where have alligators distributed had concluded community participatory co-management agreements with local communities so as to improve conservation of alligators. Through help villages with construction of roads, maintenance of dykes etc in Hongxing, Zhongqiao, Gaojingmiao and so on, the relationship between the nature reserve and local communities is getting more harmonious and consistent. The local communities obtained real benefits from the nature reserve that resulted in active involvement of the local farmers in the conservation of Chinese Alligators (Alligator sinensis). This is one of the main reasons that made the population of the wild Chinese Alligators (Alligator sinensis) stable, restored and increased.

2. Status of the Chinese Alligators *(Alligator sinensis)* Release to the Wild

The priority of the nature reserve is to protect wild population of the Chinese Alligators *(Alligator sinensis)* and allow natural development. Since the wild population and breeding rate is relative low, the population is constrained to increase. At this circumstance artificial breeding and release to the wild is one of the most effective means to rejuvenate the wild population of the Chinese Alligators *(Alligator sinensis).* The nature reserve began to implement habitat restoration and reconstruction as well as reintroduction since 2006. Now the effects had been approved very successful. The re-wild population has been primarily established.

2.1 Investigation and selection of the reintroduction sites. Feasibility study survey was conducted in most potential sites for reintroduction. The survey mainly focused on three aspects: (i) the habitat shall be easy for restoration construction; (ii) there shall be no negative impacts to local community; and (iii) released alligators can be effectively protected. After review and evaluation, the final reintroduction site was determined

within Gaojingmiao Forest Farm of Langxi County for the Chinese Alligators' (Alligator sinensis) habitat restoration construction and reintroduction. The advantages of this site are: mountain area is relatively large in the forest farm and many terraces in the forest. There is almost no human activity in this area. Besides, vegetation diversity and canopy coverage is very high in this area that provides good habitat to Chinese Alligators (Alligator sinensis) for feeding, breeding and hibernating. After restoration construction, this site will be a desired habitat for Chinese Alligators (Alligator sinensis) release and reintroduction.

2.2 Reconstruction and restoration of habitat. Habitats for Chinese Alligators (Alligator sinensis) must have water and land. The reconstruction and restoration of the habitat will mainly build dyke and dig water pool along the landform and reconstruct the site to meet requirements of alligator's inhabitant so as to restore the wetland condition. Now over 20 water pools were dug. Restored area is up to approximate 50 hm2.

2.3 Release and adaptation of the reintroduced Chinese Alligators (Alligator sinensis). Success of the reintroduction of the alligators is subject to their adaptation to the reconstructed habitat if they can move normally, dig hole for wintering and breeding etc. In 2006-2010, total 33 adult alligators were released to the site for the reintroduction. Based on monitoring and survey, all released Chinese Alligators (Alligator sinensis) have adapted the new habitat in good condition. A series of normal behaviors were found and getting more and more wildness as time going.

2.4 Breeding. After several years of release and re-wilding, the released alligator laid the first brood of 19 eggs in 2008, of which 10 eggs were hatched out successfully by nature. In 2009, 4 broods of 69 eggs were observed, of which 24 hatched out.

3. Findings in the Conservation

3.1 As the growing of the human population, economic development such as urban and rural construction etc also influences the habitat. As a result habitat environment of Chinese Alligators *(Alligator sinensis)* is facing serious threats.

3.2 Water allocation for the nature reserve and for agriculture irrigation by the local communities has direct conflict with the ecological water for Chinese Alligators *(Alligator sinensis)*, especially draught and less rainfall seasons.

3.3 Since the habitat of Chinese Alligators *(Alligator sinensis)* overlaps with economic activities by the local farmers, contradiction between human beings and alligators is still acute.

3.4 Since number of wild Chinese Alligators *(Alligator sinensis)* in the habitats is small and distribution areas are isolated from each other, genetic exchange between different communities is difficult that causes loss of fine genes and problem of genetic diversity of small population. In addition, small population has the constraint of natural population growth.

TEN-YEAR ATTEMPT AT CAIMAN MANAGEMENT IN THE BRAZILIAN AMAZON.

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Research on caiman biology and population dynamics in the Mamirauá Reserve were first implemented in the 1990s. Results of these surveys indicated high abundances of black and spectacled caiman and a trend of quick population recovery following the decrease in extensive hunting.

During the workshop on Conservation, Monitoring and Management of Caimans in Amazonas (Manaus 2000), the status of caiman populations was discussed and a political interest in developing experimental management of caiman generated.

In December 2004, the first caiman experimental hunt was performed, when 61 caiman (50 black and 11 spectacled caiman) were hunted. The main objective was to evaluate culling and meat processing methods, as well as some links of the production chain.

The Caiman Management Pilot Project in the Mamirauá Reserve continued in August 2008. This event was directed to the meat trade and involved the hunt of 245 black caiman (4.5 tons of meat). In December 2008, 253 black caiman were culled, producing 5 tons of meat and 225 skins. The main objective then was testing the skin trade and, secondarily, the meat trade.

In 2007, a series of research initiatives began, with the objective of generating information on technical criteria for establishing a scientific management program of caiman, taking into account the historical reality of the Amazon local people. In Piagaçu Purus Reserve, the BAJAQUEL Project has collected relevant information about a simple production line, according to the local context.

The Mamirauá Institute has actively accompanied the legal hunting experimented in the Mamirauá Reserve, attempting to set up scientific and technical criteria for the exploitation of caiman. A tracking system for monitoring the product (meat and skin) along the production and trade chains was implemented.

Ten years after the beginning of the proposed experimental management program, it is necessary to evaluate the information collected and generated to establish guidelines to consolidate a caiman management program that will ensure a proper conservation strategy and a real alternative for the local people.

USO DE HABITAT, ECOLOGIA E CONSERVAÇÃO DE *(caiman crocodilus)* EM RESERVATÓRIO URBANO NO BRASIL CENTRAL.

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Existe grande carência de dados sobre a biologia de Crocodilianos em ambientes periurbanos. A plasticidade ecológica de *Caiman crocodilus* permite a ocupação de ambientes alterados. Reunimos dados populacionais de *C. crocodilus* em um grande reservatório urbano, para subsidiar sua preservação. O trabalho foi conduzido no Lago Paranoá, construído em 1958. O lago possui quatro afluentes principais: Riacho Fundo e os ribeirões Gama, Bananal e Torto. As contagens noturnas foram feitas com barco a motor para percorrer longas distâncias, caiaque para rondas setorizadas em cada foz e focagens a partir da margem, usada apenas na foz do Ribeirão do Gama. Em cada avistamento foram coletados dados sobre uso de habitat, abundância, tamanho e comportamento dos indivíduos. Ferramentas espaciais em Sistemas de Informações Geográficas foram usadas para avaliar o padrão de distribuição e identificar as regiões com maior intensidade de uso. Usamos testes não-paramétricos para testar diferenças no uso de microhabitats e diferentes comportamentos em relação ao tamanho. Foram totalizados 85 avistamentos, concentrados na foz do Riacho Fundo. Os locais com maior intensidade de uso foram lagoas na foz do Ribeirão do Gama e do Riacho Fundo, onde foi feita a única captura. Indivíduos com comprimento total menor que 60cm foram avistados apenas na foz do Riacho Fundo. Os avistamentos apresentaram padrão agregado de distribuição. Indivíduos com tamanho entre 120 a 180cm apresentaram maior largura de nicho e maior sobreposição de nicho com indivíduos de tamanho entre 60 e 120cm. Houve diferença significativa no uso de microhabitat entre as classes de tamanho. Profundidade da água e distância da margem não foram estatisticamente significativas em relação ao comprimento total. O tipo de fuga não foi significativamente diferente entre às classes de tamanho. Não houve correlação significativa entre *wariness* e o tamanho. Nenhum indivíduo foi avistado fora d'água. O uso de caiaque se mostrou relevante para contagens noturnas de populações muito fugidias. A foz do Riacho Fundo é o local mais importante na manutenção do *C. crocodilus* no Lago Paranoá.

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23 YEARS OF BREEDING WITH AFRICAN SLENDER-SNOUTED CROCODILES *(MECISTOPS CATAPHRACTUS)* IN ZOO EMMEN , THE NETHERLANDS.

Eddy Even. Reptilekeeper at Zoo Emmen. the Netherlands

In 1982 the zoo acquired a small group of African Slender-snouted crocodiles (Mecistops cataphractus) for an African exhibit and in which the species formed - and still forms -the main attraction. Initially, however, the species was erroneously considered to be False gharials {Tomistoma schlegelii). Other specimens, incorrectly classified as Tomistoma, were acquired by Aalborg Zoo (Denmark), possibly from the same source. When these started to reproduce at Aalborg Zoo, the mistake was still not recognized, and the breeding was published as a successful breeding of Tomistoma in publications such as the International Zoo Year Book. In Emmen, three M.cataphractus were placed in an enclosure together with several Osteolaemus tetraspis. Due to intra- and inter-specific aggression, the group was split, and a true pair of M.cataphractus was formed. This couple had their first clutch of eggs in 1987 and since then it has produced eggs each year. An average of 30 eggs is laid (24-34). The crocodiles have two sand beaches in their enclosure, of which one is heated from underneath. This beach is always used as the nest site. Eggs are laid overnight; the female builds a nest from sand and some leaves, approximately one meter high and two meters wide. The enclosure measures 22m by 11 m, the beaches cover $45m^2$. An area of $50m^2$ is used for plants/trees, and the crocodiles do not have any access to this area. The rest ($120m^2$) is formed by a pool of which the depth is approximately 100 cm. Mating is observed in spring and eggs are laid in summer, from May to August. Eggs are incubated only on an irregular basis. This is dependent on the interest of other official zoos in obtaining any offspring. As a result, from nearly 700 eggs, a few dozen have hatched in the 23 years of breeding. Young M.cataphractus born in Emmen Zoo have found their way to zoos and other facilities around the world, like in The Netherlands, Germany, Denmark, France, United Kingdom, Czech republic, Spain, índia, Thailand and Brasil. Almost ali hatchlings which hatched before 2003 appeared to be females; the incubation temperature will be the key to this phenomenon of course. In 2003, a clutch of eggs was incubated at 32 C to produce males, but only one animal hatched. This male is developing well, but his growth rate is lower as expected. In 2005, the female hadn't built a proper nest and as a result it was hardly recognizable as such. In September, however, eggs started to hatch, and the female was observed digging the young crocodiles out from the nest, and carrying them to the water in her mouth. Not ali of them survived: out of sixteen, nine remained (5 males and 4 females).

IMPACT OF WORLD FINANCIAL CRISIS IN CROCODILES SKIN TRADE FROM SOUTH AMERICA.

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Abstract

In 2007 the world was affected by a financial crisis. Again, like during the last two events in the 90's, the crocodile skin market was affected by those crises. The main impact wasthe reduction of the exports from the producer's countries to the United States, Europe and Asian markets. The prices of the crocodile skins were reduced too. The present paper tries to evaluate the crisis impact on crocodile skin trade from South America. The skins produced on our continent are classified as "*not classic skins*". Colombia is the bigger producer with caiman skins from captive breeding operations, and yacare from Bolivia and caiman from Venezuela. To evaluate the impact, we design two questionnaires, one distributed to all South American producer countries (including producers, tanners and traders), and second distributed to buyers in France, Italy, Singapore and Thailand. Also we consult the WCMC trade data base from South American countries from 2006 to 2009 to evaluate the reports from producers to buyers countries. At the moment of the preparation of this paper, the data of 2009 was not published; we evaluated only the impact between 2006 to 2009.The evaluation between WCMC data, producers-tanners-traders and buyers reported different values and perception, the skin trade and prices from South America to markets are reduced between years evaluated. The export reduction media is 60% (sellers), 55% (buyers) and 41% (WCMC). The price reduction is 24% (sellers) and 65% (buyers).

Resumen

Desde el 2007 el planeta se ha visto afectado por una crisis mundial económica. Igual que en dos ocasiones anteriores durante la década de los 90, el mercado internacional de pieles de cocodrilos ha sido afectado. El principal impacto ha sido una reducción en las importaciones de Estados Unidos, de la Comunidad Europea y de los mercados Asiáticos, al igual que la reducción del precio de las pieles. El presente trabajo evalúa el impacto de la crisis financiera mundial en el comercio de pieles de cocodrilo desde Sur América, las cuales son catalogadas como pieles "no clásicas" en el mercado internacional. La producción es dominada por pieles producidas en cautiverio de la especie *Caimancrocodilusfuscus* de Colombia, seguida de pieles provenientes de programas de aprovechamiento de poblaciones silvestres de *Caimanyacare* de Bolivia y *Caimancrocodiluscrocodilus* de Venezuela. La información se obtuvo a través de dos cuestionarios, uno distribuido entre zoocriaderistas, curtidores y comercializadores de los países productores en Sur América y otro cuestionario entre los compradores en Francia, Italia, Singapur y Tailandia. También se consultó la base de datos de comercialización de la WCMC (años 2006-2009). El impacto sobre el comercio varía de

acuerdo a la información recabada, los productores reportan una reducción en las exportaciones del 60%, los compradores del 55% y WCMC del 41%. El precio se redujo para los productores en un 24% y según los compradores en un 65%.

Introduction

The Action Plan for crocodiles (Ross 1998) identified several diverse examples of sustainable use in crocodilians. One of the basic components for sustainability programs is the Economic Feedback, defined as: *"a proportion of the economic returns from use was retained and used to support monitoring, management and enforcement. This was usually in the form of license fees, export fees and user access charges"* (Ross 1998).

In Colombia from 2004, the farms can give to Management Authority "MinisteriodelAmbiente, Vivienda y Desarrollo Territorial (MAVDT) cash as a part of their restoration or reintroduce a caiman or babilla annual quota (Rivera et al 2008). These contributions in money have to be used in studies to determinate the caiman or babillawild population status and to determine the reintroduction or restoration areas.

The case in Venezuela is different; Velasco & De Sola (1999) explained the different taxes that have to be paidfor the caiman program, and their utilization or returns to the program itself. One of them has to be used exclusively for monitoring the caiman population every year. The other 3 taxes are used in different wildlife conservation programs.

In 1992 during the 11th Working Meeting of the CSG in Victoria Falls, Zimbabwe, a group of experts met inthe workshop on trade issues and conservation of crocodiles and noted 6 factors that contributed to the crisis in early 90s.These factors are: 1) low demand for product in Japan, 2) poor world economy, 3) consumer resistance to wildlife products, 4) paucity of manufacturing facilities worldwide, 5) imbalance of production and consumption in the USA and 6) ban on wildlife trade with Italy (Ross 1992).

Woodward et al (1993) described the first analysis of international market crisis in crocodile skins, but only for alligator or classic skins (not caiman). This analysis was based on the rise and fall of prices during early 90s of last decade. Where there price and the demand of raw classic skin, downloaded in the market. Some explanations they gave to us were mostly based on economic evaluation of demand and supply aspects.

In 1998 during the 14th Working Meeting of the Crocodile Specialist Group in Singapore, panels of experts evaluated the World trade in Crocodilian skins, current events and trends (Ross 1998),and identified these points:

a) Market trends: the reduction of price and demand is a consequence of high value classic skin products to a mix of classics and lower value caiman skin products. This increases the emphasis on quality of consumer that directly affects the price and demand for raw skins.

b) Market prospect: The weakness of Asian currencies is giving a competitive edge to Europe and USA markets. Also, China came to be an interesting market based on their low cost of caiman products.

Koh (1998) exposed the factors that affected the demand and supply of skins in Asia and the crocodilian industry. The crisis began in June 1997 when all currencies in Asia (one by one) suffered devaluations that directly affected the local economies, tourism and directly impact the crocodile industry and demand their products, producing a big reduction in products to be sold, principally because the valueswere higher with other markets, especially in Europe and USA.

MacGregor (2002) described the structure of the crocodilian skin industry from producers to consumers (fig 1). This structure regulates the skins business in term of demand. For example, if the consumer (destination for final finished articles) does not buy, the stores maintain the product stocks, affecting the manufactures and they don't buy skins from the tanneries. The tanners, for this reason, don't buy skins from the exporters, and theexportersfrom the producers. This scenario affects the market directly, stopping all transactions in the chain, where the most harmed are the producers.

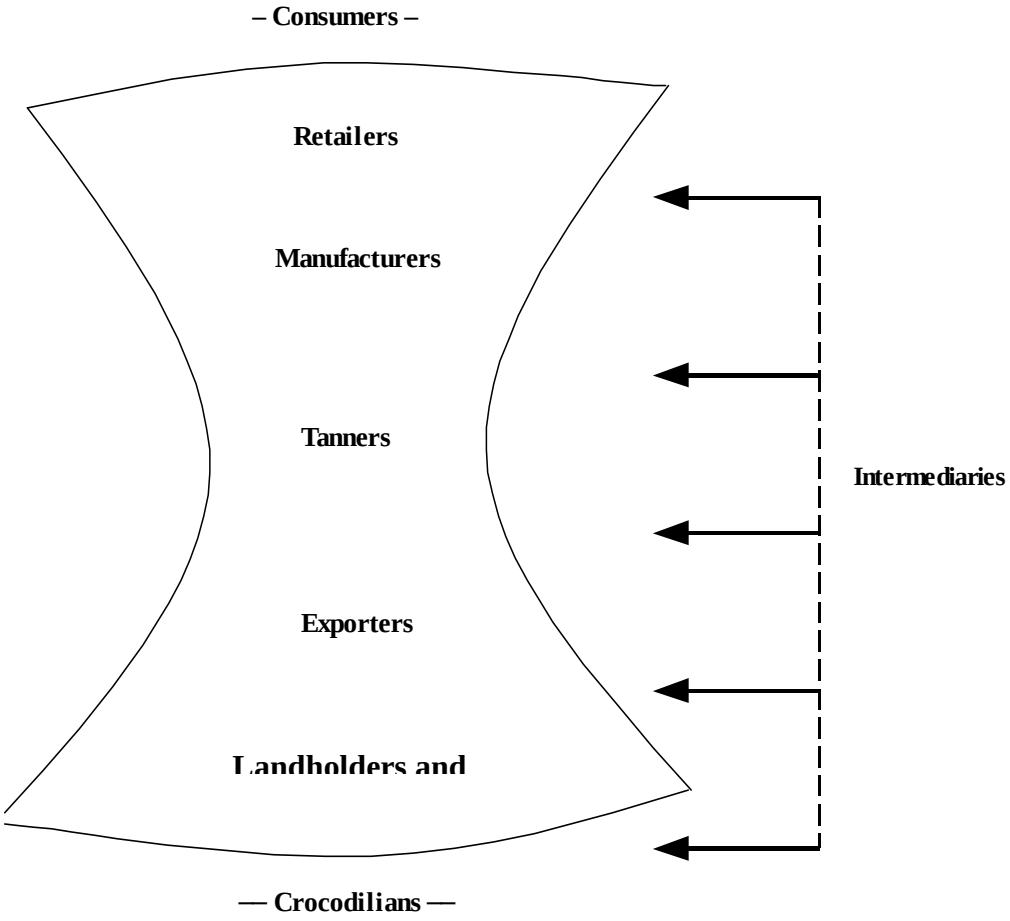

Figure 1.Structure of the crocodilian skin industry from producer to consumers (from MacGregor 2002).

The goal of present paper is tries to evaluate the crisis impact on crocodile skin trade from South America.

Methodology

Two questionnaires were distributed to all South American producer countries, including farmers, tanners and traders; and buyers in France, Italy, Singapore and Thailand, respectively. The first questionnaire asks the following issues: Type of activity, species that work; origin of products; market and % of sales; trade of products; date when note the crisis; % reduces sales and price; action to reduce the crisis impact by producer, trader and government; % of supported conservation programs and % reduction for conservation programs.

The buyers questionnaire asked: which country supplies crocodile skins; type and % skins purchased; when began reductionin your shipments; % of shipment reduction; % price reduction and % conservation program support.

The annual value of exportation from any country was obtained reviewing the Wildlife Conservation Monitoring Center (WCMC) web site, especially the information about wildlife trade. This database is based in all annual reports presented from all Parties (countries) in Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). All information was organized by country, year, and import country, specie and production system.

Results and analysis

The tables 1 and 2 show the farmers, tanners and traders answers to our questionnaire. Argentina and Colombia produce and export skins from ranching and captive breeding program, respectively. Bolivia and Venezuela export flanks from wildlife programs.

The principal markets for Ranching and captive bred skins are Europe, USA and Asia. For wild crocodiles skins is Europe, one trader is Asia and other one USA. Different kind of products are sales, the most common is salted skins and tanned in crost, less in percentage are finished skins (colored) or products.

All producers and traders began to feel the crisis in 2008, one year earlier than others, affecting initially the shipment and consequently, the prices. The shipment sales with wild skins (Bolivia and Venezuela) were reduced by 76% (50<X>100). The shipments with ranching and captive breed skins (Argentina and Colombia) were reduced by 56% (20<X>100).The price for wildlife skins were reduced by 23% (20<X>25) and ranching or captive breed skins by 25% (10<X>40).

The principal actions implemented by producers and traders were reduction instaff personnel, reduction in the production cost, trying identifying new markets and developing new colors in finish skins. The government did not implement any action to mitigate this crisis impact.

The impact in conservation activities directly affected the contributions in terms of reducing sponsored program or donations, few interviewed maintain local conservation programs.

Table 1.Answers from Producers and Traders of ranching and captive breed skins.

		Colombia					**Argentina**		
		#C1	**#C2**	**#C3**	**#C4**	**#C5**	**#A1**	**#A2**	**#A3**
Which is your activity	Producer	x		X	x	x	x	x	x
	Tanner	x	x	X					x
	Exporter	x		X		x		x	x
Species that work	*Caiman yacare*						x	x	x
	Caiman latirostris						x	x	x
	C. c. fuscus	x	x	X	x	x			
	C. acutus	x	x			x			
Markets and % of Sales	Europe	20		20			15 *latirostris*	20	10
	Mexico		22			x			

	España		4						
	Italia		3			x			
	Japon		12			x			
	China		8						
	Taiwan		5						
	Thailand		5			20			
	Asia			50	20				
	USA	40	34	30			90 *yacare*	40	90
	Singapore					50			
	Korea					x			
	Argentina						10*yacare* 85 *latirostris*	40	
	Colombia	40	7		80				
Trade products	Salted flanks			x					
	Tanned flanks			x					
	Wet Blue flanks			x					
	Salted tails			x		x			
	Tanned tails			x		x			
	Finish flanks		x	x					

	Other products		x	X	x			x	
	Salted skins		x	X	x	x	x	x	X
	Tanned skins			X					
	Finish skins	x	x	X			x	x	X
Date when note the crisis		Jan 2009	Aug 2008	Nov 08	Jun 2008	Feb 08	Jan 2008	Oct 2008	Sep 2008
% reduction of your Sales		20	35	40	40	95	100	60	60
% reduction your prices		0	28	10	40	No sales	40 yacare 25 *latirostris*	30	40
Action to reduce the financial impact (Exporter)		Reduce cost, more commercial activity and diversification products	Reduce production and personnel	Staff reduction	Sold a better market prices	Reduction the offer	Reduce production cost	Reduction sales price	Identify new markets and develop new finished skins
Action to reduce the financial impact (Producer)		Reduce cost, research to obtain the skins in low time	More control in production staff, reduction indirect employments and buy roof material	Staff reduction	Reduce cost, personnel, investment, cost and pursaches	Reduce cost	Reduce production cost	Reduction cost	Reduce production cost

Action to reduce the financial impact (Government)		Nothing	Nothing	Tax reduction	Nothing and is prohibit sales the meat	Nothing	Nothing	Nothing	Nothing
% of supported conservation programs		Support local programs estipulate by the local Authorities, CSG sponsor	Invest in water management and environment actions		4US$ for each animal to harvest and 10 US$ for the original parental stock	Through private association Azocool	0	0	10 self inicaitive
% reduction for conservation programs		0		Through local government	0	To minimum	0	0	0

Table 2.Answers from Producers and Traders of wild skins.

		Bolivia		**Venezuela**	
		#B1	**#B2**	**#V1**	**#V2**
Which is your activity	Producer	x	x		
	Tanner	x	x		
	Exporter	x	x	x	x
Species that work	*Caiman yacare*	x	x		x
	C. c. fuscus				x

	C. crocodilus			x	
Markets and % of sales	Europe	85			50
	Mexico		10		
	Italia		70	x (50)	
	France		10		
	Thailand				50
	Asia	15			
	USA		10		
	Germany			x (50)	
Trade products	Salted flanks	x		x	x
	Tanned flanks	x	X	x	
	Wet Blue flanks	x		x	
	Salted tails	x	X		
	Tanned tails	x			
	Finish flanks	x	X		
	Salted skins		X		
	Tanned skins				x
	Finish skins		X		
Date when note the crisis		Sep 2008	Mar 2009	Oct08	Jan 08

% reduction of your sales		75	50	80	100
% reduction your prices		25	20	25	No Sales
Action to reduce the financial impact (Exporter)		Identify new costumer, more commercial activity	Reduce production cost and sales price, develop other colors and manufactured products	Discussion with government to reduce the taxes	Not possible any action
Action to reduce the financial impact (Producer)		Reduce personnel and cost	Reduce production cost		
Action to reduce the financial impact (Government)		Nothing	Nothing	Nothing	Nothing
% of supported conservation programs		10	0	In the pass	0
% reduction for conservation programs		50	0	0	0

The table 3 shows the buyers answers to our questionnaire. All buyers buy skins from all Latin America, except Thailand that buy only Colombia skins. Flank sales principally tanned in crost and skins only Italy buys tanned in crost.

All buyers began to feel the crisis between September to October 2008, only one buyer answeredduring April 2009. They reduced their shipment by55% (40<X>75). The price was reduced by65% (20<X>80).

All buyers interviewed are Crocodile Specialist Group sponsored, and only one reduced its contribution by 100%.

Table 3.Answers from buyers Latin America skins.

		Singapore	**Italy 1**	**France**	**Thailand**	**Italy 2**
Which countries supplies crocodile skins to us?	Argentina					X
	Bolivia	X	X	X		X
	Brazil	X				
	Colombia	X	X	X	X	X
	Venezuela	X	X	X		X
Types of Skins we buy and by percentage?	Salted flanks					
	Tanned flanks	X	X (15)	X (90)		X (80)
	Finished flanks					
	Salted skins	X		X (10)	X (100)	
	Tanned skins		X (10)			X (20)
	Finished skins					
	Salted tails					
	Tanned tails					
	Other					

	products					
When do you begin to reduce your shipments?		Sep 08	Sep 08	Apr 2009	Oct08	Sep08
What is the percentage reduction in shipments?		50	80	50 - 100	40	50
What is the percentage drop in prices?		10 - 30	80	50	20 - 40	20 - 30
Your company is a CSG sponsor?		Yes	Yes	Yes	Yes	Yes
What percentage reduction is your CSG support?		0	100	0	0	0

Table 4 shows the annual flank trade produced from wildlife programs from 2000 to 2009 from the WCMC species trade database.The first point is in the period selected; only Bolivia and Venezuela continued put flanks into the international market. Paraguay is under *Moratorium*, and Argentina and Guyana introduce small quantities. Nicaragua only exported flanks in 2000.

Another observation is that Bolivia increased the export quantities, especially in 2007 and 2008, date when the producers and traders reported the beginning of the financial world crisis in their questionnaire answers. The case for Venezuela is different; export reduction began in 2007, a year before the trades report the crisis.

Table 4. Annual wild skins trade by country and specie.

	Venezuela (caiman)	**Paraguay (yacare)**	**Guyana (caiman)**	**Bolivia (yacare)**	**Nicaragua (fuscus)**	**Nicaragua (caiman)**	**Sub Total Wildlife**
2000	49.969	13,000	679	4,116	9,716	327	**77,807**

2001	34,193	5,585	395	49,360			**89,533**
2002	28,130	16,177	2,510	67,435			**114,252**
2003	63,272	5,862	3,000	81,180			**153,314**
2004	107,076		620	101,456			**209,152**
2005	63,403		1,300	78,158			**144,075**
2006	81,631		1,740	40,138			**125,712**
2007	36,242		16,205	94,401			**153,309**
2008	34,775		18,010	102,943			**155,728**
2009	27,906		23,000	37,926			**88,832**

Table 5shows the skin trade information from ranching and captive bred obtained from WCMC species trade database. All countries showed reduction of their annual skin exports, from 2007 to 2009. This observation is in agreement with the answers obtained from producers and traders of these countries.

Table 5. Annual ranching and captive breed skins trade by country and species.

	Panama (fuscus)	**Colombia (caiman)**	**Colombia (fuscus)**	**Colombia (acutus)**	**Brazil (yacare)**	**Brazil (caiman)**	**Argentina (latirostris)**	**Argentina (yacare)**	**Sub Total Farms**
2000	10,150		607,918		1,750	6,500			**626,318**
2001	10,325		646,693	100	3,245		88		**660,451**
2002	16,198	692	551,313		3,372		90		**571,665**
2003	14,364		522,238	193	11,155		165		**548,115**
2004	33,484		673,998		6,433		100		**714,015**
2005	4,792	4,431	640,715	128	0		991	1,214	**652,271**
2006	2,210	4,990	870,183	7	5,672		875	2,203	**886,140**
2007	25,175	4,000	833,751	85	10,254		1,125	6,761	**881,151**
2008	3,881		587,284	416	7,016		877	3,539	**605,866**

2009	1,990		385,583	409	6,567		337	10,044	**404,390**

Table 6 shows the percentages of the reduction of flanks or skins in trade by country and species.The main reduction value for the region is 26.33%. Ranching and captive bred skins show the more impact of the financial crisis that wildlife flanks, reduction of 30.41% vs. 1.48%.

Table 6.Reduction percent in trade by country and species.

	Total flanks & skins exported	**% Total reduction**	**% reduction farms**	**% reduction Colombia**	**% reduction Argentina yacare**	**% reduction Argentina latirostris**	**% reduction Panama**	**% reduction wildlife**	**% reduction Bolivia**	**% reduction Venezuela**
2006	1 011,852									
2007	1 034,760	-2.26	0.56	4.19					-135.20	55.60
2008	780,624	24.56	30.85	29.56	47.66	22.04	84.58	-11.52	-12.39	-20.48
2009	495,400	38.54	33.54	34.34	-183.81	61.57	48.72	47.19	62.71	36.09

For ranching and captive bred skins, Panama shows the biggest reduction. This country we can considerer as a tanned country, because its import from Colombia most of the skins are tanned and put into the international market.

Argentina exported small quantities of its skins, but yacare skins were more affected thanlatirostris (47.66% - 22.04%). One probable reason is that *C. latirostris* is considered more like a “classic” skin than other skins or flanks produced and exported by Latin America countries.

Colombia, the country that put more skins in the international market, reducedexportations in 2008 around 30%. The markets more affected are Singapore and Mexico, around 50%, France (80%) and Japan that bought skins in 2008.

For wildlife flanks the reduction was less than 2%. If we analyze the Bolivian and Venezuelan cases, we can see that Bolivia reported increases in exports between 2006 to 2007 and 2008 (see table 5). The explanation to this is that they maintain agreements with international traders that are impossible to break, and thus sold all inventories. In the questionnaire, Bolivian producers and traders answered that they began to be affected in September 2008 and March 2009. If we can review the trade information for 2010, when it's available, is possible the observed a reduction of its exports.

Venezuela showed a big reduction between 2006 and 2007 (55.60%) and small reduction in 2008 (4.05%). The main reason is its annual productions, which were reduced from 70,000 in 2005 to 8,000 in 2008 (Velasco 2008). All flanks sold during the last two years came from inventories of one trader and in 2009 only sold around 3,500 salted flanks. The other tanners and traders did not sales flanks during the last two years for price reasons.

Final considerations

All of the information presented in this study shows a real impact in crocodile flanks and skins trade from Latin America. One country is more is affected thanthe others, and same situation is truefor the different species.

Not all flanks and skins are used for the same products, it depends the size and species. For example, for watch strapssmall alligator skins are used, *C. c. fuscus* skins and *C. yacare* small flanks, but the watch industry still experienced a slowdown which continued in 2010. The result is not market for Latin America products. In Louisiana the farmers reduce the eggs collection like action to reduce the impact of their download sales.

The economic crisis affected the cashflow in USA, affecting the boot market from Mexico and the *C. c. fuscus* shipments. The same situation we find with handbag industry, directlyaffecting the Colombian farms and trade.

In the Asian market, we see that Japan is the first country to recognize the recession, and the reduction in the luxury crocodiles market. Thailand has internal conflicts that directly affected tourism and reduced their sales.

Also we identify the same picture for shoes and belt industry in Europe that use big caiman flanks.

What can we do? In the questionnaire, all people consulted expressed that their governments do not take any action; they reduce production cost, reduce staff and try to identify new markets. Also some began to produce finished flanks and skins, and others are using their flanks or skins to produce final products like belts, wallets, shoes and bags.

Only Venezuela reduces their annual harvest quota for domestic issues. The rest of the countries continued producing the same annual flanks or skins quotas, increasing their inventories.

Future? In USA the citizens involved in alligator program (Louisiana and Florida) made the decision to reduce their egg collections and wild hunt. The principal impacts of these actions will be a reduction in skins during a two year period(for egg collection) and a small amount of skins for this particular year (for the wild hunt).

Both impacts could be help the Latin America flanks and skins market in a middle time. I hope so.

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PREDICTING THE TOTAL LENGTH OF *Caiman crocodilus* FROM MEASUREMENTS TAKEN ON THEIR SKINS.

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ABSTRACT

Colombia has a national program exploiting caimans (*Caiman crocodilus*). It is based mainly on the brown caiman subspecies (*C. c. fuscus*) but includes some spectacled caimans (*C. c. crocodilus*). The two subspecies have similar morphology and are often mixed for regulatory purposes. The national regulation program imposes size limits, in terms of the total length (TL) of skins and specific skin pieces (flanks, tails, throats) that can be legally exported. Through CITES, these size limits thus become part of the international regulatory system. However, the relationship between skin measures and the size of *C. crocodilus* from which the skins came can be complicated by trimming and cutting, sometimes to meet market demands, and by shrinkage and expansion in various stages of preservation and tanning. In this study, basic measures of *C. crocodilus* were taken on 276 farm-raised animals when freshly culling. Detailed measurements were then taken on their skins (whole and sectioned) at various stages in the preservation and tanning process. Because tail tip amputations are common in *C. crocodilus*, snout-vent length (SVL) was used to predict a Standard TL (TLST), which is the total length of a freshly culled *C. crocodilus* with a more or less complete tail. Predictive relationships were then developed withy TLST as the dependent variable and various experimental skin measures, mostly using regression analyses. The same skin measures were taken on raw salted, wet blue, crust tanned and finished skins. Formulae for predicting TLST from all skin measurements taken at each stage of tanning are presented, along with mean correction factors to account for shrinkage and expansion in the different stages of preservation and tanning. One goal was to find the most accurate predictors of TLST, but another was to ensure equations were presented that could be used to predict TLST from pieces of skin and leather. The overall goal was to assist Colombia in its efforts to adapt and refine the use of size limits in management, and thereby assist the Parties to CITES in their efforts to assist Colombia in enforcing those size limits.

ISOTOPIC FRACTIONATION OF CARBON AND NITROGEN IN THE BROAD-SNOUTED-CAIMAN (*Caiman latirostris*).

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The natural variation of isotope ratios is useful in diet studies, because in a food chain the consumers tissues reflect their food composition (Crawford et al., 2008). However, in this kind of study we need to consider the isotopic fractionation (i.e., change in the isotope ratio due to the discrimination of one isotope over another) that occurs in natural processes such as evaporation, burning or any metabolic pathway (Farquhar et al., 1989). Studies about this issue are practically nonexistent for Neotropical crocodilians, therefore, this study aims at the description of the magnitude of isotopic fractionation of carbon and nitrogen between diet and tissues of the broad-snouted-caiman. In order to achieve this goal we determined the isotopic ratios of carbon and nitrogen in 20 samples of each nails and skin of 20 captive animals and 10 samples from their diet (e.g. chicken necks grinded). The average $\delta^{13}C$ and $\delta^{15}N$ for the diet was -19.41 ‰ and 4.11 ‰, respectively. There was no significant enrichment of nail $\delta^{15}N$ (0.03 ‰) and skin (0.19 ‰) in relation to their diet. However, there was an enhancement of the skin (2.97 ‰) $\delta^{13}C$ and the nail (1.9 ‰) in relation to the diet. The tissues of an animal kept in captivity under constant diet may have different isotopic ratios, because the isotopes can fractionate differently (Tieszen et al, 1983). These mechanisms of fractionation between diet and tissues are not yet fully understood (Rio et al., 2009). Therefore, the differences in isotopic fractionation provide the basis for interpretation of isotopic patterns in the broad-snouted-caiman, especially in future studies of dietary reconstruction of wild animals.

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TURTLES IN THE DIET OF THE BLACK CAIMAN *(Melanosuchus niger*) IN THE BRAZILIAN AMAZON BASIN.

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The black caiman (*Melanosuchus niger)* is well known throughout the Amazon Basin, once considered an endangered species it is now common to abundant in reserves of white water (Mamiraua), black water (Rio Negro), and clear water (Rio Trombetas). Published studies on the stomach contents and feeding behavior have somehow overlooked turtles in the diet of this species, but they do include vertebrates, mostly fish, but also frogs, birds, mammals, and invertebrates. Here we are reporting our first hand observations of black caimans predating turtles:1)*Peltocephalus dumerilianus* when it was caught in a fyke net in a black water tributary of the Rio Negro; 2) *Podocnemis erythrocephala* when it was caught near the surface in a trammel net in the Rio Arirara, a clear water tributary of the Rio Negro; 3) *Podocnemis expansa* adult female as she was leaving the clear water Rio Trombetas to nest on a beach; 4) *Podocnemis sextuberculata* while she was nesting on a beach in Lago Erepicu, a tributary of the Rio Trombetas. These predation events were not accidents or opportunistic feeding. These caimans were specifically searching for turtles. We watched as the caiman swam slowly along our trammel net and did not attempt to eat any of the five fish species available in the net, 28.8 kg of fish was passed by for the 0.8 kg turtle. For over 20 years one of us watched a large, 5m, black caiman patrolling the turtle nestingbeaches, thinking that maybe it captured and ate smaller species of turtles, until we saw it take an adult female of 18kg *Podocnemis expansa* as she was leaving the water. Another black caiman left the water at night and crawled several meters onto the beach to devour a nesting *P. sextuberculata*. These specific events suggest that black caimans specifically prey on turtles to a much greater extent than has been suggested in the literature. Perhaps because the stomach flushing studies did not include large adult black caimans, turtles were not found in the diet of this species previously.

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USING STABLE ISOTOPE ANALYSIS TO REVEAL ONTOGENETIC DIETARY SHIFTS IN THE NILE CROCODILE.

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The Nile crocodile, a keystone species in the aquatic ecosystems they inhabit, undergo a 3 - 5 order of magnitude increase in body size during their lifespan. This dramatic shift in size coincides with a change in resource and habitat use which influences the strength, type and symmetry of interaction with other species. Identifying the different resource-use size classes, that may even correspond to different ecological species groups, is imperative for the understanding and conservation of this and other crocodilian species. Using a unique sample comprising of 251 Nile crocodiles from the Okavango Delta (Botswana, Southern Africa), ranging in size from hatchlings (35 cm TL) to large adults (4.5 m TL), we illustrate how carbon and nitrogen stable isotope analysis of scute tissue can be used to identify ontogenetic dietary shifts. Carbon isotope ratios differ among prey species that use C3 and C4 food chains, while nitrogen isotope ratios differ within prey species relative to the trophic position they occupy. We also show how these dietary shifts correspond to changes in skull morphometrics. Our findings are validated by a direct comparison with results from a dietary study undertaken on the same crocodile population by means of the more traditional stomach lavaging technique. We demonstrate how stable isotope analysis is well suited as a quicker, easier and less intrusive alternative to current methods used to determine crocodile dietary shifts by means of stomach flushing of live animals, or gut analysis of culled individuals. The potential of this technique to identify the contribution of specific prey species to crocodile diet is also discussed.

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ADULT-YOUNG ASSOCIATIONS OF FREE-LIVING GHARIALS IN CHAMBAL RIVER, NORTH INDIA.

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Parental care (e.g., nest opening, guarding, defense of young) has been noted in captive groups of Indian gharial *Gavialis gangeticus*, but its occurrence and significance in the field have not been documented. Behavioral interactions of adults and young have been observed and recorded photographically during nesting (April-June 2009-10) and subsequently in the riverine population inhabiting the National Chambal Sanctuary, near site of mass mortality in 2007-2008 in north India.

Preliminary observations in undisturbed settings indicate that: 1) hatchlings remain closely associated with each other, typically with nest mates from the same clutch, 2) groups of hatchlings from nearby nests are usually closely associated, forming larger assemblages, numbering $\geq$ 120 young, 3) one or more adults, presumed to be the parents, are often in close proximity, 4) these presumptive parents include both sexes, large males (>5m totl., with distinct ghara) as well as nesting females (>3m totl), 5) hatchlings are gregarious, and associate with attending adults, and attending adults orient toward hatchlings, 6) hatchlings vocalize when grouping, 7) attending adults communicate with young with visual displays and/or acoustic signals, and 8) some attending adults appear ready to defend young approached closely by observers. Although this suite of adult-young interactions is most apparent immediately post-hatching (~ 6-8 wks), close associations of young with each other and with attending adults have been observed at 9 months, and may persist throughout a hatchling's first year.

In gharial, biparental care, and in particular paternal defense of young, may be the usual condition for this unique crocodilian lineage. These studies are directly relevant to management issues (what is best age to release hatchlings?) and/or conservation concerns (what water levels/depths are critical for river connectivity, movements to and from nesting areas, as well as required for survival of young?). These observations also help us understand the evolution of parental care (why do one and/or both parents care?), and its ecological determinants (e.g.,energetic cost /benefits, mating system, paternity).

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ADVANCING OUR UNDERSTANDING OF THE ECOLOGY OF *MECISTOPS* FOR ITS MANAGEMENT IN GABON.

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The slender-snouted crocodile (*Mecistops cataphractus*) is considered the least known crocodilian in the world. Until now, only a single study (e.g., Waitkuwait 1982 – 1987) has been undertaken to understand aspects of its basic ecology, and even that focused largely on breeding biology. Since the 1980s, the limited survey data on crocodile status in western Africa have suggested that *Mecistops* is in decline and in serious need of management intervention. I have undertaken to study management-relevant aspects of the ecology of this species, specifically movement dynamics, habitat selection and reproductive ecology, to facilitate the establishment of conservation measures. To date, 30 radio transmitters have been attached to individuals ranging in size from 1.0 – 2.75m. Preliminary analysis suggests that movements are largely controlled by water levels, though individual home range sizes are quite small. Habitat preference appears to vary by sex and size class. Data collection will continue over the next 8 months and focus on both fine-scale, daily movements and annual home range and dispersal. Four nests were found and blood samples were taken from all hatchlings and, in two cases, the attendant females. Analyses are underway to genetically determine aspects of the mating system of *Mecistops*, including paternal contribution. This study will complement nationwide survey efforts designed to establish at least one protected area specifically for slender-snouted crocodile conservation in Gabon.

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AGE STRUCTURE AND LONG TERM SITE FIDELY OF NESTING AMERICAN ALLIGATORS (*Alligator mississippiensis*) IN COASTAL SOUTH CAROLINA, USA: A PROGRESS REPORT.

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ABSTRACT: This is a status report on the first two years of a four-year study. Aspects of American alligator (*Alligator mississippiensis*) population dynamics have been widely studied, particularly fecundity. However, the length of time female alligators remain in reproduction is unknown and this may have a profound influence on population growth potential. To investigate this parameter, we recaptured individually marked female alligators at their nests in 2009-10, and herein report on age of nesting females based on estimated age at first capture from growth curves and length of time to most recent capture. We located 45 active alligator nests during June 2009-10 on the Yawkey Wildlife Center in Coastal South Carolina. Mean clutch size was 46 and early incubation clutch viability was 92%. We captured 32 of the attendant females between June 16 and July 15. Sixteen of these were long-term recaptures. Time between initial capture and recapture ranged from 16 to nearly 30 years. Seven recaptures were located within ≤100 m of first capture site; five were located within 300 to <1000 m of first capture site; and four were located within 1.2 km to 3.3 km of first capture site. Estimated age of recaptured females ranged from 15 to ≥53 years. Fifty-six percent of captured females were estimated at <30 years and 44% were estimated at ≥30 years of age. Twenty-eight percent were ≥40, with three of those being >52. Twentyeight percent were <22 years of age, indicating substantial female recruitment for nesting on the study area.

INTRODUCTION

In 2008, the South Carolina Department of Natural Resources (SCDNR) initiated a public hunt, allowing permits to harvest 1000 American alligators (*Alligator mississippiensis*). This harvest, the first opportunity for the general public to hunt alligators in South Carolina in over 50 years, is an attempt by the State to manage a population estimated at ≥100,000 (Butfiloski 2008a).

In 1995, South Carolina implemented the Private Lands Harvest Management Plan, 55 which utilizes the alligator resource on privately owned wetlands (Butfiloski 2008b). This plan has recently been modified to increase participation. Currently 39 properties in nine counties and including over 48,583 ha are enrolled in this program (Butfiloski 2008b). Alligators were over-harvested during the 1950s and 1960s leading to concerns about their conservation and classification as endangered in 1967 by the U.S. Fish and Wildlife Service (Neal 1987). Amendment of the Lacey Act in 1970 to include reptiles, which prohibits the interstate shipment of illegally taken wildlife, is generally thought to be the turning point in the recovery of alligator populations (Hines 1979, Joanen and McNease 1987). Since 1970, there has been a gradual increase in the South Carolina alligator population (Neal 1987), as well as an increasing nuisance alligator problem. Early policies were directed toward evaluating and relocating problem animals. However, this approach became unwieldy as problems increased.

Beginning in 1988, alligators were controlled using a Trapper Agent Program and were usually killed. There has been controversy over harvest sustainability of vertebrate animals that have long generation intervals (Congdon et al. 1994). Both private and public alligator harvests in South Carolina were designed to be sustainable. The Private Lands Harvest Management Plan has been based on harvest strategies developed for intense harvest in Florida (Woodward et al. 1992) and Louisiana (Joanen et al. 1977). Harvest rates for Florida and Louisiana alligators in the more southern part of their range may not be applicable in South Carolina, because age at sexual maturity in alligators is thought to be primarily dependent on size. South Carolina is near the northern extent of the alligator's range, where growing seasons may be shorter and growth rates slower, resulting in a longer period to reach sexual maturity, and thus in a slower population growth rate. Age at sexual maturity, nesting frequency, and length of time females remain in reproduction may affect the population growth rate (see Dinsmore and Johnson 2005 for review). Maximum sustainable harvest rate of a population is a function of intrinsic population growth rate (Caughley 1977). Population harvest modeling is an instructive first step in determining sustainable harvest rates (Nichols 1987). Aspects of crocodilian population modeling, such as female fecundity and fertility, have been widely studied (Wilkinson 1983, Joanen and McNease 1987, Woodward et al. 1992). However, the length of time female alligators remain in reproduction is unknown, and may have a profound influence on population growth rates (Nichlos 1987). This parameter is essential for calculating net reproductive rate for female alligators, or the average number of female offspring produced by each female in a population during her lifetime (Johnson 1994).

An intensive female alligator nesting ecology study was conducted during 1979-1983 on the Thomas Yawkey Wildlife Center (YWC) in South Carolina (Wilkinson 1983). Alligators have been protected from hunting on the YWC for nearly 100 years. The relatively stable, non-hunted population of alligators on the area contains several long-term groups of marked alligators, many of which have been marked for over 30 years. This presented a unique opportunity to examine age-related fertility in alligators. To investigate age-related fertility, we captured female alligators at nest sites on the YWC and examined the early-incubation viability of their clutches beginning in 2009.

STUDY AREA

This study was conducted on the South Island and Cat Island portion (6,033 ha) of the YWC, a SCDNR managed wildlife refuge, located on the north-central coast of South Carolina. The YWC is situated between the Winyah Bay and North Santee River estuaries (33° N.). Mean tide range at the YWC is 160 cm with a spring tide range of 134 cm (NOAA 2010). The dominant vegetation in the surrounding tidal marsh (2,524 ha) is smooth cordgrass (*Spartina alterniflora*). Managed impounded ponds (1,012 ha) were typically maintained at a water level of ~60 cm in depth and were vegetated with widgeon grass (*Ruppia maritima*) interspersed with giant cordgrass (*S. cynosuriodes*), saltmarsh bulrush (*Scirpus robustus*), and smooth cordgrass. Water salinity in impoundments ranged from 0 to 35 ppt, depending on weather and management practices. Historically, the YWC has been maintained as a wildlife sanctuary both privately and then by the SCDNR.

METHODS

Helicopter surveys, flown at seven-day intervals, determined the location of alligator nests. Nest sites were plotted on aerial maps to facilitate relocating nests on the ground. Once nest sites were confirmed on the ground, GPS coordinates were recorded for each nest. Additional nests were occasionally found by driving along levees and by walking to known nest sites. To determine egg viability, eggs were inspected after approximately 5 days of laying. All eggs were removed from the egg cavity and placed in a container atop nest material where they could be viewed at one time. To avoid rotating eggs from their original position in the nest, the upper surface of each egg was marked with a permanent marker. Egg viability was determined by transillumination using a battery-powered LED flashlight under dark conditions created by covering the eggs and observer with a nylon raincoat. Eggs were recorded as "banded alive," "unbanded," or "banded dead," and then replaced into the nest. Habitat description was recorded for each nest. Female alligators were captured only after oviposition. When females were present at the nest site and aggressive enough to approach, they were captured using a self-locking cable snare attached to the end of a telescoping 3.7 m fiberglass pole. Otherwise, walk-through snare traps were used to capture less aggressive females during their routine post-nesting attendance (Wilkinson 1994, Cherkiss et al. 2004). In 2009, snare traps were also set during the period of egg hatching in an attempt to capture females not captured shortly after egg-laying. We assumed that the eggs were laid by the attending female, as offspring genotypes are consistent with maternity by the female guarding the nest (Davis et al. 2001).

Measurements taken for all alligators included hind foot length, tail girth, snout length, snout-vent length, and total length (TL). We identified previously marked alligators by 57 examining notched tail scutes and clipped toes. If unmarked, we individually marked alligators by notching dorsal tail scutes (Chabreck 1963), and inserting passive integrated transponder (PIT) tags subcutaneously into the right masseter. Females were subsequently released at their capture site. We compared records of recaptures with earlier capture records to determine growth (if any), elapsed time between captures, and distance between capture locations. Salinity of water in the nearest guard hole to nests was taken using a Leica temperature compensating salinity refractometer.

We used digital map images to determine straight-line distance between capture sites of females using Google Earth mapping technology. Age–size relationships of female recaptures were determined using growth curves developed earlier for the YWC (Wilkinson and Rhodes 1997). When growth occurred between initial capture and first recapture, a size–age relationship was determined by applying these growth curves at initial capture (Wilkinson and Rhodes, 1997). We then added the interval between first recapture and last recapture to the age at capture to estimate the age of the female. If there was no discernable growth found between capture and recapture, we assumed asymptotic growth had been reached at or before initial capture. On average, it took 24 years for females to reach mean asymptotic size (251 cm TL) on the YWC (Wilkinson and Rhodes 1997). We added time between capture and recapture to 24 to establish an estimated minimum age of these recaptures. As asymptote is approached, estimate of mean age becomes less accurate with a tendency to underestimate age.

Variable water levels (Joanen, 1969) and other factors can affect the frequency of annual nesting. Thus, mature female alligators may nest only once every three to four years on average (Wilkinson 1983, Woodward et al. 1992). Although this paper reports data from two nesting seasons only, this study is ongoing and will include at least four nesting seasons to maximize the opportunity for capturing different marked nesting females.

RESULTS

We located 45 active alligator nests during June 2009-10 on the YWC (Fig. 1). Five nests were depredated before we obtained clutch information. The remaining 40 nests had a mean clutch size of 46 eggs, and a mean clutch viability of 92% (Table 1). We captured 32 attending females between June 16 and July 15 (both years combined). Sixteen of these were longterm recaptures, ranging between 16 to nearly 30 years between captures. We were unable to capture females at the remaining eight nests in September 2009 during the hatching phase of incubation. One nest hatched prior to our first visit in September, and predators destroyed five clutches (two in early incubation, and three near the expected hatching date). The two remaining intact nests hatched, apparently, without female involvement. In both cases, the hatchlings vocalized a minimum of five days before emerging on their own and going to the nearest guard hole. Mean clutch size of alligators estimated to be >40 years old was slightly 58 above average (48) with an egg viability of 92%, whereas clutch size of females estimated to be <22 years old was 48, with a mean egg viability of 95%. There was little discernible trend in clutch size with change in estimated age (Fig. 2) or change in TL of maternal female alligators (Fig. 3).

Seven females were recaptured at nest sites ≤100 m from their first capture site; five were recaptured 0.3-1.0 km from their first capture site; and four were recaptured 1.2-3.3 km from the first capture site. Time intervals between capture and recapture were 16 (n = 4), 17 (n = 5), 28 (n = 3), 29 (n = 2), and 30 (n = 2) years. Estimated ages of all nesting females (n = 32) were <22 years (31%), 22- 34 years (34%), and >40 years (34%), with three of those being ≥52 years old. While most recaptured females were originally captured along trails leading to and from impoundments, three were first captured at nests 30, 29, and 17 years prior to their recapture at nests during this study. Estimated age of all recaptures, ranged from 15 to ≥53 years. Eight of these females had not grown in TL since first captured: one for 29 years, one for 28 years, four for 17 years, and two for 16 years (Fig. 4). These were determined to be actively nesting females with viable nests at estimated ages of 40 (n = 1), >40 (n = 5), and >52 (n = 2) years.

Fig. 1. Locations of alligator nests on Yawkey Wildlife Center, South Carolina during 2009-10.

Fifty-six percent of captured females were estimated at <30 years of age and 44% percent of captured females were estimated at ≥30 years of age. Twenty-eight percent were ≥40, with three of those being >52, and 28% percent were <22 years of age, indicating substantial 60 female recruitment for nesting on the study area.

Table 1. Mean clutch size and egg viability rates for American alligator clutches sampled in 3 states. Egg viability for this study was estimated during early (<20 days) incubation.

State	Location	Reference	Period	# of	Mean Clutch Size	Egg Viability (%)
South Carolina	Yawkey WC	This study	2009-10	40	46.2	92
South Carolina	3 locations	Wilkinson (1983)	1979-83	203	44.2	NA*
Florida	Central	Woodward et al. (1993)	1983-86	682	44.8	48
Louisiana	Rockefeller Refuge	Joanen (1969)	1965-68	n.a.	38.9	NA
Florida	Northcentral	Deitz & Hines (1979)	1974-77	67	37.4	NA
Florida	Everglades	Kushlan & Jacobsen (1990)	1975-82	197	29.7	NA
Louisiana	Southeastern	Platt et al. (1995)	1987-88	32	29.4	NA

*NA = Not applicable.

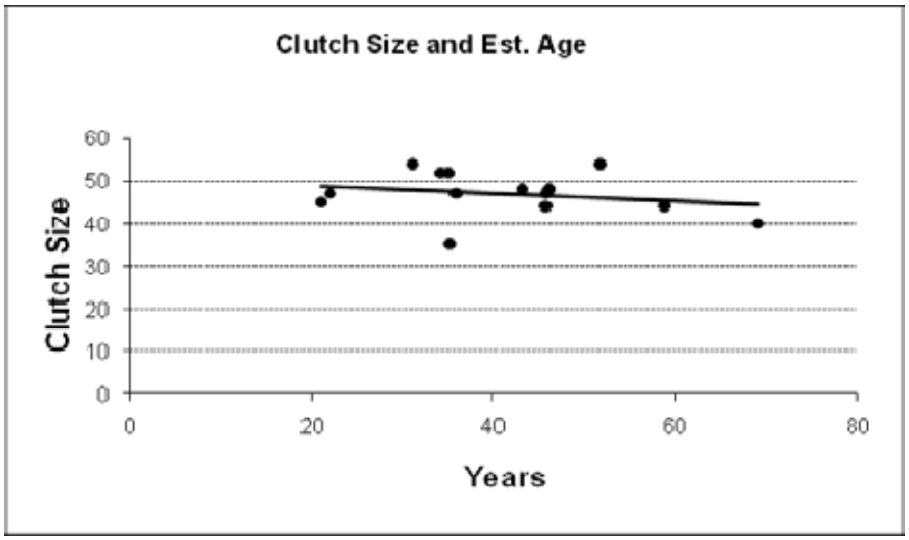

Fig. 2. Relation between clutch size and estimated age in years for nesting female alligators recaptured on Yawkey Wildlife Center, South Carolina during 2009-2010

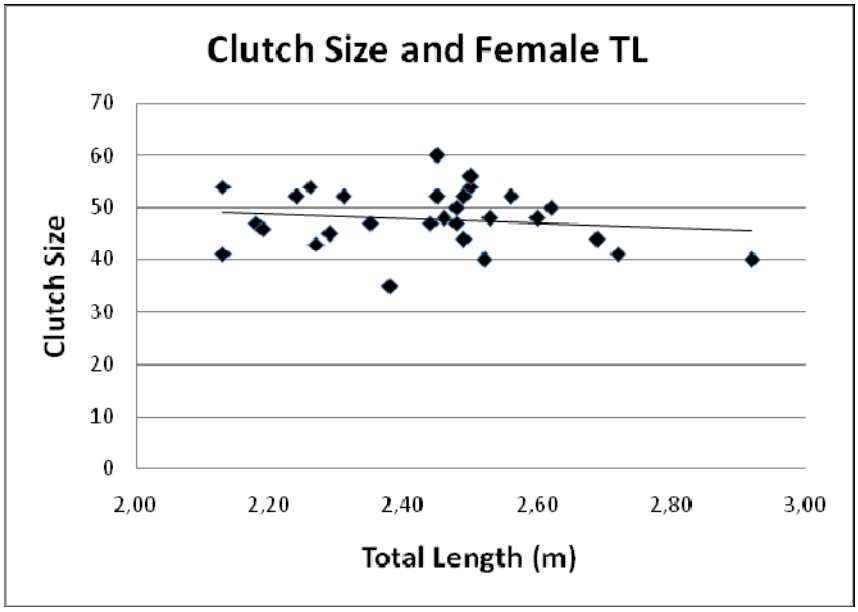

Fig. 3. Relation between clutch size and total length of nesting female alligators captured on Yawkey Wildlife Center, South Carolina during 2009-2010.

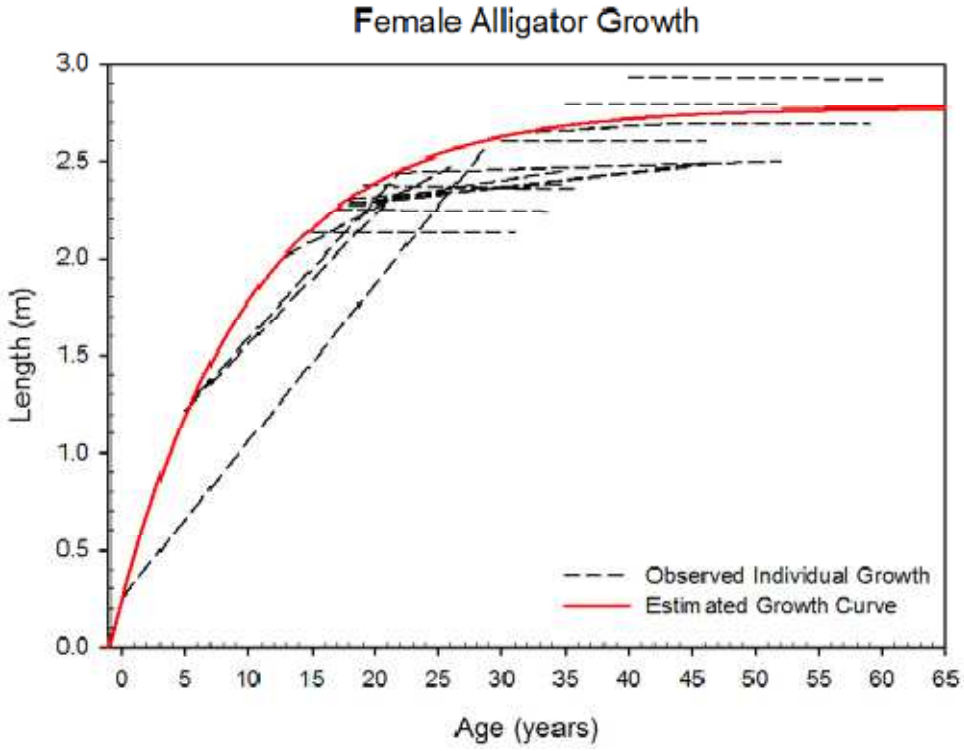

Fig. 4. Growth Curve of female alligators for South Carolina (Wilkinson and Rhodes 1997), and individual growth trajectories for female alligators previously marked on Yawkey Wildlife Center and recaptured during 2009-2010.

DISCUSSION

There has been a dearth of published information concerning the number of reproductive years of wild female crocodilians (Abercrombie 1989). Several long-term nesting records exist for captive female crocodilians; a Chinese alligator (*A. sinensis*) that nested at >43-years-old (Davenport 1982a) and a slender-snouted crocodile (*Crocodylus cataphractus*) that nested at >40-years-old (Davenport 1982b). Since the comprehensive nesting study on the YWC during 1979-1983 (Wilkinson 1983), nesting has been observed in the same proximity in various locations by YWC staff (P. Wilkinson, personal communication). Until this study, no attempts have been made to recapture nesting females; therefore, it was unknown whether the same individual or different females produced these nests.

We attempted to capture nesting females at both the egg-laying phase and the hatching phase of nesting. After oviposition, we found that most females became less attendant to their nests over time, which allowed only a short window of opportunity for capture. Additionally, trapping was done to ensure capture of the attendant female, assuming it was the maternal parent.

Objectives during the second phase of the field operation were to capture the remaining nesting females during their renewed nest attendance in the hatching phase of the incubation period. It was assumed that at hatching young alligators begin to vocalize within the nest, which usually attracts the maternal alligator to open the nest and move the hatchlings to the guard hole or other nearby water (Deitz and Hines 1979, Wilkinson 1983). This phase of the fieldwork was initiated on September 1 to coincide with onset of peak hatching (Wilkinson 1983). We found that only three nests hatched successfully, one prior to the onset of the second phase of our field operations and the other two without female involvement: therefore, none of the remaining females were captured during the post-hatchling phase of field work.
We concluded that trapping during the egg laying phase of the nesting cycle was more productive than during the hatching phase because female behavior at egg laying is more predictable, the timing of female behavior is more concise, chances of predation increases over time, and the female usually becomes less attentive over time after egg laying and may not return to the nest at hatching.

Alligator nest site fidelity has been widely reported Mclhenny (1935), Joanen (1969), Goodwin and Marion (1978), Deitz and Hines (1979), Carbonneau (1987), Reagan (2000), and Elsey et al. (2008). Although it is commonly believed that alligators nest in the same location on successive attempts, there is little data to support this. In fact, Woodward et al. 1984 have found that alligators rarely nest in the same exact site on successive years. Thirty radio-instrumented female alligators were individually monitored, each during one nesting season, over a three year period (1980-1982) on the YWC (Wilkinson 1983). Although this study indicated movement of these alligators was minimal during nesting, it was not able to address movements in other seasons or during subsequent years.

The longer movements of nesting female alligators in this study may be attributable to differences in water level management and the impoundment habitat in the study area.

There are 1,012 ha of tidally controlled marsh impoundments (N = 25) in the study area ranging from 5-170 ha, and 20 additional freshwater rain-catches ranging from <0.01- 156 ha. These impoundments and fresh water catches are the primary habitat used by alligators in the study area. Finfish and crustaceans are abundant in the impoundments, which tend to congregate at impoundment water control gates, especially during the high tide cycle when gates allow water seepage into impoundments. Alligators make periodic feeding forays to these fish and crustacean concentrations, where these prey are easily captured. Alligators also habitually use the freshwater rain-catches as basking and denning sites, and these areas are the primary habitats utilized on the YWC for nesting. Travel routes between denning, basking, and nesting sites and foraging areas are traditional which makes the walk-through snare trapping method highly efficient. In some instances, these recaptured nesting females were originally captured at specific feeding locations. Of eight females recaptured in 2009, one had been captured as a hatchling at its natal nest and was recaptured nearly 29 years later while defending her nest. The distance from the natal nest to the recapture site was 1,022 m.

Two instances of long-term movements (2.6-3.3 km) were thought to be the result of extreme drought combined with the draining of impoundments in 2010 surrounding the habitat where these alligators were originally captured. Both individuals were captured at nest sites during the 2010 season in the nearest impoundment containing water with a salinity of <5 ppt.

Nine nest sites were located in the near proximity (≤5 m) of where there was evidence of a previous nest. Four nests, located in 2010, were on or adjacent to nests located in 2009, and one nest located in 2010 was adjacent to a false nest located in 2009. However, we were able to capture the females both years at only one of these sites, and found different females used the same nest site and guard hole during successive years.

Most (96%) alligator nesting in marsh habitat in coastal South Carolina occurs in fresh to brackish wetland types, and salinity of nearest water to the nest averages 6.74 ppt (n = 306) (Wilkinson and Rhodes 1992). Once hatchlings leave the nest they will utilize freshwater guard holes near the nest until they can tolerate higher salinities (Wilkinson and Rhodes 1992), and are seldom found using guard holes with salinity of >12 ppt (Wilkinson 1983).

We measured salinity in guard holes where water was present; 86.5% had salinity of ≤10ppt and 13.5% were ≥15ppt. The 2009-10 nesting seasons occurred during a drought condition in the study area. Land management practice of draining impoundments exacerbated drought conditions during the spring and early summer of both years. This heightened drought condition and lack of sufficient fresh water in the area may have limited suitable nesting habitat, resulting in the reuse of some nest sites from the previous year.

Our recapture results on the YWC for 2009-2010 indicated that the estimated median age of nesting females was 32 years, and that these animals can successfully nest and lay viable eggs from an estimated 15 to >52 years of age. Females have been captured nesting and later recaptured at nests spanning 17, 29, and 30 years.

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ALGUNOS ASPECTOS DE LA POBLACIÓN DE *Crocodylus acutus* EN LA LAGUNA DE CUYUTLÁN, COLIMA, MÉXICO

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La laguna de Cuyutlán ubicada en el Pacífico Central Mexicano, tiene una longitud de 33 km y un ancho promedio de 2 km, las dimensiones actuales de las estructuras artificiales que la comunican con el mar permiten la existencia de condiciones hipersalinas en el estero durante el estiaje y salobres en época de lluvias. Gran parte de sus riberas se encuentran cubiertas con manglar lo cual ha favorecido la presencia de *C. acutus* en el cuerpo costero. Debido al desarrollo industrial en la región, se ampliará uno de los accesos marinos por lo que se esperan alteraciones en el hábitat lagunar. Con el fin de poder cuantificar la posible afectación sobre la población de *C. acutus*, se realizan, anterior, durante y posterior a la obra censos para observar cambios en el número, distribución y zonas de anidación del cocodrilo americano. Los resultados de 24 monitoreos de avistamiento entre septiembre de 2009 y mayo de 2010 muestran una población de aproximadamente 120 individuos, de los cuales se observan en promedio 80 individuos por monitoreo con una apreciación de tallas 2 (60-120 cm), 3 (120-180 cm), 4 (180-240 cm) y 5 (240-300 cm) de 12, 36, 27 y 3 individuos respectivamente, la densidad poblacional promedio es de 4 ind./km de costa y se encuentran distribuidos homogéneamente en ambas riberas (norte y sur). Las 27 capturas realizadas muestran una proporción de sexo 1:1. Se encontraron 4 nidos con un promedio de 33 huevos, del total solo uno fue infértil.

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ALLIGATOR MISSISSIPPIENSIS AS AN INDICATOR OF ECOLOGICAL CHANGE IN GREATER EVERGLADES ECOSYSTEMS

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A system-wide monitoring and assessment plan (MAP) has been developed to describe the monitoring necessary to track ecological responses to Greater Everglades restoration. The plan includes descriptions of selected indicators, how those indicators are linked to key aspects of restoration and performance measures. Alligators were one of those species selected as an indicator and a monitoring plan was designed to monitor relative abundance based on encounter rates, body condition using Fulton's condition factor (Fulton's K), and occupancy rates of alligator holes. Data were collected at ten áreas in marsh habitats in Arthur R. Marshall Loxahatchee National Wildlife Refuge (LOX), Water Conservation Area (WCA) 2A, WCA3A (north, central, and south), WCA3B, Everglades National Park (ENP-Shark Slough, Northeast Shark Slough, and Estuary), and Big Cypress National Preserve. Alligator hole occupancy data were collected in inaccessible áreas of Everglades National Park. Targets for alligator performance measures are based on patterns that are consider natural for Everglades ecosystems. Assessments were performed for each individual management unit. These increasing or decreasing trends of alligator populations relative to hydrologic changes permit assessment of positive or negative trends in restoration.

From 2006, relative abundance in LOX reached its restoration goals, WCA3A-Central did not meet its restoration goal and merits attention, and the remaining áreas deviated substantially from restoration targets and merits action. Five year running mean for relative abundance indicated LOX meet its restoration goals, WCA3A-Central and South did not meet its restoration goal and merits attention and the remaining deviated substantially from restoration targets and merits action. Alligator hole occupancy did not meet its restoration goal and merits attention.

BODY CONDITION OF AMERICAN AND MORELET´S CROCODILES IN THE MEXICAN CARIBBEAN.

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Healthy populations are essential for maintaining well functioning ecosystems, and healthy individuals are necessary to insure viable populations. External examinations are the first step in diagnosing the health of an animal. Body mass (weight) and morphometric data are important to determine indices of body condition, and are used as indicators of health and nutritional state of an organism. Body condition indices have been widely used to describe the physical condition of animals; in general it is assumed that animals in good physical condition have more energetic reserves than those in poor physical condition. Crocodilians are recognized as keystone species. The endangered American (*Crocodylus acutus*) and the Morelet´s (*C. moreletii*) crocodiles occur sympatrically in the Mexican Caribbean. We applied Fulton´s body condition factor (K=W/L3*10n) by establishing three categories: Excellent (E), Good (G), and Bad (B) based on the relationship between body mass (W) and circumference at the base of tail (L) of wild crocodiles from populations of both species in Quintana Roo State. We examined 243 *C. acutus*, and 333 *C. moreletii* from 5 and 11 locations, respectively. Overall, average K was higher in *C. moreletii* (K= 41.5739) than in *C. acutus* (K=37.4323). Both species presented the three K categories, but intervals were wider in *C. moreletii* [*C. acutus*: E (K>52.422), G (K 22.443-52.421), B (K<22.442); *C. moreletii*: E (K>70.47), G (K 12.66-70.46), B (K<12.67)]. Average K was higher in *C. moreletii* than in *C. acutus* (41.57 vs. 37.43), except in syntopic zones (K=36.07 in *C. acutus*; K=37.24 in *C. moreletii*). Populations of *C. acutus* from islands (Banco Chinchorro atoll and Cozumel Island) exhibited higher K values than those *C. acutus* on the mainland. There were not significant diferences in K values by sex or class sizes. Our results suggest that populations of both species are healthy, but the slight variations in K values between locations of both species suggest differences in habitat quality. These findings are essential for developing conservation strategies to preserve healthy crocodile populations and the quality of their habitats in this region.

CLUTCH SIZE AND CARE PARENTAL OF THE DWARF CAIMAN, *Paleosuchus palpebrosus*, IN HABITATS AMAZONIA AND SURROUNDING THE PANTANAL, BRAZIL.

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Information on reproduction of the dwarf caiman, *Paleosuchus palpebrosus*, is available only for Colombia, and one nest in the Brazilian Amazon. In this study we related clutch size to female size in habitats in Amazonia and surrounding the Pantanal, Brazil. Nests were searched for on foot between 2001 and 2010 (except 2003) in flooded forest around Cururu Lake, near the Solimões River, central Amazonia, and around two streams that drain into the Pantanal between 2005 and 2010. The presence of females accompanying hatchling groups was recorded during nocturnal surveys in both areas and in the Guaporé-Madeira River. We found 44 nests (8-20 per year; mean= 14.5±2.67) in Amazonia, and 13 nests (6-19 per year; mean=14.2±4.51) in the streams draining into the Pantanal. Clutch size was related to female mass (r^2 =0.694; N=7; P=0.020). The mean egg mass was not related to the number of eggs per nest (N=40; r^2 = 0.000; P=0.757), or to the size of females captured near (N=7; r^2 = 0.021; P=0.897). Female dwarf caiman were observed with hatchlings and responded to their vocalizations in 15 hatchling groups (24 hatchlings) of different ages. One female with four hatchlings (mean SVL=32.0 cm) was monitored by radio-transmitter for 2 months and remained together in the burrow.

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CRESCIMENTO DE POPULAÇÕES NATURAIS - URBANAS DO JACARÉ DE PAPO AMARELO (*Caiman latirostris*) NO RIO DE JANEIRO, BRASIL.

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O complexo lagunar de Jacarepaguá, município do Rio de Janeiro, abriga populações do jacaré de papo amarelo, *Caiman latirostris*. Um dos últimos remanescentes de regiões alagadas dentro de áreas protegidas no município esta sofrendo com a redução de áreas naturais para o crescimento cada vez mais acelerado da urbanização. O Projeto Jacaré de papo amarelo – RJ esta desenvolvendo o estudo sobre a estrutura populacional, crescimento individual e populacional, assim como a razão sexual, de uma população natural de jacarés em ambiente urbano. Observamos que a razão sexual dessa população apresenta um desequilíbrio em relação a quantidade de jacarés machos (n=203), jacarés fêmeas (n=55) e jovens não identificados (n=51). Para construir uma distribuição etária da população tem sido utilizada uma relação de tamanho/ idade (modelo de Richards). A curva etária de cada sexo tem mostrado uma carência de recrutamento de fêmeas na população, possivelmente indicando uma população com tendência a inviabilidade reprodutiva. Colocando em risco de perder a única população de jacarés de papo amarelo em Unidade de Conservação no município. Soltura de animais com origem desconhecida, e de forma descontrolada, é a principal causa para o desequilíbrio da população de jacarés nas lagoas de Jacarepaguá. Os ambientes urbanos tem sido objeto de estudo desde 2006 - atual, e as analises ainda estão em andamento.

Suporte Financeiro: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Bolsa CAPES), Student Research Assistance Scheme (CSG).

CROCODILES *(CROCODYLUSACUTUS)* AS AN INDICATOR OF ECOLOGICAL CHANGE IN EVEGLADES ECOSYSTEMS

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The system-wide monitoring and assessment plan (MAP) for the Comprehensive Everglades Restoration Plan (CERP) identifies indicators and establishes performance measures to monitor system responses and track progress toward meeting restoration goals. The American .rocodile is an indicator for the Greater Everglades module in the MAP. The distribution and abundance of crocodiles in estuaries is directly dependent on timing, amount, and location of rreshwater flow. Responses of crocodilians are directly related to suitability of environmental . editions, including changes in water levels and salinities. The crocodile indicator uses monitoring parameters (performance measures) that have been shown to be both effective md efficient in tracking trends: a three year running mean for juvenile growth and five ear running mean for hatchling survival. Assessments of parameters defined for crocodile performance measures support this contention.

We examined crocodilian data through the use of quartiles. Stoplights were developed by division along quartiles based on all animals captured, and defined as follows: red-substantial deviation from restoration target creating severe negative condition that merits action (first quartile); yellow-current situation does not meet restoration targets and merits attention (second-third quartile); green-situation is good and restoration goals or trends have been reached (fourth quartile). Currently, both growth and survival are yellow with no trend detected. In addition to existing CERP crocodile parameters, nesting success and body condition (i.e., a ratio of body length to body volume) or how crocodiles are "coping" with their environment are correlated with hydrologic conditions. These variables include depth, duration, timing, spatial extent and water quality. Nesting effort and success and body condition could be added to growth and survival as monitoring parameters.

CROCOD1LIANS IN THE RESERVOIR OF TUCURUI, PARA, BRASIL

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This was the first comprehensive study on crocodilians (caimans) in the reservoir of Tucurui Hydro-Power Complex. Caimans were found in the marginal compartment of the lake and several small stretches of river, drowned by the reservoir - where are the highest densities overall (10-12 ind / km), the marginal compartment populations are less dense (1-5 ind / km as in the black water rivers) - the same pattern repeats for hatchling pods (more abundant in the rivers). Populations of spectacled caiman (jacaretinga) Caiman crocodilus and black caiman (jacare-acu) Melanosuchus niger were observed (5763 individuals of two species counted in the campaigns). Being 869 spectacled caiman, 185 black caiman, only one Schneider's caiman (jacare-cunia) Paleosuchus trigonatus and 4709 eyes or indeterminate. The high proportion of eyes / indeterminate indicates high levels of disturbance in the reservoir. Three times more abundant at falling water and drought (9.67 ± 9.87 ind / km) than in the raising water and flood (3.08 ± 1.86 ind / km), caimans were more abundant in river habitats (9.49 ± 9.26 ind km) than islands (2.48 ± 1.94 ind / km). We have found dozens of groups of hatchlings (pods) (81 pods: 71 of spectacled caiman and 10 of black caiman). Most caiman pods was found in the falling water, season in which no black caiman pod was observed. High levels of disturbance were measured. 83°*o* of caimans observed were cautious. The biggest problems were: on the left bank the rivers Lontra and Bacuri, and on the right bank rivers Jabotizao and Jacunda, all are areas outside of any specific management for conservation and management of resources, but that concentrate the highest density of caimans in the middle course of reservoir and - at least in the river Lontra - important areas for caiman reproduction. The disturbance index increased during dry season in the rivers and in the falling waters period in the islands. The abundance measured in this study (0-34 individuals / km) can be considered intermediate to lower, compared to studies in other times and places.

Finantial support: Projeto Avaliacao e monitoramento das comunidades de vertebrados do reservatorio da UHE Tucurui (PA), convenio Museu Paraense Emilio Goeldi / Eletronorte.

ECOLOGIA TERMAL DE LA ANIDACIÓN DE *Crocodylus moreletii* EN UN LAGO URBANO DEL SURESTE DE MÉXICO.

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La ecología de anidación de *Crocodylus moreletii* en vida silvestre es poco conocida. La descripción general de los nidos ha sido descrita anteriormente, incluyendo número y tamaño de huevos, tamaño del montículo y materiales de construcción. Sin embargo, las características del nido en relación con la temperatura de incubación y la proporción sexual del *C. moreletii* en vida silvestre ha sido pobremente estudiada. Durante los años 2007, 2008 y 2009 realizamos un monitoreo de los nidos en la Laguna de las Ilusiones, en la ciudad de Villahermosa, Tabasco, México. La temporada de anidación de esta especie fue de finales de mayo, a principios de julio con el pico a mediados de junio. Se realizó la caracterización física de los nidos (n=36) y se obtuvo un grupo de nidos (n=18) que se monitorearon cada hora durante más de 30 días con data loggers. Los nidos se encuentran dentro de los tamaños reportados para la especie, pero significativamente más grandes que en otros estudios; la distancia del nido a la orilla también es mayor que en otros estudios. Un porcentaje importante de los nidos (>30%) tiene como material de construcción basura producida por los humanos. en promedio se encuentran 30.4 ±10.8 huevos por nido. El tamaño de los huevos es significativamente diferente por nidada, lo que refleja a su vez una diferencia notable en los tamaños de las hembras nidificantes. El éxito de eclosión es extremo (0% a 92.9%) y la fluctuación de la temperatura de incubación y el numero de huevos son factores influyentes. La tasa de eclosión es baja (<40%) y las crías nacidas en el periodo estudiado fueron 100% machos. Los datos de temperatura de los nidos sugieren que otros factores están influyendo en el sesgo sexual. Propuestas para el manejo de nidos se hacen necesarias para aumentar el número de hembras.

Este trabajo es apoyado y financiado por la Universidad Juárez Autónoma de Tabasco, la Secretaria de Recursos Naturales y Protección al Ambiente (Gob. Edo. Tabasco), y la Scott Neotropical Fund, Cleveland Zoological Soc. y Cleveland Metroparks Zoo. permiso SEMARNAT No. SGPA/DGVS/07231.

EFFECT OF TEMPERATURE AND PRECIPITATION IN SEX DETERMINATION OF *Caiman latirostris.*

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Expanded abstract

In this study, we compared the effects of reproductive season and nest environment on sex ratios of *C. latirostris* hatchlings incubated in the wild. In addition, we evaluated the effects of environmental condition on nest temperature and the percentage of females produced.

In the first phase of this study, we studied 83 wild nests over 9 years (1999-2008, except 2003) on Santa Fe province - Argentina. Eggs were collected after the thermosentive period (TSP), and moved to an artificial incubator until hatched. The hatchlings were kept in captivity for one year and sexed (1,320 individuals). We collected data on climatic conditions (precipitations and temperature) during the TPS to investigate the effects on the percentage of females hatched by reproductive season.

We compared seasons with 5 or more nests and found differences in the percentage of females produced among reproductive seasons ($P= 0.0388$; $H_{6,77}= 12.97$) and compared nests record the nesting environments ($P=0.7373$; $H_{2,77}= 0.60$). Of the 83 nests studied, 29% produced 100% females and only one nest produced 100% males (2001-02; Fig. 1 and Table 1). On average, females were produced more than expected and represented 74% of the hatchlings. However, environmental conditions were not a good predictor of percent females produced.

Figure 1. Percentage of *C. latirostris* females produced in the 83 nests studied during 9 reproductive seasons (1999-2008, except 2003).

Reproductive Season

Table 1.**Percentage of females and nests that produced only females in the nine seasons evaluated.**

Reproductive season	N	% ♀	Number Unisexual ♀ Nests	% Unisexual Nests ♀
2000-01	16	48.7 ± 37.7	2	19
1998-99	2	65.8 ± 48.4	1	50
1999-00	6	66.2 ± 32.8	1	14
2003-04	25	68.9 ± 28.3	5	20
2007-08	3	74.4 ± 31.0	1	33
2005-06	7	81.5 ± 14.9	2	29
2007-08	6	85.6 ± 22.7	4	67
2001-02	9	86.7 ± 14.8	4	44
2004-05	9	86.9 ± 17.7	4	44
Total Mean	**83**	**73.8 ± 12.8**	**24**	**36**

In the second phase, we installed data loggers in the egg cavity of 32 nests at the beginning of incubation. The eggs were collected after the TPS and moved to an incubator until hatched The hatchlings were reared in captivity for one year and sex determined. Only 10 data loggers were recovered. The remaining nests were lost by predation and flooding.

Temperature data from the loggers as well as additional climatic data (number of storms, amount millimetres, mean environmental temperature and variation of temperature) were used to investigate the proportion of females produced per individual nest. We found association between the environmental variables with principal components analysis. Using simple linear

regression, we saw that % of females produced had a negative relationship with nest temperature, environmental temperature, and number of days with a temperature of 33°C or more, and the variation in nest temperature.

We observed a relationship (third-degree polynomial regression) between % of females and nest temperature during the thermosensitive period (P=0.01; r^2=0.74; Fig. 2). The mean temperature of most *C. latirostris* nests was close to 31°C, a temperature that produced 100% females (Piña et al. 2003). We found a positive relationship between nest temperature and environmental temperature (P=0.0492; r^2=0.34; Fig. 3), suggesting that nest temperature was greater than the environmental temperature due to the dampening effects of nest material.

Figure 2. Relationship between the percentage of females produced and the average temperature of the nest during the TSP.

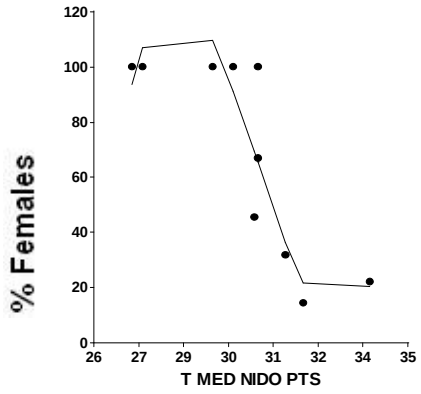
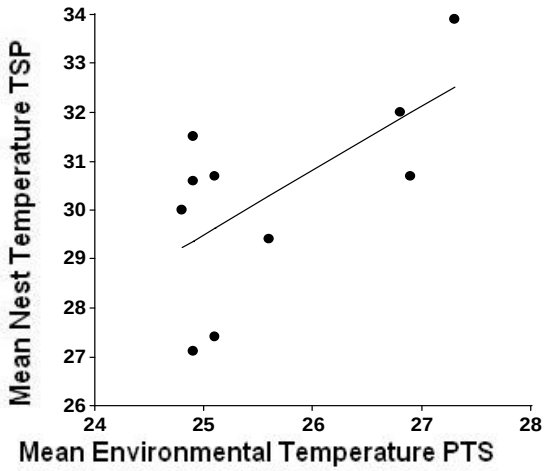


Figure 3. Relationship between the Mean Nest Temperature TSP *stris* nest during the TSP and the mean environmental temperature during the same period.



We concluded that environmental temperature affect nest temperature and its variation. Both nest temperature and its variation are good predictors of the % of females hatchlings produced

in the wild, but it is not possible to estimate the proportion of females produced knowing only environmental conditions.

Acknowledgment:

We thank other members of Proyecto Yacaré and the ‘gauchos’ for their valuable work on the field too. This study was supported by Proyecto Yacaré, Yacarés Santafesinos (Gobierno de la Provincia de Santa Fe/MUPCN), PICT 2008 N220 and N404, PIP CONICET 2005 N6375 (to Carlos Piña) and Programa de Apoyo de Investigación para Estudiantes from CSG/SSC/IUCN to M. Simoncini. We appreciate comments and suggestions of the manuscript by Kenneth G. Rice. Simoncini was a posdoctoral fellow from CONICET.

GHARIAL ECOLOGY ON THE CHAMBAL RIVER, INDIA: A PROGRESS .REPORT

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Following the die-off of *Gavialis gangeticus* in the Chambal River during winter 2007-08, ecological and behavioral studies were initiated on the resident population inhabiting a 30km stretch of river, upstream of the affected area. Ten gharial (8 females, 2 males; 2.0 to 3.3m, totl) were monitored via radiotelemetry over 14-22 months, 3-5X weekly (June 2008 thru April 2010). Local trackers recorded >2000 daily locations over the last 14 months, traveling by motorbike/on foot to elevated riversides near known basking areas.

Tagged gharial had seasonal patterns of residency, with an upstream primary (low water/dry season) location each frequented, and a downstream secondary (high water/monsoon) residence to which each moved during August-October. Then, individuals returned upstream, making seasonal movements that were shorter (4-7 km) or longer (14-16 km). Seasonal movements averaged 9.6 km, ranged from <2 to 16.4 km. Total movements per animal ranged from 0-100km, x=41km, involving 0-16 trips, averaging 7.4 trips. Transit patterns involved a series of short movements, <5 km over 1-4 days, with stopovers enroute (1 day to 2 wks). Individual residence patterns varied. One gharial occupied the same 2-3 km stretch of river year round. Two shifted back downstream post monsoon after moving upstream briefly. Another had two primary residencies, shifting often. During the 2009 nesting season, a 3.3m female disappeared but reappeared pre monsoon; in 2010, she moved again, and nested ~20 km upstream.

In the dry season, tagged gharial typically spent days basking in groups near deep water, and were observed feeding only rarely. Tagged gharials spent time each day in deep water. Premonsoon heat was avoided by daily submergence in shallow water. During high water, gharials dispersed and feeding was observed often.

Gharial discriminated among riverside activities, and responded quickly by moving away from perceived threats and/or by shifting residency to other locations if disturbed often. In contrast, they rarely reacted to other village activities, e.g. gardening, grazing. With unfavorable conditions, gharials shifted to other suitable sites; such movements/responses may be prevented by low river levels.

Financial support: San Diego Zoological Park, Zoo Praha, Ocean Parks Conservation Foundation, The Rufford Maurice Laing Foundation, Cleveland Metroparks Zoo, Crocodile Specialist Group, I.U.C.N.

LONG-DISTANCE MOVEMENT BY AMERICAN ALLIGATORS.

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As part of an ongoing study on growth and sexual maturation of the American alligator on the Rockefeller Refuge, 3601 specimens ranging in total length from 28 to 361 cm were captured from June 2000 through August 2004. Additionally, 70 more samples were collected opportunistically as part of a teaching exercise in August 2005, and 248 more samples were collected in 2006 (and one in January 2007) as a study evaluating the effects of Hurricane Rita on alligators. Representative samples from size classes greater than 60 cm were sampled in most months of the year during the major part of the study between 2000 and 2004. Each animal was tagged, measured, the sex recorded and released immediately at the site of capture. A large number of these marked animals were recaptured outside the refuge boundaries during the annual alligator hunts during the month of September. Of the 286 recaptures identified, 214 were males, 68 were females and four of undetermined sex. From each recaptured alligator, total body length and date recaptured were recorded, and minimum distance from initial capture site estimated. From these preliminary data we calculated time interval between captures, and plotted minimum distance moved. The number of days between first capture and recapture ranged from 29 to 3,336 days (9.1 years). Distance from initial capture site to final capture site ranged from 0.3 to 90.2 km. Eleven alligators moved between 30.0 and 39.9 km, and eight moved more than 40 km. Six of these moved between 40.0 and 49.9 km, and the others moved 87.4 and 90.2 km. These results greatly extend previous estimates of long-distance movement by alligators and demonstrate that both sub-adult and sexually mature animals move considerable distances. These data also showed that smaller alligators move further than larger alligators ($p = 0.0002$), and that the longer the time between captures the further the distance moved ($p < 0.0001$).

Report of CSG vet science group workshop 13 Sept 2010.

In bold action items, underscored proposed deadline, in wavy undescore points that were not specifically brought up but are logical extensions of discussions at meeting and I felt could be included in the meeting (pending attendees review of the minutes).

Agenda
1. review past 2 years activities
2. review website info and reassign tasks
3. CITES mechanisms for diagnostic and scientific samples
4. paper review prior to publication
5. present histopathology slides and gather commitments to send more
1. these were areas of veterinary science and medicine that require more input

• immunology acquired and innate
• response to stress, monitoring, physiological effects, impact on health
• emerging diseases and biosecurity, including at international levels
• reviewing health screening in the context of reintroduction following IUCNSSC reintroduction specialist group
• specific veterinary training of managers and veterinarians in various areas. Specific for crocs and adapted to the situation
• medical and husbandry training of the animals

2. previous allocation of tasks for new website
a. veterinary procedures (general exam, sampling, medication), Samuel Martin Terry Cullen pending
b. Post mortem procedures and reports, Paolo Martelli done, needs Spanish translation
c. Histology image data base, Paolo Martelli started, see http://140.112.96.83:82/OPHK/
d. compilation of (anecdotal) veterinary information including contraindications and cautionary warnings: ad hoc, needs a space no provision yet on website
e. Literature resources, Kent Vliet, no mechanism on website
f. Imaging database and techniques, Charlie Manolis pending
g. Anesthesia, Sam Seashole pending
h. Introduction techniques for new animals in captivity, Samuel Martin Terry Cullen pending

3. CITES mechanisms for diagnostic and scientific samples
Per Dietrich Jelden CITES has such provision under resolution 12.3 (Rev Cop15). It covers most of the samples we have in mind, Individuals must register with own CITES office and can then apply to CITES for pre-approved permits that just need filling.

Report

Present:

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Item 3: CITES and sample exchanges

Paolo will draft a letter for Chairman CSG to sign in support of request to obtain permits under resolution 12.3 so that individual vets can apply to their home office. Alternatively individuals can apply through organizations already registered such as museums or certain labs. End October

Item 1: Review of past activity

There have been communications on veterinary medicine from 15 countries from all continents. Feedback is that the support and feedback was useful. However we believe we generally can respond faster and also generate more communication. These exchanges are a source of information and education for the people who contact us and for the group members alike. Veterinary science and we stand to benefit from a higher volume of well formulated communications.

There are currently 12 members. Latin America is under-represented both in number and in level of participation. Suggestion to include Luis Sigler, based in USA but active in Latin America, was unanimously accepted. Paolo will take necessary steps to formally invite and include Luis on the veterinary thematic group. End October.

Additionally it was suggested the following be added to the current mailing list: Jim Wellehan and Greg Flemming (USA), Phil Ladds and Cathy Shitton (Aus), Louis lagrange and Chris Foggins (Southern Africa)

Item 2:

The Vet Sc members were generally slow to send material and then the website encountered some delays. As a result the website construction has not been as dynamic as we'd envisioned. However the process has begun and the site hosts a (not updated) version of necropsy guide to crocodilians as well as the general table of content. There is at least one example of useful application: the necropsy form format has been adopted
by the KNP Scientific Services after consulting the CSG website.

Tasks assignments were reorganized:

1. Veterinary procedures (general exam, sampling, medication), **Samuel Martin Terry Cullen** pending, send first contribution by End February open deadline for completed task.

2. Post mortem procedures and reports, needs Spanish translation **Luis Sigler** hás taken on the task of translating it into Spanish and **Samuel Martin** is in the process of translating it into French. That will cover the 3 IUCN languages. End February.

3. Histopathology images data base, started. Paolo presented to the vet group, see also http://140.112.96.83:82/OPHK/ , **Paolo** will call for more slides from CSG at large and will coordinate upload. Ongoing.

4. Compilation of (anecdotal) veterinary information including contra-indications and cautionary warnings: ad hoc, needs a space no provision yet on website.

Scrapped

5. Literature resources, Kent Vliet. Issue of copyright cannot be resolved. **Kent** Will provide a catalogue of available literature and, upon request will send PDF to individuals who contact him. First contribution End February

6. Imaging database and techniques, **Charlie Manolis**, First contribution End February. **All** provide images to Charlie by email stating species, diagnosis, Title of all emails will be "images for CSG site" to simplify Charlie's administration of the info. First contribution End February

7. Anesthesia, Sam Seashole, reassigned. **Paolo and Charlie** to locate Aus student who had contacted CSG vet group with requests regarding her a masters in Croc Anesthesia. Ask her to contribute. End October.

8. Introduction techniques for new animals in captivity, **Samuel Martin Terry Cullen.** Extended invitation to Kent Vliet. First contribution End February.

9. Biosecurity. **Eric langelet and Samuel Martin** will communicate and share each others protocol to formulate a guideline that is both practical and sound and applicable to most situations. First contribution End February

Item 4

All present are agreeable to review each others papers and papers submitted by others. Names of members agreeable will be posted on website. This will benefit the CSG vet group as literature is typically years behind current science. This will enable us to be aware of new information as it develops. The code of practice being that the confidentiality will be respected and the papers will not be shared with others. Ethics must be immaculate. Considering the nature and the lack of vested interest of our members, misuse of the privilege to review new information is not expected be an issue.

The meeting lasted from 16.40 to 18.15 on Sept 12th 2010 at the Estudio 5, Manaus Conference Center.

MICROBIOTA ORAL E CLOACAL DE JACARÉ DO PANTANAL *Caiman yacare*, DAUDIN 1802 CRIADO EM CATIVEIRO.

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Suporte financeiro: FAPEMAT

Os proprietários das criações comerciais de jacaré do pantanal do município de Cáceres relatam alta taxa de mortalidade, em torno de 10%, no primeiro ano de vida gerando prejuízos consideráveis para a atividade econômica. Visando oferecer informações sobre os potenciais agentes etiológicos patogênicos foi realizado um levantamento da ocorrência da microbiota normal nessas populações em cativeiro. Para tanto, caracterizou-se a microbiota bacteriana e fúngica da cavidade oral e cloacal dessa espécie criado em cativeiro no primeiro ano de vida. As amostras destinadas ao estudo microbiológico foram obtidas através de "swab" da língua e cloaca em 80 animais abatidos nas criações comerciais localizadas no município de Cáceres-MT. Elas foram transportadas sob refrigeração até o laboratório de Microbiologia Veterinária da Universidade Federal de Mato Grosso, onde foram semeadas e submetidas a isolamento bacteriano e fúngico. As colônias foram identificadas através de suas características morfológicas e bioquímicas. A microbiota bacteriana encontrada na cavidade oral e cloacal dessa espécie, no primeiro ano de vida foi: *Aeromonas* spp., *Bacillus* spp., *Branhamella* spp., *Micrococcus* spp., *Proteus mirabilis*, *Proteus vulgaris*, *Staphylococcus intermedius*, *Staphylococcus aureus*, *Staphylococcus hycus*, *Streptococcus* spp., Cocobacilo g+, *Corynebacterium* spp., *Pasteurella* spp., *Actinomyces* spp., *Moraxella* spp., *Flavobacterium* spp., *Escherichia coli*, *Morganella morganii*, *Pseudomonas* spp., *Citrobacter* spp., A*ctinobacillus* spp. e *Enterobacter* spp.. Poucas espécies de fungos foram isoladas sendo encontrados apenas *Aspergillus* spp. e *Candida* spp.. Dessa forma buscamos caracterizar o perfil bacteriano e fúngico nas criações comerciais com intuito de oferecer subsídios que permitam direcionar futuros tratamentos ou implementar novas medidas no manejo sanitários desses animais.

MICROORGANISMS ON *Caiman latirostris* EGGSHELL AND EGG MEMBRANE.

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The warm, moist microenvironment and presence of organic matter at nesting site of some reptiles is ideal for the growth of soil fungi that contribute to the hatching success of the eggs either by decomposing the eggshell and/or secreting mycotoxine that adversely affect the developing embryos (Elshafie et al., 2007). Fungi have been recognized to contribute to the mortality of lizard, snake and sea turtle eggs (Fitch & Fitch, 1968; Phillott & Parmeter, 2001*b*). We analyze *Caiman latirostris* egg microbiota with the aim to obtain a first list of fungi living on eggshell and/or egg membrane processing samples by particle washed method (Mueller et al, 2004). We found fungi on a 53% of the eggshell particles and 46% of the membrane particles on the other hand bacteria were more represented in the membrane than in the eggshell (57 % and 47 % respectively). We perform a Chi-square analysis and found no independence in preferences of microorganisms for different substrata ($X^2 = 13.86$). We focus on fungi and were determined to species. Exclusively for this group our results for Richness (S) and Abundance (N) were higher on membrane (S = 7 and N = 13) than in the eggshell (S = 4 and N = 9). We assume membrane is a more nutritive substratum for fungi growth than eggshell and this could be an explanation for our findings. This work is a first step on these issues for *C. latirostris* and we will use these results to analyze more aspect of the interaction fungi – egg and his effects on reproductive traits.

MOVEMENT OF JUVENILES ORINOCO CROCODILES (*Crocodylus intermedius*) IN THE COJEDES RIVER SYSTEM, VENEZUELA.

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Wild (n=36) and captive-released (n=19) juvenile Orinoco crocodiles (*Crocodylus intermedius*) have been recaptured one or several times in the Cojedes River System (CRS) in Venezuela. Elapsed time between captures ranges from 8 days to 7.14 years. Capture location allowed calculating or estimating their travelled distances along the river. Most recaptures (93.4%) came from two continuous sections of the CRS: the last portion of Caño de Agua (8.7 km downstream from Lorenzo's Bridge) and the first 12.3 km of the proper Cojedes River after its intersection with the Sarare river. Captive reared crocodiles have been released in the CRS during the rainy season. Their recaptures have occurred in subsequent dry season periods. Sixteen of them were first recaptured downstream (mean distance 4243±2873 m) and four upstream (mean distance 3220±3254 m) but difference is not significant (Wilcoxon test, $\chi 2=0.378$; P=0.54). Wild crocodiles were captured-recaptured only during dry seasons. They moved less within the same dry season (n=14; mean=416±511) than between dry seasons (n=12; mean=1020±1138 m)(Wilcoxon test, $\chi 2=1.849$; P=0.18; n.s). Data for captive-released crocodiles recaptured during the dry seasons are scant, but they suggest a high degree site fidelity (n=4; mean 118±69). For nine wild crocodiles it was not possible to determine the exact distance moved from capture to recapture, but it was possible to set bounds to it.Together with previous analyses, it could be said that individuals tended to remain in the same section of the river (or that they have returned to it). A preliminary conclusion based in our results is that captive-reared crocodiles disperse widely just after their release, but they tend to settle during the dry season in a particular river section, just as wild crocodiles do. It is probable that all crocodiles dispersed to the surrounding floodplain during the rainy season, and return again during the dry season to places where they are familiar with. The Management implications of these findings are discussed.

NEST AND HATCHLINGS CARE IN WILD AMERICAN CROCODILE (*Crocodylus acutus)*.

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Crocodilians stand out from other reptiles by showing universal parental care but few studies have focused on this behavior in wild crocodiles. This study presents first data on nest and hatchlings care in wild American crocodiles (*Crocodylus acutus*) in Quintana Roo, México. From 2006 to 2009 direct observations of crocodile's behavior were made at the encounter of nests and groups of hatchlings in Banco Chinchorro Biosphere Reserve. In 2009, trap cameras were installed at 4 nests, from the encounter to the hatching of each nest, in Banco Chinchorro and Cozumel Island. Cameras took a video and photography at each time movement was detected. Twenty-one species were identified to visit crocodile nests. Although no nest predation was observed, 9 species represent some danger for the nests and/or hatchlings: *Procyon pygmaeus*, *Rattus rattus*, *Homo sapiens*, *Felis catus*, *Iguana iguana*, *Ctenosaura similis*, *Nyctanassa violacea*, *Coragyps atratus* and *Cathartes aura*. Females seem to remain in nest vicinity during incubation. There was an absence of nest defense from human intrusion. Variability in nest visits frequencies was observed between crocodiles. Frequency of visits of other species at crocodile nests decreased with the increase of crocodile visits. Crocodiles visited the nests at night and mainly at greater darkness, corresponding to the visits of species that represent greater danger for nests. One crocodile reshaped its nest after it was disturbed. Crocodiles visited the nests more frequently at the beginning and at the end of incubation, which can be linked to different strategies to decrease nest predation at different moments of the incubation and to maximize nesting success. In Banco Chinchorro, almost all nests were opened by an adult crocodile; when listening to the vocalizations of the hatchlings, crocodile digs with its fore and hind limbs and takes the hatchlings and/or the unhatched eggs in its snout to carry them into the water, making several trips. Hatchlings care seems reduced and did not last long time after hatching. Although there was inter-individual variability in the maternal behavior of American crocodiles, this permits a relatively high nesting success.

NEST-SITE SELECTION OF *MELANOSUCHUS NIGER* AND *CAIMAN CROCODILUS* IN VÁRZEA LAKES, CENTRAL AMAZONIA, BRAZIL

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Melanosuchus niger and *Caiman crocodilus* are the largest and historically most hunted Amazonian caimans. Past hunting pressure has been suggested to shape the heterogeneous distribution of these sympatric crocodilians in the Amazon basin, sometimes underestimating their natural ecological habits. Nest distributions provide insights on habitat use by breeding populations; this could be used as a basis for conservation and management plans. Management of crocodilians is often based on source-sink models in which breeding habitat is protected and hunting concentrated in other areas. In vast regions such as Amazonia where two sympatric species of crocodilians with commercial value occur, management may be complicated and should be based on species-specific ecological peculiarities. Ground nest surveys combined with satellite imagery allowed us to evaluate the potential of source-sink models for the management of *M. niger* and *C. crocodilus* in two Brazilian protected areas with different caiman hunting histories. We analyzed 1291 caiman nests distributed along the shores of 84% of 172 water-bodies surveyed between 2005 and 2008. Our results indicate that nest-site selection around open-water lakes by *M. niger* is tightly influenced by flooding regimes of these lakes, whereas *C. crocodilus* is a generalist nester, being less dependent of permanent water-bodies. There is little evidence that past hunting pressure is the principle determinant of differences in habitat use for nesting by these crocodilians and management should be based on different conceptual models for each species (source-sink for *M. niger* and size-selective hunting for *C. crocodilus*).

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NESTING ECOLOGY OF TWO SPECTACLED CAIMAN POPULATIONS UNDER DIFFERENT HUNTING PRESSURE IN CENTRAL AMAZONIA

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In the past century, legal trade in caiman almost brought both species of Amazonian crocodilians with commercial value (*Melanosuchus niger* and *Caiman crocodilus*) to extinction. Over the last 40 years, caiman populations have been recovering throughout the whole basin, especially in floodplains from Central Amazonia. The efficiency of enforcement activities and the intensity of caiman use are not homogeneous throughout Amazonia. We compared the nesting biology of two populations of *C. crocodilus* occurring in two protected areas. The Piagaçu-Purus Sustainable Development Reserve (PP-SDR) is known to be an area with intensive hunting pressure. On the other hand, in Piranha SDR caiman populations are virtually not hunted for at least the last 15 years; but around 20 thousands eggs were collected during the 90s ranching program in the area. Our main objective was to evaluate the effect of uncontrolled hunting on size structure of nesting females and their reproductive outputs. We captured 66 nesting females, 63% in PP-SDR (2008 and 2009 reproductive seasons) and 37% in Piranha SDR (2009). We analyzed clutch characteristics for 110 nests (78% in PP-SDR and 22% in Piranha-SDR). Nests were carefully opened and eggs counted, measured and weighed. Our results indicate that the size structure of females and the mean number and size of egg produced by them are similar in both locations. Larger females tend to lay more eggs in both locations. However, larger females from Piranha-SDR produce smaller eggs than females of a similar size from PP-SDR. Principal nesting area must function as a source area for harvested population. We need to understand better what is the potential production and as a consequence the maximum sustainable yield of the population. Nest monitoring programs are relatively inexpensive and with good results to estimate the reproductive potential of populations of caimans under different hunting pressure status.

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RELATIONSHIP BETWEEN BODY TEMPERATURE AND CONDITION FACTOR OF FREE RANGE YOUNG Caiman latirostris IN SOUTHEASTERN BRAZIL.

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The broad-snouted caiman (Caiman latirostris) is a palustrine, medium-sized crocodilian, widely distributed in the eastern part of Brazil. Since 2006, we are investigating the dynamics of a natural population of broadsnouted caimans in an artificial reservoir (Três Marias dam) located in the upper São Francisco river basin, in the state of Minas Gerais, southeast Brazil. In order to identify any relationship between size, mass and body temperature 38 young individuals (one and two yrs of age) were capture by hand at night (from 18:00 to 22:00 hrs) and their cloacal temperature was determined using a Hanna® termistor calibrated. At the same time, air and water temperature, SVL and body mass were also measured. All animals were marked and released at the site of capture. Body size and mass ranged from 20.0 to 30.0 cm SVL (χ=24,8 ±0,48 cm) and from 0.2 to 0.7 kg (χ=382± 0,02 kg), respectively, whereas cloacal, water and air temperature ranged from 25.4 to 30.6 0C, (χ=27.6±0.25 0C), 27.6 to 30.4 (χ=29.2±0.2 0C) and 22.3 to 27.4 (χ=24.6±0.34 0C), respectively. There is a positive relationship between cloacal and water temperature ($t=3.26$, $n=27$, $p<0.001$), but accounting for the effect of water temperature as a covariate, no significant relationship was found between cloacal temperature and SVL and body mass ($p>0.01$). On the other hand, the residuals of the allometric relationship between SVL and body mass, which were used as an indicator of individual body condition, showed a positive significant relationship with cloacal temperature ($F_{1,25}=6.7$, $p<0.05$). Therefore, in average, caimans with warmer body temperature are in better condition when compared to those with lower body temperature, regardless of the effect of size and mass. Assuming that life history traits such as survival, growth and reproduction are positively related to individual body condition, thermoregulatory behavior plays an important role in the dynamics of wild populations of broad-snouted caiman.

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SEXUAL MATURATION AGE OF BLACK CAIMAN (*MELANOSUCHUS NIGER*) IN **THE PURUS RIVER, BRAZILIAN AMAZONIA.**

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Age at sexual maturity is a critical population parameter for sustainable management of wildlife. Males of *Melanosuchus niger* can reach up to 4.5 m in total length (TL), and females rarely exceed 3.0 m. Age at sexual maturation was estimated from Richard's and von Bertalanffy curve models constructed from capture-recapture studies in the Anavilhanas National Park and Mamirauá Sustainable Development Reserve. These models indicate that the age of mature females is between 15 and 16 years old. At that time we were not able to estimate size or age of males at maturation because of the difficulties to recaptured marked adults. Recently, the size at first maturation was determined for males and females in the Piagaçu-Purus Sustainable Development Reserve, in the Brazilian Amazonia. Humeri of eight *M. niger* were decalcified with RDO®, cut using a cryostat microtome and stained with Harris' haematoxylin. The minimum maturation age in males was 10.1 years and 16.3 years for females. The long time necessary for *M. niger* males and females to reach size/age of sexual maturation are longer than similar crocodilian species. Thus, the economic management of the species inspires much more safe options as was suggested by the pioneers in Brazilian caiman studies: Magnusson and Rebêlo almost 30 years ago.

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SPATIAL AND REPRODUCTIVE ECOLOGY, HABITAT USE AND POPULATION DYNAMIC OF THE NILE CROCODILE ATLAKE ST. LUCIA, SOUTH AFRICA.

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Lucia Estuary, situated in northeastern South Africa, is one of the largest estuarine systems on the continent and the last remaining estuary with a viable Nile Crocodile (Crocodylus niloticus) population. It hosts the largest crocodile population in a single waterbody in South Africa and is the most southern viable breeding population in Africa. The estuary is a shallow water body that experiences large fluctuations in water volume and salinity. The estuary is currently in its eighth year of drought, which has led to the closure of its mouth to the Indian Ocean in 2002. The mouth closure, as well as decreased lake levels and hypersaline conditions in parts of the system are affecting the distribution, reproduction and health of the crocodile population. In order to interpret these changes and provide scientifically sound advice to management, we embarked on a research programme in February 2009 to investigate the spatial and reproductive ecology, habitat use and population dynamics of crocodiles at the St Lucia estuary. The crocodile distribution is monitored through regular aerial surveys and individual movements through re-sightings of colour coded tagged animals (82 crocodiles tagged to date) and GPS/GSM transmitters (fitted on 8 crocodiles to date). Positional data from these transmitters allows us to investigate activity budgets and detailed movements for territorial and non-territorial males, reproductive and non-reproductive females and juveniles. Data from these telemetred animals is providing information on the selection, use and relative importance of habitats. We are also investigating threats responsible for the destruction or transformation of key habitats for important life history processes. Historical, current and potential nesting sites together with their spatial properties (distance to fresh water etc.) are mapped and the effects of natural egg predation recorded. Our markrecapture/ sight study (161 crocodiles caught to date) is providing data on the population size, sex structure per size class, reproductive frequency, rates of egg, hatchling and yearling survival and dispersal of hatchlings, yearlings and two-year old crocodiles as well as growth rates. These and other parameters will be used to construct a population model to simulate responses to various biological and environmental conditions. This study is part of a larger research programme on crocodiles in the KwaZulu-Natal Province and other focal areas include ecotoxicology, bacteriology, nutritional ecology and genetics.

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SPATIAL ECOLOGY OF *Gavialis gangeticus* IN THE CHAMBAL RIVER, INDIA.

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ABSTRACT

Following the die-off of *Gavialis gangeticus* in the Chambal River during winter 2007-08, ecological and behavioral studies were initiated on the resident population inhabiting a 30km stretch of river, upstream of the affected area. Ten gharial (8 females, 2 males; 2.0 to 3.3m, totl) were monitored via radiotelemetry over 14-22 months, 3-5X weekly (June 2008 thru April 2010). Local trackers recorded >2000 daily locations over the last 14 months, traveling by motorbike/on foot to elevated riversides near known basking areas.

Tagged gharial had seasonal patterns of residency, with an upstream primary (low water/dry season) location each frequented, and a downstream secondary (high water/monsoon) residence to which each moved during August-October. Then, individuals returned upstream, making seasonal movements that were shorter (4-7 km) or longer (14-16 km). Seasonal movements averaged 9.6 km, ranged from <2 to 16.4 km. Total movements per animal ranged from 0-100km, x=41km, involving 0-16 trips, averaging 7.4 trips. Transit patterns involved a series of short movements, <5 km over 1-4 days, with stopovers enroute (1 day to 2 wks). Individual residence patterns varied. One gharial occupied the same 2-3 km stretch of river year round. Two shifted back downstream post monsoon after moving upstream briefly. Another had two primary residencies, shifting often. During the 2009 nesting season, a 3.3m female disappeared but reappeared pre monsoon; in 2010, she moved again, and nested ~20 km upstream.

In the dry season, tagged gharial typically spent days basking in groups near deep water, and were observed feeding only rarely. Tagged gharials spent time each day in deep water. Premonsoon heat was avoided by daily submergence in shallow water. During high water, gharials dispersed and feeding was observed often.

Gharial discriminated among riverside activities, and responded quickly by moving away from perceived threats and/or by shifting residency to other locations if disturbed often. In contrast, they rarely reacted to other village activities, e.g. gardening, grazing. With unfavorable conditions, gharials shifted to other suitable sites; such movements/responses may be prevented by low river levels.

INTRODUCTION

Contemporary telemetry techniques are being increasingly utilized in a widening variety of applications in the biological study of animals, and have the potential to reveal unparalleled detailed and new information about an individual's activities and behaviours in space and in

time. Not surprisingly, a major emphasis has been on spatial ecology, in particular on movement patterns, home ranges, dispersal, and homing abilities. For any given species, these life history parameters are essential components in understanding environmental responses, especially adaptation to changed conditions in a world increasing influenced by humans. In addition, these features play critical roles in demographic/population processes that are vital to conservation and management.

In this report, we present the preliminary results of an on-going study conducted in the National Chambal Sanctuary (NCS) in 2008-2010. It was initiated in response to the die-off of 2007-2008 on the lower reaches of the Chambal River, near its confluence with the Yamuna. The study presented here has provided detailed information about gharial spatial ecology, directly relevant not only to the recent mass mortality event, but also to the long term conservation and management of the gharial in the NCS. Our specific objectives are outlined below:

1. Use radiotelemetry and ground/water based tracking to quantify seasonal movement patterns, home range characteristics, and habitat use of wild gharial.
2. Conduct a variety of related scientific studies in an effort to better understand gharial spatial ecology and general biology to provide inputs for a range-wide gharial species recovery plan.
3. Provide data that will allow conservation managers to better evaluate and implement conservation measures such as habitat restoration, captive breeding and reintroduction.
4. Continue to liaise with forest department personnel and other key stakeholders in an effort to better understand the key conservation measures required to maintain/restore habitat and revive wild gharial populations.

METHODS

Study area and species

The National Chambal Sanctuary is a 428km stretch of the Chambal River, ending at the confluence of the Chambal and Yamuna Rivers at Pachnada. The sanctuary area is located in a semi-arid zone in Northern India in the states of Rajasthan, Madhya Pradesh and Uttar Pradesh. Mean ambient temperatures range from 2 - 46 °C with a mean annual precipitation of 591.2mm, the bulk of which is received during the south-west monsoon months of May to August. The bulk of the sanctuary's landscape is dominated by ravine thorn forest, and there is no evergreen riparian forest left – ground cover is generally sparse throughout. The Chambal river itself is a fast flowing river which originates in the Vindhya hill range of Central India, it flows north-east and eventually joins the Yamuna river at Pachnada, before eventually joining the Ganges River.

This research project was focused on a 115 km stretch of river from Pinahat (N26.864170° E78.363723°) to Sasoan Ghat (N26.543776° E79.088323°), which was the affected area of the die-off. This stretch of river, particularly the downstream reaches, was the epicentre (impact area) of the gharial die-off in the winter of 2007/2008. The telemetry study and the active tracking of animals have largely been confined to a study site comprising a 30km of river, from Dinnpura (N26.779278° E78.725937°) to the Udi Bridge (N26.697508° E78.935026°).

Gharial (*Gavialis gangeticus*) is the only surviving member of its crocodilian family and is a geographically endemic, Critically Endangered species of South Asian rivers, conferring on it a scientific uniqueness possessed by few vertebrate quadruped taxa anywhere. The species, on the verge of extinction in the early 1970s with less than 300 individuals surviving globally, was slowly recovering in the National Chambal Sanctuary (NCS) as a result of concerted in-situ as well as ex-situ conservation action but has recently experienced two dramatic and near catastrophic population declines. Although gharials do occur in a few other protected areas in India, a PHVA in 1995 assessed the population in the National Chambal Sanctuary as the only viable and self-sustaining population in the world.

Animal capture, restraint, and release

Gharial of the selected size class (2-4m total length) were very difficult to capture, particularly the larger size class (3.5-4m TL), and the present study is based solely on 2.7-3.3m adults and sub-adults. The successful capture strategy employed techniques developed by local fishermen, and entailed setting curtains of mesh netting at the deep water approaches to favoured basking sites. Animals entangled in nets did not struggle, and consequently nets were checked frequently to avoid injury/drowning. Once secured with rope bindings on the limbs and snout, the captured gharial were remarkably sedate and docile, requiring a minimum of additional restraint, but protection from overheating by providing a large shade canopy and frequent wetting are essential while holding animals for tagging. On several occasions, it was necessary to retain animals for 8-10 hours prior to tagging, and under these conditions, the holding procedure that was used was well tolerated. Upon release, all tagged gharial reacted normally and typically showed defensive behaviours briefly and then bounded for the water and swam away quickly. A qualified veterinarian was on hand and assisted in all capture/tagging procedures.

Radio attachment

The rectangular, epoxy encased radio transmitters (60gm, 18x10x8cm) with trailing, flexible whip antenna (30cm) was attached to the base of tail just anterior to the junction of the single/double tail scutes. Stainless steel split rings (3, on bottom edge of each radio) were embedded in epoxy casing and were anchored with Kevlar fishing line that was inserted with the aid of a trochar style, large gauge needle as a guide, underneath the dorsal skin immediately below the bottom of the transmitter. Three strands of line were threaded through holes drilled at the base of the tail scutes on either side of the radio, and then tied to each of the three sets of rings. The knots were dabbed with 5 minute epoxy, and the knots further secured with metal swages, crimped on line ends. Local anaesthetic was available for use adlib. Radio attachment was completed within 45-60 minutes, and well tolerated by all gharial so treated. In addition, a temperature data logger and visual cattle tags were used to provide individual identification, as well as permanent scute markings.

Transmitter function

The transmitters (151 MHz; Advanced Telemetry Systems, USA) were designed to be functional for 2.5 - 3 years, and under Chambal conditions, have an effective signal range of 0.5-3 km, dependent on local terrain and prevailing weather conditions. Listening posts, on high ground (locally known as a tapu) were established about every 2 - 3 km along the riverside. Limited vegetation in the river valley and high vantage points facilitated signal reception; maximum reception was >5 km under ideal conditions. Daily observations indicate that specific behaviours and activities of an animal correlated closely with signal strength and signal variation. For example, a gharial swimming can be distinguished from one sitting

stationary on land, e.g., basking. Submergence under water results in signal loss at 2-3 m, and continual visual observations while monitoring signal strength confirmed that submerged animals were detectable even when the gharial surfaced for brief periods, e.g., 1 - 3 minutes. In the dry season when gharial spend hours submerged, monitoring was extended for 0.5 -2.0 hours at listening posts in order to adequately track resident gharial when they surfaced periodically while remaining underwater at midday.

By carefully noting signal variations, a variety of animal activities/behaviours can be detected from signal variation alone and subsequently confirmed by repeated visual sightings. All of the above protocols have been incorporated into the routine data recorded at each tracking site. The absence of a signal for a 1-3 day period indicated that an animal was likely no longer present in the area. At all listening posts, the trackers scanned all ten frequencies for signals, to prevent bias in anticipating an animal's whereabouts by selectively tracking only known local residents.

Disturbances associated with capture/tagging

Capture/tagging activities in mid March '09 extended over two weeks and resulted in disturbance at the two capture sites for the following 4-6 weeks and typical/normal behaviours, primarily basking, by gharial at these sites were only resumed by tagged as well as untagged individuals in late April/early May. Following this interruption, tagged gharial resumed association with untagged individuals and regular patterns of activity were exhibited by all resident gharial.

Tracking from listening posts on riverside high ground resulted in minimal/negligible animal disturbance, whereas tracking by boat (technique used initially) was much less productive and appeared to create a much greater disturbance which interfered with radio-location, e.g., gharial submerged on approach, and signal detection was not possible, nor were there any visual sightings.

The Chambal gharial populations resident at specific localities appear to be habituated to normal riverside activities, and display finely tuned discrimination abilities when reacting to human activities close to basking and/or nesting sites particularly. Gharial are alert to calls/signals of other sentinel riverbank inhabitants such as shorebirds and wading birds, and typically react to their alarm calls signifying unusual, atypical, often threatening activities. Gharial rapidly head for water if basking, or submerge if in the water until the potential threat wanes or disappears. Habituation to villagers using footpaths, walking with livestock, moving with camels, even crossing of shallow stretches of river on foot/camel is evident, and these activities are ignored and not responded to with escape behaviours.

In contrast, the capture-tagging forays to affix radios continued for days, and even residual human activities loosely associated with capture, such as tracking/observing, resulted in daily disturbances to normal patterns of basking and submergence by resident gharial. Frequent major disturbances at some localities appeared to result in resident gharial shifting their "normal" daily locations to nearby, undisturbed areas.

Based on repeated observations reinforcing the summary of disturbance factors (above), the optimum time for capture/tagging would appear to be in the immediate post-monsoon months (Oct-Dec) to avoid interference with important social/reproductive behaviours known to occur from mid January through the pre-monsoon months (May, June, early July) when nesting, hatching, and parental care of young has been observed in Chambal localities.

Tracking Methodology

The tracking team, based at Garhaita Village, used an inflatable boat with a 25hp OBM, and a motorcycle in conjunction with riverside foot patrols to locate telemetered gharial along a 30km stretch of river which was monitored 3-5 days a week. High ground overlooks were located at strategic sites which provided upstream and downstream coverage by utilizing 4 element Yagi antennas as well as 3 or 5-element folding antennas with portable field receivers (ATS Fieldmaster 100) that provided optimal tracking ranges of 0.5 -3.0km, dependant on local terrain and weather conditions. The tracking field team, consisting of 3 trackers, logged a total of 241 days of the 412 day tracking period.

GPS readings (Garmin Vista HCX) were taken for animal locations by triangulation on constant signals, and when feasible (ie. when tagged animals were visible), this data was collected by waypoint projections using a compass bearing along with a laser range-finder (Bushnell Sport 450).

In addition, hand drawn sketches and marked printouts of satellite maps were maintained for the most important basking sandbanks. Observations/tracking effort, consisting of daily forays of 6-10 hours, were seasonally adjusted to accommodate local weather conditions and, importantly, to the seasonal changes in gharial activities – early morning and later afternoon observations during periods characterized by the warmer, dry months (March –July; Sept-Nov) and midday observations during the wet period (July-Sept) and also for the winter months (Nov-Feb).

Tracking effort

One radio-tagged gharial (59) has been monitored for over 22 months (9 months from June ’08 to Feb ’09 intermittently; followed by 13 months regularly). The ten gharial outfitted with radio transmitters (151 MhZ; individual frequencies) have been tracked for approximately 50% of the total days (2432 of the total gharial days tagged, which were 4120) between release in mid-March, 2009 and 30th April, 2010. For the ten gharial monitored for 13 months, locations for 1795 daily monitoring gharial days were recorded, for an average of 180 tracking days during the mean 412 days tagged per animal, or approximately 44% of the days monitored. A total of 1812 daily locations were recorded for the ten monitored gharial during the 13-22 months of the study. In addition to daily tracking locations, detailed observations were recorded of environmental parameters, water levels (river) and gharial activity and behaviour, throughout the daylight hours, including morning and afternoon observations. Photos of gharial groupings, including those which included tagged gharial were taken frequently, daily to weekly, to further document gharial locations and habitat usage. A summary of the tracking effort is presented in **Table 1**.

RESULTS

Movement Patterns and Spatial Ecology of Chambal River Gharial

Synopsis

During the dry season/low water conditions, normal activities consisted of loose aggregations of gharial of all sizes at particular deep water areas, pools with riverside sand banks, sand bars and exposed mid-river sand islands. This “clumped” distribution of gharial is characteristic of

all months of observation, except the high water/monsoon months of July, August, September and October.

The radio-tagged gharial monitored for 13 months (Mar '09 – Jan '10) exhibited individually distinct patterns ranged from residency at a single location (61 at Chilonga) to wide-ranging movements upstream as well as downstream, by a gharial (59 at Nakhnoli) whose residency was loosely centred at a mid point 6km below the furthest upstream location, and 10km above the furthest downstream location. The home range of the radio-tagged animals has, for the most part, been within the 30km stretch which was the main study site, although some animals (63 and 49) have been found outside this range. The 3.3m female (63) has been recorded 22km upstream of Dinnpura and another female (49) has been recorded about 5km downstream of the Udi bridge. Summaries of the residency patterns are presented in **Table 2**, and further details of individual patterns, as well as size estimators during the dry season vs. monsoon months are shown in **Table 3** (in the section below).

Seasonal trends

Most tagged gharial showed well-defined seasonal patterns of residency, with upstream primary (low water/dry season) location(s) and downstream secondary (high water/monsoon months) residences to which each moved during August-October, and then each returned to its primary residence upstream in subsequent months. Two tagged gharial (49 and 57) varied this seasonal pattern by remaining at downstream locations and/or visiting these during the post-monsoon, dry season as well.

Two other gharial (75 and 69) with upstream residencies shifted frequently between their primary residencies and nearby localities, presumably in response to high water fluctuations that inundated mid-river islands at Dinnpura. Seasonal shifts to monsoon residencies during the high water months of August-Sept-Oct involved shorter distances (4-7km) or longer distances (14-16km), by gharial from dry season primary residencies at Dinnpura as well as those residing at Chilonga.

Distance trends

Three gharial tagged at Chilonga had their primary residency at Chilonga, and either didn't move downstream (61) or made shorter movements to secondary residencies downstream (55 and 63). Three Dinnpura residents (53, 69 and 75) moved shorter distances (7km) to secondary residences while another Dinnpura resident, 51, shifted a longer distance (16km) to its secondary downstream residence. Two other Chilonga residents (49 and 57) moved downstream and back upstream with less obvious seasonality, involving longer downstream shifts in residency. These gharial appeared to have shifted their dry season residencies in 2009 to locations downstream in 2010, and resided at or nearby their secondary residencies downstream that were occupied during the 2009 monsoon.

The mean for the ten monitored gharial was 10.2 km, but varied from < 2km for a Chilonga resident (61) which was not recorded anywhere else (tracked location on 241 days through the 412 tagged days over 13 months), to 16-21km for three wide-ranging residents (49@CH; 51@DN and 59@NK). The total recorded movements for the 10 radio tagged gharial also showed considerable individual variation. These distances ranged from 3 – 100, with an average of 55 km. Likewise, the minimum number of trips upstream and downstream recorded averaged 11.7 trips, ranging from 0 – 23 trips, roughly equally divided between downstream high water movements and upstream return movements.

Transit patterns typically involved a series of short movements between specific locations, with stopovers at transit locations as short as 1-2 days and as long as several weeks. For example, 57 shifted in late January from Baroli to Chilonga, a river distance of 11km, in 1-2 days. A number of recorded movements showed relatively short transit times of 1-4 days for distances of > 10km. The typical transit patterns are illustrated in **Figures 1 & 2** accompanied by the travel narratives of two gharial (51 and 57) which are presented in detail below.

Movement summaries for two selected individuals

To illustrate movement patterns of these two animals, residency and movements patterns have been superimposed on satellite imagery and the resulting outputs have been shown for these two animals (51 and 57). Downstream routes are denoted as yellow lines with downstream stops marked as yellow balloons; upstream routes are denoted as red lines with upstream stops marked as red balloons.

Movement Summary (2009 - 2010) – ID: 51 (2. 8m Female, captured at Nakhnoli)

This individual (51), a resident of Dinnpura and Akon Ki Mauriyan during the months of May-July, has been tracked for a total of 255 days till date (30/04/10). During the tracked days, it was found on 197 days (or 77% of the time). The total number of days this animal has been tagged is 410 and it has been tracked for 48% of the total number of tagged days. During the months of May-July, 51 moved from Dinnpura to Akon, a distance of 2.4 km, several times but remained resident in this general area. In early August, 51 made a downstream transit, first to Nakhnoli (6.9 km) and then to Chilonga (5.3 km from Nakhnoli) – a total distance of 12.2 km. Transit time from Nakhnoli to Chilonga was 1 day, and Chilonga was used as a temporary residence for 15 days.

September saw another downstream movement by 51, from Chilonga to Pachai Gaon, a distance of 4.2 km which was covered in a single day. Pachai Gaon was used as a temporary residence for about 4 days. Following the residence at Pachai Gaon, 51 moved back upstream to Chilonga in October, again covering a distance of 4. 2 km. Chilonga was again used as a temporary residence for a further period of 15 days. 51 then moved upstream to Murong and spent 2-3 days resident at this site. In early November, 51 moved upstream from Murong to Nakhnoli covering a distance of 3.4 km with a transit time of 2-3 days. In mid-late November, 51 again moved upstream, back to its May-July residence just below Dinnpura at Akon and Karot 4.5 km upstream of Nakhnoli. ***Figure 1*** *is an overview map of the movements made by 51.*

In late December, 51 moved upstream 2.4 km to Dinnpura and was resident in Dinnpura for 2 days following which there was a 6.9 km transit downstream to Nakhnoli. The downstream movement to Nakhnoli coincided with a rise in water levels and submergence of some basking sites at Dinnpura. 51 has been resident at Nakhnoli and nearby sites just upstream during late January and early February, and then returned to Dinnpura briefly for 3 days before shifting 5 km downstream to Karot where it resided thru all of April. The total distance traveled by 51 over this 13 month period was 54.5 km, the sum of all its recorded transits. It made a minimum of 15 trips, 8 up and 7 downstream (Table 2).

Movement Summary (2009 - 2010) – ID: 57 (2.9m Female, captured at Chilonga)

This individual was observed to use the Chilonga basking site fairly exclusively during the months of May, June and July. During this period, the animal was tracked for a total of 57 days and was recorded exclusively at Chilonga (it was not recorded for 12 of the 57 tracking

days – it was not found for 21% of the tracking days). In early August, the animal left Chilonga and moved downstream to another well used basking site at Badpura. The transit time for this move was 5-6 days, and the distance covered was 14.3km. 57 used Badpura as its primary residence for a period of 15-20 days.

In mid-September, 57 moved upstream to a site near the village of Baswara, where it was resident for a period of 10-15 days. This distance travelled over this transit was 6.7 km. In early October, levels of disturbance were observed to increase at the Baswara site, and 57 left Baswara and made another upstream transit to Pachai Gaon, a distance of 3.4 km. The Pachai Gaon site was used as another temporary residence and the animal spent ~15 days at this site. ***Figure 2*** *is an overview map of the movements made by 57.*

Late October to early November saw 57 making another downstream transit from Pachai Gaon to Baroli, a distance of 6.9 km with a transit time of about 5 days. Baroli was used as another significant temporary residence site and 57 spent the months of November, December and most of January there. In late January, 57 left Baroli and moved upstream to Chilonga, with no recorded stops along the route, and over a transit time of 1-2 days. This distance travelled was 11.1 km, and the animal has remained at Chilonga for 3 days, before returning to Baroli to the same locality it had occupied previously. It remained there til mid March, when it shifted downstream 3.2 km to Badpura, stayed there one day, and then returned to Baroli through the rest of March and all of April. The total distance recorded travelled by 57 over this 13 month period was 66.2 km, the sum of all major transits it made during this time. It made a minimum of 11 trips, 5 upstream and 6 downstream (Table 2).

Seasonality of movement patterns observed

The details of individual gharial's seasonal patterns of residency (dry season vs. monsoon) with respect to the main center of activity, home range size and area estimates, and movement direction and summed movement totals are presented for the ten telemetered gharial in **Table 3**. Each gharial had a well defined activity centre from which it made excursions, typically return trips, periodically.

Home ranges consisted of all tracked locations, and were larger during the monsoon months. River lengths (between most distant points of home range) averaged 4.0 km (range 1.3 to 7.3 km) in the dry season vs. 6.5 km (range 3.2 to 10.1 km) during the monsoon. Home range area (river length x river width seasonally) averaged 92 ha (range 38-208) in the dry season vs. 322 ha (range 159-503) during the monsoon. The predominant movement direction was downstream during both seasons. Trip frequency, reflected in summed movements, was not obviously related to either size or extent of home range estimates. Tracker observations strongly suggest that many short trips were directly in response to water level changes (e.g., dam releases inundating basking sites, and/or specific human activities close by basking areas that directly interfered with the daily basking routine).

Although the seasonal patterns of residency summarized here were notably consistent for all of those gharial monitored, four individuals (59, 57, 49, and 63) showed departures from the general pattern. Two (57 and 49) shifted their dry season residences downstream during 2010, close to where they initially shifted during the monsoon from previously occupied upstream residences. Another (59) had an activity center that didn't shift seasonally, but

tended to move upstream during the dry and downstream during the monsoon. Finally, the largest female (63) disappeared coincident with the nesting/hatching periods in 2009, and again in 2010.

DISCUSSION

The preliminary results outlined above indicate that the telemetry methods we employed have provided sufficient data to reveal the seasonal residency patterns of these Chambal gharial in some detail. The major findings in brief are: 1) each gharial displayed its own individual spatial preference for specific areas of the river stretch we studied, 2) activity centres and home ranges varied seasonally, 3) the primary direction of movements was downstream during the monsoon, and upstream post monsoon, 4) significant individual differences were evident as variations of the general pattern common to all. However, the study results to date are limited because 1) the 2009 monsoon was late and did not result in usual high water levels, and 2) the absence of larger gharial (3.5 to 4+m total length) limits the findings to the 2 to 3.3m residents only.

Previous studies of gharial movements have been primarily focused on tracking released juveniles (1-2m total length) as part of various head-starting/reintroduction programs within India and Nepal (Ballouard and Cadi, 2005 and WWF-India, 2009) These efforts have met with varied success which has been difficult to assess because the resident, wild populations have not been studied and/or reintroductions have been made in river stretches devoid of an established resident population. In general, although some reintroduced/released gharial remain near release points, many have been resighted >10 km away, predominately at downstream locations.

The movement patterns of wild, resident gharial utilizing telemetry to track movements has been reported by Singh (1985) at a Chambal locality upstream from the study area in the present study. One juvenile upon release moved downstream a total of 9 km in 35 days, moving 6 km in 15 days and a further 3 km in 20 days. Another juvenile translocated upstream 60 km moved 14 km downstream where it remained after 4 months, still 46 km upstream of its capture site. In a previous study (Bustard and Singh 1983), based solely on sightings of 4 uniquely marked adults (2 males, 5.4 and 6.6m total length; 2 females, 3.6 and 4.6m total length) in Satkoshia Gorge, a 22 km stretch of the Mahanadi River in Orissa, India, home range river lengths of 19.2, 12.8, 10.4, and 11.6 km, respectively were estimated based on numerous re-sightings. Maximum recorded movements in this study were 28, 44, 23, and 43 km, respectively.

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TABLES

TABLE 1: SUMMARY OF THE TRACKING EFFORT

Sex	ID	Length (mts)	Days Tagged	Days Monitored March 2009 to April 2010														Total	Not Found	Track Days
				M	A	M	J	J	A	S	O	N	D	J	F	M	A			
F	61	2.9	412	17	18	25	24	24	14	16	23	22	24	27	23	16	15	**288**	**47**	**241**
F	53	2.3	410	8	15	24	28	23	4	10	18	20	18	20	19	21	11	**239**	**45**	**194**
M	55	2.1	412	15	17	21	27	8	7	15	23	23	25	27	24	19	16	**267**	**53**	**214**
F	69	3	409	8	16	23	26	23	5	12	16	20	17	21	14	25	23	**249**	**57**	**192**
F	75	2.5	410	10	17	24	27	22	5	11	16	20	20	24	17	12	18	**243**	**62**	**181**
F	63	3.3	412	3	-	-	-	13	11	21	20	23	24	25	15	20	21	**196**	**77**	**119**
F	57	2.9	417	18	19	24	24	19	12	21	16	19	18	18	19	11	13	**251**	**61**	**190**
F	49	2.9	409	14	12	23	22	13	5	12	15	18	17	20	15	15	19	**220**	**48**	**172**
F	51	2.8	410	15	13	23	28	22	6	14	19	18	19	24	21	17	16	**255**	**58**	**197**
M	59	2	419	15	14	17	18	26	4	16	17	20	21	22	8	14	12	**224**	**129**	**95**
TOTAL				**123**	**141**	**204**	**224**	**193**	**73**	**148**	**183**	**203**	**203**	**228**	**175**	**170**	**164**	**2432**	**637**	**1795**
June 2008- March 2009																				
M	**59**	**2**	**255**				**5**	**4**				**8**	**4**					**21**	**4**	**17**
TOTAL				**123**	**141**	**204**	**229**	**197**	**73**	**148**	**183**	**211**	**207**	**228**	**175**	**170**	**164**	**2453**	**641**	**1812**

Abbreviations: CH – Chilonga, NK – Nakhnoli, BD – Badpura, PG – Pachai Gaon, DN – Dinnpura, UD – Udi Bridge, MR – Murong, CE – Chilonga East Sandbank, AK – Akon ki muariyan, BR – Baroli, LK – Lakhanpura rock pool, BS Baswara

TABLE 3- ACTIVITY CENTERS, HOME RANGE ESTIMATES, RIVER DIRECTION & SUMMED MOVEMENTS OF TEN TELEMETERED GHARIAL IN DRY SEASON VS. MONSOON, ON A 30 KM STRETCH OF CHAMBAL RIVER, UDI-DINNPURA, UP & MP STATES, INDIA

SEX	ANIMAL ID	SEASON	DRY SEASON AND MONSOON RESIDENCES		HOME RANGE		RIVER MOVEMENT DIRECTION	SUM ALL MOVEMENTS (KM)
			CENTER	RANGE	DISTANCE (K M)	AREA (HA)		
F	61	D	CH	CE-CH	1.3	38	NONE	3
	61	M	CH	CE-MR	3.2	159	NONE	
F	53	D	DN	DN-AK	2.4	70	DOWN STR	29
	53	M	NK	MR-KA	5.4	269	DOWN STR	
M	55	D	CH	CH-LK	2.1	59	DOWN STR	31
	55	M	PG	CH-PG	4.2	208	DOWN STR	
F	69	D	DN	DN-KA	5	141	DOWN STR	74
	69	M	NK	MR-KA	5.4	269	DOWN STR	
F	75	D	DN	DN-NK	6.9	197	DOWN STR	126
	75	M	NK	MR-KA	5.4	269	DOWN STR	
F	63	D	CH	CE-MR	3.2	91	NONE	10
	63	M	PG	MR-PG	6	301	DOWN STR	
F	57	D	CH (2009)	LK-CH	2.1	59	DOWN STR	66
	57	M	BR (2009)	PG-BD	10.1	503	DOWN STR	
	57	D	BR (2010)	BS-BD	6.7	189	UP & DOWN	
F	49	D	CH (2009)	NK-PG	9.5	268	DOWN STR	56
	49	M	PG (2009)	MK-PG	6	301	UP STR	
	49	D	BD (2010)	RP-BR	5.2	148	DOWN STR	
F	51	D	DN	DN-AK	2.4	70	DOWN STR	54
	51	M	NK	NK-PG	9.5	472	DOWN STR	
M	59	D	NK	NK-AK	4.5	127	UP STR	100
	59	M	NK	NK-PG	9.5	472	DOWN STR	

Abbreviations: CH – Chilonga, NK – Nakhnoli, BD – Badpura, PG – Pachai Gaon, DN – Dinnpura, UD – Udi Bridge, MR – Murong, CE – Chilonga East Sandbank, AK – Akon ki muariyan, BR – Baroli, LK – Lakhanpura rock pool, BS – Baswara

TABLE 2: SUMMARY OF DRY SEASON & MONSOON RESIDENCY, MAXIMUM MOVEMENT DISTANCES, SUMMED DISTANCES MOVED, AND TRIPS RECORDED FOR TEN TELEMETERED GHARIAL, CHAMBAL RIVER

ANIMAL DETAILS			SUMMARY									
ID	Sex	Total length mts	Track Days	Cap Site	Primary Dry Season Residence	Secondary Monsoon Residence	Max (km) Dist. Loc	Loc max	Distance (km) movement	Min # trips	UP STR trips	DWNSTR trips
61	F	2.9	241	CH	CH	CH	< 2km	CE-MR	3.2	0	0	0
53	F	2.3	194	NK	DN	NK	6.9	DN-NK	28.5	8	4	4
55	M	2.1	214	CH	CH	PG	4.2	CH-PG	31.3	13	7	6
69	F	3	192	NK	DN	NK	6.9	DN-NK	73.5	16	8	8
75	F	2.5	181	NK	DN	NK	6.9	DN-NK	125.5	23	11	12
63	F	3.3	119	CH	CH	PG	-6	MR-PG	10.2	3	1	2
57	F	2.9	190	CH	CH/BR	BR	14.3	CH-BD	66.2	11	5	6
49	F	2.9	172	NK	CH/BD	PG	21.5	MR-UD	55.9	10	3	7
51	F	2.8	197	DN	DN	NK	16.4	DN-PG	54.5	15	8	7
59	M	2	112	NK	NK	NK	16.4	DN-PG	99.6	18	9	9
	8F2M		**1812**				**X =10.2**		**X= 54.8**	**X=11.7**	**X= 5.6**	**X= 6.1**
			TOTAL				(2 - 16.4)		(3-100)	(0-23)	(0-9)	(0-12)

X= MEAN VALUE

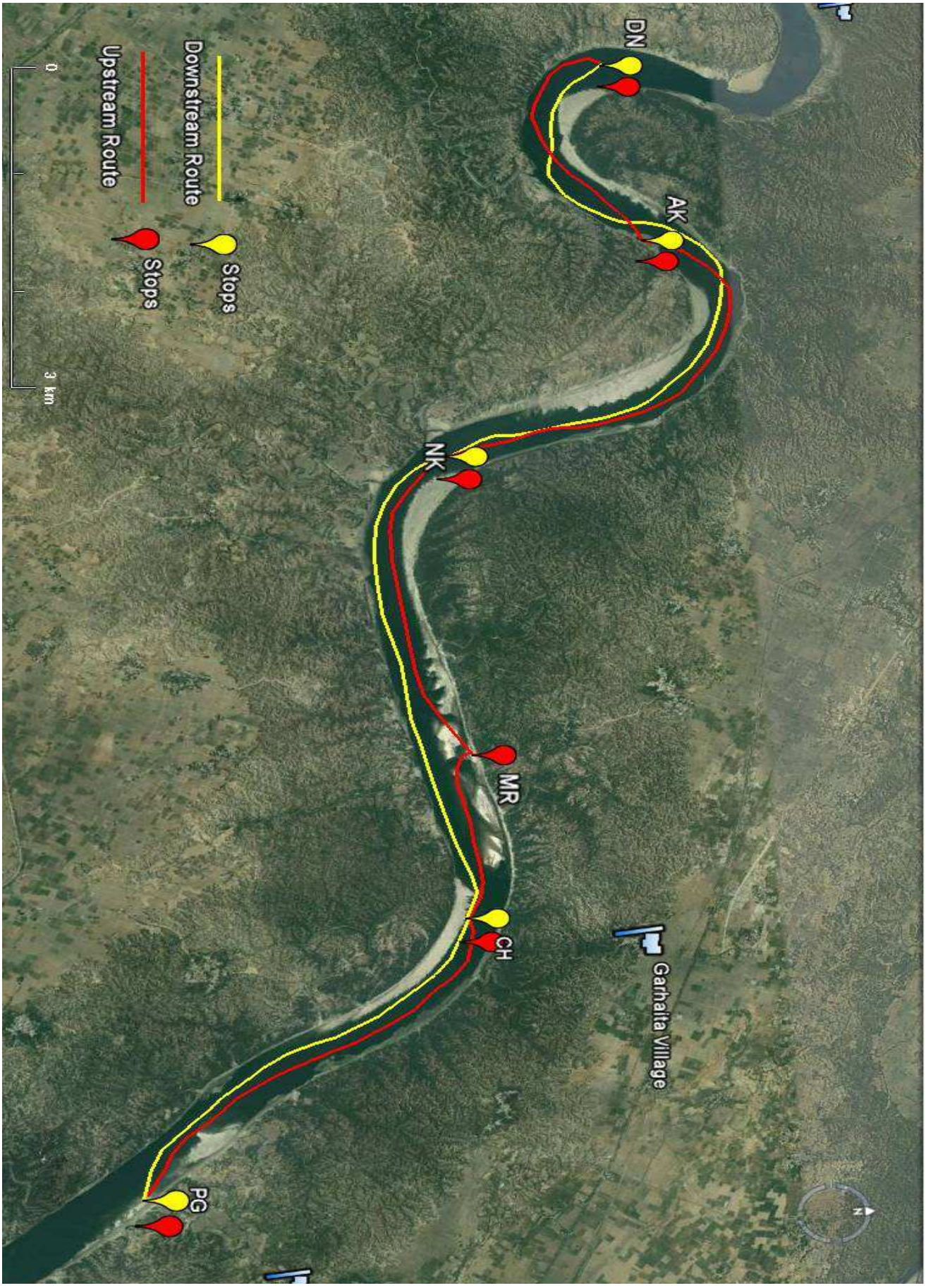
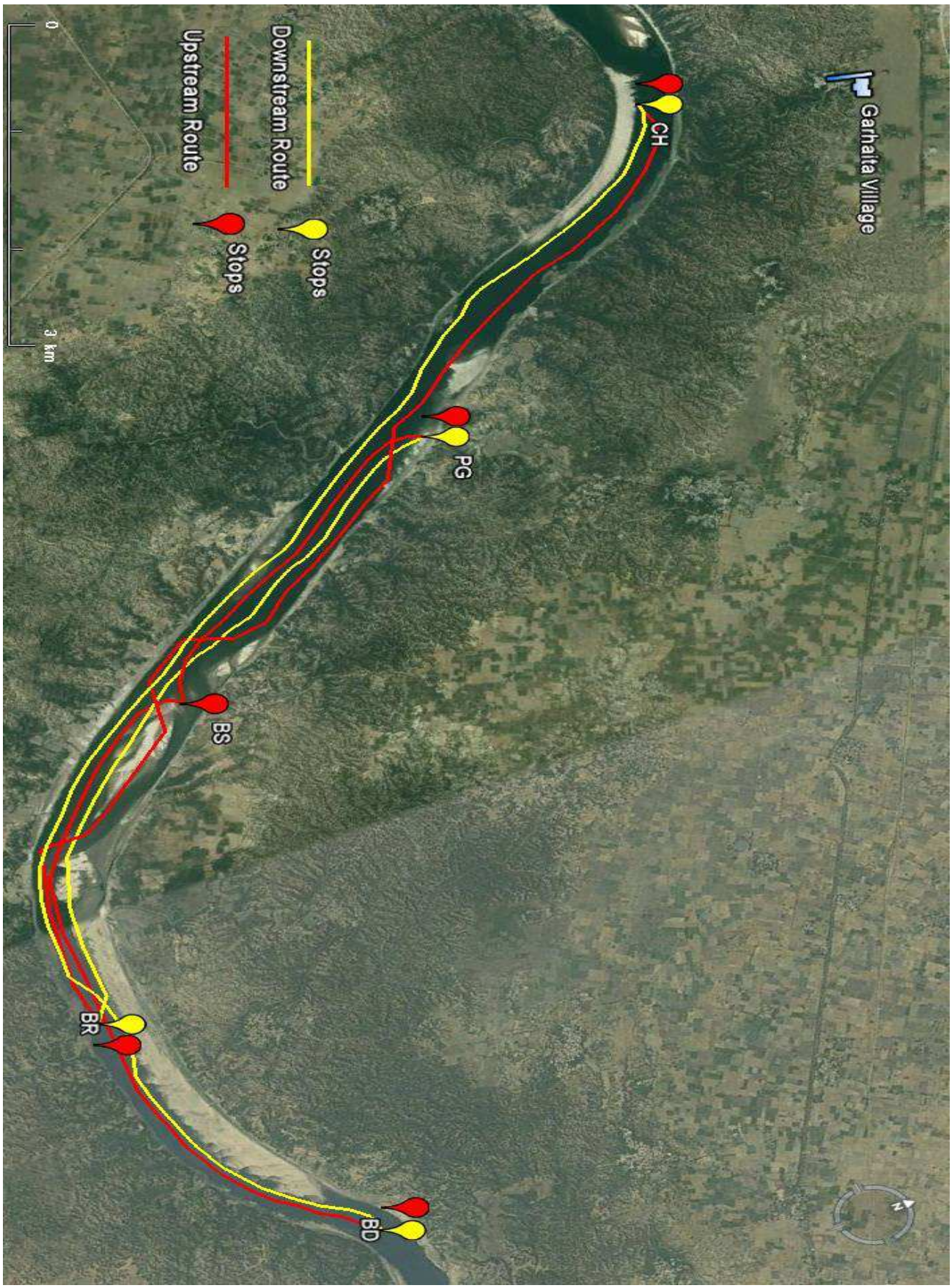


Figure 1: Movement map for Animal Number 51 showing a summary of major movements made from March 2009 May 2010

Figure 2: Movement map for Animal Number 57 showing a summary of major movements made from March 2009 May 2010



TRACKING CROCODILES WITH ACOUSTIC TECHNOLOGY: LESSONS FROM FISHERIES SCIENCE.

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New acoustic tagging and tracking technologies are transforming the science underlying fisheries management. Advances in electronic tags and sensor technologies have enabled scientists to track marine fishes throughout their lifecycle, whilst simultaneously sensing their physiological and local environmental conditions. This has provided vital data about the ecological requirements of a species, informing research managers and policy makers of the best strategies for conservation. This technology has the potential to play an important role in crocodilian research and conservation. The devices are relatively small in size and weight compared to satellite transmitters and because the transmitters communicate by acoustic waves they can be easily and safely implanted within the body of small animals. The battery life of an acoustic transmitter can last for up to 10 years, and the low monetary cost per unit means that a large number of individuals can be studied for many years. Once implanted inside the body of the crocodilian the transmitter continually emits an acoustic pulse containing a unique ID code for the animal, and if desired water depth and body temperature information. This is detected and recorded by underwater receivers deployed at discrete locations throughout the geographic range of the study animal. In this talk I will describe these new technologies and the intricacies of data analysis. I will show how acoustic tracking technology has enabled us to understand the spatial sexual segregation, diving and thermoregulatory behaviour of the Estuarine crocodile *(Crocodylus porosus),* and reveal the fascinating strategy they employ to travel throughout their geographical range.

USING ECOLOGICAL NICHE MODELS TO EVALUATE THE SEX RATIO IN CROCODILES.

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Sex ratio is an important attribute to estimate population viability in species with temperature-dependent sex determination (TSD). All crocodilians present the TSD II pattern, in which females are produced at low and high temperatures while males are produced at intermediate temperatures. However, no detailed reports exist on sex ratios of crocodiles throughout their range. Herein, we report the sex ratio of the American crocodile (*Crocodylus acutus*) and the Morelet's crocodile (*C. moreletii*) in different localities across their geographic range, characterizing the local climate and evaluating the potential impact of climate change in the next 50 years. Using the localities where sex ratio has and has not been altered we developed an ecological niche model for each species using the Genetic Algorithm for Rule-set Production (GARP) and projected them on to current and future climate scenarios to produce potential distribution maps for the two species in the two time periods. Our results present areas where we can expect skewed sex ratios due to climate change in the near future.

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USING GIS TO ASSESS NEST SITE SELECTION AN NEST ABUNDANCE OF AMERICAN ALLIGATORS (*ALLIGATOR MISSISSIPPIENSIS*).

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In Florida, alligator farmers have commercially harvested American alligator eggs from public waters since 1988. The eggs are hatched, and alligators are raised for the production of meat, hides, and other alligator products. Historically, alligator egg collection quotas were established by aerial nest surveys conducted annually by the Florida Fish and Wildlife Conservation Commission (FWC) prior to collections. Due to safety and budget issues, aerial surveys were discontinued after 2005 and quotas are now established using population estimates from alligator night-light surveys in combination with historical egg collection quotas. The objective of this project is to provide a habitat-based model for establishing public water alligator egg collection quotas that incorporates historical aerial nest survey data and night-light survey data. I will (1) develop a habitat suitability index (HSI) for Lake Kissimmee, Lake Tohopekaliga, and Orange Lake using a geo-rectified aerial map of littoral plant communities, bathymetric data, water level data, and historical aerial nest survey data; (2) test predictions made by the HSI by using subset of historical and current aerial nest survey data, and (3) use night-light survey data and the HSI to create a model to make predictions on the number of nests that will occur on a system during a given year. Field work for this project will begin June 2010, I will conduct aerial surveys of nests from 2-seat, piston-engine helicopters during the alligator nesting seasons (late June and July) of 2010-2011 on each area. I will randomly select nests from the aerial nest surveys for ground truthing and sampling. At each nest, location, distance from nest to open water, elevation above surrounding nest site, composition and abundance aquatic plant species present, and depth and composition of organic material under nest will be measured and recorded. ArcGIS 9.3 will be used to (1) overlay and analyze historical and current nest locations and characteristics; (2) create 2.5 ha hexagons to overlay over each study system; and (3) analyze geo-rectified aerial map of littoral plant communities and bathymetric data. FRAGSTATS will be used to obtain a HSI score for each hexagon. To determine the probability of a given nest falling inside a hexagon with a relatively high HSI score, nest location data will be analyzed using the statistical analysis software, SAS. Methods and preliminary results for this project will be presented.

VARIATION IN AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*) GROWTH RATES AMONG AQUATIC HABITATS IN FLORIDA.

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Growth rates are important when developing population models and estimating sustainable harvest rates for crocodilians. We used skeletochronology to estimate age to maturity for American alligators (*Alligator mississippiensis*) in 24 aquatic habitats in Florida. Median number of years for female alligators to attain 1.8 m in total length (generally considered to be the onset of sexual maturity) was 9.45 years and ranged from 7.55 to 13.99 years. Variation in growth rates among aquatic habitats can have a profound effect on reproductive potential of alligator populations, and can influence estimates of transition rates between general size classes. These parameters influence population growth rates, and this variation may explain differences in both recovery rates of depressed populations and sustainable harvest rates of recovered populations. Variability in growth may be related to nutrient levels in aquatic systems. Population modelers should carefully consider variation in growth when developing population models.

AN EXTENDED INCUBATION PERIOD IS NOT ENOUGH TO DETERMINE HATCHLINGS SEX.

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The influence of temperature on the outcome of sexual differentiation in crocodilians is well established. At present, there is no evidence of a putative target for temperature. Some authors have postulated that both, developmental rate during its first third and incubation period are better predictors of sex than incubation temperature. In *Caiman latirostris*, incubation at 33 ºC simultaneously induces shorter incubation time, and males. If the rate of development (defined in its narrowest sense as morphological changes) is more reliable than temperature to predict the sex, any factor capable of modifying the developmental ratetemperature relationship has the potential to control hatchling sex. Here, we consider whether hypoxia influences gonadal sex by affecting either the developmental rate or the incubation period, or both. Thus, caiman eggs were incubated at 31 °C and 33 °C (yielding 100 % females and 100 % males, respectively) and under various oxygen concentrations. Oxygen levels modified incubation period, but they did not affect sex determination. Nevertheless, by assessing embryos during their thermosensitive period (Stage 20-24), we observed that developmental stages were the same between oxygen treatments, despite of their differences in the timing of hatching. Our data do not support the hypothesis that sex ratio in *C. latirostris* is mediated by incubation time or oxygen availability during embryogenesis, at less under our incubation treatments. Key words: Broad snouted-caiman, hypoxia and development embryonic.

DIPEPTIDYL PEPTIDASE IV (DPPIV) ACTIVITY IN *Caiman latirostris* AND *Caiman yacare*

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The Dipeptidyl peptidase IV (DPPIV) plays an important role as physiological regulator of a number of peptides that serve as biochemical messengers within the immune system, among others. DPPIV can occur in a soluble form, or as part of the membrane of many cells, and has broad substrate specificity. The presence of DPPIV activity resulted in cleavage of AFC from a dipeptide substrate, producing large increases in fluorescent intensities that were measured spectrofluorimetrically. The DPPIV action was identified and characterized in plasma of wild specimens of *C. latirostris* and *C. yacare* at different times, temperatures and concentrations. The enzyme activity was lower in *C. yacare* than in *C. latirostris* at all temperatures tested, increasing significantly only in *C. yacare* at high temperatures, while in *C. latirostris* showed a strong correlation from the initial temperature. This difference between species could be attributed to its environmental performance. Similarly, plasma exposure of DPPIV in both species showed a time-dependent, although curves seem different between them. These results show that plasma activity of DPPIV was different between two caiman studied, may be as a consequence of differences in susceptibility to infection among them. The values found in this study are higher than those reported for other animals and humans, demonstrating another characteristic of the efficient immune system of crocodilians.

OXYGEN CONSUMPTION OF *CAIMAN LATIROSTRIS* NEONATES AT DIFFERENTS TEMPERATURES

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In ectotherms, metabolism is the main limiting of behavior, distribution and use of resources. *Caiman latirostris* is the American crocodilian species southernmost distribution. In this study we determined and compared the standard metabolic rate (SMR) at two temperatures (20 ºC and 30 °C). We calculated the rate of thermal sensitivity (Q_{10}). We utilized a method of indirect calorimetry (closed respirometer) measuring O_2 consumption under controlled temperature conditions. Measurements were performed in 28 neonates from 7 different nests prior to its first intake, or after fasting for at least 7 days. At 30 ° C, the SMR was 0.16 + / - 0.05 ml / g / h. At 20 ° C, the SMR was 0.11 + / - 0.04 ml / g / h. The Q_{10} calculated between 20° C and 30 ° C was 1.6. Consumption calculated at 20°C and 30 °C were compared using ANOVA. There were significant differences between treatments ($p < 0.05$). As the weight of the individuals increased, decreased the SMR.

SKELETOCHRONOLOGY OF *CAIMAN CROCODILUS* IN THE PIAGAÇU-PURUS RESERVE, CENTRAL AMAZONIA.

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Spectacled caiman (*Caiman crocodilus*) has the widest distribution among all Alligatoridae. However, like all crocodilian species, gonadal maturation in *C. crocodilus* is more related to body-size than to age of the individual. Skeletochronology is based on the presence of cyclic and annular bone growth, and permits counting the number of LAGs (lines of arrested growth) in cross-sections of long bones. Our objectives were to study the relationship between number of LAGs, body size (SVL, cm) and numbers of flooding pulses to estimate age at the minimum maturation size in the Piagaçu-Purus Sustainable Development Reserve. Age and minimum maturation size of males and females was estimated from previous studies. Humeri of ten *C. crocodilus* were decalcified with RDO®, cut using a cryostat microtome and stained with Harris' haematoxylin. The minimum maturation age in males was 4.7 years and 5.7 years for females. This information will be critical to support a future harvesting program of Spectacled caiman in the Piagaçu-Purus Reserve and in the Brazilian Amazonia.

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THE EFFECTS OF HYPOXIA ON OXYGEN CONSUMPTION OF BROAD-SNOUTED CAIMAN EGGS.

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Embryonic ability to tolerate hypoxia is oxygen- and temperature-dependent, and can be assessed by measuring oxygen consumption. To investigate developmental responses to hypoxia, we incubated *Caiman latirostris* eggs at two different temperatures (31ºC, 100% female-producing temperature, and 33ºC, 100% male-producing temperature) and at two O_2 concentrations (12% and 21%). Oxygen consumption was measured at embryonic stages (22 and 24) incubated at 31°C and 33°C temperatures. Closed-respirometer was used to measure the consumption oxygen .We found the same O_2 consumption at stage 22, but at stage 24, consumption at 33°C was higher than at 31°C, also it seems to be a lower consumption under hypoxia than at normal O_2 level, at this temperature. Absence of differences at 31°C in our results support the hypothesis that hypoxia interacts with incubation temperature.

THE EFFECTS OF ULTRAVIOLET RADIATION ON THE INNATE IMMUNE RESPONSE OF *Caiman latrostris*. REPORT OF ADVANCE.

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The sun emits ultraviolet radiation (RUV) that is necessary to many vital biological processes. RUV exposure is essential for development and reproduction, the synthesis of vitamin D3 one of its most important benefits. Overexposure to RUV might induce adverse biological effects such as immune suppression, which could debilitate recognition of some antigens after a few days of the irradiation. Some researches assert that the damages caused by this type of radiation might have tremendous influence on the health of populations. Although the UV-B wavelength range can exert a positive influence on diverse biological effects, excessive UVB radiation exposure interferes with the normal function of the immune system in both animals and human beings. Lipopolysaccharide (LPS) is a major component of the wall of Gram negative bacteria. LPS contains a toxic substance, Lipid A, that is recognized by the immune systems of higher eukaryotes and causes an inflammatory reaction. Twenty seven broad-snouted caiman (3 months old) will be used for this study. Eggs will be harvested from 3 different wild nests and artificially incubated under controlled conditions. Caiman will be maintained under different UVR intensities during the 60 days. The UV exposure will be of 12 hours per day. For each treatment group, we will evaluate animal growth (weight, total length and snout – vent length), as well as immune system function by total and differential peripheral leukocytes counts, serum complement activity and total and fractional concentrations of serum proteins. We suspect that overexposure to RUV will lead to an immunesuppressive effect, reducing the immune response of *Caiman latirostris* due to *E. coli* LPS.

ORINOCO CROCODILE PICTURES NEEDED FOR ILLUSTRATING DIAGNOSTIC CHARACTERS IN KEYS, AND JOHN-T'S PHOTOS MIGHT INCLUDE THEM.

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Diagnostic illustrations of the Orinoco crocodile are rarely available. The vast majority of published photos of Crocodylus intermedius show either the head or the whole animal in various lateral views, and these pictures seldom include those special characters that distinguish the Orinoco crocodile from its geographic neighbor C. acutus. For demonstrating that the American crocodile significantly differs from C. intermedius, selected photographs that directly compare the head shape of both species with each other, such as in Medem (1981: 33), are convincing.

The Orinoco crocodile has a longer and narrower snout, and this skull proportion difference is reflected in the extent of the mandibular symphysis. The American crocodile has lower jaws that are essentially straight, but in contrast C. intermedius exhibits a slightly inwards and concave bend in the shaft region of each mandibular ramus. This important distinction was illustrated by Medem (1981: 32) with the same two animals which are similar in physical size to each other.

The large fifth maxillary tooth sticks down outside the lower jaw very distinctly in the Orinoco crocodile, while in C. acutus the rows of upper and lower teeth interdigitate slightly more evenly in the mid-snout region. The concave bend in the C. intermedius mandible allows the Crocodylus stabbing tooth to remain developed, and simultaneously it lengthens the extent of the symphysis between the lower jaws, because the mandibular rami approach their anterior junction differently. The Orinoco crocodile's fifth maxillary (= tenth upper) tooth sticking downwards outside the mandible, and some similarly elongate lower teeth sticking upwards outside and through the premaxillary bones of the snout-tip in C. intermedius were illustrated in Medem (1958: 186) and Medem (1981: 28), but neither of these lateral view drawings showed the mandibular symphysis.

The extent of the suturing together of the anterior ends of the mandibular rami is related to the parallel outside edges of the lower jaws in this symphysis region, and these characters were illustrated by Medem (1958: 191), with the longest lower tooth being the "first" (anteriormost) dentary, followed by the second and fourth dentary teeth. The posterior end of the lower jaw symphysis is commonly measured by the level of the dentary teeth and alveoli located laterally adjacent to it, but the extent of the suture is difficult to see in Medem's (1958: 191) drawing, because of the lateral angle of the view (Fig. 4). For some significantly better illustrations of the C. intermedius symphysis in properly dorsal view in Brazaitis (1971: 75) and in Lutken (1884: pl. 5).

In currently general theory, the symphysis reaches the level of the sixth tooth in C. intermedius, but we note that even when viewed from directly above, and also separately when viewed from directly below, the extent of the symphysis is dorso-ventrally irregular and complex in shape, thus causing ambiguity about definitions, especially when cleaned bony mandibles (in dorsal view) are compared with ventral views of skin-covered heads. The narrowness of the space between the shafts of the lower jaws makes it difficult to see exactly where the skin of the throat actually stops. There are no illustrations in Medem (1958, 1981) that show how the symphysis is always shorter externally than it is internally in both Crocodylus intermedius and C. acutus, but this phenomenon can be seen in Medem's (1981: 26) drawing of a Melanosuchus niger osteological preparation in ventral view.

Neither the American nor the Orinoco crocodile ever have the vomer bone exposed on the palate, but the two species might possibly be distinguishable from each other by the location of their premaxillo-maxillary suture, because in C. intermedius its posterior projections can reach to the level of the third maxillary teeth (Fig. 6), and more importantly the suture along the midline between the premaxillary bones is relatively longer than in C. acutus. The elongate and narrow snout of C. intermedius distinguishes it from the American crocodile species, but the ventral view of the Orinoco crocodile skull in Medem (1958: 188) has sutures and fenestrae that resemble C. acutus quite closely, especially in the posterior half of the skull, and we note that the posterior projections of the premaxillary bones on the palate of the American crocodile species sometimes reach the level of the third maxillary tooth (Ernst et al. 1999: 3).

Photographs showing the ventral surface of overturned dead crocodilians are often so overexposed that the transverse rows of belly scales in the collar-vent count can not be clearly seen, and this is especially true for extremely white bellied species, as exemplified by the Orinoco crocodiles in Medem's (1958: 202) and (1981: 167) photos that show the C. intermedius diagnostic mandibular symphysis. The gular collar on a single commercial "Crocodylus intermedius" belly hide can be seen in Fuchs (1974: 106; 2006: 91 flesh side) and in Wermuth & Fuchs (1983), but the collar is often variable within a species, and its details and functional location in relation to the front legs is hard to see in available photos. Similarly, the scalation details around the opening of the cloaca are not clearly shown in any publication. It is probable that C. intermedius and C. acutus can not be distinguished from each other by their gular collars, and nor can these two species be keyed by their cloacal vent scales. However, locating the posterior edge of the collar, and also finding the first transverse row of ventral scales immediately anterior to the cloacal "oval" disturbance, are both required for performing the collar-vent (C-V) count.

Unfortunately the scalation diagram in Medem (1958: 197) does not show the entire C-V count because a back leg obscures part of it; and, separately the details of the collar, and also of the cloaca, cannot be seen clearly. However, the dorsal scalation of an Orinoco crocodile is illustrated in dorsal view in this diagram, and thus this illustration of a C. intermedius skin could potentially be very interesting. The anterior end of the tail is indicated on Medem's diagram as caudal whorl #1, meaning the first transverse row of dorsal scales

posterior to the back edges of the hind legs. The picture is sufficient for counting sixteen transverse rows of dorsal scales that cross the body, and anterior to them, and located approximately between the front limbs, there is a conspicuous space of unarmored skin separating the thoracic dorsal armor from the nuchals, and they are in turn separated from the postoccipital (PO) scales. The drawing shows four PO scales and approximately six nuchal scales. These numbers of scales do not distinguish Orinoco crocodiles from C. acutus, and additionally both species have their PO's separated from their nuchals, and also both taxa are characterized by a significant space of flexible skin separating the stiff nuchal cluster from the anterior edge of the thoracic and body armor. We do not completely trust Medem's (1958: 196) illustration. However, this precaudal result about what we can call sixteen "carapace" rows does not separate C. acutus from the Orinoco crocodile, because both species can loose precaudal (PC) rows #17 and #18 (Ross & Mayer, 1983: 326-327), with the PC numbering system starting at the sacro-caudal juncture.

We believe that the scale count between the hind legs in Medem's (1958: 197) diagram is inaccurate, because PC-1 should have only four or five scales across in C. intermedius, and PC-2 should have only four scales within it (Ross & Mayer, 1983: 326). The same source predicts only four contiguous scales in transverse rows PC-3 and PC-4, but the Medem (1958: 197) figure shows more than four. Thus it appears that the scalation on the carapace (PC-1 through PC-16 in C. intermedius) is stylized and although probably correct about the number of transverse rows crossing the carapace, Medem's diagram is at least sometimes misleading about the exact number of scales located contiguously within individual carapace rows.

New graphics are needed that clearly show the body carapace, including the pelvic region, from directly above a whole animal or hornback hide. The elongate shape of the carapace and neck region invites subdivision into overlapping pictures, as exemplified by photographing or drawing the sacral region very clearly and extending anterior to a marked dorsal row, and then create an overlapping and continuing series of photos that show the thoracic and cervical regions.

In addition to having too many scales across in the pelvic and lumbo-sacral zone, the midbody and thoracic details in Medem's (1958: 197) diagram are similarly exaggerated about the number of contiguous scutes contained within transverse rows, and further, the shapes of the scales themselves are too uniformly square and regular. It is difficult or impossible to find the dorsal midline along the long-axis in Medem's (1958: 197) diagram, which was based on a real Orinoco crocodile skin, but does not portray the C. intermedius carapace accurately.

The earliest dorsal view of today's Crocodylus intermedius (Graves, 1819) is an 1831 drawing that was based imperfectly on the written type description. According to Graves (1819: 346), his C. intermedius specimen (today believed to be MNHN-Paris 7512) had five oval-shaped postoccipital (PO) scales in a single transverse row behind its head. He did not say that the PO's were arranged in a bilaterally symmetrical fashion, with an unpaired midline

element in the middle of the row, but the picture in Bory de Saint-Vincent (1831) explicitly showed the postoccipital row of five independent oval scales going across the midline in a regular manner, without an unarmored midline space, and is fiction. The depicted condition never occurs on living crocodilians, all of which have a median gap separating the PO scales into left and right groupings. Similarly, the type description of Crocodilus intermedius Graves, 1819, said that the nuchal cluster was composed of six scales, and that they collectively formed an oval. The wording in Graves (1819: 346) was interpreted by Bory's (1831) artist as the nuchal cluster forming an open-centered circle like a donut (Fig. 10-A). In contrast, four scales across in the anterior row, and two scales across in the posterior row, does not really form a hollow donut shape in the Orinoco crocodile (Fig. 10-B). In comparison with a photo in Medem (1958: 200), the remarkably regular circle of nuchal scales forming a ring in Bory de Saint-Vincent (1831: plate 119 as Crocodilus journei) is evidently an artistic invention that was not based on the specimen, but rather the Bory (1831) picture was based on the text description in Graves (1819: 346), and was misleadingly interpreted.

Describing the Orinoco crocodile's type specimen, Graves (1819: 246) said that the transverse row of PO scales was separated from the nuchals by a space of unarmored skin, and similarly that the nuchal cluster was separated from the body carapace by another interruption of flexible skin. He then detailed the carapace beginning with the thoracic region and the transverse row of dorsal scales closest to the neck, saying (in French) that "four inches behind the nuchal plate, begins the dorsal scales distinctly disposed in six longitudinal rows. The scales of the two middle rows are nearly or approximately square; those of the others approach all the more oval form or round in those neighboring the flanks; all are furnished with a short longitudinal ridge. We count sixteen transverse rows up to the origin of the tail; the first row is composed only of five scales, the ten following are each of six; firstly two rows of five, next a row of four, and finally two rows of three plates."

The picture shows the anteriormost transverse row across the carapace as having five contiguous scales, of which one individual scale is centered on the midline (similar to the PO row, above). Similarly, the 1831 drawing shows the posteriormost two transverse carapace rows having three scales across, with the middle scale centered on the long-axis midline of the animal. Given that Graves (1819: 346) said that the carapace is composed of sixteen transverse rows of continuous precaudal armor, the two posterior rows of three scales in the Bory (1831: pl. 119) dorsal view are what Ross & Mayer (1983) called PC-1 and PC-2. The 1831 picture shows four scales in PC-3 and PC-4, and then six across in contiguity in PC-5 through PC-15, and lastly five across in PC-16 at the anterior end of the carapace of an inaccurate crocodile. There was explicit mention of a detached longitudinal row of enlarged flank scales in Graves (1819: 346), but they were not illustrated by Bory de Saint-Vincent (1831).

The ventral view in Bory (1831: pl. 119) has 24 rows in its C-V count, which is remarkably close to the 25-27 range in Brazaitis (1973: 72), and the 25-28 range in Fuchs (1974: 104; 2006: 90) and Wermuth & Fuchs (1983), and a C-V count of 24 is actually within

the 20-25 range in King & Brazaitis (1971: 23). We are unable to independently confirm any of the published C-V ranges for the Orinoco crocodile, and note that the King & Brazaitis (1971) and Brazaitis (1973) samples were probably extremely small, because very few (if any) whole C. intermedius specimens were available in North American museums at that time. There was no collar-vent count result in Graves (1819). Further, the single commercial ventral skin photographed in Fuchs (1974, 2006) and Wermuth & Fuchs (1983) lacks both its head and its dorsal armor, and is thus (for this purpose) unidentifiable to species. The collar-Vent (C-V, called "T.R.") range in the Charette (1995: orange 9) identification guide for C.I.T.E.S. is 25-27 in Crocodylus intermedius. However, the collar in Bory de Saint-Vincent's (1831) ventral view picture is totally stylized and misleading, as is also the cloaca, because the opening of the cloacal vent is not shown as being a longitudinal slit. Although the cloacal "oval" scalation phenomenon is positioned correctly within the base of the tail in Bory's (1831) ventral view picture, the oval's geometrically circular shape, and its perfectly circular opening in the middle (the vent itself), are technically wrong for all crocodilians.

As a factual illustration of an actual Orinoco crocodile, plate 119 in Bory de St.-Vincent (1831) does not count. It is fiction in several important ways. However, this old drawing is an example of the requested view from directly above the animal that science needs for answering questions like, for example: how many scales are in PC-15 through PC-3 individually, and what is the actual expected count in the pelvic region (PC-2 and PC-1)?

It is not uncommon for written descriptions of the Orinoco crocodile's carapace scalation to be oversimplified into slightly misleading generalizations. For example, Gray (1872: 18) diagnosed it as "Dorsal plates in six rows, all slightly and nearly equally elevated; the keels of the two vertebral series rather larger than the others, quadrilateral, rather broader than long; the lateral ones oval, with five or six large plates forming an interrupted line on the sides." The most misleading assertion is that all sixteen (or possibly seventeen) transverse rows crossing the carapace each contain six scales, because the character of having six scales within a transverse row applies to the thoracic and midbody region (PC-15 through PC-8) only, and sometimes some of these individual carapace rows are reduced to five contiguous scales (Ross & Mayer, 1983: 326-327).

Comparing the dorsal view of a cleaned skull in Gray (1872: 17) with the similar view in Medem (1958: 183), some discrepancies become apparent between the two pictures (Figs. 13-A & 13-B). The Gray (1872) skull appears to have a slightly shorter and broader snout, and the head does not widen posteriorly (across the quadrato-jugals and the quadrates) in the manner shown in Medem's (1958: 183) drawing. The text in Gray (1872: 17) said that the nasal bones on the long-axis midline region of the snout are exposed on the dorsal surface all the way anteriorly to reach the external opening of the nostrils. This condition is clearly shown in Medem's (1958: 183) Orinoco crocodile illustration, but as Gray (1872: 17) noted, the nasal bones anteriorly narrow and technically (on the surface in dorsal view) reach the nasal opening in not only C. intermedius, but in C. acutus also, as illustrated for the latter in Ernst et al. (1999: fig. 2). It is possible that the specimen shown in Gray's (1872: 17) illustration is an American crocodile, and not today's C. intermedius, but without detailed

knowledge about individual and age variation in Orinoco crocodile cranial proportions, and similarly without fully understanding both ontogenetic and individual, and additionally substantial geographic variation in C. acutus, we tentatively accept the identification in Gray (1872).

The lateral view of an American crocodile skull in Medem (1981: 31) shows the antorbital (= preorbital) hump that theoretically distinguishes C. acutus from the Orinoco crocodile, but the lateral view in Gray (1872: 17) shows his C. intermedius as being convex as opposed to concave in the snout region immediately in front of the eyes. We further note that the dorso-ventral thickness of the maxillary and premaxillary bones (seen in lateral view) is not appreciably different in the two pictures. Both species thicken the snout at the level of the fifth maxillary tooth, and the outline of the snout, including the premaxillary bones, is remarkably similar in both of these lateral view drawings of cleaned skulls. In theory the anterior end of the snout should be transversely broader in C. acutus (forming a horizontally flattened oval), while the same region in the Orinoco crocodile should be more perfectly circular in cross section.

Returning to dorsal view, the skull of C. intermedius is longer and narrower snouted than in the American crocodile, as illustrated by Medem (1981: 31 and 30 respectively). Further, these same two drawings show that C. acutus is narrower across the posterior end of the skull, compared with the Orinoco crocodile's widely expanded quadrato-jugal zone. These two specimens are essentially the same length (the acutus 51.6 cm; the intermedius 52.2 cm). In side by side comparison, the dorsal view outlines of these two somewhat dissimilar skulls are immediately believable as two separate species. Selected cranial measurements and ratios would distinguish the narrow snouted and transversely posteriorly remarkably widened Orinoco crocodile (adult) skull as being different from the more broad snouted and relatively less posteriorly widened (adult) American crocodile. However, in contrast and at the same time, the similarities between these two species are numerous, including the anteriormost (first) dentary teeth on the mandible piercing up through the premaxillaries, creating holes near the tip of the snout. The outline of the nose hole, and the way that the nasal bones reach it, and further the shape and extent of the posterior projections of the premaxillary bones, are all interesting to look at and to think about, but in many of these cases the similarities (and the differences) are difficult to actually define in words. However, many subtle and hard to define differences do occur throughout the dorsal views of these two skulls, making C. acutus appear to be clearly distinguishable from the Orinoco crocodile species; and, in general, it is awkward to express these characters in a dichotomous key.

Differing from each other in exactly the same group of dorsal view characters, the isolated skulls of C. acutus and C. moreletii in Schmidt (1924: plate 6) are clearly distinct as species. The American crocodile on the left has a longer and narrower snout than the Morelet's crocodile on the right. The nasal bones reach the external narial aperture in both species. At this point, everything appears to be simple. These three Crocodylus species have different dorsal view skull outlines. The Morelet's crocodile is less acutely snouted than C.

acutus, and simultaneously and significantly C. moreletii is more gradually widened in the region located posterior to its orbits (across the quadratojugals in adults). Thus C. moreletii from Central America has the lateral edges of its skull much closer to being parallel-sided, compared with the American crocodile.

The problem is that the American crocodile itself is remarkably variable in all of these dorsal view characters, including skull ratios. When Medem's (1981) comparative pair are compared with Schmidt's (1924) comparative pair, Schmidt's moreletii looks a lot like Medem's acutus; and, similarly, Schmidt's acutus looks a lot like Medem's intermedius. The variation within the American crocodile is as impressive as the difference between the Orinoco crocodile skull in dorsal view, compared with the Morelet's crocodile.

The best head character for separating Crocodylus acutus from C. intermedius in a dichotomous key is the mandibular symphysis. The illustrations that best distinguish the American crocodile from the Orinoco crocodile are Medem (1958: 32, and 33). We do not doubt that C. intermedius is a species, yet at the same time we have shown that the difference between C. intermedius and its geographically neighboring American crocodile is not easy to see in the published pictures of skulls. In this case, we need side by side comparisons of mandibles with the symphysis suture clearly comparable. The posterior end of the mandibular symphysis will look different on whole heads, compared with clean bone, so considerable care is required when illustrating and applying this key character.

The other key character that is commonly said to distinguish C. intermedius from the American crocodile is the dorsal armor carapace on the body including the pelvis. We are unable to find any proper dorsal views of the body of the Orinoco crocodile, and thus we today appeal for the publication of illustrations that clearly show the carapace scalation of C. intermedius for comparison with other Crocodylus species. The Charette (1995: yellow 2 and 12) diagrams of C. acutus and the Orinoco crocodile are instructive about the lateral edges of the carapace, and both examples have sixteen continuous precaudal rows, and eight nuchal scales, but the dorso-lateral view only shows one side of the animal. Both of Charette's (1995) drawings appear to have four scales across the pelvis in transverse rows PC-1 and PC-2. In general we do not completely trust the Charette (1995) artwork, but the Canada guide's C. intermedius page says that its fingers are webbed, and if this is true, it would be interesting to carefully compare this character with the American crocodile.

If anyone has an opportunity to go through Juan Caiman's photos from the 1980's in Haiti and Venezuela, the needed pictures may (we hope) already exist. It is remarkable how few photographs are in John Thorbjarnarson's papers about C. acutus and C. intermedius (Tab. 1). It was the fashion in those days for scientists to take color slides for themselves, but at the same time it was expensive to print photographs in publications. Additionally, the photos that have actually gotten published were mostly selected to show happy crocodiles. They consist of portraits of smiling adults, and baby pictures, all in somewhat lateral views. It turns out that properly ventral and properly dorsal view photographic evidence is still needed by science. Thus, if John-T carried a camera while doing field work in Haiti and Venezuela,

then publication of his American and Orinoco crocodile photos might be a good CSG project. In this case, and also as a general rule, strong preference should be given to illustrating the diagnostic characters.

Table 1: Selected publications lacking diagnostic illustrations.

1986. Anon. "WWF moves to rescue Orinoco crocodile." Focus (World Wildlife Fund) November-December issue: 4 [about Jose Ayarzaguena and John Thorbjarnarson].

1986. Thorbjarnarson, J. "The present status and distribution of Crocodylus acutus on the Caribbean island of Hispaniola." Crocodiles: Proceedings 7th CSG (Caracas, Venezuela, 1984): 195-202.

1987. Thorbjarnarson, John B. and Richard Franz. "Crocodylus intermedius" Cat. Amer. Amphib. Rept. (SSAR) 406: 2 pp.

1988. Thorbjarnarson, John B. "The status and ecology of the American crocodile in Haiti." Bulletin Florida State Mus. Biol. Sciences 33 (1): 86 pp.

1989. Thorbjarnarson, John B. "Ecology of the American crocodile, Crocodylus acutus." Crocodiles: their ecology, management, and conservation (CSG special publ.): 228-259.

1990. Thorbjarnarson, John B. "Crocodile lakes of Hispaniola." Wildlife Conservation (N.Y.Z.S.) 93(1): 42-47.

1991. Thorbjarnarson, John B. "Crocodylus acutus (American crocodile): social behavior." Herpetological Review 22 (4): 130.

1992. Thorbjarnarson, John B. and Gustavo Hernandez. "Recent investigations of the status and distribution of the Orinoco crocodile Crocodylus intermedius in Venezuela." Biological Conservation 62: 179-188.

1993. Thorbjarnarson, John B. and Gustavo Hernandez. "Reproductive ecology of the Orinoco crocodile (Crocodylus intermedius) in Venezuela. 1: Nesting ecology and egg and clutch relationships." Journal of Herpetology 27: 363-370.

1993. Thorbjarnarson, John B. "Efforts to conserve the Orinoco crocodile in the Capanaparo River, Venezuela." Zoocria de los Crocodylia (Memorias regional CSG, Santa Marta, Colombia, Nov. 1991): 320-322.

1993. Thorbjarnarson, John B. and Gustavo Hernandez. "Reproductive ecology of the Orinoco crocodile (Crocodylus intermedius) in Venezuela. 2: Reproductive and social behavior." Journal of Herpetology 27: 371-379.

The properly dorsal view photo of an authentic Orinoco crocodile skull from Colombia in Ardila-R. et al. (1999: 439, fig. 1-a) has some of its important sutures obscured, and the mandibular symphysis was not illustrated. We recommend the dorsal view drawing of the bony lower jaws and mandibular symphysis in Brazaitis (1971: 75), which is from Meta, Colombia. The dorsal and lateral and ventral view drawings of the skull of this individual C. intermedius (FMNH 75658) in Brazaitis (1971: 75) agree generally with the dorsal, lateral and ventral views of Orinoco crocodile skulls in Medem (1958, 1981). Note that in dorsal view, the mandibular symphysis shown in Brazaitis (1971: 75) extends to the level of the posterior edge of the sixth dentary tooth.

Figure 18: Brazaitis (1971: p. 75, fig. 1) set of four drawings of one Crocodylus intermedius skull and mandibles from the Rio Ariari (a juvenile female, collected by F. Medem).

At least some old keys definitely mischaracterized C. intermedius on the basis of skull drawings in Mook (1921: 167) which did not actually depict an Orinoco crocodile specimen, and similarly some old keys may have wrongly characterized the dorsal armor on the basis of a lateral view photograph of a whole animal in Sola (1933: 14) which is not actually C. intermedius. Rather, the Mook (1921) drawings and the Sola (1933) photo are apparently misidentified African slender-snouted crocodiles (Mecistops), as detailed in Brazaitis (1971). The dorsal view of the lower jaws in Mook (1921: 167, fig. 5-d) has the mandibular symphysis extending to the level of the eighth dentary tooth; and, the dorsal view of the skull of the same Mecistops cataphractus (from Africa) skull in Mook (1921: 167, figs 5-a) shows the nasal bones on the surface being distinctly separated from the external narial aperture by an intervening sutured pair of premaxillaries. It is important to remember that all of the C. intermedius Graves content in Mook (1921: 165-173 and other minor mentions) is not based on Crocodylus intermedius. The faulty Mook (1921: 67) set of five drawings, as a whole and also in parts, has been repeated many times in the relatively prominent literature, as detailed by Brazaitis (1971) and by Thorbjarnarson & Franz (1987). Thus, when researching the Orinoco crocodile in the literature, there is a high probability of the skull and mandible description (including supposedly diagnostic characters) and the illustration(s) will be errors.

In contrast to the misleading appearance of certainty about the skull and mandible characters of C. intermedius in Mook (1921) and the dorsal scalation illustrated by Sola (1933), there is thoughtful discussion and a plate of pictures of three skulls with the mandibular symphysis of each shown in Lutken (1884). In this case, the lower jaws are united to the sixth dentary tooth in the larger two specimens, and to the level of the fifth lower tooth in the smallest individual. In Lutken's (1884) opinion, the mandibular symphysis in today's Orinoco crocodile species is somewhat variable, and thus the Crocodylus intermedius species closely approaches and possibly overlaps with some C. acutus in this character.

Similarly, about the dorsal and ventral views of the C. intermedius skull, Lutken

(1884) observed that the sutures and the cranial outline and dentition all essentially overlap with variation in today's American crocodile species. On the dorsal surface of the anterior part of the snout the nasal bones terminate before reaching the nose hole in the two larger individuals, but in contrast the nasals actually narrowly pass on the surface between the premaxillary bones, and thus technically the nasal bones reach the nose hole in Lutken's (1884: pl. 5) smallest individual. The dorsal view variation in the anterior snout region of the Orinoco crocodile overlaps with variation in C. acutus, and similarly the posterior widening of the skull is variable within C. intermedius and overlaps variation in the American crocodile species (including C. pacificus). It was Lutken's (1884) conclusion that Crocodylus intermedius from Venezuela can not always be distinguished from the highly variable American crocodile by their heads in osteological preparation. Rather, it was Lutken's (1884) opinion that the dorsal carapace armor separated these two species, saying (in Danish) that "C. acutus has never more than 4, often 3, sometimes 2 shields in a transverse row" across the carapace, while in C. intermedius the carapace scalation was "16 transverse rows of shields - some longish back shields, generally 6 in each transverse row, except for 1 or 2 incomplete ones, with small scales from the - between the large back shields, longitudinal rows further down the body side; fewer than 6 are the only in the first few rows - 2-4, in the very last ones between the hind legs or right in front of these - 4-5, and exceptionally in one or another transverse row. Of equally regular development of back shields will only therefore - count 10 down back and sides of 1st part."

Lutken (1884) characterized his two C. intermedius whole animals as having two to four scales in PC-16 and PC-15, and having four or five scales in the region approaching and within the pelvic region (the lumbo-sacral and sacral vertebrae, approximately PC-4 through PC-1). Thus, PC-14 through PC-5 each have six scutes (with a few exceptions), and the total appearance (including the detached lateral scales) is that the carapace is functionally six keels across in the PC-15 to PC-5 general region. Although Lutken (1884) did not illustrate either of his two whole animals, the dorsal scalation description (in Danish) included the following data. "4-6 distinct neck shields in a line transversely, and 6 throat (sic) shields forming a cluster 2 rowed as usual in Crocodilus. There is between this last 6 shields..." and the literal translation becomes confusing. The meaning is clear that there are four to six postoccipitals (PO scales), and there are six nuchals (the latter arranged in two transverse rows, the anterior with four scales, the posterior with two). The cluster of nuchal scales is separated from the carapace by flexible and unarmored skin; and, Lutken (1884) defined the posterior end of the carapace as "a transverse line which will bridge the thighs" (?) [probably the sacro-caudal juncture between PC-1 and C-1 in Ross & Mayer (1983) terminology]. In theory, Lutken's (1884) specimens are still in Kopenhagen, Denmark.

Concluding our discussion of the dorsal armor in C. intermedius Graves, we note that the color photographs in Ardila-R. et al. (1999-b: 419) show some subjects of interest. Six postoccipital scales are arranged in a single transverse row, interrupted across the midline. The six nuchal scales form an ovate cluster that is composed of an anterior row of four scutes, and a posterior row of two. The neck armor is separated from the body carapace by a conspicuous space of unarmored skin. Based on the back edge of the hind limbs, and based

on criterion #3 in Ross & Mayer (1983: 308) involving the relative transverse widths of the lumbo-sacral and pelvic rows of proper dorsal scales, we count sixteen carapace rows on the male in the upper right photo (Fig. 20).

We agree with Lutken (1884) about there being two Crocodylus species inhabiting Venezuela and adjacent Colombia, and we today suspect that Lutken (1884) was correct about overlap in cranial and mandibular characters between C. intermedius and C. acutus, when various sizes of heads, and the entire geographic distribution of the latter is considered. Some American crocodile heads look more like C. intermedius than others; and, some Orinoco crocodile heads look more like C. acutus than others. Age variation is generally a significant factor in crocodilian skulls and mandibles. Lastly, we tentatively agree with Lutken (1884) and others that the dorsal armor on the carapace separates all C. acutus from all C. intermedius, but at the same time, we note that Lutken's (1884) dorsal armor samples of both species were small. We would not be surprised if some American crocodiles exhibit six keel-rows across in selected rows located within the anterior half or third of the carapace, and we believe that it is possible that some Orinoco crocodiles could have three transverse rows of nuchals (adding PC-19 to the neck shield), for a total of eight scales. Further, considering the nature of the anterior edge of the carapace, which overlaps with C. acutus, we predict that some Orinoco crocodiles will exhibit at least traces of PC-17.

Four notes: (1) MNHN-Paris = the Museum National d'Histoire Naturelle in Paris, France. (2) FMNH = the Field Museum of Natural History in Chicago, Illinois, USA. (3) Crocodilus pacificus from the western coast of Guatemala is subjectively a junior synonym of Crocodylus acutus. (4) Crocodilus journei is an unnecessary duplicate of C. intermedius Graves which was without locality data, and by definition, C. journei is a junior synonym of Crocodylus intermedius.

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Ross, F.D. and Pearcy, A. about “Orinoco crocodile pictures needed...”

Abstract:

More published pictures of the Orinoco crocodile are needed for showing the external characters which distinguish C. intermedius from other Crocodylus species, especially the American crocodile, C. acutus. Dr. John Thorbjarnarson’s fieldwork photos from the 1980’s could contain the desired pictures. Lateral views of the head and whole animal are less diagnostic than directly dorsal and ventral views. Subjects of special interest are the mandibular symphysis, and the dorsal scales on the body and pelvis. Of note are an 1831 picture compared with the 1819 written description of the type specimen. Selected illustrations from papers by Federico Medem, Karl P. Schmidt, Peter Brazaitis, Chr. Lutken and others are reproduced and evaluated, including some surprising data from 1884.

A MORPHOMETRIC AND GENETIC APPROACH TO DESCRIBING INCONGRUENCIES OF *CROCODYLUS* IN THE GREATER ANTILLES

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Recent preliminary genetic data have shown that American crocodiles restricted to the Greater Antilles (herein referred to as 'Antillean crocodiles') may be an ancient hybrid type between Cuban (*Crocodylus rhombifer*) and American crocodiles (*C. acutus*). We tested this relationship utilizing a genetic and geometric morphometric approach in an effort to better ascertain the evolutionary interactions leading to this present structure. Two mitochondrial DNA (MtDNA) fragments (D-loop and Cyt-*b*) and 10 microsatellite loci were amplified for captive and wild caught specimens representing Greater Antillean and other Neotropical *Crocodylus* species. Museum collections were sampled for 2-D morphometric skull data of Antillean, Cuban and other American crocodiles throughout their current and historic ranges. MtDNA analyses reveal that the Antillean crocodile possesses a haplotype more closely related to *C. rhombifer* than to other mainland *C. acutus*. Additionally, microsatellite data support an intermediate relationship of Antillean crocodiles between *C. rhombifer* and mainland *C. acutus*, although species specific alleles were identified in all three groups. Preliminary geometric morphometric data support a difference in shape change between these three groups and place Antillean crocodiles closer to mainland *C. acutus* although.

Crocodylus mindorensis x *Crocodylus porosus* HYBRIDS DETECTION IN PHILIPPINE CROCODILE SYSTEMATICS ANALYSIS.

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The Philippine crocodile (*Crocodylus mindorensis*) is an endemic freshwater crocodilian with few surviving wild subpopulations in the northern (Luzon) and southern (Mindanao) regions of the island archipelagos. It is listed as critically endangered on the IUCN's Red List of Threatened Species. In response to the National Recovery Plan and priority issues, we present the first comprehensive study of the Philippine crocodile systematics. This study investigates the genetic integrity of the Philippine crocodile using mtDNA and nuclear DNA sequence data, and validated with microsatellite genotype data using 618 *C. mindorensis* samples from the wild and captive facilities. From the mitochondrial DNA control region, we have designated seven haplotypes in the data set as M1-M6 and P1. By comparing the Philippine crocodile sequence data set with GENEBANK accessioned crocodile sequences, the M1 – M6 haplotypes cluster as *C. mindorensis* while the P1 haplotype cluster with *C. porosus*. The results of the mtDNA analysis was compared with analysis of the genotype data using computer package STRUCTURE, and the results confirm that all the P1 haplotypes cluster together, but that some of the M haplotypes clustered with P haplotypes. The clustering of P haplotypes with some M haplotypes revealed bidirectional hybridization between *C. mindorensis* x *C. porosus*. All of the hybrids were representatives from the captive population. No hybrids were detected in the wild free-ranging samples.

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GENETIC CHARACTERIZATION OF THE AMERICAN CROCODILE ON COIBA ISLAND, PANAMA.

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Coiba Island located off the western coast of Panama is an ideal locality for conservation of threatened crocodile populations due to increasing anthropogenic activities on continental Panama. *Crocodylus acutus*, was utilized as a model species for this project due to its wide range in the Mesoamerican region and its marine distribution patterns. Our purpose was to characterize the genetic and morphological composition of *C. acutus* on Coiba Island, and to infer the population structure derived from the genetic variability and the extent of the gene flow between and among different collection sites. The hypothesis in this study is that *C. acutus* populations in Coiba are a metapopulation in which subpopulation in each collection site are connected to others by small gene flow. In our research, skin clips and body measures were collected from 60 individuals in 12 sites throughout the island. Seven polymorphic microsatellite loci were amplified to test for polymorphisms and analyzed with statistical and model-based clustering analyses. These microsatellite analyses provide important information on the genetic variation of *C. acutus* relevant to specific environmental conditions of the island and the dispersion patterns of the population. Morphological data was analyzed utilizing multivariate statistical methods. Analyses of variance revealed no significant differences between females and males for the morphological variables analyzed ($P > 0.36$). A principal component analysis showed that the first principal component (PC1) accounted for 99% of the variance in all the morphological measures. Total body length (TL) showed a positive association and the largest loading value (0.85) for PC1. In conclusion, it appears that no major morphological differences discriminate between sex and location of individuals throughout the island, with TL accounting for the majority of the variation in morphological measures. Preliminary microsatellite analyses indicate that there is no relationship between genetic variation and the sample site according to model-based clustering data. Additional data will elucidate this relationship and allow us to further test the proposed hypothesis.

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GENETIC STRUCTURING IN POPULATIONS OF *Paleosuchus trigonatus* AND *Paleosuchus palpebrosus* OF BRAZILIAN AMAZON.

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The jacaré-coroa (*Paleosuchus trigonatus*) and the jacaré-paguá (*Paleosuchus palpebrosus*) are small bodied species occuring at low densities along Amazonian rivers that act as important dispersal conduits for these caiman. The jacaré-coroa preferentially inhabits small headwater streams, and is more closely associated with terra-firme habitat. The jacaré-paguá preferentially inhabits mouths of smaller streams as they enter rivers. We studied *P. trigonatus* and *P. palpebrosus* with the goal of inferring intra- and inter-specific genetic variability and population structuring. We analyzed 25 individuals of *P. trigonatus* from upper rio Madeira (N=10) and from Manaus (N=15), and 34 individuals of *P. palpebrosus* from upper rio Madeira (N=7), Manaus (N=12) and from the Pantanal (N=15). We sequenced 417 base pairs of the mitochondrial citochrome b gene. This region was variable and informative, containing 15 variable sites in *P. palpebrosus* and six in *P. trigonatus*. Genetic divergence between the two species was high, varying from 9% to 10%. Intraspecific divergence in *P. trigonatus* varied from 0.0% to 0.9%, and in *P. palpebrosus* from 0.0% to 1.7%. Molecular data also indicated strong population structuring in both species (*P. trigonatus Fst* = 0.91, $p < 0.01$ and *P. palpebrosus Fst* = 0.35, $p < 0.01$), and near complete absence of gene flow between localities of the same species. Genetic diversity observed in the two species of *Paleosuchus* were smaller than those encountered in *Caiman crocodilus* and *Melanosuchus niger*, both of which are largely panmixic in the Amazon basin. Additional populations of both species are being analyzed to verify the observed patterns of diversity and structuring. Additionally, we expect that genetic structuring also reflects local adaptation, and that environmental disturbance will have significant negative impact on both species.

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ISOLATION AND CHARACTERIZATION OF MICROSATELLITE MARKERS FOR *Caiman crocodilus*.

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Species specific macrosatellites have characteristics that make them an excellent maker for the study of systems of mating and evolutionary history of a species. With this goal, we characterized 12 di-nucleotide microsatellite loci obtained from a genomic library of *Caiman crocodilus* enriched in CT and GT di-nucleotide repetitions. The 12 loci were characterized in a population of *C. c. crocodilus* from Piagaçu – Purus Sustainable Developmental Reserve, Amazonas, Brazil. Additionally, we performed a cross amplification test with a population of *Caiman c. yacare* de Cáceres, Mato Grosso, Brazil. The number of alleles varied from 3 to 20 per locus in *C. crocodilus* and from 1 to 14 alleles per locus in *C. c. yacare*. Observed heterozygosities ranged from 0.088 to 0.816 and 0.115 to 0.833, respectively. Joint paternity exclusion was > 0.999 in both subspecies, and probability of genetic identity varied from 4.631×10^{-13} in *C. c. crocodilus* to 2.233×10^{-8} in *C. c. yacare*. All loci are unlinked, and with the exception of three loci in *C. c. crocodilus* all loci are at Hardy-Weinberg equilibrium. The characteristics of these loci makes them an excellent tool set for the study of mating systems, and fine-scaled population structuring in the *Caiman crocodilus* species complex.

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MULTIPLE PATERNITY IN *Caiman crocodilus* FROM THE PIAGAÇU – PURUS SUSTAINABLE DEVELOPMENT RESERVE

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Abstract: The mating system of *Caiman crocodilus* was investigated at the Piagaçu - Purus Sustainable Development Reserve, state of Amazonas, Brazil. This is the first study on the mating system of *C. crocodilus* and the frequency of multiple paternity is among the highest values reported thus far for species of crocodilians. These data will be used as part of a management plan for the species in the Piagaçu - Purus Sustainable Development Reserve.

Keywords: *Caiman crocodilus***,** mating system, microsatellite.

Introduction

The inference of a mating system based on microsatellite markers has demonstrated that polygamy or multiple paternity is frequent in a number of species of vertebrates and invertebrates (Fantin *et al*., 2008, 2010; Buresch *et al*., 2001). There are reports of multiple paternity among *Alligator mississippiensis* (Davis *et al*., 2001), *Crocodylus moreletti* (McVay *et al*., 2008), *Caiman latirostris* (Amavet et al 2008), *Melanosuchus niger* (Muniz *et al*., 2011) and *Alligator sinensis* (Hu & Wu 2010) and both pluriannual multiple paternity and fidelity to a long-standing companion in *Alligator mississippiensis* (Lance *et al*., 2009).

Understanding an animal's system of mating is a decisive factor for the long-term success of conservation or management plan for any particular natural population (Frankham *et al*., 2002). With this goal in mind, the objective of the current study was to analyze the mating system of *Caiman crocodilus* in a region of the Brazilian Amazon that has historically been subjected to an intensive illegal bush meat trade - the Piagaçu - Purus Sustainable Development Reserve (Marioni, 2007) using species - specific microsatellite markers (Oliveira *et al*., 2010).

Materials and Methods

The present study were carried out in the Piagaçu - Purus Sustainable Development Reserve, state of Amazonas, Brazil, which is located along the lower Purus River in the central region of the state of Amazonas, Brazil (4º05' to 5º35' S and 61º73' to 63º35' W) (IPi unpubl data).

The nests were located during scanning walks along the banks of lakes, with the active participation of local residents who worked as field assistants. We sampled eggs from 13 nests of *C. crocodilus* (from 30 to 100% of the total number of eggs per nest), totaling 198 fertilized eggs during the 2007 and 2008 reproductive seasons. We also sampled 11 females that were guarding these nests, and 21 males and potential fathers in the area.

Total DNA was isolated from the muscular tissue using protocols CTAB 2% (p/v) (Doyle & Doyle 1987). Six highly polymorphic loci with high probability of paternity exclusion and low probability of genetic identity were amplified in the 230 individuals using a multiplex PCR, and genotyped an ABI 3130xl automatic sequencer (Applied Biosystems, Foster City, CA, USA) using ROX500 fluorescent size standard (DeWoody *et al*., 2004). Alleles were visualized and binned using the software GeneMapper v 4.0 (Applied Biosystems, Foster City, CA, USA).

To determine parental contribution to each nest, we used a method of simple allelic counting (Myers & Zamudio 2004), and the reconstruction of parental alleles to infer the relative contribution of individual males to each nest using the Gerud 2.0 program (Jones, 2005).

Results and Discussion

The results were comparable between the two methods of analysis, and the null hypothesis of monogamy was rejected for all 13 nests. Each nest had from at least two to four contributing males, demonstrating that females of *Caiman crocodilus* are polyandrous. This study is the first analysis of the mating system of *Caiman crocodilus* and indicates that multiple paternity is common in the species, and that frequency of multiple paternity is greater than observed in other crocodilian species: *Alligator mississippiensis* (31.8% of 22 nests) (Davis *et al*., 2001), *Crocodylus moreletii* (50% of 10 nest) (McVay *et al*., 2008, *Caiman latirostris* (50% of 4 nests) (Amavet *et al*., 2008, *Alligator mississippiensis* (40 to 67%

between years of 92 nests) (Lance *et al*., 2009), *Alligator sinensis* (30% of 10 nests) (Hu & Wu, 2010), *Melanosuchus niger* (50% of 6 nests) (Muniz et al., 2011).

The results will incorporated into a management plan of *Caiman crocodilus* in the Piagaçu – Purus Sustainable Development Reserve.

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MULTIPLE PATERNITY IN NESTS OF *MELANOSUCHUS NIGER* FROM THE MAMIRAUA SUSTAINABLE DEVELOPMENT RESERVE, AMAZONAS, BRAZIL

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Although the jacare-acu, *Melanosuchus niger***,** is of considerable economic and ecological importance, relatively little is known about the behavior and its ecology in nature. With the goal of contributing more detailed information about the system of mating of this species, 10 nests of jacare-acu from the RDS Mamiraua were genotyped using five microsatellite markers. We genotyped 10 nests, each with 13 to 35 eggs, for each of the five microsatellite loci (clau6, amiu8, amiull, amiul6 and amiu20). To test the efficiency of the microsatellite loci we calculated the probability of genetic identity for each locus (I] and their Joint probability (IC), and the probability of paternity exclusion for each locus (Q) and their joint probability (QC). All loci had high exclusion probabilities to efficiently test the hypothesis of multiple paternity and were sufficiently polymorphic to evidence additional alleles than are expected to be present in a monogamous mating system. To test for multiple paternity, we used the method of simple allelic counting which consists of counting all allelic states that exist within a nest, and the inference of paternal genotypes based on the presence of homozygotes, and assuming normal pattern of Mendelian inheritance. Multiple maternity was clearly observed in nine of the 10 nests analyzed. The evidence of multiple paternity in *M. niger* is a vital piece of information about the reproductive dynamics of this species, and should be used in conservation and management programs of this icon of the Amazonian flooded forest.

Keywords: Multiple paternity, *Melanosuchus niger***,** microsatellite

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POPULATION GENETICS OF THE AMERICAN CROCODILE IN COIBA MARINE NATIONAL PARK, PANAMA.

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Phylogeographic studies of the American crocodile (*Crocodylus acutus*) have shown correlation between population structure and geographic distribution. Within Coiba Marine National Park (CMNP) in Panama, *C. acutus* is widely distributed among a large complex of islands throughout a 1043 square miles range. Our null hypothesis assumes these populations are isolated with no gene flow among them. Although ecological and ethological observations describe *C. acutus* as an active colonizer through marine dispersion and are consistent with an alternative hypothesis that *C. acutus* populations on the islands of CMNP belong to one cohesive population. Delineating populations as Evolutionarily Significant Units (ESUs) based on their genetic and geographic distribution is important especially when considering conservation and management actions. Our study will address the following questions: 1) Are populations on six study islands of CMNP (Isla Afuera, Isla Uva, Isla Contreras, Isla Pajaros, Isla Brincanco and Isla Rancheria) ESUs or are they panmictic populations related by some level of gene flow? 2) What is the level of gene flow, if any, among these populations? To address these questions, we are currently genetically characterizing *C. acutus* populations of the six study islands within CMNP by amplifying seven polymorphic microsatellite loci. Our preliminary data shows low genetic variation among *C. acutus* populations of the study area but also indicate some level of gene flow is occurring. The genetic information obtained upon the completion of our study will be invaluable to devising an effective management plan for *C. acutus* within CMNP and facilitate reintroduction and sustainable use projects in Panama and throughout the American crocodile's known range.

POPULATION GENETIC STRUCTURE IN THE BROAD-SNOUTED-CAIMAN (*Caiman latirostris*).

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Broad-snouted-caiman's (*Caiman latirostris*) geographic distribution comprises one of the widest latitudinal ranges among all crocodilians. In the present study, we analyzed the relationship between geographic distance (along the species' latitudinal and longitudinal range) and genetic differentiation by analyzing mitochondrial DNA sequences and nuclear microsatellite loci. Study sites ranged from the northernmost (Natal, in the state of Rio Grande do Norte) to the southernmost (Taim, in the state of Rio Grande do Sul) limits of the broad-snouted-caiman geographic distribution (Verdade and Piña, 2006). The westernmost limit for the species in Brazil was also included (Bonito, in the state of Mato Grosso do Sul) as well as an insular population (Cardoso Island, off the Atlantic coast of the state of São Paulo). Blood samples collected in previous studies by Verdade et al., 2002; and Villela, 2009 were also included in the present work). On a global scale, the inter-population variation of alleles indicated strong differentiation (RST = 0.407, P < 0.001). Results suggest that there is a consistent relationship between geographic distance and genetic differentiation, although other biogeographical factors seem to be relevant. The Atlantic chain (Serra do Mar) seems to be an effective geographic barrier, restricting the genetic flow between populations of the coast and continent. In addition, coastal populations seem to have been well connected in recent geological time (Pleistocene 16,000 years ago) all along the eastern Brazilian coast. By AMOVA, 71.84% ($p<0.001$) of the total variability occurs between costal and continent populations. Analyses from the Structure software assigned the twelve populations to ten clusters showing little exchange among some populations. Results contribute to knowledge of the genetic structure of this species, and in the future, these data will be useful for conservation purposes.

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TESTING THE PHYLOGENETIC UTILITY OF 40 MICROSATELLITES ON MORELET'S AND AMERICAN CROCODILES.

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Recently, workers have isolated and characterized 253 novel polymorphic microsatellite loci from the saltwater crocodile (*Crocodylus porosus*), and tested them for cross-species amplification. These markers have yet to be tested thoroughly in the 4 currently recognized New World crocodiles (*C. acutus, C. intermedius, C. moreletii* and *C. rhombifer*), which we propose to accomplish. Within the genus *Crocodylus*, many microsatellite loci are conserved across species and are useful in interspecific and intraspecific marker comparisons. Such conservation allows for descriptions of genetic diversity and hybridization analyses; to date, microsatellites have been isolated or cross-species amplified in almost all species of crocodilians. Therefore due to the overlapping ranges of *C. acutus* and *C. moreletii* samples in this study, hybrid analysis utilizing bi-paternally inherited markers is warranted. Information garnered from this study has the potential to assist in determining the conditional status of the crocodylian populations and to reinforce conservational efforts for sustainable use programs. Development of sustainable programs would be beneficial to local communities that use crocodile meat and skin as a commodity and basing these programs off the utilization of hybrid crocodiles could indirectly reduce competition with pure species in the wild.

Utilizing this methodology, the purpose of our study is to test 40 of the aforementioned loci for amplification and polymorphism on an individual- and population-level in order to describe the allele distribution of pure species of American (*C. acutus*) and Morelet's (*C. moreletii*) crocodiles and hybrids collected from multiple localities within and Mexico. A comparison of recent genetic work on crocodiles from these localities and throughout the New World indicates a relatively high degree of admixture between these two species and warrants additional multi-locus data to further our understanding of intra-species *Crocodylus* interactions. Utilizing a large set of multi-locus markers, information gathered from this study will increase our knowledge of *C. acutus* and *C. moreletii* genetic variation, fragmentation and hybridization, affording greater resolution. We also intend to look at museum specimens of *C. acutus* and *C. moreletii* from Mexico in order to gain a more historical perspective of those populations, which will aid in describing natural and (or) anthropogenic causes of hybridization and population declines in recent years.

Sampling: We are analyzing (7) *C. moreletii*, (5) *C. acutus*, and (5) *C. moreletii & C. acutus* hybrid individuals previously identified by Rodriguez et al. 2008. Polymerase chain reactions (PCR) are being done using primers and protocols described by Miles et al. 2009 and modified in Lou Densmore's lab. All the forward primers were modified adding the 5'end an m-13 tail (CAC GAC GTT GTA AAA CGA). Loci are being genotyped and analyzed with distance and model-based clustering methods and compared to previous genetic data. Our preliminary results have found consistent cross-species amplification for 10 of these markers in both species and indicate differing degrees of genetic variation. The purpose of our presentation here is to describe the methodology and preliminary results of these analyses.

HOST-PARASITE INTERACTION OF THE ORDER CROCODYLIA.

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It is possible that parasites of crocodilians are highly host specific, the results of a relationship that began over 65 million years ago. Records of parasitism in crocodilians dates back to the early 1800s, distributed among published and unpublished manuscripts, and international parasite catalogs. Previously published checklists of vertebrate or reptilian parasites have included crocodilians, however many did not include all crocodilian species, or all crocodilian parasite species that had been found up to that date. Additionally, various species of crocodilians and their parasites have been through extensive taxonomic evaluation and past sources of data may not have identified host or parasite with its new systematic name. This can be confusing for scientists, researchers, students, or parasitologists and herpetologists interested in crocodilian parasitology. To decrease any ambiguity I have created a crocodilian-parasite database to bring an up-to-date document of this particular host-parasite relationship in order to assist those pursuing investigations on the ecological, biological and veterinary significance of crocodilian parasites. In addition I have analyzed parasite distribution among crocodilian taxa, postulating host-parasite evolutionary and ecological interactions.

Crocodilians appear to be parasitized by a diverse array of parasitic phyla and species. Patterns of parasitism among crocodilian species can be described in two categories: generalist and host specialists. Generalists parasitize various crocodilian species, whereas host specialists or host-specific parasites infect a single host species. Overall, there are fewer host specific (~95) than generalist (~310) parasites (categorization did not include unidentified parasite species or parasites only identified to genus). Species-specific parasitism can be attributed to the lack of sympatry among crocodilian species and/or populations (Brooks, 1979a,b; Brooks and O'Grady, 1989; Huchzermeyer, 2003). Many crocodilian species are isolated either due to geographic or anthropogenic barriers (Huchzermeyer, 2003). Therefore a parasite must evolve strategies or life cycle patterns that minimizes or removes obstacles posed by vicariant barriers, enabling the capability of the parasitic species to infect multiple hosts throughout a geographic range. Three propositions are suggested that can assist in explaining the evolution of generalist parasites in crocodilian species: host dispersal, similar life-history traits and diets, and broad range of intermediate hosts. In evaluating the association of generalist parasites to geographic region, a pattern emerged reflecting three geographic regions: the Americas (includes North, Central, and South America), Africa, and Indo-Australia. The majority of generalist parasites shared amongst crocodilians within these regions were nematodes from the family Ascarididae.

Crocodilians are parasitized by several parasitic phyla, and are briefly discussed:

Acanthocephala: Acanthocephalans infecting crocodilians are under the order Polyacanthorhynchida, represented by one species. *Polyacanthorhynchus rhopalorhynchus*

parasitizes the intestines of all members of the genera *Caiman*, *Melanosuchus*, and *Paleosuchus*. Although Bush et al. (2001) state that only acanthocephalans from the order Polyacanthorhynchida parasitize crocodilians, two other orders are documented to infect crocodilians. *Gorgorhynchoides* sp. from the order Echinorhynchida was found in *Crocodylus acutus* in Mexico, and *Polymorphus mutabilis* in the order Polymorphida was discovered in the small intestine of *Crocodylus rhombifer* in Cuba.

Apicomplexa: Seventeen known species of coccidia (not including unidentified species) from four families under the order Eucoccidiorida parasitize crocodilians worldwide. Route of infection is most parsimoniously explained via horizontal transmission through contaminated water or food (Bush et al., 2001; Combes, 2001; Huchzermeyer, 2003). The majority of these protozoans (13 known species, 4 unidentified species) are from the family Eimeridae infecting thirteen crocodilians.

Arthropoda: The order Porocephalida includes a group of parasites commonly known as tongue worms. This order includes the families Subtriquetridae, Sebekidae, and Porocephalidae that contain crocodilian specific parasites. The majority of these described pentastomids are adults found in the lungs and trachea of their host, but some are known to parasitize other parts of the body such as the nasal cavity and intestine.

Nematoda: Nematodes are the second largest group parasitizing crocodilians

Adult nematodes parasitize various organs and tissue in crocodilians, but most documentation of parasitism is described from the stomach. Besides inflammation caused by stomach nematodes (Huchzermeyer, 2003) or scarring such as by *Paratrichosoma*, there are no ill effects unless the host is immunocompromised.

Platyhelminthes: Platyhelminthes is the most diverse and largest phylum parasitizing crocodilians, comprising of five orders, 16 families (not including one superfamily), and 125 species. Three orders of Platyhelminthes appear to have an ecological and/or evolutionary relationship with crocodilians. Parasites of the order Echinostomida are a diverse intestinal parasitic group of reptiles that are considered not to be host specific (Bush et al., 2001), yet the majority recorded in crocodilians are found in only one crocodilian taxon. Furthermore, most documentation of echinostomes are described from South American caimans, principally in the region of Matto Grosso, Brazil. Plagiorchiida is the second largest order of crocodilian platyhelminthes. Almost all plagiorchiids are described as intestinal parasites, yet few are found in other organs such as *Pseudotelorchis caimanis* discovered near the oviduct of *Caiman yacare,* and *Renivermis crocodyli* from the kidneys of *Crocodylus porosus.* The third largest order of platyhelminthes parasitizing crocodilians is also the most diverse in location of parasitism. Species of the order Strigeidida are documented from the buccal cavities, cloaca, major organs (including the brain), yet majority are found in the intestinal tract.

Sarcomastigophora: Trypanosomes have an ancient evolutionary relationship with crocodilians, dating back to the late Cretaceous (Viola et al., 2009). Two species have been described from two crocodilians, *Trypanosoma cecili* from *Caiman crocodilus crocodilus*, and *Trypanosoma grayi* from *Crocodylus niloticus.*

There are other parasites that have been documented in crocodilians, but considering these phyla are represented only by one parasite and were found in only one host within the crocodilian assemblage, it is hypothesized that these reports are examples of opportunistic parasitism.

It is probable that a unique mutualistic or commensal relationship between crocodilians and their parasites has developed over evolutionary time, allowing them to adapt to changing environments and novel pathogens. However, human conflict, climate change, and habitat loss, pose a threat to this dynamic, resulting in one of two negative outcomes. First, anthropogenic interactions can decrease parasitic prevalence and abundance in a host population by external factors hindering parasitic transmission or killing free-living stages of the parasite (Bush et al., 2001). As this may seem beneficial, parasites that are host-specific for crocodilians may have developed a commensal relationship over evolutionary time with their archosaurian host, contributing to crocodilians' ability to eradicate a broad spectrum of invasive pathogens over evolutionary time. Therefore the alteration of a beneficial coevolved dynamic may contribute to crocodilian populations inability to adjust to anthropogenic disturbances or novel pathogens. In contrast, ecosystem perturbations may enhance parasitic prevalence, intensity and abundance of a host population (Combes, 2001; Lafferty and Holt, 2003; Lafferty and Kuris, 2008). Increase stress due to ecosystem disturbance, or accumulation of toxic metals can interfere with hosts' immune function (Sures 2006; Arkoosh et al., 2008; Lafferty and Kuris, 2008; Rohr et al., 2008). Immunosuppression allows viral, bacterial and parasitic infections to proliferate, ultimately causing extreme morbidity, or mortality, of the host. Either alternative illustrates that a disruption in this reptilian-parasite system will have a detrimental outcome for the individual, population, or crocodilian species under investigation, resulting in a negative trophic cascade due to their role as keystone predators.

The purpose of this crocodilian-parasite database is to provide a foundation for future research on crocodilian parasitism. Data extrapolated from this study can be utilized to investigate coevolution and host phylogeny, as well as the role of crocodilian parasites in food webs, and ecosystems, and how external stressors may alter host-parasite dynamics. Previous ecological parasitology studies have linked predator reduction to reduced presence of trophically transmitted parasites, and an increase in other types of parasites of abundant hosts at lower trophic levels (Lafferty and Kuris, 1999; Combes, 2001; Bush et al., 2001; Lafferty et al., 2008). Moreover, the fundamental dependence of parasites on both host and environment make them biological indicators of the stability of the environment. Therefore, quantifying parasites of keystone predators, such as crocodilians, may enable analysis of ecosystem function. In a rapidly changing environment (due to climate change, land use practices, and direct exploitation of the environment), knowledge on the significance of crocodiles and their parasites is necessary to propose proper action for conservation and responsible stewardship of their environment.

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FACTORS AFFECTING SIZE OF CAIMANS POACHED WITH BAITED HOOKS IN FLOODED FORESTS OF CENTRAL AMAZONIA, BRAZIL

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Illegal caiman hunting in the lower Purus River is carried out using baited hooks suspended upon the water surface, or directly thrown on the water bodies' shore. The effects of this technique on caiman populations and the size of captured individuals are unknown. During 2008 we followed 31 hunting events in the Piagaçu-Purus Sustainable Development Reserve. The objective of this study was to evaluate the effects of hook height upon water surface, size, distance from the water-land interface and water depth on the size of hunted caimans. Simple or multiple linear regressions were used to evaluate these effects upon caiman snout-vent length (SVL). The SVLs of 71 *Caiman crocodilus* ranged from 55.0 to 114.0 cm (mean= 82.4, SD= 15.5) and for 53 *Melanosuchus niger* SVL ranged from 55.0 to 135.5 cm (mean= 96.9, SD= 21.4). Mean hook height (p= 0.012) and mean hook size (p= 0.001) explain 48% of variance on mean size of caimans captured with suspended hooks ($F_{2,24}$= 11.163, P< 0.001) and both variables showed a positive effect. The multiple regression model used to evaluate the effects of hook height and water depth explain 38% of variance on mean size of caiman captured ($F_{2,24}$= 7.323, P= 0.003). In this case, hook height had a positive effect (p= 0.008) but water depth (p= 0.007) had a negative effect on dependent variable and consequently on total meat produced. Mean hook distance from the water-land interface explain 60% of the variance ($F_{1,9}$= 13.664, P= 0.005). Populations of *C. crocodilus* and *M. niger* in the lower Purus River are subject to the largest hunting pressure known over the entire Amazon Basin. Our results can be used to test size selectivity of the baited hook technique and compare it to traditional harpoon hunting. Replication of this technique should be tested in areas without caiman commercial hunting to confirm such size selectivity.

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TAXAS DE CRESCIMENTO DE FILHOTES DE JACARÉ-DO-PANTANAL CRIADOS EM CATIVEIRO SOB DIFERENTES DENSIDADES

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O plantel de Jacaré-do-pantanal (Caiman yacaré) criado em cativeiro em Mato Grosso superou os 325 mil animais no final de 2008. Entretanto, dados informados pelos criadores junto ao IBAMA, permitem inferir que as criações carecem de padronizações de manejo, especialmente pelas taxas de mortalidade que variam de 5% a 63%. Dado o custo inicial que cada filhote representa num criatório (trabalhos de levantamento populacional, coleta de ovos, incubação, eclosão e alimentação inicial) é necessário estabelecer as densidades ideais para sua criação, otimizando a área física que lhes é destinada, sem comprometimento de seu desenvolvimento. Assim, objetivou-se avaliar os ganhos de massa e de comprimento de filhotes de Jacaré-do-pantanal criados em cativeiro, utilizando-se delineamento inteiramente casualizado com cinco tratamentos (densidades de lotação de 10, 20, 30,40 e 50 animais/m^2) e quatro repetições. Os 3600 filhotes avaliados foram distribuídos em recintos de alvenaria, com piso cimentado (seis m^2), sendo metade da área seca e a outra coberta com lâmina d'água de 20 cm de profundidade média e cobertos com tela de polietileno com fator de sombreamento de 80%. As biometrias da massa corpórea (MC) e comprimento rostro-cloacal (CRC) foram realizadas mensalmente em 10% da população inicial, sendo a primeira no início do experimento (julho de 2008) quando os animais apresentavam, aos 4 meses de idade, MC e CRC mínimos, máximos e médios de, respectivamente, 49,29 g, 50,96 g, 49,91 g, 13,32 cm, 13,54 cm e 13,44 cm. Os resultados obtidos no final do período experimental (janeiro de 2009), aos 10 meses de idade, revelaram ganhos de massa corpórea e de crescimento variando, respectivamente, entre 348,26 g a 418,69 g e de 10,51 cm a 11,84 cm, sem diferença significativa entre os tratamentos. Assim, sugere-se para animais de até 10 meses de idade densidade de criação em cativeiro de até 50 animais/m^2, sem que haja prejuízo no ganho de massa e de crescimento, aproveitando-se melhor os espaços disponíveis nos criadouros comerciais.

INJURY PATTERNS IN A MELANOSUCHUS POPULATION IN THE RUPUNUNI REGION OF GUYANA.

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Rupununi Learners Inc., Yupukari Village, Region # 9 Guyana.

In September 2005 an ecological study of the black caiman (Melanosuchus niger) was initiated at Yupukari Village, Region # 9, Guyana. A continuing mark/recapture component is central to this community participation effort and encompasses a range of age/size classes of caiman (N = 575). For each capture a broad morphometric and descriptive data set is collected. All injuries and defects, including missing eyes, boné breaks, missing limbs, limb parts or toes, significantly shortened tails, (represented by 50% verticel loss) as well as general perceived health and body condition, (relative wt, girth) are recorded. Etiology of injuries is interpreted where possible; i.e, INT, (intraspecific; other caiman) HI, (human induced). Depending on severity and type, 12 categories of injury are classified. Perceived developmental defects, (i.e. cleft snouts) are not considered injuries. The majority of individuals in the Rupununi Melanosuchus population display at least one category of injury. However 45% of specimens show no significant defects, (PR); 19.5 % have missing or broken toes or toe parts, (TT) followed significantly by + 15% which show intraspecific injuries, (INT's) via other caiman ranging from jawbone dislocations and breakages, crushing tail injuries and destroyed eyes, to less severe puncture wounds and rake marks. Predatory fish such as Black piranha, (Serrasalmus rhombeus) account for + 5% of all injuries, while 2% of non-fatal injuries are caused by indigenous Macushi principally using arrow points. It is noted and expected that injuries to individual caiman will accumulate over time. Remarkably, many specimens living with permanent, apparently debilitating injuries appear to be in thriving condition. While recaptures demonstrate a lengthening time-line of survival for injured caiman it is difficult to gauge the percentage of non-survivors not recovered to full health after initial traumas. Beyond profiling injury patterns in a local population of black caiman, the data is significant in further demonstrating the outstanding ability of crocodilians to suppress threats from bacterial infection from open wounds sustained in wet tropical environments; this feat accomplished by secretion of natural antibiotics, (Merchant, M. et. al. ; J. of Exp. Zoology 2009: 311(9): 662-6). Furthermore, many specimens stabilize and continue to thrive in the aftermath of permanent injuries that typically incapacitate and curtail life in other vertebrate groups. Because so many Melanosuchus remain alive long after the insult of injury a more complete record of their embattled life histories is available to analyze, thus providing unusual insights into the traumatic history of populations.

PANSTEATITIS ASSOCIATED MORTALITIES IN NILE CROCODILES FROM SOUTH AFRICA – A RETROSPECTIVE OVERVIEW.

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Nile crocodile (*Crocodylus niloticus)* mortality due to pansteatitis was confirmed in Lake Loskop and the Olifants Gorge, South Africa. Both localities are in the Olifants River; Lake Loskop (upper Olifants River) in the Loskop Dam Nature Reserve and the Olifants Gorge (lower Olifants River) in the Kruger National Park (KNP). These are the first confirmed cases of pansteatitis in wild Nile crocodiles in South Africa. A multi-species fish die-off in Lake Loskop during August 2007 was caused by acid mine drainage released in the upper catchment of the Olifants River. Dead crocodiles were found 2-3 weeks after the start of the fish die-off. Gross and histopathological lesions in the crocodile carcasses were typical of pansteatitis. The trigger for the pathological changes in the fat depots of the crocodiles was speculated to be the preceding fish die-off, seeing that confirmed cases of pansteatitis in southern Africa have been linked to the feeding of rancid fish material to farm crocodiles. Lower down in the Olifants River (Olifants Gorge), large numbers of crocodiles died during the winters of 2008, 2009 and 2010. A diagnosis of pansteatitis was made based on the typical pathological changes observed in all the fat depots of numerous crocodiles that were necropsied. In the pansteatitis outbreaks (2008, 2009 and 2010) in the Olifants Gorge, no fish die-offs were reported before the start of the crocodile deaths. However, it was confirmed that most of the Sharptooth catfish (*Clarias gariepinus*) in the Gorge were obese with pathological lesions consistent with steatitis. Catfish collected from the Gorge were caught alive and, except for the obesity and steatitis, no obvious clinical signs were observed. Catfish collected from other rivers in the KNP, during the same periods, did not show any pathological changes as observed in the catfish from the Gorge. The large number of crocodiles that died during the different outbreaks, in the upper (2007) and lower (2008, 2009 and 2010) parts of the Olifants River, raised concerns that wild Nile crocodiles could disappear completely from South African aquatic ecosystems in the near future. The crocodile pansteatitis outbreaks in Lake Loskop and the Olifants Gorge will be reviewed with special reference to the history of the outbreaks, observed pathology, the suspected pathogenesis and future research.

RESULTADOS PRELIMINARES DE SALUD de *Crocodylus acutus* y DE *Crocodylus moreletii* EN EL CARIBE MEXICANO.

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El estudio presenta los primeros resultados sobre la salud de cocodrilos americanos (*C. acutus*) de la isla de Cozumel (agua salada) y de los cocodrilos de Morelet (*C. moreletii*) del Río Hondo (agua dulce), en Quintana Roo, México. De 2008 a 2010, se colectaron hisopos orales y cloacales para cultivo y aislamiento bacterial en 33 *C. acutus* y en 28 *C. moreletii*. Se colectaron muestras de sangre de 18 *C. acutus* y 14 *C. moreletii*. Se utilizaron muestras de suero de 6 *C. moreletii* y de 18 *C. acutus* para detección de anticuerpos contra *Leptospira interogans*. También se observó la prevalencia de *Paratrichosoma sp.*en los cocodrilos capturados. En *C. acutus* se aislaron 19 especies de bacterias en la cavidad oral y 14 en la cloaca. En *C. moreletii* se aislaron 23 bacterias orales y 14 cloacales. Ocho bacterias orales y8 cloacales estuvieron presentes en ambas especies de cocodrilos a pesar de la diferencia de salinidad entre los sitios. Los cocodrilos no mostraron ningún signo clínico de enfermedad pero bajo ciertas circunstancias algunas de las bacterias aisladas pueden ser patógenas. Los valores hematológicos de ambas especies se encuentran dentro de los rangos reportados por el International Species Information System (ISIS). Sin embargo 17 individuos de *C. acutus* presentan una eosinofilia marcada, lo que podría atribuirse a la presencia del hemoparásito *Hepatozoon sp.* Se encontraron títulos de anticuerpos de las siguientes serovariedades de *L. interogans* en el suero de los cocodrilos: Autumnalis, Bataviae, Bratislava, Canicola, Gryppotyphosa, Hardjo, Icterohaemorrhagiae, Pomona, Pyrogenes, Tarassovi y Wolffi. Todas esas serovariedades se detectaron en *C. acutus*, y sólo Icterohaemorrhagiae y Tarassovi no fueron detectados en *C. moreletii*. El ectoparásito *Paratrichosoma sp.* se observó en 62.9% de los cocodrilos americanos y en 19.1% de los cocodrilos de Morelet. Esta evaluación preliminar establece las bases para un estudio más preciso de salud de los cocodrilos en esta región.

THE GASTROINTESTINAL FLORA OF WILD AND FARM-RAISED AMERICAN ALLIGATORS (*ALLIGATOR MISSISSIPPIENSIS*)

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Despite biochemistry, physiology, and pathology studies of the American alligator *{A. mississippiensis),* a thorough description of the gastrointestinal (GI) microbial flora (microbiome) has not been established. Previous research on bacteria associated with alligators focused on culture-based methods, which can severely underestimate the diversity and abundance of microbes in samples. To circumvent this issue, tag-encoded FLX amplicon pyrosequencing, a next generation molecular detection method, was utilized to generate a portion of bacterial 16S rRNA genes from GI tract tissues collected during dissection of farmed and wild, wintering (non-feeding) *A. mississippiensis,* from Rockefeller Wildlife Refuge, Louisiana (USA). A comparison of bacterial sequences from 13 samples from the farm-raised and wild alligators revealed distinct microbiomes for each animal at the genus level, and significant differences in bacterial groups from the mouth to the colon. Approximately 50% of the bacterial operational taxonomic units, defined at the genus-level, were retrieved from both the wild and farm-raised GI tracts, indicating that the remaining bacterial sequences were unique to each individual. The oral cavities were dominated by *Betaproteobacteria* and *Bacteroidetes* for both animals, but the farmed alligator stomach and duodenum contained almost exclusively *Clostridia* compared to *Gammaproteobacteria* in the wild. *Bacteroidetes* dominated the farmed host ileum and colon, and *Fusobacteria* dominated the wild ileum and colon. The dominance of *Fusobacteria* and *Proteobacteria* contrasts other vertebrate GI tract microbiomes. Feces were analyzed for the farm-raised animal, and the bacterial composition did not reflect the GI tract communities, missing diversity at the phylum-level and over-representing other groups. This calls into question the utility of feces as an accurate indicator of internal GI microbial composition. Results from this study can provide insight into pro-and pre-biotic regimes of captive animals, and should aid veterinarians in the identification of pathogenic and non-pathogenic bacteria inhabiting alligators.

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ESTABLISHING A EUROPEAN PROGRAM FOR BLACK CAIMANS, AND LESSONS LEARNED ABOUT CROCODILIAN HEALTH.

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Black caiman populations have recovered dramatically over the past two decades, with the species now listed as Lower Risk by IUCN. However, the species is still poorly represented in zoos around the world. Our aim from the beginning was to display this impressive species. In 2004, after almost 10 years of contact with Pablo Evans and his ranch in Ecuador, we imported 15 black caiman. However, due to changes made to the diet of the caimans within the ranch, all 15 caimans were suffering from steatitis - a debilitating hardening of the fatty tissues, particularly around the abdomen and tail. Chiefly caused by feeding crocodilians fish that is not fresh, a lack of vitamin E is implicated in the condition, and it makes actions such as swimming and even eating difficult. All 15 animals were given vitamin E, but only 3 survived. As the surviving animals grow, the hardened areas will become proportionally smaller, and be less of a problem. We learned that 100 animals on the ranch had since died, and we returned to help them. Our assessment indicated that of the remaining animals, 22 were in good health, 28 were suffering but could be saved, and 31 were in very bad shape. We immediately altered the diet to be based around fresh chicken, with a positive response in the health of the animals. In 2007, we imported 17 healthy black caimans, and also released 10 caimans into the Tipotini area. In October 2009, the ranch sent us the final two caimans, a 3.7m male, and a 2.4m female. During the flight to Denmark, sadly the shipping compartment did not maintain the required temperature, and upon arrival they were both cold - the female around 12C. With heat treatment and veterinary help, the male recovered quickly. We noted the female maintained a posture with her head turned to the left, and a swollen area on her side. Despite various treatments, she died 5 months later. Necropsy results showed she had a long-standing liver condition. We have since learned that her posture is also noted in other taxa - eg. zebra - with liver problems. The male was successfully paired with another female in March 2010, and we have already noted behavior that gives us hope for mating in the near future. This would be the first time black caimans would have reproduced outside of South America.

Caiman latirostris HEMATOLOGICAL PARAMETERS UNDER HYPOXIC INCUBATION CONDITIONS.

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Many physiological processes have been described as a consequence of hypoxia environment in many vertebrates. Frequently, hypoxic incubation is a tool used to address studies of morphological and physiological characteristics during animal development. The aim of this study was determine if there was hematological response to hypoxia incubation conditions. We compared hematocrit (Ht), hemoglobin concentration (Hb) and red blood cells count (RBC) from embryos incubated at 31 °C and 33 °C and under hypoxia (12% Oxygen concentration) and normoxia conditions. Hypoxic incubation of *C. latirostris* resulted in physiological changes. We detected difference in Ht, Hb, and RBC at 31°C ($p<0.05$) but not at 33 °C ($p>0.05$). The results showed that embryos incubated under hypoxia showed a blunted hematological compensative response indicated by variables mentioned. At 31°C, *C. latirostris* embryos would compensate low oxygen available during incubation with physiological repertoire, as it is shown by the increment of hematological variables evaluated.

ECOTOXICOLOGY, NUTRITION AND THEATS TO NILE CROCODILES (*Crocodylus niloticus*) IN KWA ZULU-NATAL, SOUTH AFRICA.

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The recent die-off of Nile Crocodiles (Crocodylus niloticus) in the Kruger National Park (KNP) following an outbreak of pansteatitis has significantly elevated the species' conservation plight and highlighted the threat of environmental contaminants to protected aquatic ecosystems in South Africa. As a result, multifaceted research has begun on C. niloticus in KwaZulu-Natal (KZN) at the iSimangaliso Wetland Park, Jozini Dam and Ndumo Game Reserve, the only three remaining viable populations in the country outside of KNP. Although radiotelemetry has revealed baseline ecological differences among populations resulting from distinctive ecosystem processes – iSimangaliso is largely an estuarine system, Ndumo and Jozini are associated with a large freshwater river – there are commonalities among the direct and indirect anthropogenic threats C. niloticus face in these three protected areas. Poaching is primary among these, with two iSimangaliso aerial counts in June and July 2009 at Lake Sibaya, the largest freshwater lake in southern Africa, documenting a major population crash (6 and 7 individuals counted respectively, down from 90-134 in previous years) attributed to intentional C. niloticus killings. Crocodile populations in KZN at this time are likely not vulnerable to acute pollution-related crashes as documented in KNP, but preliminary analysis of C. niloticus livers from two emaciated iSimangaliso individuals indicated suspect lead levels (3.0 and 5.7 mg/kg, respectively). To date, almost 300 C. niloticus of varying size classes have been captured at iSimangaliso, Jozini and Ndumo since February 2009 and tissue analyses of blood, scutes and urine for ecotoxicological (bioaccumulation of heavy metals) and nutritional (13C and 15N stable isotope analysis) parameters is underway.

GENOTOXICITY IN *Caiman latirostris* EMBRYOS INCUBATED UNDER HYPOXIA CONDITIONS.

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Hypoxia is known as a stressor that alter genetic machinery. Hypoxic conditions in cells have been shown to promote clastogenicity (chromosome breakage) and contribute to genetic instability. The aim of the present study was to evaluate genotoxic effects on *Caiman latirostris* incubated under different oxygen pressures and temperatures. A total of 48 eggs of *C. latirostris* from 3 different clutches were incubated under 2 temperatures (31 and 33° C) and 2 oxygen pressures (normoxia-hypoxia). Genotoxic effect was evaluated in hatchlings erythrocytes through the micronucleus (MN) test. Blood smears were done for each animal and micronucleus frequency determined by fluorescent microscope analysis. Results shown an increase in MN frequency in caimans incubated at hypoxia condition in comparison with those incubated at normoxia ($p<0.05$). Temperature induced no genotoxic effect ($p>0.05$) and no interation was observed between temperature and O_2 pressure condition ($p>0.05$). These results demonstrated that changes in embryonic availability of oxygen induced DNA damage and may lead to alterations in different physiological functions in neonates.

GENETIC, ENZYMATIC AND DEVELOPMENTAL ALTERATIONS IN *Caiman latirostris* EXPOSED TO PESTICIDE FORMULATIONS AND MIXTURES IN A FIELD-LIKE EXPERIMENT.

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In a previous study we demonstrated genotoxic effects induced by pesticide formulations and mixtures in *Caiman latirostris* exposed *in ovo* in a field-like experiment simulating a possible environmental exposure in areas situated near crops. The aim of the present study was to confirm genotoxic results and characterize potencial enzymatic, metabolic and posnatal development alterations under the same exposure conditions. We design a semi-controlled experiment in which 3 groups of 3 artificial nest each (N=9) were contructed. We put eggs inside and the area was sprayed in two different moment of incubation as follow: a- control group: sprayed with tap water, b- treatment 1 (T1): received glyphosate formulation (GF; herbicide) in two applications, c- treatment 2 (T2): was sprayed with GF (herbicide) in the first application and a pesticide mixture of GF and two insecticides: endosulfan and cypermethrin, in the second application. Hatchlings were measured in body mass, SVL and TL and bled for genotoxic assays. At 3 and 12 months old, caimans were measured again to evaluated growth and blood samples were obtained to perform enzymatic and metabolic determinations: Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Alkaline phosphatase (ALP), Lactate dehydrogenase (LDH), Creatin kinase (CK-NAC), Cholinesterase (ChE), Total Protein (TP) and Serum Albumin (ALB). Results indicated genotoxic effects with both assays (MN test and CA) ($p< 0,001$), less size, and alterations in CK, AST, ALT and TP ($p< 0,05$) in exposed groups compared to control, at birth and 3 month old. No effects was observed at 12 months old. These results confirm our previous data on genotoxic effects of both GF and herbicide-insecticides mixture at concentrations commonly used in agriculture, and demosntrated that after several months of the exposure event, animals still show enzymatic and metabolic alterations as well as less growth.

JUVENILE AMERICAN ALLIGATOR (ALLIGATOR M1SSISSIPPIENSIS) MOVEMENTS IN AN IMPOUNDED WETLAND IN FLORIDA.

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Lake Apopka is a large lake in central Florida plagued with nutrient and organochlorine pesticide (OCP) contamination. The marsh surrounding the lake was drained in the 1940's and farmed intensively for vegetables and also plagued with OCP contamination. Restoration of Lake Apopka greatly depends on the ability to restore the structure and function of wetlands along its north shore. An important part of restoration involves monitoring OCP levels in soils and fish to estimate potential risk to fish-eating birds. Alligators and have been shown to accumulate OCPs and may be good indicators of bioaccumulation in restored wetlands. The main objective of the project was to determine the feasibility of using juvenile alligators to monitor OCP concentrations within the units of the NSRA. However, until recently, movement of juvenile alligators between lake and marsh systems has been conjecture.

We investigated movements of juvenile alligators between Lake Apopka and its north marsh impoundments through radio telemetry. Results of this study indicate a net movement of alligators from the lake into the newly flooded marsh, with very little movement of alligators from the marsh into the lake. Approximately 78% (n=14) of the alligators radio tagged on the lake moved into the adjoining marsh within a few months after tagging. We also found that only about 3% (n=70) of the alligators radio tagged in the marsh, subsequently moved to the lake. The reason for this net movement to marshes is unclear. Lake Apopka alligators had significantly lower body condition ($P < 0.001$) than the alligators in the marsh. This may indicate food viability is greater in marsh. We hypothesize that the movement out of Lake Apopka could be a result of less suitable habitat, less food resources, and elevated predation pressure from larger alligators. In summary, our telemetry investigations indicate that alligators are stationary enough under certain conditions to be used as bioindicators.

MERCURY LEVELS OF TWO SPECIES OF CAIMAN IN THE RIO PURUS BASIN, BRAZILIAN AMAZON.

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In the Amazon Basin, mercury (Hg) levels in soils are naturally high and studies in some areas of this basin have found exceptionally high levels of Hg. Crocodilians are important sources of protein to the Amazonian human population and need to be studied to analyze their potential health risk. We determined the total mercury levels of 2 crocodilians species in the Rio Purus basin and their Hg levels correlated with body size. We collected 10 *Caiman crocodilus* and 11 *Melanosuchus niger* in March and August 2008 using reptile snare, ketch-all animal restraining pole, locking cable snares as well as manually. Two-cm3 skinless boneless muscle was taken from the posterior portion of the animals, close to the tail. These samples were kept in plastic bags and maintained frozen until analysis by cold vapor atomic fluorescence spectroscopy for total Hg at UFPA. *C. crocodilus* had an average concentration of 75.38ppb (61.9 – 98.0) and *M. niger* had an average concentration of 104.6ppb (75.3 – 190.9). There was a positive relation between Hg concentration and *M. niger* body size (DF=6; F=13.21; p=0.0054). However, no relation was found between *C. crocodilus* and body size (DF=9, F= 0,45; p= 0,519). The lack of correlation between Hg concentration and size of *C. crocodilus* might be due to the low size variability of individuals collected. Both species in this study had concentrations lower than the maximum allowable level of 500 ppb Hg recommended by the World Health Organization and by the Brazilian Health Ministry. This suggests that the consumption of these two species of crocodiles does not pose a health risk for people consuming them.

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AVALIAÇÃO DAS APREENSÕES DE JACARÉS PARA O TRÁFICO ILEGAL NO ESTADO DO AMAZONAS.

EVALUATION OF SEIZED CAIMANS FROM ILEGAL TRADE IN THE AMAZONAS STATE.

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INTRODUÇÃO

A caça de jacarés amazônicos para o mercado de peles foi intensa no mínimo durante três décadas (SMITH, 1980). No Brasil, a caça comercial destes répteis foi legal até meados da década de 1960, sendo terminantemente proibido após a publicação da Lei nº 5.197 de Proteção à Fauna (BRASIL, 1967).

O Estado do Amazonas foi o maior exportador de peles de jacarés do mundo até 1970, pois os estoques puderam ser comercializados nos três anos seguintes à promulgação da lei citada anteriormente. No entanto, nas últimas décadas o Amazonas tornou-se a região de maior produção ilegal de carne de jacaré do mundo. As principais espécies deste comércio foram o jacaré-açu (*Melanosuchus niger*) e o jacaré-tinga – Ca*imam crocodilus* (DA SILVEIRA, 1999, 2003; DA SILVEIRA & THORBJARNARSON, 1999; MARIONI; MÜHLEN & DA SILVEIRA, 2007). Até recentemente, o registro do tráfico de animais silvestres no Estado do Amazonas foi realizado basicamente pela Divisão de Controle e Fiscalização (DICOF) do Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), mas estas informações nunca foram detalhadamente analisadas.

O nosso objetivo neste estudo foi avaliar o comércio ilegal de carne de jacaré no Estado do Amazonas, segundo o registro histórico oficial contido nos autos de apreensão na (DICOF) do IBAMA/AM. Nós identificamos as espécies comercializadas, avaliamos a contribuição relativa das espécies e a ocorrência mensal ou por região do Estado entre 1992 e 2007.

MATERIAL E MÉTODOS

A coleta de dados foi realizada entre fevereiro e dezembro de 2008, mediante triagem nos arquivos da (DICOF-IBAMA/AM.

Média e desvio padrão foram utilizados como estatísticas descritivas dos dados. As informações foram apresentadas em histograma ou gráfico de dispersão.

RESULTADOS E DISCUSSÃO

O número de jacarés apreendidos por ano variou de um a 5102 (média = 1608,4; DP = 1781,3). Do total de indivíduos registrados, 69,5% foi apreendido entre 1999 e 2001 (Figura 1A).

O número de jacarés por auto de apreensão variou de um a 3788 (média = 240; DP = 63). Apreensões superiores a 2000 jacarés por auto ocorreram somente em 1999, 2001, e em 2005. A maioria (50,7%) das apreensões foram superiores a 20 animais. (Figura 1B).

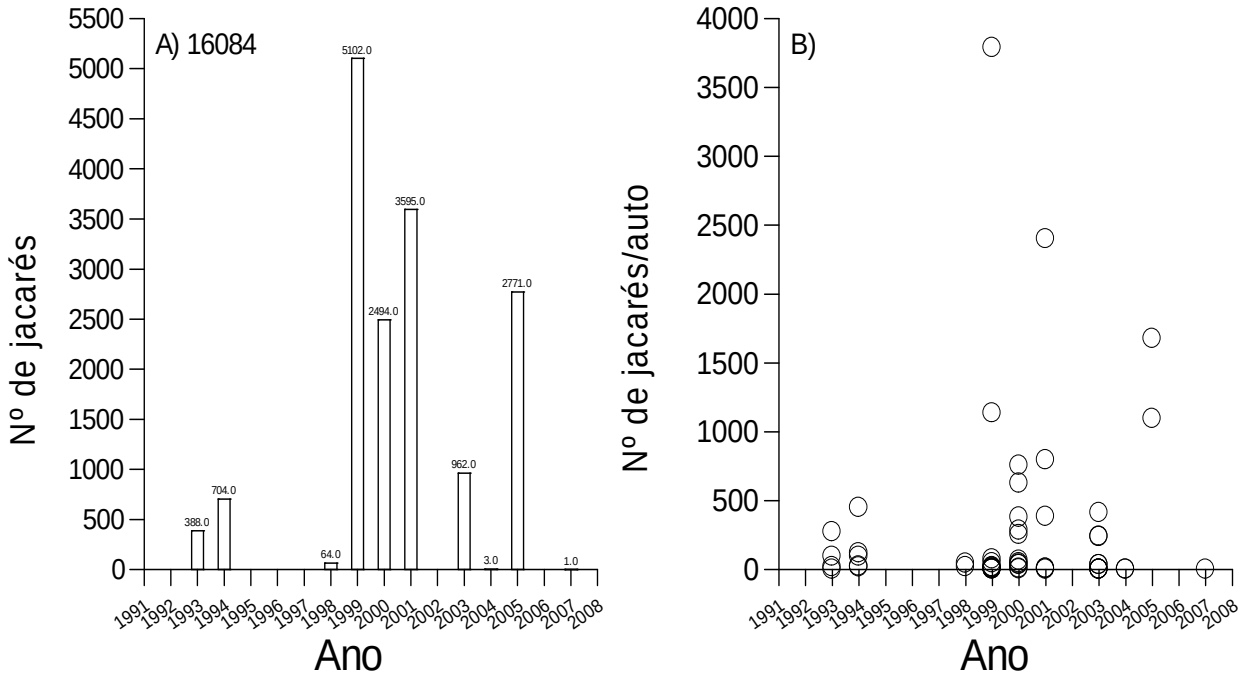

Figura 1. Número de jacarés apreendidos registrados no IBAMA/AM por ano (A) e por autos (B) entre 1992 e 2007 no Estado do Amazonas. Cada ponto na B representa um auto de apreensão.

Apreensões de jacarés ocorreram em quase todos os meses, exceto em abril. No total foram apreendidos 16084 jacarés. Deste total, 1095 eram filhotes vivos de jacaré-tinga (*Caiman crocodilus*) oriundos de um único auto de apreensão lavrado no município de Fonte Boa no Rio Solimões em 2005. Também foram apreendidas duas peles de jacaré-açu (*Melanosuchus niger*) em Manaus. Os 14987 jacarés restantes foram apreendidos na forma de mantas de carne salgada-seca. O número de mantas por auto variou de um a 3788 (média = 227, DP = 598). A maioria (89%) das mantas foi apreendida no período entre novembro e março, totalizando 13308 jacarés caçados (Tabela 1).

Os jacarés foram apreendidos principalmente nos rios Solimões (59%) e Purus (39%). Não houve apreensões nos rios Anamã, Negro, Japurá e Juruá e Nhamundá (Tabela 1).

Tabela 1. Número de jacarés, na forma de mantas salgada-seca, apreendidos por mês e por região entre 1991 e 2007 no Estado do Amazonas, segundo os autos de apreensão

MÊS OU REGIÃO												
Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez	Subtotal
931	3151	2180		249	1017	35	343	19	16	5235	1811	14987
Solimões		Purus		Manaus		Amazonas		Madeira		Atumã		
8879		5941		101		63		2		1		14987

do IBAMA.

O estudo mais completo sobre a caça comercial de jacarés na Amazônia foi realizado na Reserva de Desenvolvimento Sustentável Mamirauá (DA SILVEIRA & THORBJARNARSON, 1999). A caça praticada naquela região, até 1995, era realizada com arpão e se concentrava principalmente nos meses do segundo semestre, coincidindo com o período da vazante e de ocorrência de densidades altas de jacarés na Amazônia Central (DA SILVEIRA et al., 2008). Estudo posterior realizado na Reserva de Desenvolvimento Sustentável Piagaçu-Purus retratou uma caça de jacarés praticada com anzol e com indicativo de ocorrência ao longo de todo o ano (DA SILVEIRA, 2003). O meu estudo evidenciou que as apreensões de jacarés ocorreram em todos os meses do ano, exceto em abril. Em Mamirauá, a caça anual terminava em março, uma vez que um grande volume da carne de jacaré seria consumido na Colômbia durante a Semana Santa, em abril (DA SILVEIRA & THORBJARNARSON, 1999).

O Amazonas foi até 1970 o maior exportador do mundo de peles de jacarés (SMITH, 1980). Com a promulgação da Lei de Proteção da Fauna em 1967 (Lei 5.197 de 03 de janeiro de 1967), essa atividade foi substituída pelo comércio ilegal de carne de jacaré (DA SILVEIRA & THORBJARNARSON, 1999). Na década de 1980, já havia sido noticiado para a região de Tefé/AM um comércio intenso de carne de jacaré (BEST, 1984). Essa atividade foi comum na Reserva Mamirauá até por volta de 1995, quando aparentemente deslocou-se para a calha do baixo Rio Purus (DA SILVEIRA, 2003), onde hoje se localiza a Reserva Piagaçu-Purus (DEUS, DA SILVEIRA & PY-DANIEL, 2003).

Desde o término do comércio legal de peles, o Amazonas tornou-se o maior produtor ilegal do mundo de carne de jacaré (DA SILVEIRA, 2002). Segundo os dados que levantei, 99% dos 14987 jacarés apreendidos pelo IBAMA/AM eram oriundos dos rios Solimões ou Purus. Isso sem considerar os 1095 filhotes de jacaré-tinga (*C. crocodilus*) apreendidos em Fonte Boa/Rio Solimões e que provavelmente seriam destinadas a algum particular que queria criar ilegalmente a espécie em sistema de *ranching*, que geralmente consiste na coleta de ovos na natureza para crescimento até o ponto de corte em cativeiro (VERDADE, 2004). Os autos de apreensão do IBAMA/AM ratificam suposição anterior de que a caça de jacaré, pretérita ou

presente, sempre esteve associada às várzeas associadas aos rios de origem andina (DA SILVEIRA, 2003).

Em termos de peles, somente duas peles de jacaré-açu (*Melanosuchus niger*) foram apreendidas pelo IBAMA/AM no período de 16 anos. Indicando que este comércio na região realmente cessou na década de 1980 (REBELO & MAGNUSSON, 1983); salvo algumas peles de *C. crocodilus* que foram apreendidas pelo IBAMA/AM na região de Caapiranga/AM (DA SILVEIRA et al., 1998). O destino dessas peles apreendidas em 1998 nunca foi esclarecido, mas suspeita-se que visava abastecer uma criação legalizada de *C. crocodilus* no município de Manacapuru/AM. A ocorrência dessas peles não foi detectada nos arquivos da DICOF/IBAMA-AM, apesar de ter sido uma apreensão realizada pelos agentes daquele órgão federal.

A carne de jacaré produzida ilegalmente no médio Rio Solimões até 1995 visava abastecer o mercado colombiano (DA SILVEIRA, 2002, 2003). Atualmente, toda a carne oriunda do baixo Rio Purus (DA SILVEIRA, 2003; MARIONI; MÜHLEN; DA SILVEIRA, 2007; MENDONÇA, 2009) destina-se ao comércio paraense, principalmente às feiras livres de Abaetetuba (BAÍA JR., 2004). Além disso, a utilização de carne de jacaré para a captura do peixe liso piracatinga (*Calophysus macropterus*/Pimelodidae) é muito intenso no médio Rio Solimões desde 2000 (DA SILVEIRA & VIANA, 2003), mas registro algum desta atividade apareceu nos autos de infração do IBAMA/AM.

Os dados aqui expostos seguramente representam apenas uma parcela pequena da dimensão real do que é o comércio ilegal de carne de jacaré oriunda do baixo Rio Purus na Amazônia Central. Espera-se que este estudo possa contribuir para o aprimoramento dos protocolos ou de novas estratégias de manejo de jacaré na região amazônica. Destaco que este estudo não pretendeu esgotar o tema proposto, mas servir como referência para estudos futuros voltados ao tema.

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EVALUATION OF SEIZED CAIMANS FROM ILEGAL TRADE IN THE AMAZONAS STATE.

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Amazonas State is historically one of the major sources for caiman products from the Brazilian Amazon Basin. Between 1950 and 1970 almost 7.5 million skins were traded from this region. Ban of wildlife hunting in 1967 did not prevent poaching and a wide regional trade based on caiman salted meat still occurs throughout Amazonian varzea floodplains. To date, only two field studies have been carried out in the Mamirauá and Piagaçu-Purus Sustainable Development Reserves, however our knowledge is incomplete and incipient. Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) carry out enforcement actions to restrain hunting. But these registers of seized animals were never available. Our objective was to gather data from 1992 to 2007, to estimate the caiman hunting history in the Central Amazon Basin. During this period at least 16,084 caimans were confiscated. More than 90% was salted meat without the possibility to identify the species; but probably it was *Melanosuchus niger* and *Caiman crocodilus* individuals. Another 1,095 live juvenile *C. crocodilus* and two *M. niger* skins were also seized in this period. Maximum number of individuals confiscated per year was 5,102 (mean = 1,608, SD = 1,781). More than two third of caimans was confiscated between 1999 and 2001, and 90% between November and March. Less than 10% was confiscated downstream from Manaus, and the rest came from Purus and Solimões rivers. Of course these values are sub estimating the real number of hunted caimans, but indicated a large caiman trade in the region during the last 16 years. It is important to note, that the success of the harvesting caiman program in the region depends on the real control of this common and destructive poaching practice.

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MORPHOLOGICAL VARIATION OF THE SUBFAMILY CAIMANINAE FROM THE AMAZONIA TO THE PANTANAL.

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There has never been an analysis of variation across populations representing the entire range of the Caimaninae. We examined variation among individuals from different localities along the axes from Caracarai-Roraima to Porto Murtinho-Mato Grosso do Sul in Brazil and bounders of Paraguay and Bolivia. During five years between 2003 and 2008 we captured 463 individuals, and collected morphometric data for 314 individuals of the *Caiman*, 37 *Melanosuchus* and 40 *Paleosuchus*. Three species were captured at Guapore and Mamore rivers. Twenty characters were measured; two counts of scales and four skull measurements showed significant variation, and we compared them with variation in jaw spots. Jaw spots were present in the southern *Caiman*, but do not exist in northern individuals. The cline or gradient observed in *Caiman* morphology and coloration is similar to that described in the literature, but more diverse. It corresponds with hydrological and geological differences as well as the type of environment present on each basin. There were significant differences in *Caiman* skull morphology, rostrum width, braincase size and coloration between individuals from Pantanal to the Amazonia. The Pantanal individuals had wider and larger skull bones than *Caiman* Amazonian individuals. In transition regions, such as the Guapore River, individuals were more variable than further north or south. The morphological data indicate three largely parapatric evolutionary *Caiman* lineages, two sympatric *Paleosuchus* lineages (*Paleosuchus trigonatus* and *Paleosuchus palpebrosus*) and only one *Melanosuchus niger* clade. Molecular additional data set will be necessary to confirm these results.

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