

CROCODILE SPECIALIST GROUP NEWSLETTER

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APRIL 2011 - JUNE 2011

IUCN - Species Survival Commission

CHAIRMAN:

Professor Grahame Webb
PO Box 530, Karama, NT 0813, Australia

EDITORIAL AND EXECUTIVE OFFICE:

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COVER PHOTOGRAPH: Captive adult Siamese crocodiles (*Crocodylus siamensis*) in Vietnam. The species was the focus of a CSG Regional Species Workshop (see pages 6-7). Photograph: Charlie Manolis.

EDITORIAL POLICY: All news on crocodilian conservation, research, management, captive propagation, trade, laws and regulations is welcome. Photographs and other graphic materials are particularly welcome. Information is usually published, as submitted, over the author's name and mailing address. The editors also extract material from correspondence or other sources and these items are attributed to the source. If inaccuracies do appear, please call them to the attention of the editors so that corrections can be published in later issues. The opinions expressed herein are those of the individuals identified and are not the opinions of CSG, the SSC or the IUCN unless so indicated.

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The CSG Newsletter is produced and distributed by the Crocodile Specialist Group of the Species Survival Commission (SSC) of the IUCN (International Union for Conservation of Nature).

The CSG Newsletter provides information on the conservation, status, news and current events concerning crocodilians, and on the activities of the CSG. The Newsletter is distributed to CSG members and to other interested individuals and organizations. All Newsletter recipients are asked to contribute news and other materials.

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Editorial

The focus of the CSG Regional Species Meeting held at Mahidol University, Bangkok, Thailand (4-6 April 2011) was the "Critically Endangered" Siamese crocodile *Crocodylus siamensis*. Some 74 participants, from 17 countries attended the meeting, demonstrating the level of interest in *C. siamensis* conservation, management and sustainable use. A summary report, which was included in *Species* (Issue 53), can be found at page 4. A full report covering the outcomes of the meeting is currently being finalised, and the full proceedings of the meeting will be included on the CSG website.

Following a US Fish and Wildlife Service advertisement regarding the proposed "12-month Finding/Delist of Morelet's Crocodile" under the U.S. Endangered Species Act (ESA), I sent CSG comments supporting the Mexican proposal for the delisting under the ESA.

The Government of Madagascar (GOM) continues to have problems managing its *C. niloticus* ranching program and fulfilling the recommendations of the CITES Standing Committee following CoP15. I wrote to the CITES Secretariat, suggesting that perhaps the industry might be able to encourage the GOM to address the problems of crocodile management in Madagascar.

I also wrote to the CITES Secretariat seeking clarification as to which countries have stricter domestic legislation that does not recognise the provisions of Resolution Conf. 13.7 (Rev. CoP14) regarding the "Control of trade in personal and household effects". This arose from some industry

members who have experienced difficulties with the non-implementation of Resolution Conf. 13.7 (Rev. CoP14) by several countries.

Concerns were expressed recently by CSG members, both in the Philippines and the USA, about an American TV reality show that was planning to capture a "supposed" problem Saltwater crocodile in the Agusan Marsh Wildlife Sanctuary, which is also a RAMSAR site and a UNESCO World Heritage Site, in the Philippines. Following encouragement from many of our USA members, the Philippine Parks and Wildlife Bureau wrote to the television company requesting them to refrain from the proposed activities, as they portrayed the real situation inaccurately, and were not considered to be in the best interests of conservation efforts in the Philippines.

A Philippine Crocodile Reintroduction Workshop was held at the Philippine National Museum, Manila, on 12 May 2011 to discuss present and future Philippine crocodile reintroduction projects (see pages 10-12).

Organisers of the 20th CSG Working Meeting (Manaus, Brazil) have advised that the Proceedings will be despatched to participants in late June or early July 2011.

We were saddened to hear that Dhruvajruoti Basu, a well-respected CSG member from India, who was involved for many years on Gharial conservation, died tragically on 20 April 2011 (see page 3).

The International Human-Crocodile Conflict meeting in Kuching, Sarawak, Malaysia, will now be held at the Harbour View Hotel, 19-21 October 2011. The Registration Fee is \$US200 (RM600). The contact person is Mr. Francis Gombek (fgombek@sarawakforestry.com).

Registrations for the 21st CSG Working Meeting, to be held at the National Museum of the Philippines, Manila, 22-25 May 2012, can now be made online at "www.csgmanila.com". Please assist organisers by registering your intention to attend the meeting as soon as possible, and in particular advise them if you intend to make a presentation.

The CSG website is to be overhauled completely, and so the current site will not be updated. We seek your understanding with this issue, and hope that the new website will soon be up and running. Some CSG members have provided ideas on how the site can be improved, and we welcome any further comments from all members. Please send comments to Tom Dacey (csg@wmi.com.au).

The CSG Executive Officer sent out annual letters of requests to CSG donors, whose support to the CSG is critical to its ability to operate, particularly in these difficult economic times. I am personally very grateful to everyone who has made a contribution, past and present.

Grahame Webb, CSG Chairman, <gwebb@wmi.com.au>.

Obituary

Remembering Mr. Gharial



Photograph: Rom Whitaker.

I first met Dhruvajyoti Basu in 1973, when several students at the prestigious Indian Institute of Technology (IIT), Madras (now Chennai), started coming over to the newly created Madras Snake Park in Guindy Deer Park. We needed help with the throngs of visitors, so my sister Nina would give them a crash course in reptile facts and being nice to people (except the ones who threw stones at the snakes, crocs and lizards on display). and thanks to IIT we soon had a group of regular volunteers. Perhaps this wasn't so good for their academic careers, however it was just too much fun. And the fun got better when we started field surveys of sea turtles, crocodiles and other herps around the country.

One of the 'IITans' who started spending time with us was Dhruva Basu, to us: 'Basu'. Here was one amiable, usually unflappable character, who was just naturally well-liked for his sense of humour and keen interest in anything he was involved with. We quickly found that he had a talent for drawing and layouts and he became the Madras Snake Park's first Staff Artist. Basu's engineering career was coming to an abrupt end (being a proactive college dropout myself I deeply empathized), but we didn't know then what this would mean to the survival of the Critically Endangered Gharial in northern rivers.

Basu and the rest of us honed our skills doing herp surveys in Point Calimere and the Shevaroy Hills in Tamil Nadu, accompanied by Irula tribals Natesan and/or Rajamani, our tutors of the wild. He was often part of the teams which walked the beaches of the Coromandel Coast south of Madras, monitoring the nesting of the Olive Ridley's sea turtle and saving their nests from the rampant egg poaching going on there. These were training periods for all of us, we weren't

scientists or wildlife biologists (India didn't have any yet, except in the realm of bird studies), but we were poignantly aware that we were watching the demise of wild species about which almost nothing was known. Basu helped us design proformas for data collection, interview local people about reptiles of their areas, write popular articles about what we were finding and started to write reports and scientific notes some which were graciously published in the Journal of the Bombay Natural History Society (JBNHS).

And then we started to get serious about crocodilians in India. Our early 1970s surveys showed us that the Mugger was still widely distributed, the Saltwater crocodile was hanging on in Bengal, Orissa and the Andamans, but the Gharial was almost gone. Basu carried out the first Gharial surveys in Katarniaghat (now a Wildlife Sanctuary, with the second most important wild population of Gharial), Assam, Bhutan and the Chambal River of Central India (now the repository of most of the surviving Gharial in the wild).

And Basu also started to get serious. He had already quit IIT and decided that the main way he could do something solid for the Gharial was to join the Forest Department. Around that time the Government of India was, on the heels of Project Tiger, starting a serious crocodile conservation effort, Project Crocodile, with the financial and technical help of FAO/UNDP. Basu was an experienced surveyor by now and the Uttar Pradesh Forest Department (UPFD) hired him as a Surveyor (the first wildlife surveyor hired by any State in the Union!).

In 1974 Basu, along with Andy Ross (Smithsonian Institution) and I, spent a memorable month in Corbett Park doing the very first survey and study of Gharial behavior there. One day Basu and I were checking out some of the isolated ponds where we suspected Mugger to be and he said he'd walk up the trail and wait for me there. I crouched by a pond waiting for a Mugger to surface when suddenly a tiger came ambling past, heading in Basu's direction! Next moment I was yelling 'Basu, TIGER!' and the big cat surged forward. I got up and ran after the tiger, truly expecting something awful to happen. When I reached Basu, there he was peacefully asleep under a tree next to the trail, the tiger's deep pugmarks just a few metres away, heading up a steep cliff. The cat must have seen the sleeping man and freaked out. That evening we chuckled about the day's events over rum and smokes. Another strange day in Corbett, the Gairal Rest House cook served us omelettes laced with bhang, known to the rest of you as marihuana. We spent the whole of that day next to the river, meditatively reflecting on the future of the Gharial basking below us and tripping on a pulsating world full of birds, turtles, barking deer and Mugger.

In 1975 I visited Katarniaghat, where Basu had collected the very first wild Gharial nest for the new Project and put the eggs into a makeshift brick incubator designed by the FAO consultant, Robert Bustard. About 35 baby Gharial successfully hatched, an exciting moment in the history of Gharial conservation. Basu's initial experience, his popularity with local boat people and fishermen and continuing obsession

with the strangest of all crocodilians resulted in the formation of India's largest Gharial rearing (and eventually breeding) center, at Kukkrail near Lucknow. A large percentage of the over 5000 young Gharial which were head-started and released into wild habitats around north India were hatched in Kukkrail under his expert guidance and the keepers he trained.



Basu (right) supervising Gharial release. Photograph: Rom Whitaker.

In a letter to me dated 21 October 1978, Basu is ecstatic: "Good news for gharial! The Govt of India formally sanctioned the Chambal River National Gharial Sanctuary on the 18th of September, with a project cost of Rs.35 crores (350 million), that's big!" The Chambal Sanctuary was India's first and only tri-state sanctuary and still the only extensive (435 linear river kilometres) river-landscape Protected Area. Basu travelled the length of this last large safe haven for the Gharial (and the endangered Ganges River dolphin, mahseer, smooth-coated otter, turtles, Mugger and a host of waterfowl) which was also the robbing grounds of famous bandits, called dacoits, like Man Singh and the Bandit Queen, Phoolan Devi.

One day Basu was carrying out surveys along the Chambal when he and his unarmed group encountered Phoolan Devi, who seemed amused and perhaps a bit awed that these people would risk their lives to (of all things) count basking Gharial. She took a shine to his 10x50 power binoculars and, he recalled later, asked him rather gently to hand them over. "Don't worry" said the dacoit queen who was alleged to be responsible for dozens of murders and robberies, "I know the Forest Department will give you trouble for losing your 'durbeen' (binocs), here I'll give you a receipt with my signature". And she did!

But working for the Forest Department had its trials and tribulations, in another 1980s letter he wrote: "As there is no progress visible in my career (with the Forest Department), I've decided to take up an offer in Calcutta of setting up a dairy/poultry dealership".

Well, luckily Basu stuck it out and was soon kept very busy by the UPFD, looking after the Gharial rehabilitation

program at Kukkrail, releasing hundreds of baby Gharial at various Protected Areas from where they had mostly been extirpated and continuing surveys and monitoring of wild Gharial populations. His expertise in Gharial husbandry was extremely useful when the Ganges River Cleanup Programme started in the 1980s. In an enlightened move by the then Department of Environment, funds were sanctioned to do a head-starting program for river turtles, especially the large (up to 80 kg) Ganges soft-shelled turtle, a voracious predator/scavenger which, amongst other things, does a great job eating up the human corpses dumped into the holy river. Thousands of baby turtles were hatched and released into the Ganges River over the next few years.

In 1983 Basu and I did a review of the Gharial in a paper for the JBNHS, basically summarizing everything that was known about the creature to date. The data he collected over the years has yet to be collated and published, but his encouragement and guidance to colleagues such as Rishikesh Sharma of the Madhya Pradesh Forest Department were instrumental in ensuring that the Departments supported annual surveys and continuing collection of data on Gharial nesting and hatching success.

In recent years Basu retired from the UPFD and joined us in the Gharial Conservation Alliance/Worldwide Fund for Nature collaboration we called Riverwatch. He was a key player during the terrible Gharial die-off of 2007/08 and continued survey work wherever it was needed in northern rivers. In the parlance of the American cowboys, Basu 'died with his boots on'. He met his tragic end in April 2011 while in the midst of a Gharial and turtle survey of the vast Brahmaputra River system in Assam, very close to where he did some of the first Gharial surveys of the 1970s. Basu will be missed by a large coterie of colleagues and friends, from boatmen to scientists. We commiserate with his wife, son and daughter, and we can all pay him the compliment of redoubling efforts to ensure the survival of the creature for which he spent a big chunk of his life: *Gavialis gangeticus*.



From left: Basu, Rom Whitaker and Suresh Pal Singh, who was trained by Basu and who now looks after the Gharial and turtle rehab center at Kukkrail, near Lucknow. Photograph: Janaki Lenin.

Rom Whitaker, PO Box 21, Chengalpattu 603001, TN, India

CSG Regional Species Meeting Mahidol University, Bangkok, Thailand 4-6 April 2011

Although the CSG has both biennial global working meetings, and on occasion regional meetings, this is the first time that a CSG regional meeting has ever been dedicated to improving the conservation of one species. The Siamese crocodile (*Crocodylus siamensis*), which meets the IUCN Red List criteria for “Critically Endangered”, and is on Appendix I of CITES, was a deserving species on which to focus.

The meeting was held the prestigious Mahidol University in Bangkok, Thailand, from 4-6 April 2011. It is a measure of the widespread interest in this species that 74 participants from 17 countries attended (Australia, Brazil, Cambodia, France, Germany, Hong Kong, Indonesia, Japan, Lao PDR, Malaysia, Philippines, Poland, Thailand, Ukraine, United Kingdom, USA, Vietnam). Most participants were responsible for meeting all of their own travel costs.

Participants were welcomed by Dr. Apichart Termvichakorn, Fisheries Department of Thailand, Prof. Parntep Ratanakorn, Dean of Veterinary Science Faculty of Mahidol University, and Prof. Grahame Webb, CSG Chairman. Keynote addresses were given by Mr. Yosapong Tamsiripong on the Biology of *C. siamensis* - Wild and Captive, the Hybridisation of *C. siamensis*, and the proposed Bung Boraphet Reintroduction Program. Dr. Dietrich Jelden gave a presentation on “What we want to achieve” at the regional meeting through workshops. This was then followed by “Country Reports” from Thailand (Mrs. Yoo-ee Getpech), Cambodia (Mr. Heng Sovannara), Vietnam (Mr. Thai Truyen), Indonesia (Dr. Nandang Prihadi), and Lao PDR (Mr. Chanthone Phothitay). Presentations were also given on “Studies in Cat Tien N.P., Vietnam” (Mr. Kristian Pahl), the “Results of Survey in Lake Mesangat, East Kalimantan, Indonesia” (Ms. Agata Staniewicz) and an overview of the potential of Lake Mesangat as a prime conservation site for *C. siamensis* (Mr. Rob Stuebing).

Some Working Group goals were advanced in Plenary, with full participation, and others were split into small Working Groups reporting back to Plenary. On the afternoon of the last day, following presentation and discussion of each workshop’s report, participants unanimously endorsed a combined working group report. This was comprised of five sections:

A. Conservation - Restoring and/or better protection of wild populations (Chair: Prof. Grahame Webb - compiling plenary contributions)

Separate recommendations were made for each country, which were tailored to the national problem and management context. The goal was to get short-term conservation actions started as soon as possible, so that the advances made can be reported on at the next CSG Working Meeting (Manila, Philippines, May 2012). For Vietnam and Thailand, the priority was to try and create

some new wild populations in areas where *C. siamensis* is known to have become extinct. Vietnam’s successful re-establishment of a wild population of *C. siamensis* in Cat Tien National Park remains a strong beacon of success. For Cambodia, a priority is to boost the remaining wild population by restocking, while efforts aimed at reducing the take of wild crocodiles for farms continue. For Indonesia, the priority was to advance efforts to conserve Lake Mesangat. For Lao PDR, the priority was deemed to be a CSG review team to examine a proposed program aimed at achieving livelihood benefits from crocodiles.

B. Conservation - Strengthening enforcement capacities at all relevant agencies (Chair: Mr. Thai Truyen)

The current status *C. siamensis* in each country is to be reviewed and the CSG will solicit appropriate information from members and make such materials readily available.

C. Compliance with CITES (Chair: Dr. Dietrich Jelden)

Ensure that all Customs, Fisheries and Forestry Administration officials should be able to do inspections at borders including airports. In Vietnam, Cambodia and Thailand, implement a scute-marking system with hatchlings, as has been done in Argentina and Colombia, to differentiate between wild and captive-bred animals. Hatchlings intended for re-introduction should be clearly marked in a different way (multiple scute marks). Existing penalties within Range States are to be reviewed and harmonized, where possible. Continue dialogue under appropriate regional bodies.

D. Captive production and industry - monitoring of crocodile holding facilities and manufacturing industry (Chair: Dr. Paolo Martelli)

Marking of crocodiles of legal origin, in captivity and in trade, was considered potentially beneficial. The CSG will enter into dialogue with various Range States and to provide guidelines, with recommendations, on how marking systems could be implemented. Farmers associations ultimately benefit conservation. The CSG will distribute available documents on current effective farming associations. Cambodia, Thailand and Vietnam need to investigate the issue of hybridisation within their countries. The problem of marking products and live animals in trade, particularly between Cambodia, Thailand, Vietnam and China needs to be investigated. The CSG will establish a Discussion Group on this issue.

E. Captive production and industry - capacity building of stakeholders involved with captive management of the Siamese crocodile (Chair: Dr. Bill Magnusson)

Training for crocodile farmers is a regional priority. CMAT and the Thai Department of Fisheries already run courses that could be made available to other Range

States. Monitoring wild populations is constrained (by the lack of wild populations), but Range States should report on what monitoring is occurring within their jurisdictions. CSG documents on Monitoring should go onto the CSG website for general information. Range States need to consider capacity building independently.

On 7 April the meeting was followed by a field trip to Bung Boraphet, Nakorn Sawan, which appears to be an ideal site in which to reintroduce *C. siamensis* back into the wild in Thailand.

In overview, the meeting was considered highly successful and resulted in a series of practical actions that each Range State will hopefully be able to advance. The CSG and its members will do all they can to help. The conservation of *C. siamensis* in the wild, within Southeast Asia, is a complex undertaking. Participants welcomed the meeting and its outcomes, and supported the idea of a follow-up meeting, to assess progress, at the next CSG Working Meeting.

Professor Grahame Webb, *CSG Chairman*.

Crocodile Red List Update

The IUCN Red List is the authoritative list of globally threatened animals and plants, now on-line, fully searchable and listing more than 35,000 animals. The Red List has always been generated by species experts of the Species Survival Commission specialist groups - like CSG. CSG used new criteria to assign Red List categories to all 23 crocodilians in 2002 and has re-evaluated several species since then, notably the Gharial (*Gavialis gangeticus*) and Cuban crocodile (*Crocodylus rhombifer*). However, most CSG crocodilian assessments are unchanged and largely unexamined since the mid-late 1990s and are overdue for updates.

From early, fairly informal beginnings in 1972, the list and the process that produces it has steadily become more objective, scientific and (unavoidably) more complex. This article describes the current IUCN process and how CSG intends to assess crocodilians for Red Listing. Full descriptions of the criteria and process can be found at <http://www.iucnredlist.org/> - resources.

Red List categories and criteria are now based on IUCN Red List categories and criteria Version 3.1 (2001). Species are assigned to one of 7 categories if, and only if, they meet just one of the criteria applying to any category. Three of the categories are familiar 'threatened' status (Vulnerable, Endangered and Critically Endangered). The other categories accommodate species that are not threatened (Least Concern, Near Threatened, Extinct in the Wild, and Extinct). The criteria for threatened species cover 5 broad indices of extinction risk:

- A. Reduction in population size
- B. Limited geographic range
- C. Small population size combined with other risk factors

(decline, population structure)

D. Extremely small population size

E. Quantitative analysis indicating risk of extinction

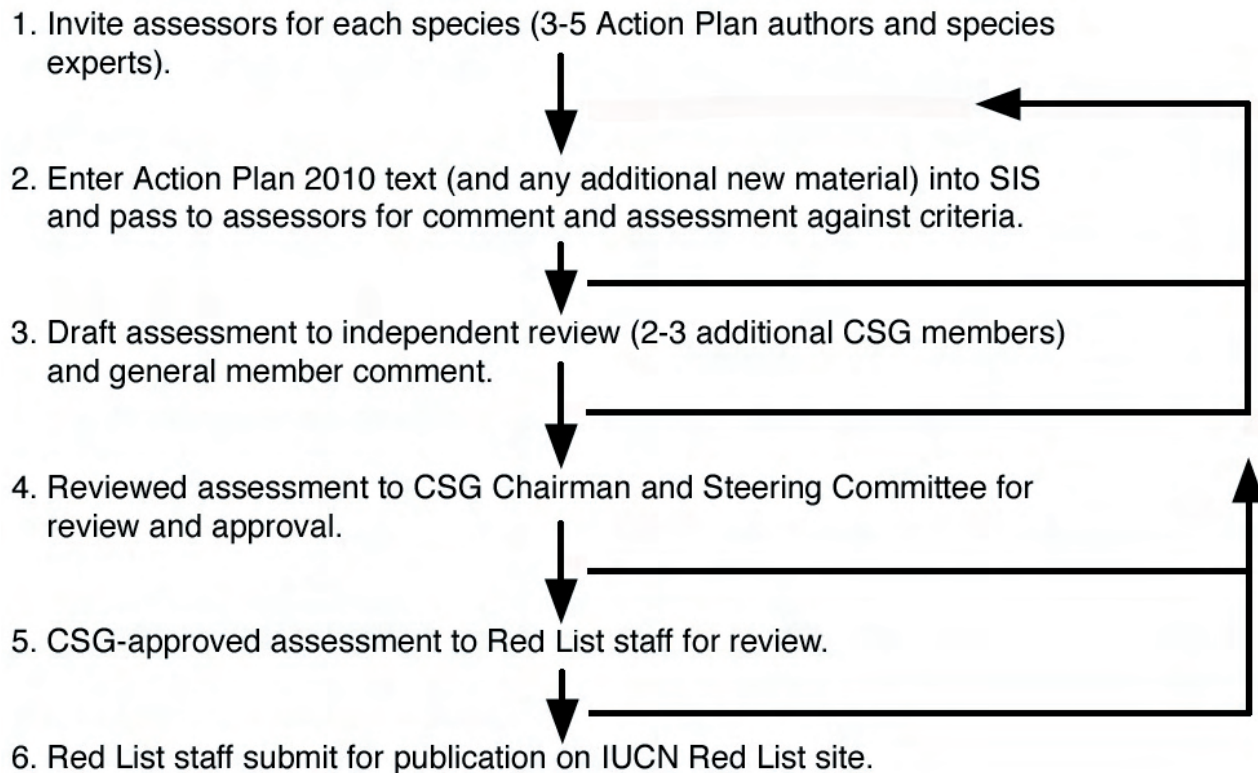
Each criterion has detailed components and sub-criteria and objective, quantitative thresholds. The terminology for Red List criteria is specific to this use and carefully defined. There are rules and Guidelines for applying the criteria and a large body of case history and precedent to guide their application. The Red List only considers all of a species throughout its global range, but there are additional criteria to adjust assessments of local or regional populations.

All Red List assessments are now entered and processed through IUCN's Species Information System (SIS) - an automated on-line data base for Red List assessment. These components are all very fully described in the Red List materials and guidelines so I do not provide details here.

To apply these criteria to a species, an 'assessment' is performed. This is usually done by specialist groups or by specially convened Global Biodiversity Assessment Workshops. Assessments undergo a procedure of drafting, review and evaluation, checking by IUCN Red List staff, and then publication on a roughly annual schedule (Assessments completed by August of one year are published by May of the following year). Each specialist group (including CSG) established a "Red List Authority" (RLA) under the guidance of an RLA focal point to coordinate, review and submit its assessments.

For CSG, the final authority for Red Listing crocodiles lies with the CSG Chairman operating with the CSG Steering Committee. The Chairman has designated Perran Ross to be the RLA focal point and coordinate our internal process. Perran, in consultation with the Chair and Steering Committee, proposes small groups of 'assessors' who generate the raw material of each species assessment. Each assessment is then independently reviewed by 2-3 experts additional to the assessors. The reviewed assessments will then be approved by the Chair and passed to SSC Red List staff. They will perform their own review - largely to ensure correct application and interpretation of the criteria - and upon approval, pass the assessment into the publication stream.

CSG has just completed and published on-line revised 'Action Plan' sheets for each crocodilian species (http://www.iucncsg.org/ph1/modules/Publications/ActionPlan3/ap2010_index.html) and these summarize the most current information, threats and situation review. These 2010 Action Plan sheets will be the basis for the next round of crocodilian Red List Assessments and their authors will be invited to be the core group of 'assessors' for each species. The contents of each species action plan can be transferred (largely cut and paste) into the required modules of SIS. With information and coaching from the RLA focal point, assessors can determine which, if any, of the criteria are supported by the available data and which threatened category, or none, applies. This draft assessment then needs to be externally reviewed by additional experts to confirm both the data and the application



CSG Red List Process diagram

and interpretation of the Criteria. After review the draft will pass to the CSG Chair and Steering Committee for their review and approval before submitting to IUCN Red List staff. IUCN staff will review again and may request additional information or changes from the assessors and RLA before accepting the assessment for publication at the next available opportunity. We may also use CSG meetings or dedicated workshops as opportunity arises to use the assembled expertise of CSG members to conduct an assessment.

Dr. Perran Ross, *CSG Red List Authority focal point*,
pross@ufl.edu.

Temporal Storage for Grey Literature on Crocodylia Topics: a Website as a Library for Theses

With the goal of having a website that makes grey literature, mainly dissertations and research reports on Crocodylia topics, more readily available, the Universidad Autónoma de Chiapas through the Faculty of Veterinary Medicine, in collaboration with the Universidad Juárez Autónoma de Tabasco through the Academic Division of Biological Sciences, created the website called “Temporal Storage for Gray Literature on Crocodylia Topics” - otherwise known as “Crocoteca”.

The site aims to temporarily house theses (Bachelor, Masters and PhD) as well as research reports and documents that have little or no editing, by general definition the main feature of grey literature.

The object of the Crocoteca is to make grey literature available to anyone interested in Crocodylia. Although such literature may not eventually be published, it nonetheless may contain valuable information. The Crocoteca operates in a non-profit capacity, respecting and promoting respect for copyright. The material is intended for academic use, and those who access the site automatically agree to the respective credits to the authors of stored documents. In the same way, the material stored in the Crocoteca is the direct responsibility of authors, with views expressed in the documents representing the opinion of those authors and not representing the perspectives and objectives of the Crocoteca or any of its directors or institutions.

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Access to Crocoteca is open to all, but is necessary to send a request to the address above, and you will be sent a personal login and password. The Crocoteca is hosted on the server of the Autonomous University of Chiapas in the courses section of Distance Education (Educad) and mounted on a platform with free software. Thus, we hope you will send us your contributions and encourage you to deposit all theses, research reports and any document of limited distribution or poor edition work. The site address is: <http://educad.unach.mx/>.

Hernán Mandujano-Camacho (*Universidad Autónoma de Chiapas - Facultad de Medicina Veterinaria y Zootecnia, México*) and Fernando Rodríguez-Quevedo (*Universidad Juárez Autónoma de Tabasco - División Académica de Ciencias Biológicas, México*).

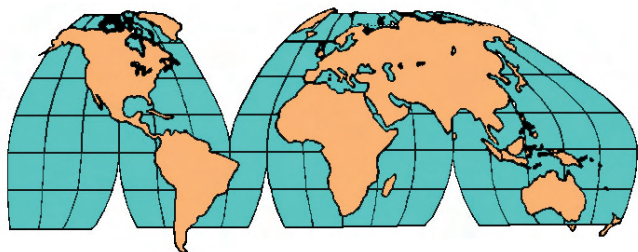
CSG Student Research Assistance Scheme Update

The CSG Student Research Assistance Scheme has provided funding to a further two students, bring the total to five in 2011 so far:

1. Jennifer Nestler, Department of Geoscience, University of Iowa, USA: A geometric morphometric analysis of the Nile crocodile (*Crocodylus niloticus*): implications for species conservation.
2. Adam Parlin, Framingham State University, Massachusetts, USA: Population characteristics and habitat use of *Alligator mississippiensis* at the edge of the geographic range.
3. Natascha Behler, University of Bonn, Germany: Natural History of *Crocodylus siamensis* at Lake Mesangat and adjacent wetlands, East Kalimantan, Indonesia.

Tom Dacey, *Executive Officer*, csg@wmi.com.au.

Regional Reports



North America

USA

BETTER TO BE SAFE THAN SORRY! Police officers in Kansas City, Missouri, responded to a report of a large alligator near a pond. Conservation officers instructed police to shoot the animal, as there few no other options available at that time.

The police officer shot the alligator twice, the bullets bounced off each time. Not surprising, as the alligator was made of cement. The property owner had placed the cement alligator at the pond to keep children away. In hindsight the incident was somewhat humorous, but police are obliged to take such reports seriously. Alligators do not occur in the north of the state, as it is too cold.

Source: Kevin Murphy, *Reuters* (<http://www.reuters.com/article/2011/06/03/us-shooting-alligator-fake-idUSTRE7522U420110603>).

Australia and Oceania

Australia

TWO CROCODILE ATTACKS ON BOAT OCCUPANTS IN NORTHERN AUSTRALIA. Two similar Saltwater crocodile (*Crocodylus porosus*) attacks occurred in northern Australia in April and May 2011 respectively. Both attacks involved 2.5 m long crocodiles attacking the occupants of boats.

The first attack occurred in One Tree Creek, on the South Alligator River, Northern Territory on 24 April. Kevin Eccles (59 y) was sitting in a boat at night, when a 2.5 m long crocodile leapt into the boat (4.55 m), grabbing him on the hand and shoulder. The crocodile appeared to be trying to drag Mr. Eccles into the water, and only let him go after he punched and poked the crocodile in the eye. Prior to the attack Mr. Eccles had been fishing.

The second attack occurred on 30 May, in Secure Bay, Western Australia, well over 1000 km away from the location of the first attack. A 2.5 m long crocodile jumped onto the boat and bit Bruce Rudeforth (59 y) on the shoulder. The victim caused the crocodile to release him by hitting it with his elbow. The crocodile again approached the boat, and the occupants used an oar to fend it off. This attack occurred during the day.

Of the 92 crocodile attacks in northern Australia since 1971, 9 (9.8%) have involved people in boats (7 non-fatal) or canoes (1 fatal, 1 non-fatal). In the case of attacks involving canoes, the attacks occurred during the day, involved 3.5 and 4.0 m long crocodiles, and resulted in serious injury and death of the victim respectively. Attacks on people in boats have occurred during the day (5) and night (2), and have involved crocodiles ranging from 1.8 to 4.0 m total length.

Considering the high number of “boat hours” expended in the Northern Territory, the frequency of attacks on boats is low. That over half of the attacks on people boats have involved relatively small crocodiles (<3 m) is surprising. The use of canoes in areas containing *C. porosus* is considered unsafe, but people in boats are generally considered safe from attack. Even in areas where crocodiles are fed as part of tourist activities, the crocodiles appear to respond to the large tour boats rather than any small craft in the area.

Charlie Manolis, *CSG Regional Chairman for Australia and Oceania* (cmanolis@wmi.com.au).

INDIAN GIRL WINS SWIMMING EVENT IN “CROCODILE-INFESTED” WATERS. In May 2011, 12-year-old Indian swimming sensation Swapnali Yadav, nicknamed the “little Mermaid”, became the youngest person to win the Kimberley National Lake Argyle Swim in Kununurra, Western Australia.

Swapnali was a special invitee for the 20 km Open swim in the 80 km picturesque Lake Argyle, which contains more than 25,000 Australian Freshwater Crocodiles (*Crocodylus johnstoni*), and the occasional Saltwater crocodile (*C. porosus*). She won the Women's category, and finished second overall in the Open category, completing the swim in 7 hours and 7.4 minutes. Swim organisers have nicknamed Swapnali the "Crocodile Princess".

Source: <http://ibnlive.in.com/generalnewsfeed/news/indian-kid-wins-oz-swimming-event-in-crocodileinfested-waters/678838.html>.

Latin America and the Caribbean

Haiti

CROCODILES THREATEN RESIDENTS AND LIVESTOCK IN FLOODED TOWN. Following torrential rains and flooding in Ouest Department, crocodiles have become a potential threat to residents and their livestock in the village of Thomazeau, near the brackish Lake Azuei, bordering the Dominican Republic.

Large crocodiles have been sighted in the flooded areas, and many farmers have chosen to remain to defend their cattle from theft and the "appetite" of crocodiles rather than be evacuated from their flooded homes. Border Development Fund teams are trying to find solutions to the problem as quickly as possible.

Source: <http://defend.ht/news/articles/environment/1234-residents-and-livestock-threatened-by-crocodiles-in-flooded-town>.

South Asia and Iran

Philippines

PHILIPPINE CROCODILE REINTRODUCTION WORKSHOP. On 12 May 2011 a workshop was held at the National Museum of the Philippines (NMP) in Manila to discuss present and future Philippine crocodile (*Crocodylus mindorensis*) reintroduction projects. The Philippine crocodile remains critically endangered despite ongoing *in situ* conservation efforts in both northern Luzon and southeastern Mindanao, the two last strongholds of this endemic freshwater crocodilian. Reintroducing captive-bred Philippine crocodiles has long been regarded a crucial element of the recovery of the species by policy makers and conservationists, including the Crocodile Specialist Group.

In 1987 the Crocodile Farming Institute (CFI) was established by the Philippine government with Japanese assistance. The dual aim of this project was to establish a *C. porosus* farming industry in the Philippines and breed *C. mindorensis*

in captivity for future reintroductions. The CFI, now known as the Palawan Wildlife Rescue and Conservation Center (PWRCC), has successfully bred 2252 *C. mindorensis*, of which 700 individuals have reached maturity, from an initial founding stock of 233 heads. But actual reintroduction of Philippine crocodiles into the wild did not take place until very recently, as decision-makers feared suitable habitat was no longer available and local communities would not accept crocodiles.

The Mabuwaya Foundation in northern Luzon showed that suitable Philippine crocodile habitat is still available and that local support for crocodile conservation could be won through intensive communication and awareness raising campaigns. The municipality of San Mariano adopted a series of local laws to protect crocodiles and their habitats and declared the Philippine crocodile their flagship species. Local communities are actively engaged in protecting wild crocodiles in village crocodile sanctuaries here. Since 2007, Mabuwaya has been releasing head-started crocodiles back into the wild in San Mariano. Wild hatchlings are collected and raised in captivity for about two years to augment hatchling survival rates. These are then released, often by school children and other community members. Monitoring studies show that released crocodiles adapt well to wild conditions. These positive experiences with community-based crocodile conservation and the adaptation of captive-raised crocodiles to wild conditions led to renewed optimism about the reintroduction of captive-bred *C. mindorensis*.

During the "Forum on Crocodiles in the Philippines" in February 2007 at the National Museum in Manila resolutions were adopted by the participants urging the reintroduction of captive-bred *C. mindorensis* in Dicitian Lake in the municipality of Divilacan, Isabela Province, in northern Luzon (Resolution 1.5) and in other selected areas including the Pag-asa farms on Mindanao (Resolution 1.6).

On 30 July 2009, the PWRCC, the Department of Environment and Natural Resources (DENR), representatives of the village of Dicitian and the municipality of Divilacan and the Mabuwaya Foundation reintroduced 50 captive-bred *C. mindorensis* in Dicitian Lake. This man-made 14 ha lake is situated in the Northern Sierra Madre Natural Park. No people live along the lake itself but several families use lake water for rice irrigation downstream and about 100 households live in the vicinity of the lake. A series of community consultations led to the declaration of the lake as a crocodile sanctuary by both the village council of Dicitian and the municipality of Divilacan. The sub-adult crocodiles of c. 1.2 m total length were immediately released after being transported from the PWRCC facilities on Palawan and not fed after release ("hard-release"). A monitoring program by the Mabuwaya Foundation has since yielded a wealth of information on crocodile movements, survival, growth, mortality, adaptation and human-crocodile conflicts.

Also in 2009, Vic Mercado of Crocodylus Porosus Philippines Inc. (CPPI), a consortium of crocodile farmers in the Philippines, introduced three captive-bred *C. mindorensis*

into a large swamp area at Pag-asa Farms in Davao del Norte on Mindanao. These crocodiles had been accustomed to wild conditions prior to release in a semi-wild pen (“soft-release”).



Figure 1. Glaiza Belesario and Jun Dionko Ayun, of the village of San Isidro, releasing a head-started Philippine crocodile in Dunoy Lake II in the municipality of San Mariano, Isabela. Photograph: Merlijn van Weerd/Mabuwaya Foundation 2010.

The Mabuwaya Foundation, the National Museum of the Philippines and the Protected Areas and Wildlife Bureau (PAWB) organized a Philippine crocodile reintroduction workshop in Manila on 12 May 2011. The workshop was funded by the Mabuwaya Foundation through a Rufford Foundation Grant and hosted by the National Museum of the Philippines.

The participants were Nermalie Lita and Esteven Toledo (PAWB), Ronnie Sumiller (PWRCC), Resti Antolin (DENR Region II), Vic Mercado, Dennis Angelo Romero, Ben Solco and Caren Belo Solco (CPPI), Arvin Diesmos and Charles Andy Ross (NMP), Rheyda Hinlo (Foundation for the Philippine Environment), Neil Hendrix Margarico (Avilon Zoo), Sam Telan, Jessie Guerrero, Dominic Rodriguez, Willem van de Ven, Marites Balbas and Merlijn van Weerd (Mabuwaya Foundation). Joni Acay was the rappateur.

Ronnie Sumiller presented an update on the Philippine crocodile captive breeding program at the PWRCC. Vic Mercado presented the reintroduction program in Davao and the status of the Ligawasan Crocodile Rescue and Breeding Center that was established by the University of Southern Mindanao (USM) with support by CPPI. Merlijn van Weerd and Marites Balbas presented the Philippine crocodile conservation program of the Mabuwaya Foundation in Isabela Province. Dominic Rodriguez presented the results of monitoring studies of the Dicitian Lake reintroduction program. Willem van de Ven presented the head-start program of the Mabuwaya Foundation. Rheyda Hinlo presented the results of studies that she and John Tabora of USM have been conducting on Philippine crocodile genetics. Arvin Diesmos presented a proposed *C. mindorensis* reintroduction program

on the island of Siargao. Esteven Toledo presented Philippine policies and protocols regarding the release of crocodiles in the wild based on the IUCN/SSC Guidelines for Reintroduction.

The main issues and solutions that came up during the presentations and resulting discussions were:

1. The genetic studies seem to indicate that quite a number of crocodiles at PWRCC are *C. mindorensis*/*C. porosus* hybrids, although results are preliminary and somewhat controversial as there seems to be no physical evidence of hybridisation. The genetic studies also found differentiation between *C. mindorensis* island sub-populations with the largest differences between Mindanao and Luzon. Proposed actions include the genetic screening of all *C. mindorensis* in captivity, including crocodiles held at Avilon Zoo and in foreign collections. Only “pure” crocodiles would be selected for future captive-breeding and reintroductions. Preferably only crocodiles originating from Luzon would be reintroduced there but currently there is no captive-breeding program with Luzon crocodiles except perhaps at Avilon Zoo in Manila of which the origin of breeders is unknown.
2. Young (small) head-started crocodiles in San Mariano and older soft-released crocodiles at Pag-asa farms adapted well to wild conditions whereas most of the older (larger) hard-released crocodiles in Dicitian Lake seemed to have considerable adaptation difficulties. Mortality in Dicitian was high and growth of recaptured crocodiles 2 years after release slow or negative (weight). Several crocodiles have left the lake and have started to prey on livestock in nearby farms thereby creating a conflict with local residents. Prey availability in Dicitian Lake seems not to be the problem, the lake and its banks are teeming with known prey species. Proposed actions for future reintroductions include using only crocodiles up to 2 years old and soft-releasing crocodiles for a period of at least 6 months prior to release in semi-wild but controlled conditions with as little human interference as possible. Soft-release enclosures are already available at the farm of Vic Mercado in Mindanao and at the head-start facility of the Mabuwaya Foundation on Luzon. A future Philippine crocodile reintroduction program could include a captive-breeding and soft-release facility on Mindanao and one on Luzon.
3. There is a need for a Philippine crocodile reintroduction protocol that includes a format for habitat assessments of possible release sites, a list of the formal and legal steps to be taken and a format for post-release monitoring. The Manila workshop is the first step towards the development of such a protocol, which would officially be adopted by PAWB. The workshop participants will collaboratively develop the protocol further. The workshop report will be shared with all participants and other stakeholders and will be made publicly available on the CSG website.

The Philippine crocodile reintroduction workshop contributes to updating of the Philippine Crocodile National Recovery

Plan in preparation for the CSG meeting in Manila in May 2012.

Merlijn van Weerd, *Director, Mabuwaya Foundation, Cagayan, Isabela, Philippines* (merlijnvanweerd@yahoo.com), Marites Balbas, Sam Telan, Dominic Rodriguez, Jessie Guerrero and Willem van de Ven (*Mabuwaya Foundation* (mabuwaya@yahoo.com)).

Science



Recent Publications

Escobedo-Galván, A.H., Casas-Andreu, G., Barrios-Quiroz, G., Sustaita-Rodríguez, V.H. and López-Luna, M.A. (2011). Observations on nests of *Crocodylus moreletii* in San Luis Potosí, Mexico. *Revista Mexicana de Biodiversidad* 82: 315-317.

Abstract: Nesting ecology of Morelet's crocodile (*Crocodylus moreletii*) has been documented since 1940. However, only 2 nests constructed on floating vegetation have been recorded. Here, we presented additional information from a mainland population of *C. moreletii* in the Ciénega de Cabezas wetland, San Luis Potosí, describing 2 nests constructed on floating mats of cattails. The nests were constructed using *Typha* sp., close to the main channel. One nest was lost due to flooding, and contained 32 eggs. Seven eggs had a mean 72.6 ± 2.63 mm length (range 70.0-75.0 mm), 45.0 ± 2.30 mm width (range 41.0-48.0 mm), and 140.7 ± 2.98 mm diameter (range 136.0-145.0 mm). We suggest that the use of floating vegetation for nesting by *C. moreletii* is related to the availability of aquatic vegetation, combined with the lack of adequate nesting sites on land.

Casas-Andreu, G., Barrios-Quiroz, G. and Macip-Ríos, R. (2011). Reproduction of *Crocodylus moreletii* in captivity in Tabasco, Mexico. *Revista Mexicana de Biodiversidad* 82: 261-273.

Abstract: Between 1990 and 1993 we studied the Morelet's crocodile reproduction in captivity, with a sample of 27 males and 109 females. Females were larger (60 to 140 cm SVL) than previously known. Most frequent size of nesting females was between 81 and 100 cm of SVL. Sexual maturity in females was attained at a minimum size of 135 cm. The courtship, mating, nesting and hatching occurred between February and September. In the sample of females 8.25% nesting in each one of the 4 years of study, 11% in 3 years, 28.44% in 2, and 52.29% in one. The reproductive events mentioned were related to the highest average environmental temperatures, and nesting to the beginning of the rainy season. The number of eggs per nest fluctuated between 6

and 50 (29.24 ± 8.72). The body size and body mass were not good fine predictors of the reproductive characteristics. There was not correlation between egg characteristics and the clutch size, being different from the expected pattern. The body size and body mass were only slight correlated to clutch size, therefore, environmental factors, the reproductive quality of males, the physical condition of the females, the stocking rates, sex ratios, and territoriality may be influencing the reproductive traits.

Somaweera, R., Webb, J.K. and Shine, R. (2011). It's a dog-eat-croc world: dingo predation on the nests of freshwater crocodiles in tropical Australia. *Ecol. Res.* (doi 10.1007/s11284-011-0853-0).

Abstract: Predation on eggs is an important source of mortality for many long-lived organisms, but causes of egg mortality from specific predators remain poorly known in most cases. Understanding the identity of predators, and the rates and determinants of their effects on a cohort of recruits, can provide a valuable background for attempts to exploit, control or conserve populations. We used remotely triggered cameras to study predation on the nests of freshwater crocodiles (*Crocodylus johnstoni*) inhabiting Lake Argyle, in tropical Australia. We also supplemented our work on natural crocodile nests with artificial nests. Overall, 80 of 111 natural nests were opened by predators, and predation occurred throughout the study period (7 weeks). Unlike in other parts of the species' range, most nestrobbers were dingoes (*Canis lupus dingo*, responsible for 98% of all predator visits in the northern sites, and 54% in the Ord River site), with minimal additional predation by reptiles and birds. Contrary to expectation, rates of nest predation were not influenced by spatial clumping of nests: the probability of predation per nest did not change with total numbers of nests laid in an area, and artificially aggregated versus dispersed nests experienced similar levels of predation. Nest vulnerability was linked to abiotic features including slope of surrounding banks, compactness of nesting substrate, and distance from the nearest forest. Abundant aquatic food resources support a large crocodile population, but a lack of suitable nest sites forces the crocodiles to concentrate nesting in small areas readily accessible to wide-ranging nest predators. Collectively, our results suggest that distinctive attributes of the lakeside landscape alter predator guilds and fashion unique predator-prey interactions.

Somaweera, R., Webb, J.K., Brown, G.P. and Shine, R. (2011). Hatchling Australian freshwater crocodiles rapidly learn to avoid toxic invasive cane toads. *Behaviour* 148: 501-517.

Abstract: Predicting the ecological impacts of invasive species on native fauna is a formidable challenge for conservation biologists. One way to deal with that challenge is to stage encounters between the invader and native species in the laboratory, to illuminate likely outcomes of encounters in the wild. The invasion of the highly toxic cane toad *Rhinella marina* across tropical Australia threatens many frog-eating

predators, including freshwater crocodiles (*Crocodylus johnstoni*). To predict the impact of cane toads on crocodiles, we need to know whether crocodiles will attack cane toads, and whether predators that survive the toads' poisons will learn to avoid toads. We quantified these traits under laboratory conditions in hatchling freshwater crocodiles from Lake Argyle in Western Australia. All toad-naïve hatchling crocodiles attacked toads during their first encounter, and none showed signs of overt illness after consuming toads. However, crocodiles rapidly learnt to avoid toads as prey, and only four out of the 10 crocodiles attacked toads during subsequent encounters. Compared to control (toad-naïve) conspecifics, toad-smart crocodiles inflicted fewer bites on toads, held toads in their mouths for shorter time periods, and were more likely to reject toads as prey. In the field, toads were consumed more rarely than native frogs. Our results show that hatchling freshwater crocodiles can rapidly learn to avoid cane toads as prey. Hence, even if toads cause mortality of larger crocodiles (as happens in some areas), populations may recover via hatchling recruitment.

Van der Ploeg, J., Cauilan-Cureg, M., Van Weerd, M. and De Groot, W.T. (2011). Assessing the effectiveness of environmental education: mobilizing public support for Philippine crocodile conservation. *Conservation Letters* 00: 1-11. (doi 10.1111/j.1755-263X.2011.00181.x).

Abstract: There is little quantitative data on the cost effectiveness of environmental communication and education efforts. This study evaluates a public awareness campaign for the conservation of the Philippine crocodile in the northern Sierra Madre in terms of outputs, outreach, cognitive and affective outcomes, and impact through a counterfactual comparison. The campaign succeeded in raising awareness on and transforming attitudes toward *in situ* Philippine crocodile conservation: most people living in close proximity to crocodiles now know that the species is legally protected and support *in situ* conservation. As a result, crocodiles are no longer purposively killed. Substantial gains can be made in environmental conservation by investing more in communication, education, and public awareness campaigns, particularly in developing countries. Awareness on legislation and pride in the conservation of a rare and iconic species are strong incentives for poor, rural communities to support *in situ* wildlife conservation.

Eme, J., Hicks, J.W. and Crossley, D.A. (2011). Chronic hypoxic incubation blunts a cardiovascular reflex loop in embryonic American alligator (*Alligator mississippiensis*). *J. Comp. Physiol. B: Biochemical, Systemic and Environmental Physiology* (doi 10.1007/s00360-011-0569-z).

Abstract: Hypoxia is a naturally occurring environmental challenge for embryonic non-avian reptiles, and this study is the first to investigate the impact of chronic hypoxia on a possible chemoreflex loop in a developing non-avian reptile. We measured heart rate and blood pressure in normoxic and hypoxic-incubated (10% O₂) American alligator embryos

(*Alligator mississippiensis*) at 70 and 90/95% of development. We hypothesized that hypoxic incubation would blunt embryonic alligators' response to a reflex loop stimulated by phenylbiguanide (PBG), a 5-HT₃ receptor agonist that stimulates vagal pulmonary C-fiber afferents. PBG injection caused a hypotensive bradycardia in 70 and 95% of development embryos (paired t tests, $P < 0.05$), a response similar to mammals breathing inspired air (all injections made through occlusive catheter in tertiary chorioallantoic membrane artery). Hypoxic incubation blunted the bradycardic response to PBG in embryos at 95% of development (two-way ANOVA, $P < 0.01$). We also demonstrated that the vagally mediated afferent limb of this reflex can be partially or completely blocked in ovo with a 5-HT₃ receptor blockade using ondansetron hydrochloride dihydrate (OHD), with a ganglionic blockade using hexamethonium, or with a cholinergic blockade using atropine. Atropine eliminated the hypotensive and bradycardic responses to PBG, and OHD and hexamethonium significantly blunted these responses. This cardiovascular reflex mediated by the vagus was affected by hypoxic incubation, suggesting that reptilian sympathetic and parasympathetic reflex loops have the potential for developmental plasticity in response to hypoxia. We suggest that the American alligator, with an extended length of time between each developmental stage relative to avian species, may provide an excellent model to test the cardiorespiratory effects of prolonged exposure to changes in atmospheric gases. This extended period allows for lengthy studies at each stage without the transition to a new stage, and the natural occurrence of hypoxia and hypercapnia in crocodilian nests makes this stress ecologically and evolutionarily relevant.

Milián-García, Y., Venegas-Anaya, M., Frias-Soler, R., Crawford, A.J., Ramos-Targarona, R., Rodríguez-Soberón, R., Alonso-Tabet, M., Thorbjarnarson, J., Sanjur, O.I., Espinosa-López, G. and Bermingham, E. (2011). Evolutionary history of Cuban crocodiles *Crocodylus rhombifer* and *Crocodylus acutus* inferred from multilocus markers. *J. Exp. Zool.* 313A (doi 10.1002/jez.683).

Abstract: Among crocodilians, *Crocodylus rhombifer* is one of the world's most endangered species with the smallest natural distribution. In Cuba, this endemic species coexists with the American crocodile (*Crocodylus acutus*). Hybridization between these two species is well known in captivity and might occur in the wild, but has never been demonstrated genetically. Here, we combined molecular data with environmental, geographic, and fossil data to infer the evolutionary history of *Crocodylus* in the Cuban Archipelago, and to evaluate genealogical support for species boundaries. We analyzed seven microsatellite loci plus DNA sequence data from nuclear (RAG-1) and mitochondrial (cytochrome b and cytochrome oxidase I) genes from 89 wild-caught individuals in Cuba, Grand Cayman Island, Jamaica, and Central America, and two samples from zoo collections. Microsatellites showed evidence of introgression, suggesting potential hybridization among Cuban groups. In Cuba, *C. acutus* contained one mitochondrial DNA (mtDNA) haplotype, whereas *C. rhombifer* contained two haplotypes. MtDNA

data showed that *C. acutus* is paraphyletic with respect to *C. rhombifer*, revealing 1% sequence divergence between species within Cuba vs. 8% divergence between Cuban forms and mainland *C. acutus*. We suggest that hybridization has been a historical as well as a current phenomenon between *C. acutus* and *C. rhombifer*. These findings suggest that long-term conservation of crocodiles in Cuba will require identification of genetically pure and hybrid individuals, and a decrease in anthropogenic activities. We also recommend more extensive morphological and genetic analyses of Cuban population to establish clear boundaries of the hybrid zone between *C. acutus* and *C. rhombifer*.

Rainwater, T.R., Millichamp, N.J., Barrantes, L.D.B., Barr, B.R., Montero, J.R.B., Platt, S.G., Abel, M.T., Cobb, G.P. and Anderson, T.A. (2011). Ocular disease in American crocodiles (*Crocodylus acutus*) in Costa Rica. *Journal of Wildlife Diseases* 47: 415-426.

Abstract: Beginning in early 2006, an ocular disease of unknown etiology was routinely observed in American crocodiles (*Crocodylus acutus*) inhabiting the highly polluted Tarcoles River in westcentral Costa Rica. We examined the nature and incidence of ocular disease in Tarcoles crocodiles and assessed the possible association between the disease and accumulation of chemical pollutants in diseased individuals. During 12-15 September and 12-13 December 2007, crocodiles were captured and examined for ocular disease and sampled to determine environmental contaminant accumulation. Three of 11 (27.3%) crocodiles captured (all males) exhibited unilateral ocular disease, primarily characterized by corneal opacity and scarring, anterior synechia, and phthisis bulbi. Multiple pollutants were detected in crocodile caudal scutes (organochlorine pesticides [OCPs] and metals), crocodile blood (OCPs), and sediments (OCPs and metals) from the Tarcoles, but no associations were found between contaminant accumulation and the incidence of eye disease. On the basis of the limited number of diseased animals examined and the potential exposure of crocodiles to pathogens and other pollutants not targeted in this study, we cannot rule out infection or chemical toxicosis as causes of the eye lesions. However, circumstantial evidence suggests that the observed ocular disease is likely the result of injury-induced trauma (and possibly secondary infection) inflicted during aggressive encounters (eg territorial combat) among large adult crocodiles living at relatively high densities.

Meredith, R.W., Hekkala, E.R., Amato, G. and Gatesy, J. (2011). A phylogenetic hypothesis for *Crocodylus* (Crocodylia) based on mitochondrial DNA: Evidence for a trans-Atlantic voyage from Africa to the New World. *Molecular Phylogenetics and Evolution* (doi 10.1016/j.ympev.2011.03.026).

Abstract: The phylogenetic relationships among extant species of *Crocodylus* (Crocodylia) have been inconsistently resolved by previous systematic studies. Here we used nearly complete mitochondrial (mt) genomes (16,200 base pairs) for all described *Crocodylus* species, 8 of which are new to

this study, to derive a generally well-supported phylogenetic hypothesis for the genus. Model-based analyses support monophyly of all Asian + Australian species and paraphyly of *Crocodylus niloticus* (Nile crocodile) with a monophyletic New World clade nested within this species. Wild-caught Nile crocodiles from eastern populations group robustly with the four New World species to the exclusion of Nile crocodiles from western populations, a result that is also favored by parsimony analyses and by various subpartitions of the overall mt dataset. The fossil record of *Crocodylus* extends back only to the Late Miocene, while the earliest fossils assigned to *C. niloticus* and to New World *Crocodylus* are Pliocene. Therefore, in combination with paleontological evidence, mt DNA trees imply a relatively recent migration of *Crocodylus* from Africa to the Americas, a voyage that would have covered hundreds of miles at sea.

Hussain, S.A., Shrama, R.K., Dasgupta, N. and Raha, A. (2011). Assessment of Minimum Water Flow Requirements of Chambal River in the Context of Gharial (*Gavialis gangeticus*) and Gangetic Dolphin (*Platanista gangetica*) conservation. Wildlife Institute of India: India.

Eaton, M. and Link, W. (2011). Estimating age from recapture data: integrating incremental growth measures with ancillary data to infer age-at-length. *Ecological Applications* (doi 10.1890/10-0626.1).

Abstract: Estimating the age of individuals in wild populations can be of fundamental importance for answering ecological questions, modeling population demographics and managing exploited or threatened species. Significant effort has been devoted to determining age through the use of growth annuli, secondary physical characteristics related to age, and growth models. Many species, however, either do not exhibit physical characteristics useful for independent age validation or are too rare to justify sacrificing a large number of individuals to establish the relationship between size and age. Length-at-age models are well represented in the fisheries and other wildlife management literature. Many of these models overlook variation in growth rates of individuals and consider growth parameters as population parameters. More recent models have taken advantage of hierarchical structuring of parameters and Bayesian inference methods to allow for variation among individuals as functions of environmental covariates or individual-specific random effects. Here, we describe hierarchical models in which growth curves vary as individual specific stochastic processes, and show how these models can be fit using capture-recapture data for animals of unknown age along with data for animals of known age. We combine these independent data sources in a Bayesian analysis, distinguishing natural variation (among and within individuals) from measurement error. We illustrate using data for African dwarf crocodiles, comparing von Bertalanffy and logistic growth models. The analysis provides the means of predicting crocodile age given a single measurement of head length. The von Bertalanffy was much better supported than the logistic growth model and predicted that dwarf crocodiles

grow from 19.4 cm total length at birth to 32.9 cm in the first year and 45.3 cm by the end of their second year. Based on the minimum size of females observed with hatchlings, reproductive maturity was estimated to be at 9 years. These size benchmarks are believed to represent thresholds for important demographic parameters; improved estimates of age, therefore, will increase the precision of population projection models. The modeling approach we present can be applied to other species and offers significant advantages when multiple sources of data are available and traditional aging techniques are not practical.

Pawaiya, R.V.S., Sharma, A.K., Swarup, D. and Somvanshi, R. (2011). Pathology of mycotic gastritis in a wild Indian freshwater/marsh crocodile (Mugger; *Crocodylus palustris*): a case report. *Veterinari Medicina* 56(3): 135-139.

Abstract: There is no report on systemic mycotic disease in wild crocodilians so far. This report describes possibly the first ever case of deep gastric mycosis in a wild Indian crocodile. A carcass of an adult female, broad snouted Indian marsh crocodile was brought for necropsy. Externally, all visible mucous membranes, eyes, cloacal opening and joints were normal. On opening the carcass, all visceral organs were found in normal position and appeared grossly normal. The stomach was empty except for the presence of a few small wooden and bony pieces, and several dark blackish patches of raised plaques on the gastric mucosa. Other areas of gastric mucosa showed diffuse congestion with petechial haemorrhages and oedema. Microscopically, gastric mucosa in plaque areas appeared extensively thickened and fibrosed with moderate infiltration of mononuclear cells. Gastric glands were atrophied due to massive fibrosis which appeared to have completely replaced the mucosal architecture in the affected area. In the superficial gastric mucosa and also deep in the fibrosed tissue, spherical to oval, variable sized, thick walled bodies, several of them budding and often forming small chains, sprouting and even germinating, giving rise to branched hyphae, were conspicuously observed. These fungal bodies were found to be PAS-positive. Species identification of the mould could not be done. The present case appears to be the first report of invasive mycotic gastritis in a wild Indian crocodile (*Crocodylus palustris*), most probably caused by *Candida albicans*.

Wu, T.H. (2011). Evaluation of organochlorine residues in Morelet's and American crocodile eggs from Belize. PhD Thesis, Texas Tech University Libraries (<http://hdl.handle.net/2346/9564>).

Abstract: Non-viable eggs of Morelet's crocodile (*Crocodylus moreletii*) and American crocodile (*Crocodylus acutus*) were collected from various locations in Belize and screened for organochlorine (OC) compounds using gas chromatography (GC) with electron capture detection (ECD). Seven complete clutches (1 non-viable and 6 flooded nests) of eggs from Morelet's crocodiles were also collected to examine distribution of OCs and determine the appropriate minimum

number of eggs to sample in the field to obtain an accurate mean p,p-DDE concentration representative of the full clutch. All but one egg (American crocodile. Maps Cay, Nest 2) analyzed tested positive for one or more OCs. The primary contaminant was p,p-DDE (99%). Other OCs detected included p,p-DDT, p,p-DDD, methoxychlor, endosulfan I and II, endrin, aldrin, and α -chlordane. Concentrations of individual OCs on a wet weight calculation ranged from 1 ppb (ng chemical/g egg) to >0.5 ppm (jig chemical/g egg). Total concentration of OCs (sum of all OCs) for one egg collected from a nest at Gold Button Lagoon (GBL) reached as high as 0.7 ppm. No significant difference ($p < 0.05$) between non-viable eggs from American ($n = 12$) and Morelet's ($n = 13$) crocodile nests was observed for egg p,p-DDE concentration using a Wilcoxon rank sum test. However, significant differences were observed with absolute mean p,p-DDE contamination among complete clutches ($n = 7$) of eggs from Morelet's crocodile using Welch ANOVA ($p < 0.0001$). Correlation coefficients for DDT and DDT metabolites within complete clutches of eggs varied from an r of 0.95 to 0.24. The weaker correlation coefficients between DDT and DDT metabolites may suggest the possibility of another source of contaminants in eggs besides by maternal transfer. A statistical evaluation of p,p-DDE levels in three complete clutches (GBL 2, 1999; GBL 3, 1997; and GBL 4, 1997) of eggs recommended a minimum sample size of 11. This sample size should give an accurate estimate of contaminant levels in a full clutch of eggs based on an average standard deviation (0.26 ng/g), average clutch size ($n = 20$), acceptable deviation from the mean (± 0.1), and a confidence interval of 90%. The statistically recommended sample size of 11 eggs was successfully tested on four additional clutches. Sediment and nest media (soil and plant material) collected from GBL and New River Lagoon (NRL) also tested positive for OCs (lindane, aldrin, heptachlor, methoxychlor, endrin aldehyde, p,p-DDT among others). Contaminated media could be a potential source for transfer of volatile OCs into eggs. Based on the 264 egg samples analyzed, Morelet's and American crocodiles from Belize are being exposed to OCs. Such exposure may present a health threat to populations of crocodilians in Central America.

Abdel-Maksoud, G. and Abdel-Hady, M. (2011). Effect of burial environment on crocodile bones from Hawara excavation, Fayoum, Egypt. *Journal of Cultural Heritage* 12(2): 180-189.

Abstract: Many different archaeological materials were found in Hawara (Fayoum, Egypt) during the excavation of the Egyptian-Polish mission in 2008. A complete crocodile skeleton, and many incomplete crocodiles were found in this area. The skeletons of these crocodiles suffered from salt crystallization, erosion, pitting, change of the color, etc. This study focuses on the mechanism of deterioration processes that affects bone and tusks. Surface modification, change of color, study of soil components and bone crystallinity, degradation of collagen, pH, bone histology, and the surface morphology were investigated by visual examination, UV spectrophotometry, X-ray diffraction, FTIR, pH meter,

polarized light microscope (PLM) and scanning electron microscope (SEM), respectively. The results revealed that soluble salt (sodium chloride) and insoluble salt (calcium sulfate) played an important role in the deformation of bone. FTIR proved that archaeological bones undergo changes in their chemical stability. Differing colors, and cracks on the surface of the bones indicate that they were exposed to different temperatures.

Wheatley, P.V. (2010). Understanding saltwater tolerance and marine resource use in the Crocodylia: A stable isotope approach. PhD Thesis, University of California, Santa Cruz. 175 pp.

Abstract: Today, crocodylians are primarily freshwater-adapted today, though estuarine populations of *Crocodylus acutus* and *C. porosus* are notable exceptions. But beginning in the 1980s scientific work involving phylogeny, biogeography and osmoregulatory physiology suggested that Crocodylia had been more adept in coastal and marine environments in the past. Here I use stable isotopes as natural tracers of inputs to modern and fossil crocodylians to explore their current and past reliance on marine resources. Using carbon and oxygen isotope ratios from the carbonate portion of tooth bioapatite, I estimate the marine resource use of modern coastal populations of *C. acutus* and *Alligator mississippiensis* by comparing them to marine reptiles and inland populations of *A. mississippiensis*. Coastal *A. mississippiensis* and *C. acutus* feed from marine foodwebs in roughly equal percentages (~60% and ~70% respectively). I estimate the amount of seawater ingestion for *C. acutus* to be 80% on average (*A. mississippiensis* is an obligate freshwater drinker). Thus, many of the osmoregulatory behaviors assumed to be necessary for *C. acutus* (such as actively seeking out fresh drinking water) may not be necessary. I examine the long-term diet of *A. mississippiensis* from Rockefeller Wildlife Refuge, Louisiana, by measuring carbon and nitrogen stable isotope ratios in alligator prey items and the bone and tooth collagen of the alligators themselves. I use a Bayesian mixing model to estimate the percent contribution of various prey to alligator tooth collagen and, separately, alligator bone collagen. Because reptiles constantly replace their teeth, tooth collagen is a much more recent record of dietary input than is bone collagen. I take advantage of these different time frames to examine differences between adult and juvenile diet. My work documents a movement to a more diverse and generalized diet (incorporating more brackish water taxa and terrestrial mammals) when alligators reach a total length of about 1.3 m. Results point the importance of nutria, potentially when alligators are growing quickly, and the possibility of seasonal prey items being of importance. To estimate marine resource use and to pinpoint the origin of saltwater tolerant physiology in fossil crocodylians, I analyzed the carbonate and phosphate portions of tooth enamel from crocodylians and their close relatives for carbon and oxygen isotope ratios. I find an origin for saltwater tolerance at least as old as the common ancestor of Crocodylia + Dyrosauridae (Cretaceous) and perhaps as old as the common ancestor of Crocodylia + Metriorhynchidae (Jurassic), depending upon the phylogenetic

hypothesis employed. I also found strong evidence of marine food dependence for several crocodylians, including seagrass ecosystem dependence for tomistomines and pelagic resource consumption in the dyrosaurids. Though modern crocodylians are largely freshwater focused, the group as whole had strong ties to the marine realm in the past. This physiology easily allows for the possibility of long-range oceanic dispersals to explain the biogeography of many lineages of crocodylians.

Haddad, Jr., V. and Cardoso Fonseca, W. (2011). Fatal attack on a child by a Black caiman (*Melanosuchus niger*). Wilderness and Environmental Medicine 22(1): 62-64.

Abstract: We describe a fatal attack by a black caiman (*Melanosuchus niger*) on an 11-year-old child with comments on the reptile's aggression mechanisms and the conditions under which this kind of incident takes place in the Amazon region.

Mahony, M.E. and Bartels, W.S. (2011). Comparison of Eocene basin-center crocodiles from the Bridger Formation, Green River Basin, Wyoming. Paper No. 13-13, Geological Society of America, Northeastern (46th Annual) and North-Central (45th Annual) Joint Meeting (20-22 March 2011).

Abstract: This study describes new specimens of Eocene crocodylids from basin-margin deposits and compares them morphologically to age-equivalent specimens from basin-center environments. Fossil crocodylians are abundant and diverse elements in Rocky Mountain Paleogene faunas. The majority of described specimens and taxa are known only from basin-center deposits representing distal fluvial, lake-margin, and lacustrine depositional environments well removed from upland source areas. Several different crocodile species have been described from the Green River Basin, the most common being the large and relatively broad snouted "*Crocodylus*" *affinis* that is found in meandering stream deposits of the basin-center. Other species include the narrow snouted "*Crocodylus*" *acer*, which was the dominant species in the lacustrine environment, and "*Crocodylus*" *sulciferus*, and *Borealosuchus wilsoni* which may also have been environmentally restricted. The South Pass area of the northern Green River Basin preserves several hundred metres of lacustrine deposits of the Green River Formation alternating with predominantly fluvial deposits of the Wasatch and Bridger Formations. The crocodiles described in this study were recovered from meandering stream channel sandstones of the lower part of the Bridger Formation exposed on the flank of Continental Peak. Based on mammalian biostratigraphy and magnetostratigraphy, these deposits are early Blacksforkian (Br1b, early Bridgerian, "Bridgerian A") in age. The basin-margin crocodile specimens described in this study have been prepared and compared to the descriptions of the known basin-center crocodile species. The cranial morphology of these basin-margin specimens are most similar to "*Crocodylus*" *affinis* and *B. wilsoni* but differ in several minor ways from the basin-center specimens. Vertebrate faunas from basin-margin settings are characterized by anachronistic taxa (appearing

earlier or later than in basin-centers), rare taxa (common in basin-margins but rare in basin-centers), unique taxa (found only in basin-margins), and morphologically distinct forms assignable to basin-center taxa. The crocodiles described here appear to be an example of this last pattern.

Lauridsen, H., Hansen, K., Wang, T., Agger, P., Andersen, J.L., Knudsen, P.S., Rasmussen, A.S., Uhrenholt, L. and Pederson, M. (2011). Inside Out: Modern Imaging Techniques to Reveal Animal Anatomy. PLoS ONE 6(3): e17879. doi 10.1371/journal.pone.0017879.

Abstract: Animal anatomy has traditionally relied on detailed dissections to produce anatomical illustrations, but modern imaging modalities, such as MRI and CT, now represent an enormous resource that allows for fast non-invasive visualizations of animal anatomy in living animals. These modalities also allow for creation of three-dimensional representations that can be of considerable value in the dissemination of anatomical studies. In this methodological review, we present our experiences using MRI, CT and μ CT to create advanced representation of animal anatomy, including bones, inner organs and blood vessels in a variety of animals, including fish, amphibians, reptiles, mammals, and spiders. The images have a similar quality to most traditional anatomical drawings and are presented together with interactive movies of the anatomical structures, where the object can be viewed from different angles. Given that clinical scanners found in the majority of larger hospitals are fully suitable for these purposes, we encourage biologists to take advantage of these imaging techniques in creation of three-dimensional graphical representations of internal structures.

Zhang Man, Wang Yishu, Yan Peng and Wu Xiaobing (2011). Crocodilian phylogeny inferred from twelve mitochondrial protein-coding genes, with new complete mitochondrial genomic sequences for *Crocodylus acutus* and *Crocodylus novaeguineae*. International Journal of Biodiversity and Conservation 3(1): 19-23.

Abstract: We report complete mitochondrial genomic sequences for *Crocodylus acutus* and *Crocodylus novaeguineae*, whose gene orders match those of other crocodilians. Phylogenetic analyses based on the sequences of 12 mitochondrial protein-coding genes support monophyly of two crocodilian taxonomic families, Alligatoridae (*Alligator*, *Caiman*, and *Paleosuchus*) and Crocodylidae (*Crocodylus*, *Gavialis*, *Mecistops*, *Osteolaemus*, and *Tomistoma*). Our results are consistent with monophyly of all crocodilian genera. Within Alligatoridae, *Alligator* is the sister taxon of a clade comprising *Caiman* and *Paleosuchus*. Within Crocodylidae, the basal phylogenetic split separates a clade comprising *Gavialis* and *Tomistoma* from a clade comprising *Crocodylus*, *Mecistops*, and *Osteolaemus*. *Mecistops* and *Osteolaemus* form the sister taxon to *Crocodylus*. Within *Crocodylus*, we sampled five Indopacific species, whose phylogenetic ordering is ((*C. mindorensis*, *C. novaeguineae*),

(*C. porosus*, (*C. siamensis*, *C. palustris*))). The African species *C. niloticus* and New World species *C. acutus* form the sister taxon to the Indopacific species, although our sampling lacks three other New World species and an Australian species of *Crocodylus*.

Sharma, R.K., Singh, H. and Dasgupta, N. (2011). A survey of habitat invetorization and habitat potentiality for sustenance of Gharial in Sone (*Gavialis gangeticus*) Gharial Sanctuary. International Journal of Biodiversity and Conservation 3(1): 19-23,

Abstract: The present study was carried out to find out the diversity of Gharial and potential habitat for its survival. A total of 161 km area in the Sanctuary was studied and data related with population of Gharial, habitat features, river profile, human activities and threats were collected. The Sone River apparently supports a few viable populations of Gharial. The population of Gharial shows 40% reduction since 1996 to 2010 in Sone Gharial Sanctuary. Much of the river was found sub-optimal for sustenance of viable population of Gharial for low flow conditions due to construction of Dam at upstream region. The other stretches have potentiality as good habitat for Gharial as some of them are presently used by the species for nesting. Some recommendations have been suggested on the basis of the observations to maintain those habitats for propagation, release and management of the species to raise the present population to a stabilized and viable one.

Moore, B.C., Milnes, M.R., Kohno, S., Katsu, Y., Iguchi, T., Woodruff, T.K. and Guillelte, L.J. Jr. (2011). Altered gonadal expression of TGF- β superfamily signaling factors in environmental contaminant-exposed juvenile alligators. The Journal of Steroid Biochemistry and Molecular Biology (doi 10.1016/j.jsbmb.2011.01.004).

Abstract: Environmental contaminant exposure can influence gonadal steroid signaling milieus; however, little research has investigated the vulnerability of non-steroidal signaling pathways in the gonads. Here we use American alligators (*Alligator mississippiensis*) hatched from field-collected eggs to analyze gonadal mRNA transcript levels of the activin-inhibin-follistatin gene expression network and growth differentiation factor 9. The eggs were collected from Lake Woodruff National Wildlife Refuge, a site with minimal anthropogenic influence, and Lake Apopka, a highly contaminated lake adjacent to a former EPA Superfund site. The hatchling alligators were raised for 13 months under controlled conditions, thus limiting differences to embryonic origins. Our data reveal sexually dimorphic mRNA expression in 13-month-old alligator gonads similar to patterns established in vertebrates with genetic sex determination. In addition, we observed a relationship between lake of origin and mRNA expression of activin/inhibin subunits α and β B, follistatin, and growth differentiation factor 9. Our study suggests that embryonic exposure to environmental contaminants can affect future non-steroidal signaling patterns in the gonads of a long-lived species.

Brito, J.C., Martínez-Freiría, F., Sierra, P., Sillero, N. and Tarroso, P. (2011). Crocodiles in the Sahara Desert: An Update of Distribution, Habitats and Population Status for Conservation Planning in Mauritania. PLoS ONE 6(2): e14734. doi:10.1371/journal.pone.0014734.

Abstract: Relict populations of *Crocodylus niloticus* persist in Chad, Egypt and Mauritania. Although crocodiles were widespread throughout the Sahara until the early 20th century, increased aridity combined with human persecution led to local extinction. Knowledge on distribution, occupied habitats, population size and prey availability is scarce in most populations. This study evaluates the status of Saharan crocodiles and provides new data for Mauritania to assist conservation planning. A series of surveys in Mauritania detected crocodile presence in 78 localities dispersed across 10 river basins and most tended to be isolated within river basins. Permanent gueltas and seasonal tãmoûrts were the most common occupied habitats. Crocodile encounters ranged from one to more than 20 individuals, but in most localities less than five crocodiles were observed. Larger numbers were observed after the rainy season and during night sampling. Crocodiles were found dead in between water points along dry river-beds suggesting the occurrence of dispersal. Research priorities in Chad and Egypt should focus on quantifying population size and pressures exerted on habitats. The present study increased in by 35% the number of known crocodile localities in Mauritania. Gueltas are crucial for the persistence of mountain populations. Oscillations in water availability throughout the year and the small dimensions of gueltas affect biological traits, including activity and body size. Studies are needed to understand adaptation traits of desert populations. Molecular analyses are needed to quantify genetic variability, population sub-structuring and effective population size, and detect the occurrence of gene flow. Monitoring is needed to detect demographical and genetical trends in completely isolated populations. Crocodiles are apparently vulnerable during dispersal events. Awareness campaigns focusing on the vulnerability and relict value of crocodiles should be implemented. Classification of Mauritanian mountains as protected areas should be prioritised.

Stoker, C., Repetti, M.R., García, S.R., Zayasa, M.A., Galoppo, G.H., Beldoménico, H.R., Luque, E.H. and Muñoz-de-Torrea, M. (2011). Organochlorine compound residues in the eggs of broad-snouted caimans (*Caiman latirostris*) and correlation with measures of reproductive performance. Chemosphere (doi 10.1016/j.chemosphere.2011.04.013).

Abstract: Organochlorine compounds (OCCs), like pesticides (OCPs) and polychlorinated biphenyls (PCBs), are persistent lipophilic chemicals classified as endocrine-disruptors. *Caiman latirostris* inhabits wetlands throughout north-eastern Argentina and may accumulate OCCs. The aims of this study were to determine OCC residues in the eggs of *C. latirostris* and to correlate OCC burden with clutch size, hatching success and hatchling survival as measures of reproductive performance. Fourteen caiman clutches were harvested from sites with different degrees of anthropogenic intervention on

wetlands surrounding Paraná River tributaries. Two to four eggs by clutch were used to quantify OCCs. OCP residues were found in all clutches. The principal contributors to the OCPs burden were the DDT family (range BDL-153.0 ng g⁻¹ lipid) and oxychlordane (range BDL-34.3 ng g⁻¹ lipid). PCBs were present in 92.9% of the clutches (range BDL-136.6 ng g⁻¹ lipid). Both higher concentrations and higher diversity of pesticides, including endosulfan sulfate, were found in the nests harvested close to croplands. A negative correlation was found between clutch size and Σ OCCs ($p=0.02$, Pearson $r=-0.53$, $r^2=0.28$), mainly due to the Σ OCPs ($p=0.04$, Pearson $r=-0.54$, $r^2=0.30$). Since egg OCCs concentrations predict maternal burden, present findings suggest that higher OCCs exposure could lead to smaller clutches. Although, other factors like mother age could influence clutch size. Additionally, as caimans are a long-lived and non-migratory species, the maternal OCCs burden reflects the environmental status throughout their home range; thus, caiman eggs could be useful as a biomonitor of local contamination.

Lima, F.C., Vieira, L.G., Santos, A.L.Q., Pereira, H.C., De Simone, S.B.S., Hirano, L.Q.L., Romão, M.F., Silva, J.M.M. and Coutinho, M.E. (2011). Skeletogenesis of the pectoral girdle and forelimbs in embryos of *Caiman yacare* (Daudin, 1802) (Crocodylia, Alligatoridae). J. Morphol. Sci. 28(1): 4-10.

Abstract: Embryos of *Caiman yacare* were collected and subjected to the bone clearing and staining protocol in order to analyze the ontogenetic patterns of ossification of the pectoral girdle and forelimb skeleton. The osseous structure of the girdle and forelimbs of *C. yacare* begins to ossify starting at 30 days of incubation, with the presence of dye retention in the scapula, coracoids, humerus, radius and ulna bones. During embryonic development, the autopodio of *C. yacare* has four bones in the carpus, the radial, ulnar, pisiform and carpal distal 4+5 bone. Their ossification begins at 39 days of incubation with the radial, followed by the ulnar, and at 54 days, the pisiform and the distal carpal 4 + 5. Each mesopodio has 5 metacarpi and are present 15 phalanges, two in digits I and V, three in digits II and IV, and four in digit III (phalangeal formula 2:3:4:3:2). Ossification of the metacarpi starts at 27 days of incubation, following the sequence MCII=MCIII=MCIV>MCI>MCV. The first phalanges begin the process of ossification on day 36, continuing up to the last day of incubation. The sequence of ossification of the proximal phalanges is PPI=PPII=PPIII>PPIV=PPV, that of the medial phalanges is MPPI>MPpIII>MPdIII>MPPIV, and that of the distal phalanges is DPI>DPII>DPIII>DPV>DPIV. The ontogenetic pattern of the bones of the forepaw of *C. yacare* generally differs from that of other reptiles, although there are some similarities.

Delaney, M.F., Woodward, A.R., Kiltie, R.A. and Moore, C.T. (2011). Mortality of American alligators attributed to cannibalism. Herpetologica 67(2): 174-185.

Abstract: Mortality of juvenile (<122 cm total length; TL)

American Alligators (*Alligator mississippiensis*) attributed to cannibalism on Orange Lake, Florida was examined. Alligator web tags used in mark-recapture studies were found in 12% of 267 stomachs sampled from alligators ≥ 168 cm TL. Captive alligators retained 76% of force-fed tags during a 588-d tag-retention trial. Models relating the probability of tag recovery to the annual probabilities of juvenile survival, cannibalism, tag retention, adult survival, and adult harvest suggested that cannibalism may on average remove 6-7% of the juvenile alligator population annually. Vulnerability continued to 140 cm TL (age 6-8 y). Cannibalism of juveniles may serve to regulate the alligator population on Orange Lake. Alligator cannibalism may vary widely among populations, depending on demography and environmental conditions. The role and importance of cannibalism in alligator population dynamics should be more fully assessed and environmental and population factors that influence cannibalism identified to better evaluate management programs.

Alibardi, L. (2011). Histology, ultrastructure, and pigmentation in the horny scales of growing crocodilians. *Acta Zoologica* 92: 187-200.

Abstract: The present morphological study describes the color of hatchling, juvenile, and adult crocodilian skin and the origin of its pigmentation. *In situ* hybridization and immunostaining indicate that crocodilian scales grow as an expansion of the proliferating epidermis of the hinge region that form thin lateral rings. In more central areas of growing scales, new epidermal layers contribute to increase the thickness of the stratum corneum. The dark pigmentation and color pattern derive from the different distribution of epidermal and dermal chromatophores. The more intensely pigmented stripes, irregular patches and dot-like spots, especially numerous in dorsal scales, derive from the incorporation of the eumelanosomes of epidermal melanocytes in differentiating beta cells of the epidermis. Dermal melanophores, mainly localized in the loose upper part of the dermis, also contribute to the formation of the dark or gray background of crocodilian scales. The eumelanosomes of dermal melanophores determine the darkening of the skin pattern in association with the epidermal melanocytes. Iridophores are infrequent, while xanthophores are present in the species analyzed with a sparse distribution in the superficial dermis among melanophores. The presence of xanthophores and of the few iridophores in areas where epidermal melanocytes are absent appear to determine the brown or the light yellow-orange background observed among the darker regions of crocodilian scales.

Siroski, P.A., Merchant, M.E., Marcó, M.P.V., Poletta, G.L., Ortega, H.H. (2011). Comparison of plasma dipeptidyl peptidase IV activity in two caiman species: *Caiman latirostris* and *Caiman yacare* (Crocodylia, Alligatoridae). *Animal Biology* 61(2): 199-210.

Abstract: Dipeptidyl peptidase IV (DPPIV) is a well-characterized protease with broad substrate specificity, functionally-related to the activity of many bioactive

peptides. It plays an important role as physiological regulator of a number of peptides that serve as biochemical messengers within the immune system. Plasma DPPIV activity was characterized with respect to temperature, kinetics and concentration dependence in two species of caiman, the broad-snouted caiman (*Caiman latirostris*) and the black yacare (*Caiman yacare*). DPPIV activity showed a significant positive correlation from titrations carried out in the presence of different plasma concentrations. DPPIV activity was lower in *C. yacare* than in *C. latirostris* at all temperatures tested. *C. yacare* DPPIV activity showed a significant increase only at higher temperatures whilst *C. latirostris* plasma demonstrated a strong positive correlation starting at the lowest temperature, probably due to an adaptation for the tolerance of lower temperatures. Exposure of *C. latirostris* and *C. yacare* plasma at different time points showed that plasma DPPIV activities were time-dependent, and that the titer-dependent curves were different for the two species. These results revealed that plasma DPPIV activities were different between these two crocodilian species, which could contribute to the differences in susceptibility to infection between them.

Doody, J.S. (2011). Environmentally cued hatching in reptiles. *Integr. Comp. Biol.* (doi 10.1093/icb/icr043).

Abstract: Evidence is accumulating for the widespread occurrence of environmentally cued hatching (ECH) in animals, but its diversity and distribution across taxa are unknown. Herein I review three types of ECH in reptiles: early hatching, delayed hatching, and synchronous hatching. ECH is currently known from 43 species, including turtles, crocodilians, lizards, snakes, tuatara, and possibly worm lizards. Early hatching caused by physical disturbance (eg vibrations) is the most commonly reported ECH across all groups; although it apparently serves an antipredator function in some species, its adaptive value is unknown in most. Delayed hatching, characterized by metabolic depression or embryonic aestivation, and sometimes followed by a hypoxic cue (flooding), occurs in some turtles and possibly in monitor lizards and crocodilians; in some of these species delayed hatching serves to defer hatching from the dry season until the more favorable conditions of the wet season. Synchronous hatching, whereby sibling eggs hatch synchronously despite vertical thermal gradients in the nest, occurs in some turtles and crocodilians. Although vibrations and vocalizations in hatching-competent embryos can stimulate synchronous hatching, cues promoting developmentally less advanced embryos to catch up with more advanced embryos have not been confirmed. Synchronous hatching may serve to dilute predation risk by promoting synchronous emergence or reduce the period in which smells associated with hatching can attract predators to unhatched eggs. Within species, advancing our understanding of ECH requires three types of studies: (1) experiments identifying hatching cues and the plastic hatching period, (2) experiments disentangling hypotheses about multiple hatching cues, and (3) investigations into the environmental context in which ECH might evolve in different species (major predators or abiotic influences on the egg, embryo, and hatchling). Among species and groups,

surveys for ECH are required to understand its evolutionary history in reptiles. The probability of ECH occurring is likely influenced by a species's life history, ecology, behavior, and interrelationships with other species (e.g., sizes of predator and prey). More broadly, the discovery of embryo-embryo communication as a mechanism for synchronous hatching in crocodylians and turtles indicates that the social behavior of (nonavian) reptiles has been underestimated.

Puértolas, E., Canudo, J.I. and Cruzado-Caballero, P. (2011). A New Crocodylian from the Late Maastrichtian of Spain: Implications for the Initial Radiation of Crocodyloids. *PLoS ONE* 6(6): e20011. (doi 10.1371/journal.pone.0020011).

Abstract: The earliest crocodylians are known primarily from the Late Cretaceous of North America and Europe. The representatives of Gavialoidea and Alligatoroidea are known in the Late Cretaceous of both continents, yet the biogeographic origins of Crocodyloidea are poorly understood. Up to now, only one representative of this clade has been known from the Late Cretaceous, the basal crocodyloid *Prodiplocynodon* from the Maastrichtian of North America. The fossil studied is a skull collected from sandstones in the lower part of the Tremp Formation, in Chron C30n, dated at -67.6 to 65.5 Ma (late Maastrichtian), in Arén (Huesca, Spain). It is located in a continuous section that contains the K/P boundary, in which the dinosaur faunas closest to the K/P boundary in Europe have been described, including *Arenysaurus ardevoli* and *Blasisaurus canudo*. Phylogenetic analysis places the new taxon, *Arenysuchus gascabadiolorum*, at the base of Crocodyloidea. The new taxon is the oldest crocodyloid representative in Eurasia. Crocodyloidea had previously only been known from the Palaeogene onwards in this part of Laurasia. Phylogenetically, *Arenysuchus gascabadiolorum* is situated at the base of the first radiation of crocodyloids that occurred in the late Maastrichtian, shedding light on this part of the cladogram. The presence of basal crocodyloids at the end of the Cretaceous both in North America and Europe provides new evidence of the faunal exchange via the Thulean Land Bridge during the Maastrichtian.

Gribbins, K.M., Touzinsky, K.F., Siegel, D.S., Venable, K.J., Hester, G.L. and Elsey, R.M. (2011). Ultrastructure of the spermatozoon of the American Alligator, *Alligator mississippiensis* (Reptilia: Alligatoridae). *J. Morphol.* (doi 10.1002/jmor.10984).

Abstract: This study details the ultrastructure of the spermatozoa of the American Alligator, *Alligator mississippiensis*. American Alligator spermatozoa are filiform and slightly curved. The acrosome is tapered at its anterior end and surrounded by the acrosome vesicle and an underlying subacrosomal cone, which rests just cephalic to the nuclear rostrum. One endonuclear canal extends from the subacrosomal cone through the rostral nucleus and deep into the nuclear body. The neck region separates the nucleus and midpiece and houses the proximal centriole and pericentriolar material. The distal centriole extends through the midpiece and has 9 × 3 sets of peripheral microtubules with a central

doublet pair within the axoneme that is surrounded by a dense sheath. The midpiece is composed of seven to nine rings of mitochondria, which have combinations of concentrically and septate cristae. The principal piece has a dense fibrous sheath that surrounds an axoneme with a 9 + 2 microtubule arrangement. The sheath becomes significantly reduced in size caudally within the principal piece and is completely missing from the endpiece. Dense peripheral fibers, especially those associated with microtubule doublets 3 and 8, penetrate into the anterior portion of the principal piece axoneme. The data reported here hypothesize that sperm morphology is highly conserved in Crocodylia; however, specific morphological differences can exist between species.

Unajak, S., Meesawat, P., Anyamaneeratch, K., Anuwarepong, D., Srikulnath, K. and Choowongkamon, K. (2011). Identification of species (meat and blood samples) using nested-PCR analysis of mitochondrial DNA. *African Journal of Biotechnology* 10(29): 5670-5676.

Abstract: Crocodile meat product is an alternative protein source. Although, crocodile meat is more expensive, its taste is similar to that of chicken and fish. The authentication of commercial meat species is important for consumer's confidence. In this study, sensitive and specific method multiplex nested-PCR was applied to identify commercial meat species. Dried blood was used as an alternative DNA source for detection. The detection sensitivity was enhanced by primers specifically designed to encompass the mitochondrial Cytochrome b and NADH dehydrogenase 5/6 genes. The specificity and sensitivity of multiplex PCR system were tested. Different lengths of specific nested-PCR products were detected to be 350, 570, 750 and 1000 bp for chicken, pig, cow, and crocodile, respectively. The system allowed detection with as little as 5 nanogram of DNA from either meat or blood sample. Detection sensitivity of individual species was improved, enabling the detection of DNA with as little as 1 picogram. Cross reaction was not detected among the tested species. It was shown that the multiplex-PCR assay enhanced the sensitivity of routine species identification and allowed the use of blood as an alternative DNA source for detection.

Submitted Articles

BACTERIAL ISOLATION FROM WOUND AND FIBRINCESS IN WILD AMERICAN CROCODILES (*CROCODYLUS ACUTUS*) OF BANCO CHINCHORRO. Clinical examinations of crocodiles in the wild are limited. Generally, nocturnal surveys and captures of crocodiles are conducted using small boats, limiting the amount of material that you can bring in the field. Moreover, crocodile habitat (mangrove swamp, lagoons) does not make easy to perform complete clinical procedures. The carrying out of a general clinical examination has to include visual inspection of the skin and palpation of the entire body, in order to detect lesions, abscesses and fractures. This inspection must be systematic and meticulous. Sometimes we can find hard swellings forming at the site of an infected wound called

fibrissess (Huchzermeyer and Cooper 2000).

In August 2010 we captured two adult males of American crocodiles (*Crocodylus acutus*) at Cayo Centro, Banco Chinchorro Biosphere Reserve (Mexico), using the break-away snare technique. Banco Chinchorro has been described elsewhere (Charruau *et al.* 2005, 2010). One crocodile (240 cm total length) presented a fibrissess in the tarsus or the ankle bone (Fig. 1) and another crocodile (225 cm total length) presented an open wound in the groin (Fig. 2). Samples were taken by passing sterile culture swab (BBLTM Culture SwabTM Plus) inside the wound and inside the fibrissess after making a transversal cut. Swabs were then preserved at 2 to 8°C in AMIES transport mediums, ideal for aerobic and anaerobic bacteria, and were send for analyses to the Africam Safari Zoo laboratory in Puebla, Mexico.



Figure 1. Wound in the tarsus (ankle bone). Photograph: Pierre Charruau.



Figure 2. Open wound in the groin. Photograph: Pierre Charruau.

Bacterial cultures were made using different bacterium growth medium including Blood Agar 5%, McConkey Agar, Mannitol Salt Agar, Brilliant Green Agar, and *Salmonella-Shigella* agar. Inoculated plates were incubated at 37°C for 24 h. Plates of Blood agar were incubated at a carbon dioxide atmosphere of 5% and the other plates were incubated in aerobic conditions. After 24 h of incubation, bacteria morphology was analyzed microscopically and by gross observations to record characteristics like color, size, form, hemolysis, pigment production, smell and reaction to the

indicators of the differential medium.

Subsequently, each bacterial colony was submitted to catalase and oxidase tests and a smear of each colony was heat-fixed for Gram staining. After gross observations, we proceeded to the identification of the Gram-negative bacteria with biochemical tests in tubes: mobility, indole, decarboxylation of ornithine and lysine, fermentation of lactose, sacarose and dextrose, oxidation of iron, use of citrate as source of carbon, hydrolysis of urea, gas production, deamination of phenylalanine, nitrate reduction and differentiation of oxidative or reductive metabolism of bacteria. All these reactions, with the characteristics obtained during primary identification, were compared with reference tables of biochemical reactions to obtain the final identification (Cowan and Steel 1974; Quinn *et al.* 1994; Murray *et al.* 1999). For *Salmonella* and *Shigella* species, samples were sent for serotyping to a laboratory (Asesores Especializados en Laboratorios S.A. de C.V.).

Bacteria isolated were *Citrobacter freundii* and *Salmonella enterica* subsp. *arizonae* from the fibrissess and *Shigella sonnei* from the wound, all being Gram-negative and facultative aerobic species. In a current study of bacterial flora of *C. acutus* in Quintana Roo, we detected *Shigella sonnei* and *Salmonella enterica* subsp. *arizonae* from the cloacal cavity of crocodiles of Banco Chinchorro (unpublished data). *Citrobacter freundii* was not detect in cloacal or oral cavity of crocodiles from Banco Chinchorro but was isolated from both cavities in individuals of Cozumel Island (unpublished data). The presence of these bacteria in the wound and fibrissess could result from bite of other crocodiles during agonistic interactions or bacterial contamination from the environment. These bacteria can be a potential threat for crocodile health. Huchzermeyer (2003) report that few bacteria cause specific diseases in crocodiles and even fewer are crocodile-specific, but many bacteria can cause non-specific septicemia. *Salmonella* spp. can cause enteritis and septicemia in individuals subjected to severe stress conditions (Huchzermeyer 2003). *Citrobacter freundii* has also been isolated from case of septicemia in crocodiles (Huchzermeyer 2003). *Shigella sonnei* has been detected in oral cavity of *Caiman latirostris* (Silva *et al.* 2009) but no health problems caused by this bacterium has been described in crocodilians. Bacterial dermatitis can lead to septicemia and death of crocodiles when subjected to environmental stress (Garcia *et al.* 2008; Huchzermeyer 2003); therefore, skin lesions must be recognized early for appropriate therapy (Nevarez 2005). Fibrissess do not respond to antibacterial therapy (Huchzermeyer 2003).

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Jonathan Pérez Flores¹, Pierre Charruau² and Jose Guadalupe Pérez Juárez¹, ¹Departamento de Salud y Bienestar Animal, Africam Safari Zoo, Puebla, Puebla 72960, México; ²Departamento de Zoología, Instituto de Biología, Universidad Nacional Autónoma de México, Distrito Federal 04510, México.

“CAIMÁN” - A COMMON NAME IN DANGER OF EXTINCTION. In 1825, when Spix gave the generic name “*Caiman*” to the Alligatorid that has received many common names throughout its distribution (eg baba, babilla, yacaré, guajipal, lagarto blanco, arí and many others), he dug a hole where the original meaning of that name was eventually buried. The word “Caimán” (with an accent on the second “a”) was used by the Caribbean Indians long before the arrival of Europeans to the Americas. They used the name to designate the American crocodile *Crocodylus acutus*. The Caribbeans were the dominant people in Cuba, Española (Dominican Republic and Haiti), Jamaica and other islands of the Antilles,

and also exerted their domain along the mainland coast from Venezuela to southeastern Mexico.

The coincidence between the scientific name given to the baba and the common name used by the Caribbeans for the American crocodile confuses some people. This is particularly the case in documentaries and TV programs, especially those translated from English to Spanish. The confusion has extended to the point that the Dictionary of the Real Academia de la Lengua Española (Royal Academy of the Spanish Language) states that the word “caimán” comes from the Taino “kaiman”; after that they describe what is clearly an alligatorid. However, the Tainos were the Caribbean Indians who inhabited Cuba and Española, islands where the only indigenous crocodilian belongs to the genus *Crocodylus*. How could it be possible that the Tainos named an animal they did not know?

Rómulo Gallegos, one of the most important Venezuelan writers, wrote in his novel “Doña Bárbara” about the ferocious Caimán known as “El espanto del Bramador” (the terror of Bramador), a dangerous beast whose “number of ... victims, both horses and cattle, had gone beyond reckoning”. How could we give that name to a baba? Unfortunately the novel’s translator (Robert Malloy) used the expression “Alligator” for “caimán”, instead of crocodile, and “alligator hunting” for “cacería de caimanes” instead of “crocodile hunting”, which I think is an aberration.

There are cultural reasons to insist on using the word Caimán to name the crocodiles from Venezuela (or Colombia, Panamá, Nicaragua, Cuba, Dominican Republic and even Mexico). In every country throughout the historical distribution range of *Crocodylus intermedius* and *C. acutus*, there are places that received their names due to these crocodiles. Toponymics such as “Punta Caimán”, “Paso de Caimán”, “Puerto Caimán” or simply “Caimán” are widespread, even in places where no indigenous alligatorid were found (as in Cuba and the Dominican Republic). There is no doubt that people that gave these names were referring to a crocodile and not to an alligatorid. Besides, were the Cayman Islands named after an alligatorid? No way.

On the other hand, there are popular sayings (difficult to translate into English) well established in the popular language, that refer to the large crocodiles as Caimán. Famous songs like the one that talks about the “caimán que se va para Barranquilla” refers undoubtedly to *C. acutus*. That is also the case of Simón Díaz’s humorous song where he refers to “un caimán que mide más de una cuadra” (a crocodile longer than a street block).

As conservationists we should be interested not only in genes and populations, but cultural diversity should also be preserved. I am aware that the strong power of television would force, in the not too distant future, the use of the word “cocodrilo” instead of “caiman” to refer exclusively to the members of the genus *Crocodylus*, but it will not be me contributing to an acceleration of that process.

Andrés E. Seijas, Guanare, Venezuela (aeseijas@gmail.com).

Steering Committee of the Crocodile Specialist Group

Chairman: Professor Grahame Webb, P.O. Box 530, Karama, NT 0813, Australia

For further information on the CSG and its programs, on crocodile conservation, biology, management, farming, ranching, or trade, contact the Executive Office (csg@wmi.com.au) or Regional Chairmen

Deputy Chairmen: Dr. Dietrich Jelden, Bundesamt für Naturschutz, Konstantin Str. 110, Bonn D-53179, Germany, Tel: (49) 228 849 11310, Fax: (49) 228 84911319, <DietrichJelden@BfN.de>. Alejandro Larriera, Pje. Pvd. 4455, Centeno 950, Santa Fe, Argentina, Tel: (543) 42 4531539, Fax: (543) 42 558955, <yacareovero@fibertel.com.ar>.

Executive Officer: Tom Dacey, P.O. Box 98, Clifton Beach, Qld 4871, Australia, Tel/Fax: (61) 7 40553060, Cell: (61) 419704073, <csg@wmi.com.au>.

Regional Chairman, South and East Africa: Dr. Richard Fergusson, 8 Maiden Dr., Highlands, Harare, Zimbabwe, Tel/Fax: (263) 47 76203, Cell: (263) 91 285103, <fergusson@mailweb.co.za>.

Regional Vice Chairmen: Christine Lippai <lippainomad@gmail.com>, Dr. Alison Leslie <aleslie@sun.ac.za>.

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Regional Chairmen, East and Southeast Asia: Dr. Toshinori Tsubouchi <t_tsubouchi@seisa.ac.jp>, Dr. Jiang Hongxing, State Forestry Administration of China <hongxingjiang@yahoo.com>.

Regional Vice Chairmen: Dr. Choo Hoo Giam <giamc@singnet.com.sg>; Dr. Nao Thuok <naothuok.fia@maff.gov.kh>; Uthen Youngprapakorn <thutroc@ksc.th.com>; Yosapong Temsiripong <yosapong@sirachamoda.com>.

Regional Chairman, Australia and Oceania: Charlie Manolis, P.O. Box 530, Karama, NT 0813, Australia, Tel: (61) 8 89224500, Fax: (61) 8 89470678, <cmanolis@wmi.com.au>. **Regional Vice Chairmen:** Eric Langelet <crocotech@mainland.com.pg>, Steve Peucker <speucker@barneveld.com.au>.

Regional Chairman, South Asia and Iran: Janaki Lenin <janaki@gmail.com>. **Regional Vice Chairmen:** B.C. Choudhury <bcc@wii.gov.in>; Anslem de Silva <kalds@sltnet.lk>; Abdul Aleem Choudhury <aleemc1@gmail.com>; Asghar Mobaraki <amobaraki@hotmail.com>; Dr. S.M.A. Rashid <rashidsma@yahoo.co.uk>.

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Regional Chairmen, Europe: Dr. Jon Hutton, UNEP World Conservation Monitoring Centre, United Nations Environment Program, 219 Huntingdon Road, Cambridge CB3 0DL, UK, Tel: (44) 1223 277314, Fax: (44) 1223 277136, <Jon.Hutton@unep-wcmc.org>; Dr. Samuel Martin, La Ferme aux Crocodiles, Pierrelatte, France, <s.martin@lafermeauxcrocodiles.com>. **Regional Vice Chairman:** Ralf Sommerlad <crocodilians@web.de>.

Regional Chairmen, North America: Dr. Ruth Elsey, Louisiana Wildlife and Fisheries Department, 5476 Grand Chenier Highway, Grand Chenier, LA 70643, USA, Tel: (1) 337 5382165, Fax: (1) 337 4912595, <relsey@wlf.louisiana.gov>; Allan Woodward, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, FL 32601, USA, Tel: (1) 352 9552081, Fax: (1) 352 9552183, <allan.woodward@myfwc.com>. **Regional Vice Chairmen:** Noel Kinler <nkinler@wlf.louisiana.gov>; Harry Dutton <harry.dutton@myfwc.com>.

Vice Chairman for IUCN: Dr. Perran Ross, Department of Wildlife Ecology and Conservation, P.O. Box 110430, University of Florida, Gainesville, FL 32611, USA, Tel: (1) 352 392 7137, <pross@ufl.edu>.

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CSG Red List Authority: Dr. Perran Ross, Department of Wildlife Ecology and Conservation, P.O. Box 110430, University of Florida, Gainesville, FL 32611, USA, Tel: (1) 352 392 7137, <pross@ufl.edu>.

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Task Force/Working Group Chairmen: Chinese Alligator, Dr. Jiang Hongxing <hxjiang@forestry.ac.cn>; Tomistoma, Bruce Shwedick <Bshwedick@aol.com>; Human-Crocodile Conflict, Dr. Richard Fergusson <fergusson@mailweb.co.za>.

