

EARTHWATCH INSTITUTE FIELD REPORT

Project Title: Crocodiles of Cuba

Principal Investigators:

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Research site

The research site is the north-western sector (Monte Cabaniguan) of the Delta del Cauto Wildlife Refuge, in southeastern Cuba. This protected area, with a total surface of 626 km², encompasses the most important coastal wetland ecosystem of eastern Cuba and the second largest on a national scale. The wildlife refuge is bordering the Gulf of Guacanayabo, on the south of Las Tunas and Granma provinces, and constitutes the lower plains of river basins that join to form a continuum and complex delta landscape dominated by mangrove swamp, coastal and inland lagoons, tidal rivers and creeks. Saw grass marshes, tropical hardwood forest and palm savannas also occur in the peripheral areas. Most of the area is not higher than 5 m above the sea level. The Monte Cabaniguan sector covers 140 km² of the above-mentioned total surface, occupying the North- western section of the protected area, corresponding to Las Tunas province, Municipality of Jobabo. The area is also a Ramsar wetland of international importance. The central point of the Monte Cabaniguan Sector is the Field Station "Don Miguel Alvarez del Toro" located on the mouth of the Jobabo Norte tidal river (20°40'52"N; 77°17'47"W).

The primary species being studied by the project is the American crocodile (*Crocodylus acutus*); also some amount of study is being carried out on the Cuban Iguana (*Cyclura nubila*).

Key research objective

Our main objective is to obtain information on natural history and ecology to design a long-term management program for the conservation of the American crocodile (*Crocodylus acutus*) in the Delta del Cauto Wildlife Refuge. This general goal will be achieved through research in the following particular aspects of either species:

1. Population Biology

To estimate:

- Abundance, age class structure, age class spatial distribution and population trend;
- Birth rate, mortality rates of the different age classes, population growth rate, and migration patterns.

2. Nesting Ecology

To investigate:

- Influence of environmental variables on incubation success and nest productivity;
 - Influence of incubation temperatures on sex determination and post-hatching growth;
 - Timing of reproductive events and its relationship with climate variables.
3. Behavior and other biological aspects
To document:
- Parental care of nests and offspring;
 - Diet by size classes and season
 - Body size relationships (i.e. footprint – total length).

Data Collection and Results

The past field season covered two important moments of the American crocodile's life cycle at the research site: nest construction and egg-laying season (March – April), for teams 3 and 4, and hatching season (May – July), for teams 5 and 6.

Teams 3 and 4 participated in the location of 113 crocodile nests on 5 nesting beaches, within a radius of 10 km from the field station. They helped document the following aspects of a sample of 42 nests, during the egg laying season: date of egg laying, nest location (nesting area and site), number of eggs, nest dimensions (depth, width, depth of upper and deepest egg), height of nest above upper tide, lower tide, and surrounding ground levels, distance of nest to upper and lower tide levels, distance to closest nest and closest tree or shrub, nest exposition to sunlight. Six eggs from each sampled nest were weighed and measured. Crocodile footprints that could be related to single nests were also measured; these measurements were correlated to clutch and egg size. On a daily basis, air and water temperature, and water salinity were recorded on each visit to the nesting beaches and at the field station. 21 data loggers for the recording of nest temperature during the incubation period were launched and placed in a corresponding number of nests on 4 nesting beaches.

Teams 5 and 6 participated in the research tasks corresponding to hatching season. They helped to document the fate of 113 nests on 5 nesting beaches. From 42 out of 113 nests they collected information on date of hatch, number of hatched eggs, number of eggs that did not hatch and causes of egg mortality (non fertile eggs, early or late embryonic death, and causes of egg mortality related to female's behaviour, such as totally or partially destroyed nests –as results of females' activity-, and deserted nests). The volunteers participated in the capture, measuring, weighing, sexing, tagging, and release of 251 hatchlings. They also helped collecting the data loggers from the nests and reading them out in a computer. The volunteers also participated in other tasks, such as the construction of ground water gauges at the nesting beaches, and the cleansing of the field station and its surroundings.

Team 5 had a very active roll helping our field staff and Lic, Grisell Díaz Ramírez, investigator at the Faculty of Biology, University of Havana, in capturing, measuring, sexing, weighing and tagging an extensive sample of Cuban iguanas.

Thanks to this valuable aid, we have made the following progress towards achieving our original objectives:

- We have added another successful year of study to our long-term research and monitoring program for American crocodile nesting in the Delta del Cauto Wildlife Refuge, something we have been doing since 1987
- We completed our third year of studying the effects of incubation temperature on the sex-ratio (number of males and females) that hatch from nests in the region

- This year was a particularly dry year. The participation of Earthwatch volunteers allowed us to amplify the number of meteorological and soil moisture observation and evaluate their effect on egg incubation. This has been particularly valuable information for understanding the effects of dry conditions on nests, something we have not been able to do in the past, and a better overall understanding of the important impacts of weather conditions on the reproduction of American crocodiles.
- The support of Earthwatch allowed us to carry out significant improvements for living and work conditions at the biological station in the reserve, as well as equipment and supplies important for carrying out our work.

Brief summary of research results

From the ample variety of data collected with the aid of Earthwatch volunteers, we have already processed, in a very preliminary way, those related to egg mortality associated to female's behavior, and relationship between footprint size and clutch size. Here are summaries of these results:

AMERICAN CROCODILE EGG LOSS ASSOCIATED TO FEMALE BEHAVIOR AT THE WILDLIFE REFUGE DELTA DEL CAUTO, SECTOR MONTE CABANIGUAN.

At the Delta del Cauto Wildlife Refuge (a 640 square kilometer coastal wetland in southern Las Tunas and Granma provinces, along the Gulf of Guacanayabo, on the Southeast of Cuba) a limited amount of nesting habitat is available to a highly dense American crocodile population. A high rate of egg and hatchling loss during the incubation period is associated to high nesting densities, among other factors.

Crocodile nesting activity was recorded during regular visits to ten gregarious nesting beaches during the annual reproductive period (February to July) from 1993 to 2004. A total of 2218 nests of *C. acutus* were analyzed on 5 permanent and 5 temporary nesting beaches. Nest fate and causes of nest and egg loss in particular, were recorded after analyzing nest content or remains during hatching-season visits (mid May – early July). Nests were considered to be successful if at least one hatchling emerged successfully.

A significant fraction of the eggs produced annually by adult females are lost through one or the other of three forms of female behavior: a) Discarded nests (when females dropped their eggs on the surface of the soil without burying them); b) Excavation of prior nests, and c) Nest desertion. Over the 10-year period of this study, an average of 31.1 % of all nests and a 26.1% of the estimated egg production was lost due to the combination of these factors. In some years this value was above 50%.

Discarded eggs (103 clutches) represent a 5.1 % of total clutches. We interpreted discarded nests to be eggs left by smaller, younger females, unable to locate suitable nesting sites, or that have lost agonistic interactions with larger females on nesting beaches. Partially destroyed nests averaged 9.1 % of the total number of nests. If totally destroyed nests had been left in the ground, they would have represented the 10.4 % of the total number of nests, with annual values ranging from 1.6 % to 21.8 %. Both discarded eggs and excavation of prior nests are related to high nesting density. When females do not return to open their nests, the young remain trapped inside the egg cavity, and only a small fraction escape by digging their way to the surface. 200 nests (11.6 % of all nests analyzed) were deserted during the period of study. Of a sample of 148 deserted nests examined, 122 hatchlings were determined to have escaped, representing 5.3% of the total number of eggs in these nests.

Nest or clutch losses attributable to these three female behavior-related causes represented the 61.9 % of total losses; the remaining 38.1 % are nest losses associated to climate events such as nest flooding and nest washout, after heavy rainfalls, wave and tide action. Nest site conditions such as altitude, soil composition and exposition to wave and tide action modulate the effect of climate events on nest survival. These site conditions and nesting densities were found to behave as interacting factors; E.g.: beaches with better nesting conditions show higher nesting densities than sub-optimal sites, while high nest densities on optimal sites would force sub-dominant females (e.g.: through

agonistic encounters) to utilize sub-optimal nest sites, with a consequent foster of embryonic mortality. Also female behavior, and climate related factors are likely to interact, as in the case of nest desertion, which has ever increased after flooding events throughout the period of study.

Sustainable utilization through ranching is especially suitable to such areas as MCWR, where large quantities of eggs and hatchlings are lost during the incubation process, as effect of natural factors. An average of 2000 eggs could be recovered every year by collecting them at an early stage of incubation in sub-optimal nest sites and beaches with high nesting densities.

FEMALE SIZE AND CLUTCH CHARACTERISTICS

There is a clear relationship between the total length of footprints and female size (Fig. x). Using this relationship, we estimated the size of 28 nesting females where the clutch characteristics were known. From these data we determined that female size was correlated with clutch mass and egg mass, and to a lesser degree with clutch size (Fig. 1 - 3). According to these results, mean clutch mass can then be used to estimate the size of nesting females.

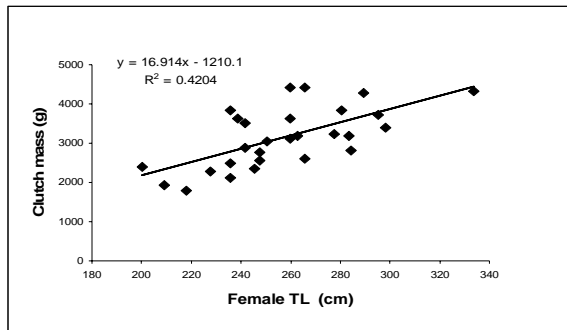


Fig. 1. Regression female total length vs. clutch mass.

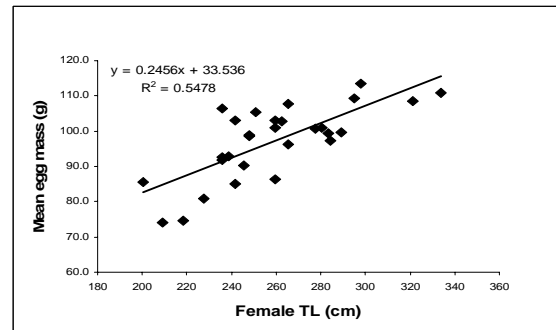


Fig. 2 Regression female total length vs. mean egg mass

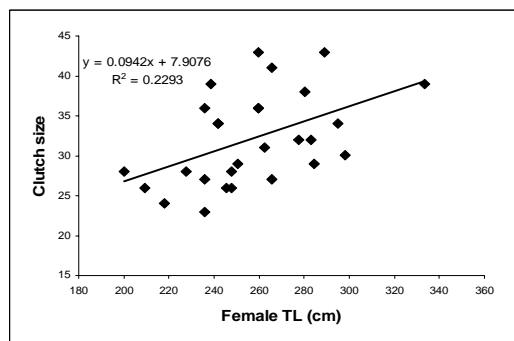


Fig. 3. Regression female total length vs. clutch size

Significance/Benefits of Research

The collaboration of the Earthwatch Institute with our research project has brought the following benefits:

At the local level:

- Has permitted a significant improvement in the infrastructure of the D. Miguel Alvarez del Toro, biological station in the Delta del Cauto Wildlife Refuge, providing better living and work conditions for the Project personnel and the opportunity to obtain important supplies and equipment necessary for our research
- The Earthwatch volunteer teams have provided us with additional work force that has allowed us to expand the spectrum of topics that we address at the research site. This year we have been able to carry out additional field experiments and add research protocols that we have not been able to conduct in the past due to limitations of time or personnel. These new possibilities have richened significantly the content and the range of topics we have addressed and allowed us at the same time to carry out our core work in a more complete and precise fashion.
- The volunteers have not only been helpful in terms of expanding our field workforce, they have contributed in many other ways. For example, with creative ideas, suggestions and critical observations that have help us improve our work dynamic and the quality of life at the biological station. They have provided us with video and photographs of our work, which have helped us to illustrate our project, with all types of books and scientific and popular magazines to add to our small library, with delicious cooking recipes, and most particularly with a valuable supply of enthusiasm, moral support and friendship that has greatly helped our work experience under the sometimes difficult conditions in the swamp. Without doubt, all these factors reflect positively in the accomplishment of our work objectives and the quality of our final results.
- The results of the work carried out with the assistance of the Earthwatch volunteers have contributed to the development of management plans for American crocodiles and the mangrove habitat in the Delta del Cauto Wildlife Reserve and guarantee the species long-term conservation.

At the national level:

- The project has become a site for testing, putting into practice new research ideas and for training Cubans. These methods are then put into practice in other parts of the country and the results allow us to compare between areas and obtain a better understanding of the status, distribution and behavior of the American crocodile in Cuba and design a national strategy for its conservation
- The work that has resulted from this project has formed a fundamental basis for the Cuban CITES proposal to downlist the American crocodile from Appendix I to Appendix II, which will provide the basis for developing sustainable use projects for the species, principally based on rearing animals in captivity.

At the international level:

- International divulgation of part of the biodiversity research and conservation activities in Cuba
- The results of this work are applicable for the understanding, conservation and management of this and other species of crocodiles in other countries.

b) How do your findings contribute to issues of sustainability?

- The research provided the basis for the reclassification of the Cuban population of American crocodiles under CITES (see above).
- Development of plans for a sustainable ranching program for American crocodiles that could provide a source of employment and income for local communities

Dissemination of Results

a) Have you provided details of results from your research to or within:

- Results of the research have formed much of the basis of the management plan for the Delta de Cauto Wildlife Reserve
- Technical reports are submitted on a regular basis to the Flora and Fauna office in Havana as well as the local offices in Las Tunas and Granma provinces
- Part of the results were used in the CITES proposal that was submitted earlier this year and discussed (and approved) at the XIII COP (Conference of Parties) held in Bangkok, Thailand in early October
- Currently we are working on two papers to be submitted to scientific journals outside of Cuba

