



COLLABORATION FOR ENVIRONMENTAL EVIDENCE

SYSTEMATIC REVIEW PROTOCOL NO. 54

**WORKING TITLE: EFFECTIVENESS PROTECTED AREAS FOR THE
CONSERVATION OF THE ORINOCO CROCODILE (*CROCODYLUS
INTERMEDIUS*) AND THE AMERICAN CROCODILE (*C. ACUTUS*) ALONG
THEIR DISTRIBUTION RANGE**

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COVER SHEET

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1. BACKGROUND

Crocodylian is a common name used to refer broadly to crocodiles, alligators, caimans and gavials. All of them belong to the Order Crocodylia. These animals are widespread occupants of aquatic environments in tropics and subtropics, with a few species reaching into the warm temperate zones. They are prominent animals due to their large size and, in some situations, ferocity. Ecologically they are considered as key species, in the top of the food web of the ecosystems they occupy. There are 23 extant crocodylians, grouped in three families (or sub-families according to some): The Gavialidae, with only one species (*Gavialis gangeticus*); the Alligatoridae, with eight species, seven of them found in America and one in China; the Crocodylidae, of pantropical distribution, with 14 species (King and Burke 1997).

The American crocodile (*Crocodylus acutus*) and the Orinoco crocodile (*C. intermedius*) are two of the four species of crocodylians found in the Neotropics. These are species of contrasting historical distribution. The former is restricted to the lowlands of the Orinoco River drainage in Colombia and Venezuela, whereas the American crocodile is widely distributed and is found in rivers, coastal and lowland wetlands of 17 countries (Medem 1981, 1983; Ross 1998). The population status of these species varies from one country to another. In some areas of their original distribution range the population of these crocodiles are depleted, or even have been completely extirpated due to past commercial hunting or other negative human related factors. Both are considered in need of protection under national and international laws and are included in the Appendix I of CITES, in order to protect them against illegal international trade (Ross 1998). Moreover, they appear in the IUCN Red List as “Critically endangered” in the case of the Orinoco crocodile, and “Vulnerable” in the case of the American crocodile (Rodríguez and Rojas-Suárez 1995).

The American crocodile can occupy a wide variety of wetlands but is most typically found in fresh and brackish water along the coast (estuaries, coastal lagoons, mangrove swamps). In some instances this species extends its distribution well inland along the course of large rivers and their associated wetlands habitats (Alvarez del Toro 1974, Medem 1981, Thorbjarnarson 1989). A highly adaptable species, *C. acutus* is regularly found in small offshore island and atolls throughout its range. The species also inhabits lakes (including reservoir) of varying salinities including hypersaline ones (Thorbjarnarson 1989, Seijas 1986). Besides reservoirs, the American crocodile has been reported in other man-made bodies of water such as borrow pits and canals (Thorbjarnarson 1989).

In the past Orinoco crocodiles were found in a wide variety of water bodies (including lagoons and swamps), but the most important habitat of this species are rivers and “caños” (smaller rivers that are reduced to a series of interconnected or isolated pools during the dry season). It reached its greatest numbers in the highly productive white-water rivers of the Llanos savannah region (Godshalk 1978, Ross 1989, GECV 2007). In contrast to the American crocodile, *C. intermedius*, adapt poorly to reservoirs, presumably for the limitations imposed by the lack of adequate nesting substrate.

Crocodiles are the largest predators in their habitats and can threaten human and their livestock; they are also a valuable source of food and other resources (fat, skins, and hatchlings) that could be traded at a local, national and international level (Ross 1998, Thorbjarnarson and Hernández 1992, Huerta and Ponce 2002, Finger *et al.* 2002). On the other hand, large crocodiles are seen as vermin as they may affect human activities such as fishing and tourism. For all above-mentioned reasons, there are ample

possibilities of negative human-crocodiles interactions, where the later usually take the worse part. Therefore, long-term conservation of these threatened species ideally requires maintenance of viable populations in protected areas, where human activities could be minimized or strictly regulated.

In this review we will examine if protected areas have really played a role in the conservation of the American and Orinoco crocodiles. Its results could help planners and wildlife managers on the design and effective implementation of conservation programs that lead to the recovery of these species.

2. OBJECTIVE OF THE REVIEW

To determine to what extent protected areas have contributed to the conservation of local Orinoco and American crocodile populations along their historical distribution range.

2.1. Primary question

What has been the effectiveness of protected areas as a conservation strategy for Orinoco and American crocodile populations (*Crocodylus intermedius* and *C. acutus*) in their historical distribution range?

2.2. Secondary questions

What factors (characteristics of protected areas, population restoration, law enforcement level, hunting and other negative human-crocodile interactions) have determined the success of protected areas for the conservation of *C. intermedius* and *C. acutus*?

Are the main populations of these species protected within national parks or other kind of strict conservation areas?

Are there differences in the status of Orinoco and American crocodile populations (in terms of number of individuals or other population parameters) inside or outside protected areas?

3. METHODS

3.1 Search strategy

3.1.1. General databases

The following databases and catalogues will be consulted to locate peer-reviewed journal articles that contain relevant information on distribution and population status of *Crocodylus acutus* and *C. intermedius*:

- ScienceDirect (www.sciencedirect.com)
- sScience.gov (www.science.gov)
- Scielo Chile (www.scielo.org.cl)
- Metabase (www.metabase.net)
- Redalyc (redalyc.uaemex.mx)
- Bioone (<http://www.bioone.org>)

3.1.2. Specialised Sources

The following databases will be consulted:

- Crocodile Specialist Group Proceedings Bibliography (www.flmnh.ufl.edu/coop/CSGbib.htm).
- Crocodile Specialist Group webpage (<http://iucncsg.org>)
- Herpllit database (www.herpllit.com).

The first source contains an Endnote library that includes references for all the papers presented at the Crocodile Specialist Group meetings up to year 2000 (CSG/SSC IUCN). The second allows downloading of all the CSG Newsletter published up to date by the CSG. The Herpllit database contains several thousand references on herpetological literature. The proceedings of working meetings of regional organizations (Grupo de Especialistas en Cocodrilos de Venezuela, GECV; Comité para el Manejo de los Cocodrilos de México, COMACROM) will be also checked for papers.

Information regarding protected areas in different countries (size, year of creation, general characteristics) will be consulted on the web pages of public institutions of each country in charge of the conservation of the environment and/or management of protected areas (INPARQUES, SINAP, SINAC, SNAP, SINAMPE, MARENA, to mention just a few of them).

3.1.3 Internet searches

Searches will be carried out using the following search engines:

- Google Scholar (www.scholar.google.com)
- Google (www.google.com)

The following keywords, in English and Spanish, will be combined to search for information for the systematic review:

Spanish	English
Áreas protegidas	Protected areas
Parque	Parks
Refugios de fauna	Wildlife refuges
Reservas de Fauna	Wildlife reserves
Protección de hábitat	Hábitat protection
Caimán del Orinoco	Orinoco crocodile
Cocodrilo del Orinoco	
Caimán de la costa	American crocodile
<i>Crocodylus acutus</i>	<i>Crocodylus acutus</i>
<i>C. acutus</i>	<i>C. acutus</i>
<i>Crocodylus intermedius</i>	<i>Crocodylus intermedius</i>
<i>C. intermedius</i>	<i>C. intermedius</i>

During the searching process the words indicating the intervention will be combined with the common and scientific names of the species, one species at a time. Initially, the first 50 documents found in each search will be reviewed to determine if the contents is relevant to the study.

3.1.4. Specialised journals

International and regional journals publishing papers related to ecology and conservation of crocodylians will be searched; these include *Conservation Biology*, *Biological Conservation*, *Oryx*, *Herpetologica*, *Journal of Herpetology* and *Copeia*. Among the regional journals we have: Memorias de la Fundación de Ciencias Naturales La Salle, Acta Biológica Venezolana, Ecotrópicos, Boletín del Centro de Investigaciones Biológicas de la Universidad del Zulia, Biollania, Caldasia, Revista de la Academia Colombiana de Ciencias, Revista de Biología Tropical, Brenesia, Vida Silvestre Neotropical, Caribbean Journal of Science, and others). Many of these journals are include in the Scielo and Redalyc databases mentioned in point 3.1.1.

3.1.5. Consulting with researchers and research institutions

A list with known references that will be not possible to get after the searching procedure will be prepared. It will be sent to regional researchers that have worked with crocodylians in Latin-America, questioning about the possibilities of receiving those papers from them. They will be also asked for the existence of articles that escaped our scrutiny.

3.2 Study inclusion criteria

All studies initially retrieved whose titles include the Latin or common name(s) of the **relevant subjects** and key words indicating a potential association to the objective of this review will be read and the following criteria will be used to accept articles for a more detailed review:

- Report population data in terms of encounter rates (**ER**, individuals per kilometre).
- Report on total population estimates (number of individuals present in the study area)
- Reports on reproduction (number of nests, hatchlings pods, number of individuals in the reproductive fraction of the population).

Studies not fulfilling any of the preceding criteria will be discarded for this review.

3.3. Study quality assessment

The studies will be assessed according to the detailed information provided: state of crocodile population within protected and unprotected areas; intensity of the field work, protection level (law enforcement, management plans that are being carried out) and effectiveness indicators of this protection; population restoration programs with the crocodile species; ecological characteristics of the protected area.

3.4. Data extraction strategy

All of the selected studies will be analysed, and the information will be extracted and organised in spreadsheets. The data to be extracted may be found in Table 1.

Tabla 1. Data will be extracted from each of the selected studies

Data	Information to be extracted
Type of study	Grey literature (thesis, technical report), article in refereed journal.
Species	Crocodile species on which the study was carried out.
Dates of the study	Year and period in which the evaluation of managed populations was carried out.
Population characteristics	Size, age structure, spatial distribution in the study area. Population trends.
Population restoration program	Presence or absence of population restoration programs. Characteristics of restoration programs. Number, gender, size and weight of liberated/released individuals.
Ecological characteristics of study area	Habitat quality, area size
Human presence	Human population density. Hunting pressure. Negative interactions with humans.
Protected area management	Intensity of environmental nursery activities. Human activity restrictions/limits. Community education and involvement programs.

Once the selected studies have been analysed, the above list may be extended or modified.

During the data extraction, the following data must be recorded: study type (experimental, theoretical), locality, date, educational level of the researchers, heterogeneity source, study quality categories and others.

Data extraction will be undertaken using a spreadsheet. For each locality with information on the population status of the species, a row of the spreadsheet will be filled with the following data (columns): 1) Name of locality or region, 2) Country, 3) State, department or province, 4) *Crocodylus* species, 5) Type of habitat, 6) Protected area (yes or no), 7), Surface of protected area in ha, 8) Protected area category, 9) protection year, 10) Author and year of publication, 11) Evaluation year, 12) Distance surveyed in km, 13) Elapse time, in years, between protection and evaluation, 14) Number of surveys, 15) Encounter rate (ER, ind/km), 16) Standard Deviation of ER, 17) Type of survey, 18) minimum reported or calculated population size, 19) maximum reported or calculated population size, 21) Procedure used to estimate population size, 22) Reported nesting, 23) population reinforcement.

3.5. Data synthesis

The analyses and synthesis methods of the extracted data will vary according to the type of data that is extracted from the studies included in the review. From a general point of view, summary tables will be created to compile the information on the

authors, organisation, year and area of study, bibliographical sources and others.

For each of the analysed studies, summary tables or cards where the most important extracted information will be inserted: characteristics and quality of the study, sources of heterogeneity, most important results (qualitative and quantitative) and others. These summary tables will include a narrative synthesis that describes the study.

If important and sufficient data is extracted, quantitative analyses will be carried out as could be: semi-quantitative syntheses, secondary analyses or meta-analyses. The statistical treatments that will be used to analyse the data will vary according to the type and amount of data. All of the quantitative data will be summarised in tables, so that they may be compared and analysed in an orderly fashion.

4. POTENTIAL REASONS FOR HETEROGENEITY

Habitat quality (extension, resource availability) in each of the parks or wildlife refuges can affect the status of its crocodile populations. Protected area type (Park, reserve, refuge, private reserve). Connectivity, and proximity to other crocodile populations. Law enforcement effectiveness. Human activities within the protected area. Interactions with crocodilian species.

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