ASSOCIATION OF ZOOS & AQUARIUMS

CROCODILIAN ADVISORY GROUP

North American Regional Collection Plan 2007

First Edition

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Table of Contents

Introduction

The Crocodilian Advisory Group (CAG) is the Association of Zoos and Aquariums' oldest taxon advisory group, sanctioned by the WCMC in 1986. This document is the CAG's 2007 update of the North American Regional Collection Plan for crocodilians (the Crocodylia), including alligators and caiman, crocodiles, and gharials. Due largely to unregulated hunting of many of these animals for their hides, as well as unrelenting persecution of crocodilians as predators, many crocodilian species have faced possible extinction. In the 1970's and early 1980's, no less than 18 of the 23 recognized species were considered endangered or vulnerable to extinction. In the intervening years, however, the status of a large number of these species has brightened, improving from endangered to vulnerable or lesser risk. This improvement was due largely to the development of management programs, the application of sustainable utilization as a conservation strategy, and international regulation of trade in crocodilian products. However, not all species of crocodilians have benefited from these changes. Seven species of crocodilians are still endangered or have continued to decline to a critically endangered status. These seven include five Asian species: the Chinese alligator (*Alligator sinensis*), the Siamese crocodile (*Crocodylus siamensis*), the Philippine crocodile (*C. mindorensis*), and two species of gharial, the Indian gharial (*Gavialis gangeticus*) and the Tomistoma or Malay gharial (*Tomistoma schlegelii*). Additionally, two Neotropical crocodiles are also endangered: the Cuban crocodile (*Crocodylus rhombifer*), and the Orinoco crocodile (*C. intermedius*). Although the factors responsible for the precarious status of each of these species vary, generally these species are of low economic value and have not benefited from the sustainable utilization model that has worked with so many other crocodilians. Hunting of these animals for their hides is no longer the primary cause of their demise – habitat loss and degradation is the principle factor leading to the decline of most of these species.

Captive breeding of critically endangered species in managed propagation programs can be a powerful conservation strategy. Several endangered species of crocodilians can be assisted by captive breeding programs, including programs within our North American living institutions. The greatest challenge to date for the CAG has been the marshalling of the necessary space and resources for the captive management of imperiled crocodilian species. Generally, crocodilian programs have been given a relatively low priority for construction funds in most North American zoos. Unfortunately, in the case of crocodilians, there does not appear to be enough room in AZA institutions for us to develop programs for all of the endangered forms. This situation is made worse due to the large portion of current AZA space resources that is being utilized by non-targeted taxa. Relocating these non-targeted specimens out of AZA facilities can greatly increase the needed space for programs with endangered crocodilians. The CAG is cognizant of the impediments these space limitations impose and has redirected some of its attention to include more focus on education and the promotion of *in situ* conservation efforts.

Another critical difficulty that the CAG has encountered with our regional crocodilian programs is a lack of zoo professionals with expertise in the management of this unique group of reptiles. The CAG is composed of 16 steering committee members (Appendix 1). This comprises a large part of the entire pool of individuals with expertise in crocodilians in AZA zoos. For this reason, the CAG, with the AZA Board of Regents, has developed the Crocodilian Biology and Captive Management (CBCM) Training School. Over 140 individuals have been trained through this program over the last seven years. The CBCM appears to be achieving the results we hoped of it – increased interest in crocodilians in AZA institutions, increasing numbers of exhibits devoted to crocodilians, and the recruitment of new professionals with an interest in crocodilians into the CAG. One quarter of the CAG steering committee is now made up of CBCM graduates.

The CAG has also taken a very proactive approach in the management of AZA crocodilian programs. Four taxa are designated for PMP management. These taxa are reviewed yearly for appropriate pairings and placement by the CAG working members and an SPMAG representative in a population management plan. Again, if the limited amount of space in American zoos for crocodilians is considered, this proactive management approach by the CAG for all crocodilians is essential to guarantee that captive space is allocated efficiently for all AZA crocodilian programs.

Finally, we are making a plea for space and resource allocation in North American institutions for crocodilians. The Crocodylia represent the sole survivors of an ancient group. Some taxa are among the most endangered vertebrates in the world. Crocodilians make spectacular displays and draw great interest from the visiting public. Yet members of this group are often omitted from new zoo projects where they could be incorporated. Consideration must be given to more resource allocation for crocodilians if the AZA is going to make a long-term contribution to the conservation of these most endangered archosaurians.

This RCP has been posted on the AZA web site and made available to the institutional representatives of the CAG for a 30-day review period prior to publication.

CAG Mission Statement

To enhance and promote the preservation and understanding of the world's crocodilians and their habitats through excellence in education, animal management and scientific endeavor.

- Monitor surplus crocodilians and explore avenues of placement in accordance with AZA guidelines
- Monitor status of crocodilian species and recommend appropriate programs
- Serve as a clearinghouse for information
- Develop studbooks and SSP programs where appropriate
- Monitor progress of zoological populations of crocodilians, analyze data
- Facilitate cooperation and collaboration between colleagues and institutions throughout the scientific and captive propagation community
- To see a consensus on captive breeding and research priorities
- Serve as a management advisory group for targeted species
- Develop programs and goals to further crocodilian conservation, breeding and management
- Explore avenues for furthering public education, the goals and missions of the AZA and the CAG

CAG Taxonomic Purview

There are generally recognized 23 living species of crocodilians. The extant Crocodylia consist of three families: the Alligatoridae, Crocodylidae, and Gavialidae. The alligatorids include alligators and caimans. *Alligator* includes not only our own familiar American alligator (*Alligator mississippiensis*) but the small, critically endangered Chinese alligator (*A. sinensis*) as well. The eight or so species of caiman are included in three genera – *Caiman*, *Melanosuchus*, and *Paleosuchus*. Living crocodylids, the true crocodiles, are organized into three genera. At present, 11 species of *Crocodylus* are recognized. The genus *Osteolaemu*s, the African dwarf crocodiles, consists of a single species, but subspecies are recognized and the taxonomic diversity represented in this taxon is a subject of interest. The newly resurrected genus *Mecistops* includes only one species, the African slender-snouted crocodile (*Mecistops cataphractus*). Gavialids include the gharial. Often considered a monotypic family consisting only the Indian gharial (*Gavialis gangeticus*), recent molecular and biochemical studies strongly, almost overwhelmingly, suggest that the Malay gharial (*Tomistoma schlegelii*) is in fact a gharial and not a longirostrine crocodile as previously thought.

A complete list of the 23 recognized species of crocodilians, complete purview of the Crocodilian Advisory Group, is given below, including both common and scientific names. Species accounts for each of these species begin on page 17.

CROCODYLIA	
ALLIGATORIDAE	
American alligator	*Alligator mississippiensis*
Chinese alligator	*Alligator sinensis*
Common caiman	*Caiman crocodilus*
Broad-snouted caiman	*Caiman latirostris*
Yacare caiman	*Caiman yacare*
Black caiman	*Melanosuchus niger*
Dwarf caiman	*Paleosuchus palpebrosus*
Smooth-fronted caiman	*Paleosuchus trigonatus*
CROCODYLIDAE	
American crocodile	*Crocodylus acutus*
Orinoco crocodile	*Crocodylus intermedius*
Australian freshwater crocodile	*Crocodylus johnsoni*
Morelet's crocodile	*Crocodylus moreletii*
Philippine crocodile	*Crocodylus mindorensis*
Nile crocodile	*Crocodylus niloticus*
New Guineae crocodile	*Crocodylus novaeguineae*
Mugger crocodile	*Crocodylus palustris*
Saltwater crocodile	*Crocodylus porosus*
Cuban crocodile	*Crocodylus rhombifer*
Siamese crocodile	*Crocodylus siamensis*
African dwarf crocodile	*Osteolaemus tetraspis*
African slender-snouted crocodile	*Mecistops cataphractus*
GAVIALIDAE	
Malay gharial	*Tomistoma schlegelii*
Indian gharial	*Gavialis gangeticus*

Space Estimation and Census Data

Available space estimations were made using an electronic space survey through the AZA institutional representative (IR) list server in late spring 2006. A few other large private facilities that have demonstrated a continued support of AZA crocodilian programs were also included in the survey process. This IR list was used because it contains all institutions that have made their interest in crocodilian programs known to the CAG by designating an IR. Sixty-seven out of 72 institutions responded with a completed survey, representing ~93% of all institutions that have an active interest in crocodilians. Also, a draft of this RCP was posted on the AZA website for final review and no AZA institution without a designated IR provided any response to the draft. This is another indication of the inclusiveness of crocodilian interests represented on the IR list server. The allocation numbers indicated in the tables below were made based on these 67 responding AZA institutions. The survey included both current and future holding capacities. Results of the space survey are tabulated in Appendix III. Other sources of data used to allocate space included ISIS and the individual expertise of the members of the CAG. The CAG acknowledges with much appreciation the work by Jessi Krebs, Omaha's Henry Doorly Zoo, in conducting, tabulating and summarizing the current space survey.

Current census of data are provided for each species from studbooks, where available, or ISIS for non-studbook species.

Self-Sustaining Managed Population Size

Crocodilians present unique potential among the vertebrates for long-term genetic management of captive populations. There are no existing studbook databases that include the entire lifespan of any crocodilian. To model this population potential, the Cuban crocodile studbook was used in ZooRisk to represent a generic crocodilian. These data were modified by increasing the life expectancy to 75 years, an adult probability of any adult female breeding at 10%, and increasing mortality rates to reflect that 5% of the animals will die per decade between 35 and 65 years of age. These animals are long lived (>75 years), have high fecundity, are reproductive to a late age (>65 years), lay eggs, and have temperature-dependent sex determination which allows the sex of the offspring to be predetermined during incubation. In ZooRisk, this generic crocodile was evaluated as at "low risk" in all categories except "reproduction in the last generation" where they are considered endangered because less than five pairs are expected to reproduce in each generation. This is not unexpected considering the longevity of these species in which they are reproductive for five plus decades. This issue was not considered a significant problem. In general, a target of 75 is the minimum carrying capacity assigned SSP species in this RCP. This was increased if there was substantial interest to maintain a taxon by AZA institutions (e.g., Chinese alligators). PMP programs may be managed with fewer animals (or greater if they are of interest to AZA institutions, *i.e.*, Nile crocodiles) and lower genetic goals. If a good unrelated founder base can be established (*i.e.*, minimum of 10 pairs), and the founders are maintained until they are no longer reproductive, 90% of gene diversity can be easily maintained for 100 years with a population size of less than 75 animals.

Non-member Participation

As indicated in the Introduction to this document, the lack of sufficient captive space is a significant factor affecting the development of captive breeding programs for crocodilians in North American collections. In light of this trend, and in addition to utilizing all space made available to crocodilian programs in AZA institutions, the CAG has recruited space in the private sector to hold and, in some cases, to breed animals for AZA conservation programs. These private facilities also provide critical space to hold less important specimens that would otherwise take valuable zoo space away from targeted species. For many years, a few private and non-commercial facilities, including non-AZA participants, have cooperated and collaborated with the CAG and its programs, offering expertise, advise, captive specimens and space resources for our programs. These individuals and facilities are keenly aware of AZA policies and procedures and are committed to the conservation of these animals and the programs the CAG and AZA have established to further these goals. In the past, two facilities have been actively involved in CAG SSP programs. These two private non-member participants have been registered and inspected by CAG members to comply with AZA standards for non-member participants, and both of these non-member participants are involved with our two current SSPs (Chinese alligator and Cuban crocodile). Other non-member participants currently hold other specimens of SSP animals (Chinese alligators) and these animals will be brought back into AZA accredited zoos or will be surplused from the SSP populations. However, non-member participants do contribute to other (i.e., non-SSP) programs. Most importantly, these private collaborators offer space resources most AZA institutions cannot or have not made available for crocodilians. The additional space made available by non-member participants allows non-targeted species, surplus specimens, and excess progeny from breeding programs to be moved out of AZA exhibits and holding spaces, relieving some AZA crocodilian space limitations and allowing the CAG to expand certain programs within AZA institutions.

The chairs of the CAG have discussed the WCMC requirements for non-member participants with the SSP coordinators. They are aware that their non-member participants are due to be re-inspected, and that the CAG steering committee will be monitoring their compliance with the WCMC regulations. We have also brought this to the attention of those who are likely to be the coordinators of our future SSP programs.

Species Selection Decision Process

The Crocodilian Advisory Group (CAG) has prioritized species for inclusion in North American collections based on several factors. First, endangered taxa that do not have adequate *in situ* protection and recovery programs were given highest priority. Second, the probability of successfully contributing to the conservation of an endangered taxon was factored in (e.g., availability of founders for captive propagation, the prospects of aiding the conservation of the species in the wild, existing husbandry expertise, etc.). Third, consideration was given to the biological uniqueness of each taxon to produce a regional collection plan that will represent the diversity of the Crocodylia. In some cases when several closely related taxa fell into the same categories, the CAG has initiated and supported *in situ* conservation efforts (e.g., Morelet's crocodile, *Crocodylus moreletii*) while recommending that these animals not be maintained in AZA institutions. Fourth, consideration was given to ongoing and future proposed research projects for crocodilians in zoos. There is still a great deal that can be learned about these animals and, in many cases, can be learned more easily in captive situations (e.g., social and parental behavior, temperature-dependent sex determination). Finally, the CAG recognizes that

there are specific geographical considerations and individual institutional needs that must be considered in the allocation of crocodilian space. These considerations include the necessity to display the American alligator within its range and zoogeographic or ecosystem themes of some institutions. In such cases, the CAG has suggested a reduction in numbers of these species in North American zoos to direct resources towards more endangered taxa.

A decision tree was developed to categorize crocodilian species by level of management (page 7). WCMC Program selection criteria questions (page 8) were also used to classify species as to the type of management deemed necessary in AZA institutions. A summary of the CAG steering committee's responses to those criteria questions for species targeted for conservation programs is also provided in Table 1 (page 9).

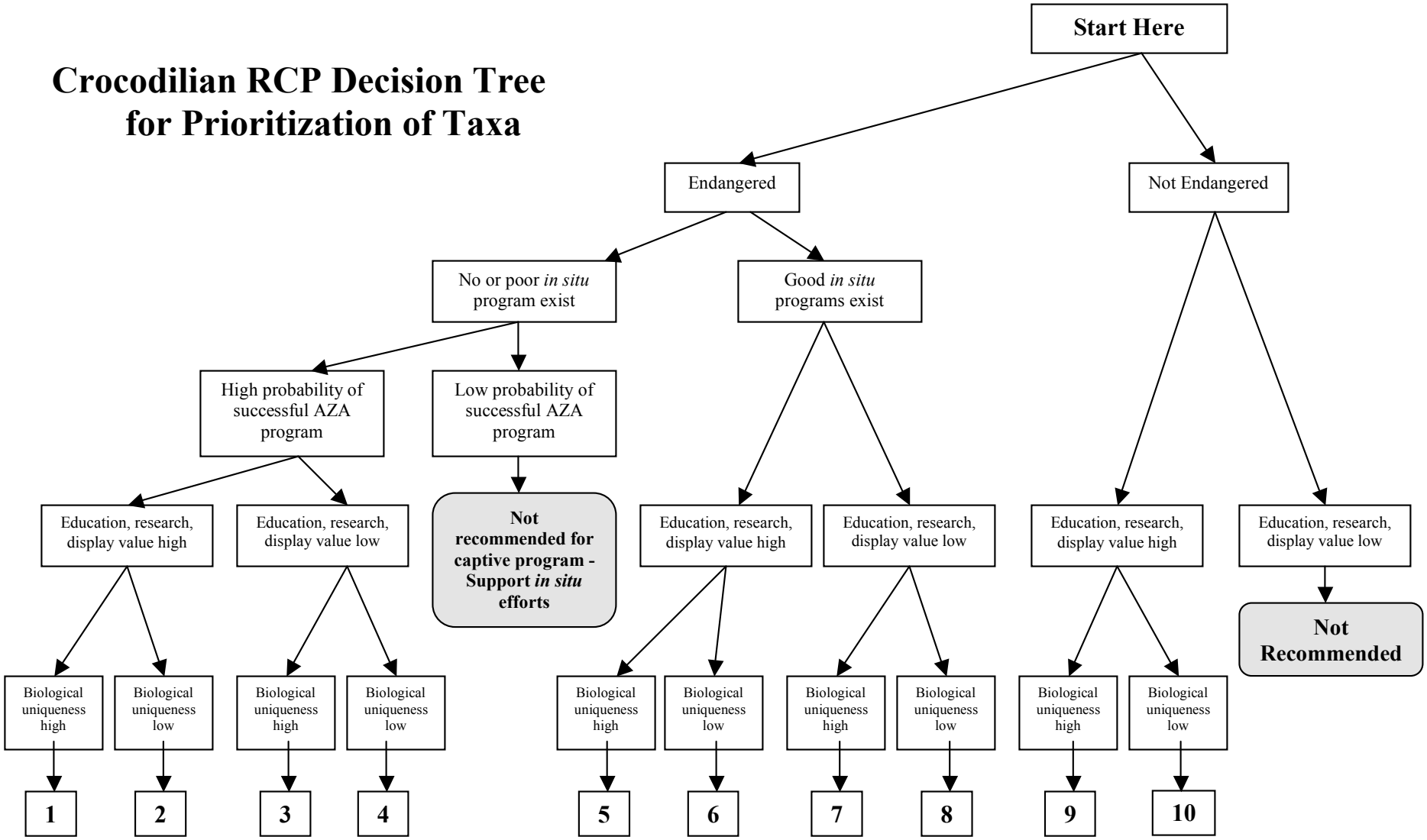
To aid collection managers at individual institutions in the selection of species, a recommendation matrix is also provided (page 10). This matrix can be used in the decision process in the development of an Institutional Collection Plan. Both targeted and untargeted taxa are present in this matrix. It is strongly suggested that institutions dedicate resources for the targeted species but, when this is not possible because of zoogeographic or space limitations, alternatives are suggested to meet the institution's goals.

TAG Recommendations: Categories

The following is a list of CAG recommendation categories used in this regional Collection Plan:

- **SSP Population**
  - Intense management
  - Studbook necessary
  - Maintain x% genetic diversity for x years
  - Participating institutions sign MOP
  - Compliance by participating institutions expected
  - Make breeding recommendations and develop masterplan
  - Management Group
- **PMP Population**
  - Moderate management
  - Long-term objective to maintain population
  - Studbook necessary
  - No MOP
  - Encourage institutional compliance
  - Breeding recommendations offered
  - Masterplan not required
  - No Management Group
- **DERP: Display/Education/Research Population**
  - No studbook
  - Long-term genetic/demographic management not required
- **Phase Out Population**
  - Moratorium on breeding and acquisition
  - Species champion monitors phase-out through ISIS
- **Phase In Population**
  - Species not currently in AZA institutions
  - TAG hopes or plans to import founders
  - Once in North America Population will be reassigned to another category

Crocodilian RCP Decision Tree for Prioritization of Taxa



INCREASING PRIORITY FOR AZA EFFORTS

WCMC Program Selection Criteria

1. What is the availability of the species/taxon in AZA collections?
2. What is the availability of the species/taxon outside AZA collections?
3. What is the extinction risk for the species/taxon within AZA collections if it is not managed?
4. In what direction does the extinction risk within AZA collections move if it is?
5. What is the demand for the species/taxon within AZA collections (from survey)?
6. What is the institutional commitment to the species/taxon within AZA membership (from survey)?
7. How easy is it to breed the species/taxon?
8. What is the extinction risk for the species/taxon in the wild?
9. What are the program operating costs for this species/taxon?
10. Is there an international conservation/management program for this species/taxon?
11. What type of link would a management program have to conservation of this species/taxon in the wild (outlined in species account)?

Table 1. Responses to the WCMC Program selection criteria questions by the CAG steering committee and the resulting decisions on level of management for targeted species.

Taxon	Availability AZA	Availability Non-AZA	Extinction Risk – Not managed	Extinction Risk – Managed	Demand in AZA	AZA Institutional Committment	Ease of Breeding	Extinction Risk in Wild	Program Operating Costs	International Conservation Programs	Link to Management Program	Level of Management
Alligator sinensis Chinese alligator	Low	Non-existent	Very high	Much lower	Very high	Very high	Moderate	Critically endangered	Moderate	Yes	Direct support, reintroduction	SSP
Crocodylus mindorensis Philippine crocodile	Extremely low	Low	Very high	Decreases	Moderate	High	Low	Critically endangered	Moderate	Yes	Yes,	SSP (future)
Crocodylus rhombifer Cuban crocodile	Moderate	Low	Endangered	Decreases	High	High	Moderate	Endangered	Moderate	Yes	Yes	SSP
Crocodylus siamensis Siamese crocodile	High	Moderate	Moderate	Stable	Moderate	Moderate	High	Critically endangered	Moderate	Yes	Yes	PMP
Mecistops cataphractus Slender-snouted crocodile	Moderate	Low	Vulnerable	Stable	High	Moderate	High	Vulnerable	Moderate	No	No	PMP
Tomistoma schlegelii Malay gharial	Low	Very low	Endangered	Decreases/stable	High	High	Very low	Endangered	High	Yes, a few	Yes	SSP (future)
Gavialis gangeticus Indian gharial	Low	Non-existent	Very high	Decreases	High	High	Moderate/low	Critically endangered	High	Yes	Yes	SSP (future)

Species Recommendation Matrix

The following decision matrix can be used to aid the selection of crocodilian species for an individual institution to meet specific needs and limitations. Selections of species indicated in dark boxes are strongly encouraged and targeted for cooperative programs by the Crocodilian Advisory Group. If space requirements limit selection to a small species of crocodilian, and if zoogeographic restraints prevent selection of a targeted Asian species, species indicated in bold text are suggested. Species indicated in light text are discouraged by the CAG but are provided as suggestions if specimen size or zoogeographic requirements prevent selection of targeted species.

		GEOGRAPHIC REGION			
		AFRICA	**ASIA**	**AUSTRALIA**	**AMERICAS**
SIZE	**SMALL**	***Osteolaemus tetraspis*** **(African dwarf crocodile)**	***Alligator sinensis*** **(Chinese alligator)**	--	***Paleosuchus palpebrosus*** **(Dwarf caiman)**
	MEDIUM	***Mecistops cataphractus*** **(Slender-snouted crocodile)**	***Crocodylus mindorensis*** **(Philippine crocodile)** **(highest priority)** **or** ***Crocodylus siamensis*** **(Siamese crocodile)** **(lower priority)**	*Crocodylus johnsoni* (Australian freshwater crocodile)	***Crocodylus rhombifer*** **(Cuban crocodile)**
	LARGE	*Crocodylus niloticus* (Nile crocodile)	***Tomistoma schlegelii*** **(Malay gharial)** **or** ***Gavialis gangeticus*** **(Indian gharial)**	*Crocodylus porosus* (Saltwater crocodile)	*Crocodylus acutus* (American crocodile) or *Crocodylus intermedius* (Orinoco crocodile)

Summary Tables

The next pages contain tables that summarize assessments for all crocodilian species and those used in the selection of taxa, the recommendations for AZA institutions, the programs themselves, and contact information:

Table 2. Assessment of Captive Propagation Programs for Crocodilian Species and Need for Captive Programs. Reintroduction potential, existence and viability of captive populations, and scientific and research potential categories are restricted to North American zoological institutions.

Taxon	Conservation Status	Reintroduction Potential	Existence and Viability of Captive Populations	Scientific and Research Potential	Other Regional Captive Propagation grams	Exhibit Value	Husbandry Expertise
Alligator mississippiensis American alligator	IUCN-Low Risk	Not needed	Yes Hundreds	High - Large research base	Extensive farming and ranching in United States	High	Excellent
Alligator sinensis Chinese alligator	IUCN- Critical	Poor/No Habitat	Yes, SSP 69.57.26	Conservation program with China	Large captive breeding programs in China - Some animals in Europe	High	Good
Caiman crocodilus Common caiman	IUCN-Low Risk	Not needed	Yes 4.8.17	Minor	Farmed extensively in South American	Low	Very good
Caiman latirostris Broad-snouted caiman	IUCN-Low Risk	Not needed	Yes 8.3.8	Minor	Breeding programs in Brazil, Paraguay, Uruguay and Argentina	Moderate	Very good
Caiman yacare Yacare caiman	IUCN-Low Risk	Not needed	Probable 2.12.1	Some taxonomic questions remain	Farming and ranching in Brazil	Low	Very good
Melanosuchus niger Black caiman	IUCN-Endangered	None at present	No-too few animals, 1.3.0	Husbandry research	Ranching in Ecuador	High	Low
Paleosuchus palpebrosus Dwarf caiman	IUCN-Low Risk	None	Yes 32.32.47	Minor	None	Moderate	Good
Paleosuchus trigonatus Smooth-fronted caiman	IUCN-Low Risk	None	Uncertain but probable 3.6.2	Minor	None	Low	Good
Crocodylus acutus American crocodile	IUCN-Vulnerable	Low	Yes 8.8.18	Good	Central America/South America	High	Moderate
Crocodylus intermedius Orinoco crocodile	IUCN-Critical	High	No 2.3.0	Field research, reintroductions	Established captive breeding programs in Venezuela , Columbia	High	Moderate
Crocodylus johnsoni Australian freshwater crocodile	IUCN-Low Risk	Low	Moderate 2.6.4	Minor	Raised on numerous farms in Australia	Moderate	Moderate
Crocodylus mindorensis Philippine crocodile	IUCN-Critical	Not at present But *in situ* exchange	Developing 3.2.47	Husbandry research	Programs exist for farming & research	Moderate	Moderate
Crocodylus moreletii Morelet's crocodile	Indeterminate-Possibly Low Risk	Low	No 2.2.2	Minor	Large populations in Mexican institutions	Low	High
Crocodylus niloticus Nile crocodile	IUCN-Low Risk	Not needed	Yes 39.26.19	Minor	Extensive farming program in Africa	High	High
Crocodylus novaeguineae New Guinea crocodile	IUCN-Low Risk	Low	No 2.1.0	Minor	Ranching and farming programs in Papua New Guinea	Moderate	Moderate
Crocodylus palustris Mugger crocodile	IUCN-Vulnerable	Low	No 2.2.1	Minor	Numerous government and private breeding facilities in India	Moderate	High
Crocodylus porosus Saltwater crocodile	IUCN-Low Risk	Low	Improbable 1.4.2	Minor	Extensive programs in Australia, PNG, India, Indonesia, etc.	High	Moderate
Crocodylus rhombifer Cuban crocodile	IUCN-Endangered	Moderate	Yes 10.25.23	Cooperate with *in situ* programs	Large captive population in Cuba	High	High
Crocodylus siamensis Siamese crocodile	IUCN-Critical	Low	Yes 6.6.42	Minor	Large captive population in Asian institutions	Moderate	Excellent
Mecistops cataphractus Slender-snouted crocodile	Indeterminate-Prob. Endangered	Not at present Surveys needed	Yes, Studbook 12.11.15	Yes, biology unknown, Surveys needed	A few in captive collection, e.g., St. Lucia, South Africa	High	Moderate
Osteolaemus tetraspis African dwarf crocodile	IUCN-Vulnerable	Not at present	Yes 14.20.17	Taxonomic questions	Abidjan Zoo, Ivory coast, St. Lucia, South Africa	Moderate	Excellent
Tomistoma schlegelii Malay gharial	Indeterminate-Prob. Endangered	Low	Low, need for founders 11.18.5	Strong need for husbandry research	Held in several institutions in Asia	High	Low
Gavialis gangeticus Indian gharial	IUCN-Endangered	Low	Good 5.13.2	Husbandry research	Numerous government and private breeding facilities in India/ Nepal	High	Moderate

Table 3. Assessment of relevant factors and Crocodilian Advisory Group recommendations for management categories of crocodilian species held in North American zoological collections.

Taxon	Education Value	Availability of potential founders	Taxonomic and/or Morphological Uniqueness	Potential for *in situ* conservation of this species	Decision tree rating	Management Category
Alligator mississippiensis American alligator	High	High	Only alligatorid from United States	High Established management programs	10	DERP
Alligator sinensis Chinese alligator	High	Good	Only Asian alligatorid	Captive propagation programs New potential for reintroduction	2	SSP
Caiman crocodilus Common caiman	Low	High	Low	Moderate – sustainable harvest Established management programs	NR	Phase out
Caiman latirostris Broad-snouted caiman	Moderate	Moderate	Low – broadest snout	Good On going research	9	DERP
Caiman yacare Yacare caiman	Low	Good	Taxonomic position unclear at this point	Yes But extensive harvest	NR	Phase out
Melanosuchus niger Black caiman	Moderate	Poor	Largest tropical alligatorid Taxonomy under investigation	Yes	1	DERP
Paleosuchus palpebrosus Dwarf caiman	Low	High	Smallest crocodilian	Poor	9	DERP
Paleosuchus trigonatus Smooth-fronted caiman	Low	High	Low	Poor	9	Phase out
Crocodylus acutus American crocodile	High	High	Low	High in Florida population	6	DERP
Crocodylus intermedius Orinoco crocodile	High	Moderate	Low	High – reintroduction programs have been established	6	DERP
Crocodylus johnsoni Australian freshwater crocodile	Low	Low	Narrow snout	High- large number of captive breeders Established management programs	9	DERP
Crocodylus mindorensis Philippine crocodile	High	Possible in future	Low	Low Strong need for captive propagation	1	future SSP
Crocodylus moreletii Morelet's crocodile	Low	High	Low	Good, ranching in Mexico	8	Phase out
Crocodylus niloticus Nile crocodile	Moderate	High	Low	High Established management programs	10	DERP
Crocodylus novaeguineae New Guinea crocodile	Moderate	Poor	Possibility of sibling species	High, value added conservation	10	Phase out
Crocodylus palustris Mugger crocodile	Low	Good	Low	High Established management programs	4	Phase out
Crocodylus porosus Saltwater crocodile	Good	Moderate	Widest ranging crocodilian taxon Largest species	Excellent Established management programs	10	DERP
Crocodylus rhombifer Cuban crocodile	High	Good	Low	High and ongoing	1	SSP
Crocodylus siamensis Siamese crocodile	Moderate	High	Low	Low, but new surveys expanding known distribution	4	PMP
Mecistops cataphractus Slender-snouted crocodile	High	Good	Monotypic genus	Yes Great need for surveys and research	1	PMP
Osteolaemus tetraspis African dwarf crocodile	Moderate	High	Taxonomy in need of investigation Monotypic genus	Uncertain Need for surveys and research	9	DERP
Tomistoma schlegelii Malay gharial	High	Low	Monotypic genus, Familial affiliation uncertain	Low, Need for regional conservation programs	1	PMP/future SSP
Gavialis gangeticus Indian gharial	High	Good	Monotypic genus Narrowest snout	High Established management programs	1	PMP/future SSP

Table 4. Crocodilian Advisory Group recommendations for captive management of crocodilian species held in North American zoological collections and AZA contact person for each species. Contact information is provided in Appendix II.

Taxon	Primary Role and Purpose of Taxon Recommended for Captive Management	Target Pop. Size	Basis for listing and comments	Recommendations	AZA Contact(s) (See Appendix 2)
Alligator mississippiensis American alligator	Regional education programs Conservation education	427	North American dominant crocodilian species	Do not breed. Use for education or regional exhibits	Kent Vliet
Alligator sinensis Chinese alligator	Genetic reservoir	164	One of the most critically endangered crocodilian species	Maintain SSP Identify and track new potential founders	Joe Abene Melanie Litton
Caiman crocodilus Common caiman	Phase out	0	Space limitations	Phase out	Peter Brazaitis
Caiman latirostris Broad-snouted caiman	Education	15	Education value	Maintain only for education	Bruce Shwedick
Caiman yacare Yacare caiman	Phase out	0	Space limitations	Phase out	Peter Brazaitis
Melanosuchus niger Black caiman	Research population and captive husbandry research	13	Research for captive husbandry	Work out captive husbandry. Support in situ projects	Bruce Shwedick
Paleosuchus palpebrosus Dwarf caiman	Only if you must display small American species	83	Theme exhibits	Phase out	John Brueggen
Paleosuchus trigonatus Smooth-fronted caiman	Space limitation	0	Space limitations	Phase out	John Brueggen
Crocodylus acutus American crocodile	Education	42	United State's only crocodile	Education, *in situ* research in FL	Steve Conners
Crocodylus intermedius Orinoco crocodile	Only if you must display an Orinoco species	28	Theme exhibits	Explore management efforts *in situ*	Luis Sigler
Crocodylus johnsoni Australian freshwater crocodile	Phase out	32	No conservation value in North America.	Do not breed	Jessi Krebs
Crocodylus mindorensis Philippine crocodile	Genetic reservoir, captive propagation	75	Most endangered crocodile, IUCN recommends captive program	Acquire additional founders	Colette Adams
Crocodylus moreletii Morelet's crocodile	Phase out	0	Little exhibit or conservation value	Do not breed	John Brueggen
Crocodylus niloticus Nile crocodile	DERP	100	No conservation value in North America.	Phase out	Rick Hudson
Crocodylus novaeguineae New Guinea crocodile	Phase out	0	Extensive farming/ranching programs *in situ*	Do not breed	John Brueggen
Crocodylus palustris Mugger crocodile	Phase out	0	Limited space, large captive population in India	Phase out	Bruce Shwedick
Crocodylus porosus Saltwater crocodile	Only if you must display large Australian species	33	Extensive farming/ranching programs *in situ*, Space limitations	Do not breed	John Brueggen
Crocodylus rhombifer Cuban crocodile	Genetic reservoir	75	Limited geographic distribution	SSP Integrate program with Cuba	Bill McMahan Steve Conners
Crocodylus siamensis Siamese crocodile	Genetic reservoir	75	Critically endangered in the wild	Maintain self-sustaining population	Andy Snider
Mecistops cataphractus Slender-snouted crocodile	Need for management research	50	Unique morphologically, endangered status	Continue PMP, Support *in situ* efforts, develop and complete survey	John Groves
Osteolaemus tetraspis African dwarf crocodile	Only if you must display small African species	75	Theme exhibit	Do not breed	R. Andrew Odum
Tomistoma schlegelii Malay gharial	Genetic reservoir, research husbandry techniques	92	Unique, need to conserve genetic diversity	Importation of founders, pairing of potential founders, reproduction	Scott Pfaff
Gavialis gangeticus Indian gharial	Education, uniqueness	75	Taxonomically unique, distinct	Import potential founders, reproduce	Kent Vliet

Table 5. Summary of Crocodilian Advisory Group recommendations, program leaders and studbook keepers for managed taxa.

Common Name	Scientific Name	Recommendation	Program Leaders
Chinese alligator	*Alligator sinensis*	SSP (current)	SSP Coordinator: Joe Abene, Bronx Zoo 718-220-5042, jabene@wcs.org Studbook Keeper: Melanie Litton, Audubon Zoo 504-212-5343, reptiles@audubooninstitute.org
Philippine crocodile	*Crocodylus mindorensis*	SSP (future)	Species Contact: Colette Adams, Gladys Porter Zoo 956-546-9431, cadams@gpz.org
Cuban crocodile	*Crocodylus rhombifer*	SSP (current)	SSP Coordinator: Bill McMahan, Louisville Zoological Gardens 502-459-2181, bill.mcmahan@louisvilleky.gov Studbook Keeper: Steve Conners, Miami Metro Zoo 305-251-0401, sconner@miamidade.gov
Siamese crocodile	*Crocodylus siamensis*	PMP	PMP Mgr and Studbook Keeper: Andy Snider, Chaffee Zoological Park 559-498-5914, asnider@fresnochaffeezoo.com
Slender-snouted crocodile	*Mecistops cataphractus*	PMP (current)	PMP Mgr and Studbook Keeper: John Groves, North Carolina Zoo 336-879-7620, john.groves@nczoo.org
Malay gharial	*Tomistoma schlegelii*	PMP (current), SSP (future)	PMP Mgr and Studbook Keeper: Scott Pfaff, Riverbanks Zoological Park 803-779-8717 x1119, spfaff@riverbanks.org
Indian gharial	*Gavialis gangeticus*	PMP, SSP (future)	PMP Mgr and Studbook Keeper: Kent Vliet, St. Augustine Alligator Farm 352-392-1565, kent.vliet@zoo.ufl.edu

Table 6. Crocodilian Advisory Group program status summary for managed taxa.

Program	Date Program Initiated	Current Program Leader	Date Leadership Assumed	Date of last studbook update	Date of last PMP publication	Date of last master plan publication
Chinese alligator *Alligator sinensis* SSP	12/31/1982	SSP Coordinator: Joe Abene, Bronx Zoo Studbook Keeper: Melanie Litton, Audubon Zoo	5/23/2007	6/30/1998		not published
Cuban crocodile *Crocodylus rhombifer* SSP	12/17/1993	SSP Coordinator: Bill McMahan, Louisville Zoological Gardens Studbook Keeper: Steve Conners, Miami Metro Zoo	12/17/1993	12/31/1991		7/31/2004
Philippine crocodile *Crocodylus mindorensis* SSP (future)	future program	Species Contact: Colette Adams, Gladys Porter Zoo	future program	not published		
Siamese crocodile *Crocodylus siamensis* PMP	4/13/1989	PMP Mgr and Studbook Keeper: Andy Snider, Fresno Chaffee Zoological Park	12/31/2002	7/1/2007	not published	
Slender-snouted crocodile *Mecistops cataphractus* PMP	1/27/1997	PMP Mgr and Studbook Keeper: John Groves, North Carolina Zoo	1/27/1997	4/1/1997	not published	
Malay gharial *Tomistoma schlegelii* PMP	12/31/1995	PMP Mgr and Studbook Keeper: Scott Pfaff, Riverbanks Zoological Park	7/8/1996	3/1/04	3/1/04	
Indian gharial *Gavialis gangeticus* PMP	3/26/1992	PMP Mgr and Studbook Keeper: Kent Vliet, St. Augustine Alligator Farm	2/7/2000	8/8/2007	not published	

CROCODILIAN SPECIES ACCOUNTS

The Crocodilian Advisory Group gratefully acknowledges the extensive editorial work performed by Colette Adams, Gladys Porter Zoo, on these crocodilian species accounts. Colette assembled the accounts, configured them into a common format, edited their content, and inserted current ISIS numbers for each species.

American alligator *Alligator mississippiensis*

STATUS: IUCN - Lower Risk, least concern
CITES - Appendix II
ESA - Similarity of Appearance

The American alligator is among the most temperate of crocodilians with a wide distribution in the southeastern United States. Although the maximum size of this species rarely exceeds 4.5 meters, records of much larger specimens exist. The alligator is principally a palustrine species, inhabiting swamps and marshes, though they may be found in virtually any freshwater and many brackish water habitats. Many alligators spend the winter months in dens dug into the banks. Females are known to allow hatchlings to over winter in these sites. In the northern portions of its range, the alligator may survive short periods of freezing weather with their snouts frozen in the surface ice, allowing them to breathe.

Both males and females attain sexual maturity at about 1.8 meters in length. Courtship occurs in the early spring months, typically April and May. Females build mound nests of soil and vegetation in which they lay 35-45 eggs. Nesting is highly synchronized in a population with almost all nests being laid within a two-week period in June. Incubation typically takes 65-68 days.

American alligators were very heavily exploited by humans in the 1800s and first half of this century and were considered endangered by many in the 1950s and 1960s. They were listed as an endangered species in the U.S. Endangered Species Act in the early 1970s. Populations responded well to this protection and recovered rapidly. The American alligator has been reclassified as Threatened by Similarity of Appearance throughout its entire range. The current population of American alligators is large and may be more than 1.5 million. Several southern states have sustainable management plans involving harvest of adults, farming and ranching.

The North American captive population currently consists of 1012 (190.182.640) in 117 institutions. The CAG will assist any institution trying to do so in placing these animals. Replace with targeted taxa.

RECOMMENDATIONS:
DERP – Display/Education/Research. Do Not Breed

No cooperative captive management plan for this species is recommended. The CAG recommends that this species should be held only for education (e.g., to display an endemic species of crocodilian or as an example of a successful conservation program) or for other special reasons, such as collections with a zoogeographic theme. **Whenever possible, display and holding space should be reallocated to endangered species of crocodilians**. **Do not breed**.

Chinese alligator *Alligator sinensis*

STATUS: IUCN - Critically Endangered
CITES - Appendix I; Appendix II Captive bred population in China
ESA - Endangered

This is a relatively small species, reaching lengths of about 2 meters. It is one of the world's most endangered crocodilians; at one time it was widely distributed in China, but is now found only in southeastern Anhui Province of the lower Yangtze River. Their wild population has experienced greater than 80 % decline in 3 generations, and there may be fewer than 125 adults left in the wild.

The Chinese alligator inhabits the area of climatic transition between subtropical and temperate regions of eastern China. They are inactive from late October through mid April in subterranean dens dug into the edges of ponds, marshes, or rice paddies. Wetlands they formerly occupied have been lost to agriculture. The few remaining adults have little opportunity to reproduce. In 1999 only four females nested in the wild. Eggs were collected and taken to ARCCAR. Adults continue to be persecuted. In recent times animals have been shot and poisoned or displaced from their last refuges by drought and floods.

Captive reproduction has proven very successful at ARCCAR, a Chinese breeding center established in 1979. In some years, 500 - 900 hatchlings were produced. This species has also reproduced well in captive situations outside of China. The Bronx Zoo, Houston Zoo, St. Augustine Alligator Farm, and the Rockefeller Wildlife Refuge in the U.S. have produced hatchlings. This species was designated an SSP species in 1982. Joe Abene (Wildlife Conservation Society - Bronx Zoo) serves as SSP Coordinator and Melanie Litton (Audubon Zoo) as Studbook Keeper.

The North American captive population currently consists of 152 (69.57.26) in 24 institutions.

RECOMMENDATIONS:
SSP Program (Current)

Manage as SSP with long-term goals to preserve genetic diversity. There is a need for additional holding and exhibit space. This taxon should be considered as a high priority for space in American institutions.

Common caiman *Caiman crocodilus*

STATUS: IUCN - Lower Risk
CITES - Appendix II, except *C. c. apaporiensis*, Appendix I
ESA - Not Listed, except *C. c. apaporiensis*, which is listed as Endangered

The common caiman reaches a maximum of 2.8 meters in males, and is considered a small to medium-sized crocodilian. It inhabits almost every type of low elevation wetland habitat in the neotropics. Its range is from southern Mexico to Peru and Brazil. The taxonomy of this animal is unclear. Generally, 4 or 5 subspecies are recognized, based mostly on geographic variation. These are: *Caiman c. crocodilus*, *C. c. fuscus*, *C. c. chiapasius*, and *C. c. apaporiensis*. The validity of *C. c. apaporiensis* is doubted by most authorities. *Caiman c. fuscus* and *C. c. chiapasius* may not be distinct from one another, but may, in fact, be a different species from *C. crocodilus*.

Though its skin is considered of inferior commercial quality when compared to that of most crocodiles and the American alligator, it is a species for which there are numerous sustainable management programs. This includes extensive cropping of wild populations, as well as farming and ranching operations. Almost 3/4 of the world's legal crocodilian skins are supplied by *C. crocodilus* and *C. yacare*. This species enjoys an overall good status, although there may be some regions of local depletion due to over-hunting.

Female common caiman reach sexual maturity at just over a meter in length. They lay 20-40 eggs in a mound nest during the wet season.

The North American captive population currently consists of 29 (4.8.17) in 16 institutions.

RECOMMENDATIONS:
Phase Out. Do Not Breed

Broad-snouted caiman *Caiman latirostris*

STATUS: IUCN - Not Listed, lower risk
CITES - Appendix I, except in Argentina, where it is Appendix II (ranching)
ESA - Endangered

The broad-snouted caiman has proportionately the widest snout of any crocodilian. It is a medium-sized crocodilian, capable of attaining lengths of 3.5 meters, but it is rare to find an animal in the wild in excess of 2 meters. It ranges from northeast Argentina, through southeast Bolivia, Paraguay and northern Uruguay. It also inhabits Atlantic coast drainages from the eastern tip of Brazil to northeast Uruguay. It is generally found in dense, quiet waters, but has been known to colonize isolated cattle stock ponds.

The skin of this species is considered better for manufacturing goods than the other species of *Caiman*. Commercial hunting originally depleted wild populations. Currently, because of reduced population density, improved protection, and legal skins becoming more attractive to traders, illegal hunting is no longer a major problem for this species. Habitat destruction and pollution currently pose the greatest threats to the taxon.

Sustainable use programs have been developed in Argentina and Brazil. This species has reproduced at several North American facilities.

Broad-snouted caiman are mound nesters, and 18 - 50 eggs are laid during the wet season.

The North American captive population currently consists of 11 (8.3.8) in 4 institutions.

RECOMMENDATIONS:
DERP - Education/Display. Do Not Breed.

Yacare caiman *Caiman yacare*

STATUS: IUCN - Lower Risk, least concern
CITES - Appendix II
ESA - Endangered

The Yacare caiman is a small to medium-sized crocodilian that reaches 2.8 meters in length. It is native to southern Brazil and Bolivia, through the Paraguay and Parana River systems of Paraguay and northern Argentina. This was previously considered a subspecies of *Caiman crocodilus*. Further work is needed to sort out the *Caiman crocodilus* complex. Because of the Yacare's distinct geographic range and unique role in the skin trade, the USFWS has classified it as endangered, unlike other populations of the *Caiman crocodilus* complex.

Yacare are depleted in all four countries due to illegal hunting in the 1970s and 1980s. However, they have learned to be extremely wary, and there is evidence that even though poaching is widespread, it has not adversely affected the total population. Commercially oriented programs are in place in 3 of the 4 countries they inhabit. There is a need for regulation and control of the captive breeding operation in Brazil. There is also a need to develop a relationship between the skin trade and the protection of wild caiman and their habitats.

Yacare caiman are mound nesters and egg laying usually peaks in the middle of the wet season. Clutch size is usually 25-35 eggs.

The North American population currently consists of 15 (2.12.1) in 4 institutions.

RECOMMENDATIONS:
Phase Out. Do Not Breed.

Black caiman *Melanosuchus niger*

STATUS: IUCN – Endangered
CITES - Appendix I, except in Ecuador, where Appendix II
ESA - Endangered.

Black caiman grow to be very large – over 4 meters in length for males. Populations have been greatly reduced over the years due to over-hunting, and continue to be reduced by poaching. It is considered severely depleted in four of the seven South American countries in which it occurs; it is considered depleted in the remaining three with an estimated total decline of greater than 50% in the last 3 generations. Although legislation is in place to protect the black caiman throughout its range, in many areas it is ineffective in stopping illegal trade in skins.

Female black caiman reach sexual maturity at 2.8 meters in length. They are mound nesters, and the average clutch size is about 40 eggs.

The North American population currently consists of 4 (1.3.0) in 2 institutions.

RECOMMEDATIONS:
DERP - Husbandry Research Population

This animal cannot be easily obtained for North American collections, and there has been a history of difficulties in maintaining this species in captivity using husbandry practices that are effective for other species of crocodilians. Investigate feasibility of pairing the sole male in North America (AZA institution) with one of the three females as pilot husbandry program. Support *in situ* conservation efforts if possible.

Dwarf caiman *Paleosuchus palpebrosus*
(Cuvier's smooth-fronted caiman)

STATUS: IUCN -Lower Risk, least concern
CITES - Appendix II
ESA - Endangered

This species is essentially restricted to the Amazon and Orinoco river drainages and the Atlantic coast drainages that lie between these two rivers. Small populations inhabit the upper Paraguay River drainage. The dwarf caiman inhabits a number of aquatic habitats in the Central Amazon basin, including flooded forests near major rivers and lakes. Overland movements may be extensive to reach ephemeral wetlands. Dwarf caiman are present in both large rivers and small streams in Bolivia, usually along stretches of bare shore frequently in association with dead trees.

This is the smallest species of crocodilian, with the maximum length for males reported to be about 1.6 meters. Female caiman are known to be mound nesters, laying 10-15 eggs.

Paleosuchus have well-developed osteoderms present over most of the body. This, as well as the small size, makes their hide virtually worthless commercially and has resulted in minimum pressure from hide hunting. Gold mining activities and the resulting pollution are increasing and have had an impact upon this species in certain areas. Ecological studies are currently being undertaken in Brazil.

The North American captive population currently consists of 111 (32.32.47) in 29 institutions.

RECOMMENDATIONS:
DERP – Education/Display. Do Not Breed.

Smooth-fronted caiman *Paleosuchus trigonatus* (Schneider's smooth-fronted caiman)

STATUS: IUCN - Lower Risk, least concern
CITES - Appendix II
ESA Endangered

The smooth-fronted caiman is somewhat larger than the dwarf caiman. Maximum male length is 2.3 meters.

The distribution of this species is similar to the dwarf caiman but it does not reside in the Brazilian shield or the Paraguay River drainage. It is restricted to rivers and streams of the Guyana shield in Venezuela and has been reported at elevations of up to 1300 meters. Studies of this species reveal that the diet is mostly comprised of terrestrial vertebrates.

Environmental pollution and habitat destruction associated with gold mining is having an adverse affect on the entire ecosystem. This in turn has a negative impact upon the wild populations of *P. trigonatus*. Because of this species' small size and ventral ossification, the commercial value of the hide is extremely low.

This species may have the longest incubation period of any crocodilian, which may last in excess of 100 days. Smooth-fronted caiman are mound nesters and typically build nests adjacent to or on top of termite mounds, which maintain elevated nest temperatures. Egg laying generally begins at the end of the dry season.

The North American captive population currently consists of 11 (3.6.2) in 5 institutions.

RECOMMENDATIONS:
Phase Out. Do Not Breed.

Paleosuchus palpebrosus has been recommended as the target *Paleosuchus* species for North American collections. Barring zoogeographical restrictions, the space available should be used for other small crocodilians (see matrix, page 10).

American crocodile *Crocodylus acutus*

STATUS: IUCN – Vulnerable
CITES - Appendix I
ESA - Endangered

The American crocodile is a large species, with males reaching maximum lengths of 5 - 6 meters. It is primarily an estuarine form, inhabiting the New World mangrove swamps of southern Florida, Cuba, Haiti, Dominican Republic, Jamaica, Central America and northern South America. It is a morphologically variable species, particularly where it may come into contact with congeners. It is an ecologically adaptable nester, utilizing marl, earth, and even crushed shell substrates in both hole and mound nests. During the dry season, a female will typically lay 30 - 60 eggs, although clutches as small as 20 eggs have been reported.

Extensive commercial hunting in the 1930s through the 1960s for the skin industry is largely responsible for the present population status throughout its range. Currently, habitat destruction for beach development is a concern, as females often use communal nesting sites much smaller than a hectare in size. These sites, specially chosen by the female crocodiles for optimum drainage, sun, etc., need enforceable protection.

Currently, Cuba supports some of the largest populations and is conducting research programs on this species.

The North American captive population currently consists of 34 (8.8.18) in 15 institutions.

RECOMMENDATIONS:
DERP – Display/Education. Do Not Breed.

This is the only crocodile found in the continental United States (Florida). Because of the geographically wide distribution of this species and the large housing requirements of this taxon, it is recommended that *in situ* projects be supported.

Orinoco crocodile *Crocodylus intermedius*

STATUS: IUCN - Critically Endangered
CITES - Appendix I
ESA – Endangered

The Orinoco crocodile is a large crocodile native to the mid and lower reaches of the Orinoco River in Venezuela and Colombia. Historical records exist of animals reaching lengths of over 7 meters, but it is more likely that today large males only reach lengths of 5 meters. It is the most critically endangered New World crocodilian, and has suffered a population decline of over 80% within the last 3 generations. There may be less than 250 individuals left in the wild. This species is legally protected in both Venezuela and Colombia, but the protection has had little effect in Colombia in the past. Nothing is known about the status of this crocodile in Colombia, while significant research and conservation activities have taken place in Venezuela.

This species is a hole nester, laying 40 - 70 eggs in exposed sandbars and riverbanks during the dry season. Hatching is correlated with the onset of the wet season and the natural rise in water levels.

The North American captive population currently consists of 5 (2.3.0) in 2 institutions.

RECOMMENDATIONS:
DERP - Husbandry Research Population and Display

Due to the very low number of animals in our institutions, this species should be considered for pilot husbandry research only.

Australian freshwater crocodile *Crocodylus johnsoni*

STATUS: IUCN - Lower Risk, least concern
CITES - Appendix II
ESA -Endangered

This freshwater crocodile is native to tropical northern Australia. It is a small to medium-sized crocodile, and is readily identified by its elongated, narrow snout. Males grow to a length of nearly 3 meters.

There may be as many as 30,000 to 60,000 freshwater crocodiles in the Northern Territory; because their habitats are intact and their skins are of low value, they seem relatively secure in the wild.

Females dig hole nests during the dry season, and clutch size averages about 13 eggs.

The North American captive population currently consists of 12 (2.6.4) in 5 institutions.

RECOMMENDATIONS:
DERP – Display of small Australian species.
Replace with targeted taxon where possible.

Philippine crocodile *Crocodylus mindorensis*

STATUS: IUCN - Critically Endangered
CITES - Appendix I
ESA - Endangered

This is a relatively small freshwater crocodilian that has been eliminated from most of its historical range. It now occurs only in very small populations in Mindanao, Negros and Mindoro in the Philippines. Males of the species seldom attain lengths over 3 meters. The wild population has declined more than 80% in 3 generations, initially due to commercial overexploitation and currently due to habitat loss and killing by local people. There may be fewer than 100 adult/sub-adult left in the wild. A large commercial breeding facility, the Crocodile Farming Institute (CFI), has been established on Palawan and since the mid 1990s has produced over 500 hatchlings annually. Silliman University in Dumagete City has a sole breeding pair, which has produced many offspring. The government of the Philippines has recently appointed a National Crocodile Recovery team. A recovery plan for the conservation of the species has been approved.

Philippine crocodiles are mound nesters and lay 10 - 22 eggs. Females reach sexual maturity at a length of approximately 1.5 meters.

The North American population currently consists of 52 (3.2.47) at 5 institutions. There has been high juvenile mortality due to intra-specific aggression.

RECOMMENDATIONS:
SSP (Future)

Establish a stable, genetically diverse captive population in North America by obtaining unrelated stock from CFI in the Philippines. As young captive Philippine crocodiles are extremely territorial in low densities, they should be reared individually until close to breeding age. With additional founders, future formation of an SSP is warranted.

Morelet's crocodile *Crocodylus moreletii*

STATUS: IUCN - Data Deficient, Lower Risk
CITES - Appendix I
ESA - Endangered

This broad-snouted species rarely exceeds 3 meters in length. It is primarily a freshwater species, but has been known to inhabit brackish waters. Its range extends from the Atlantic coast of Mexico down to northern Central America. In the southernmost portion of its range, it overlaps with *C. acutus*.

Morelet's crocodile suffered from uncontrolled hide hunting in the 1940s and 1950s. There are stable populations at Cox Lagoon and other locations in Belize, but the status of the species in Mexico and Guatemala remains unknown. Interest has been expressed in Guatemala and Belize to initiate sustainable use programs. In 1996, the CITES Secretariat approved an application to register a captive-breeding facility in Sinaloa, Mexico.

This species is exclusively a mound nester, with clutches consisting of 20 - 40 eggs deposited prior to the rainy season.

The North American captive population currently consists of 6 (2.2.2) in 4 institutions.

RECOMMENDATIONS:
Phase out. Do Not Breed.

Nile crocodile *Crocodylus niloticus*

STATUS: IUCN - Lower Risk, least concern
CITES - Appendix I in all countries except Madagascar, and Uganda (subject to export quotas), Botswana, Ethiopia, Kenya, Malawi, Mozambique, South Africa, Zambia, Zimbabwe (subject to ranching provisions), and Tanzania (subject to annual quotas and ranching provisions), where they are listed as Appendix II.
ESA - Threatened

This crocodile is among the largest and most well-studied of the crocodilians. Very large males can reach lengths of 6 meters. Although it is widely distributed in Africa, the populations appear to be declining. Unfortunately, reliable survey data is available for only a few countries in its extensive range. The primary factors contributing to its apparent decline in the wild are habitat destruction, degradation of the rivers in which it lives and hunting for food and hides. This species is, however, being farmed and is a good candidate for sustainable use management.

Females are hole nesters and lay 45 to 50 eggs during the dry season.

The North American captive population currently contains 84 (39.26.19) specimens at 10 institutions with many additional unrecorded specimens being held at private facilities.

RECOMMENDATIONS:
DERP – Display of large African species – Do not Breed.

Replace this species with *Mecistops cataphractus* for exhibit and educational purposes where possible.

New Guinea crocodile *Crocodylus novaeguineae*

STATUS: IUCN - Lower Risk, least concern
CITES - Appendix II
ESA - Endangered

The New Guinea crocodile is a medium-sized crocodile that inhabits the island of New Guinea. Males attain lengths of 3.5 meters. Recent studies reflect major differences, both in morphology and breeding habits, between northern and southern (Papua) populations. Wild populations are currently secure, with effective sustainable use programs in effect.

New Guinea crocodiles are mound nesters, and females reach sexual maturity at lengths of 1.5 to 2 meters. Northern populations have a tendency to lay larger clutches of smaller eggs than the populations in the south.

The North American captive population currently consists of 3 (2.1.0) in 1 institution.

RECOMMENDATIONS:
Phase out. Do Not Breed.

Replace wherever possible, with other targeted species of Asian crocodiles (see matrix, page 10).

Mugger crocodile *Crocodylus palustris* (Marsh crocodile)

STATUS: IUCN - Vulnerable
CITES - Appendix I
ESA - Endangered

The Mugger is the once common freshwater crocodile of India, Sri Lanka and Nepal. It also inhabits Pakistan and Iran. It is extinct in the wild in Bangladesh. The Mugger inhabits a variety of freshwater and coastal habitats and has invaded man-made reservoirs and canals. It is a medium to large species with an adult size of 4 to 5 meters; it has a wide alligator-like head. Populations were decimated in India during the 1950s and 1960s due to the trade in skins, but today the species is primarily threatened due to the loss of its natural habitat and conflicts with fisherman.

Muggers have been extirpated in many parts of their range, leaving an estimated 5,000-7,000 in isolated populations scattered across India and at two locations in Sri Lanka. Nepal and Iran are believed to have small but stable populations. A head-start recovery program is being considered in Pakistan. Captive breeding and collection of eggs from wild nests have resulted in a captive population of over 12,000 in India, where large numbers of these crocodiles have been released into National Parks and other sanctuaries. A lack of suitable habitat and local public support has hindered restocking efforts.

Females mature at 1.8 to 2 meters in length and lay 25 - 30 eggs in a hole nest during the dry season.

The North American captive population currently consists of 5 (2.2.1) in 2 institutions.

RECOMMENDATIONS:
Phase out. Do Not Breed.

Replace with targeted species where possible. Support *in situ* efforts in India.

Saltwater crocodile *Crocodylus porosus*
(Indo-Pacific crocodile, estuarine crocodile)

STATUS: IUCN - Lower Risk, least concern
CITES - Appendix II in Australia and Papua, New Guinea,
Appendix I in all other countries
ESA - Endangered

The saltwater crocodile is the world's largest crocodilian, attaining lengths of up to 7 meters. This species is the most widely distributed crocodilian, ranging from southern India throughout Southeast Asia to the Philippines, Palau and the Solomon Islands, as well as New Guinea and northern Australia. Severely depleted through most of its range from the 1940s to the 1970s, it has made an incredible comeback in Australia and New Guinea, where sustainable use programs are in effect. It is becoming rare, however, through most of the rest of its range, due to habitat loss and persecution by local people.

Females reach maturity at lengths over 2 meters, and build mound nests during the rainy season. Clutch size ranges from 40 - 60 eggs.

The North American captive population currently consists of 7 (1.4.2) in 4 institutions.

RECOMMENDATIONS:
DERP – Display of large Australian species – Do not breed.

Cuban crocodile *Crocodylus rhombifer*

STATUS: IUCN - Endangered
CITES - Appendix I
ESA - Endangered

The Cuban crocodile is a highly endangered freshwater species, which is currently restricted to Cuba. The species had a much wider distribution in Cuba in the past, and subfossil material indicates that its former range also included the Bahamas and Cayman Islands. This species currently is confined to a core area of approximately 300 square kilometers inside the Zapata Peninsula in Cuba and has been reintroduced into about 100 square kilometers of the Lanier Swamp on Cuba's Isla de la Juventud.

Hybridization with the American crocodile in nature, and with several *Crocodylus* species in captivity *(C. siamensis, niloticus, acutus* and *palustris*), poses a grave threat to the Cuban crocodile's genetic integrity. Poaching is a serious problem in Cuba, as is the introduction of a flourishing, exotic crocodilian (*Caiman crocodilus*) on Isla de la Juventud."

Usually not exceeding 3.5 meters in length, it has a bright yellow and black speckled pattern and is heavily armored. This species is known for its ability to jump, its alert and active behavior and strong feeding response.

Females usually build mound nests, and clutch size is typically 30 - 40 eggs. It has been bred at several facilities in Cuba and the United States.

The Cuban Crocodile SSP has a strong *in situ* component and is working closely with Cuban conservation authorities. Bill McMahan (Louisville Zoo) is the Species Coordinator and Steve Conners (Miami Metro Zoo) is the studbook keeper.

The North American captive population currently consists of 58 (10.25.23) in 16 institutions.

RECOMMENDATIONS:
SSP (current)

Siamese crocodile *Crocodylus siamensis*

STATUS: IUCN - Critical
CITES - Appendix I
ESA - Endangered

This is a medium-sized crocodile that reaches up to 4 meters in length, although most individuals rarely exceed 3 meters. Its historical range includes Thailand, Cambodia, Vietnam, Indonesia, Lao PDR, and Malaysia. Viable populations occur only in the Mekong River basin in Cambodia and Lao PDR; even these populations are fragmented and depleted. Very little is actually known about their natural history. They are currently considered critically endangered, with greater than 80% decline in wild populations in three generations.

There are thousands of pure *C. siamensis* in many of farms in Thailand and Cambodia Unfortunately there has been efforts at many farms to hybridize *C. siamensis* with *C. porosus* in an effort to produce a faster animal with more marketable hide. If pressures, such as human disturbance and habitat loss can be controlled or reversed, there are enough wild crocodiles left for the species to recover in many areas where it has been severely depleted.

Females construct mound nests during the wet season and lay clutches of 20 - 50 eggs. All of the information available on reproduction has come from captive specimens.

The North American population currently consists of 54 (6.6.42) at 7 institutions. The North American Regional Studbook is maintained by Andy Snider at Chaffee Zoological Park.

RECOMMENDATIONS:
PMP (Current)

Establish a self-sustaining population of 75 animals in North American institutions.

African slender-snouted crocodile *Mecistops cataphractus*

STATUS: IUCN - Data Deficient, possibly Endangered or Vulnerable
CITES - Appendix I
ESA - Endangered

This medium-sized African species of crocodile is considered to be one of the most morphologically unique crocodile species, which has been recently formalized in its taxonomy with the resurrection of a unique genus for this species (*Mecistops*). It has a narrow snout, and reaches a maximum length of 4 meters. This species is believed to be declining throughout its range, but surveys are needed to determine its current status. Of the 24 countries that this species inhabits, only four countries have basic survey data on their populations. Regulated hunting of this crocodile is permitted in Chad, Sierra Leone, Togo, Cameroon and Zaire, but there are no management plans associated with these activities. Habitat destruction and degradation of the rivers in which it lives are the most serious threats to this species. Hide trading, although not considered a serious threat to its populations at this time, may have a greater impact on this species as its populations decline due to continued habitat destruction.

Females build mound nests, in which they lay approximately 16 relatively large eggs at the beginning of the wet season.

The North American captive population currently contains 38 (12.11.15) at 10 institutions. However, progeny of only five wild-caught specimens are currently represented in the captive population. John Groves (North Carolina Zoological Park) maintains the regional studbook for this crocodile.

RECOMMENDATIONS:
PMP (Current)

The African slender-snouted crocodile is recommended for exhibit and educational programs where a large to moderate sized African species is needed. A stable, well-managed captive population of this species is the goal of this program. Space will be needed to allow the current population to grow to the 75 specimens needed to maintain genetic diversity in zoological institutions. Unpaired founder specimens need to be matched for additional breeding and incubation of the eggs must be managed for control of sex and number of offspring. Field surveys and educational programs in the 24 countries where this crocodile occurs are urgently needed to help manage this species in the wild to ensure its future.

African dwarf crocodile *Osteolaemus tetraspis*

STATUS: IUCN - Lower Risk, least concern
CITES - Appendix I
ESA - Endangered

The smallest species of crocodile, the African dwarf crocodile attains a maximum length of only 2 meters. This genus currently is considered to contain one species, but the taxonomic position of *O. tetraspis osborni* from the upper Congo River in Zaire is still questioned by some workers. The population status of this species is currently unknown from most countries it inhabits, but five of the 20 countries in its range have listed it as depleted or severely depleted. Field surveys have been conducted in only four of the 20 countries in its range. The primary threats to the continued survival of this crocodile in the wild are illegal hunting for food and habitat destruction. The hide produces a relatively poor quality leather product. Future conservation plans include captive-breeding projects, tourism, and possible meat production in Togo, Cameroon and Nigeria.

The North American captive population contains 51 (14.20.17) at 16 institutions. No reporting institutions list *O. t. osborni* in their collections.

RECOMMENDATIONS:
DERP - Education/Display. Do Not Breed.

The African dwarf crocodile is recommended for exhibit only when enclosure space is a limiting factor and a small African species or a small crocodile is necessary. Where an African species is not necessary, space should be made available for another small crocodilian species that is currently being managed.

Malay gharial *Tomistoma schlegelii*
(False gharial, Tomistoma)

STATUS: IUCN – Endangered – Critical 1
CITES - Appendix I
ESA - Endangered

Tomistoma is a monotypic genus of crocodilian that may be critically endangered. The historical range of the species includes the Malay Peninsula, Sumatra, Borneo, West Java and possibly Vietnam and Sulawesi. Preferred habitat appears to be restricted to peat swamp forest. Habitat needs may be specific for shaded, slow moving water. The size of the remaining wild population is unknown, but is suspected to be small, of low density, and highly fragmented.

This is a very large species, with males attaining sizes of up to 5 meters in length. Females build mound nests, and lay 20 - 60 large eggs. Sexual maturity in females is reached at approximate lengths of 2.5 to 3 meters.

The current North American population is 34 (11.18.5) in 14 institutions. There have only been three captive breedings in the US. The North American Regional Studbook and PMP is maintained by Scott Pfaff (Riverbanks Zoo).

RECOMMENDATIONS:
PMP - Future SSP

This species is currently a PMP overseen by Scott Pfaff of the Riverbanks Zoo. When husbandry issues have been overcome, the RCP recommends the development of an SSP program. In any case, intensive management to optimize reproductive potential is necessary to maintain this species in North American institutions. Given the lack of reproduction of *Tomistoma* in captivity, ascertaining the reasons for breeding failures must be a high priority.

Gharial *Gavialis gangeticus* (Gavial)

STATUS: IUCN Critically Endangered
CITES - Appendix I
ESA - Endangered

This is a very large, distinctive crocodilian from India, Nepal, Pakistan and Bangladesh. Known to inhabit four river systems of the northern Indian subcontinent - the Ganges, the Mahanadi, the Brahmaputra and the Indus. The species has probably been extirpated in Bangladesh. Preferred habitat is deeper pools of flowing rivers characterized by high sand banks and healthy stocks of fish. Survival in reservoirs needs to be ascertained as a possible way to ensure long-term survival as rivers become increasingly inhospitable

The gharial is generally considered to be the only living member of the family Gavialidae, although recent molecular evidence suggests that *Tomistoma* may be closely related. Gharial are distinguished by extremely long slender snouts. Adult males grow a large bulbous swelling around the external nares known as a 'ghara.' The species is highly aquatic, with short, flattened legs. Gavials may well be the longest living crocodilian, with males attaining lengths of 6 - 7 meters.

Gharial are primarily piscivorous, but are known to take other vertebrate prey. They nest on large high sand banks. Gharial lay the largest eggs of any crocodilian, about 160 grams on average. Thirty to 50 eggs are laid in hole nests. Females mature at a length of 3 meters; males at almost 4 meters.

Current threats include massive dam and irrigation projects that change river courses and drastically reduce river flow as well as irregular water releases from dams that flood nests and flush juvenile gharial downstream. Illegal fishing in Protected Areas, resulting in entanglement (hooks and nets), drowning, de-beaking and beheading of gharial caught in nets, is a leading cause of mortality. Aready marginal habitats are rapidly becoming uninhabitable for gharial due to dams, canals, siltation, sand mining, water removal for agriculture, riverbed cultivation, livestock and human disturbance at basking and nesting beaches. Over 80% of known gharial habitat loss has already been lost.

The gharial is a critically endangered species. At present there are an estimated 200 breeding adult gharial left in the wild. There are three places in India where a total of 88 nests were recorded and one location in Nepal where 6 nests were recorded in 2006. The gharial is now considered the most endangered large animal on the Subcontinent. In spite of high fecundity and a massive egg collection/head-starting/release programme (12,000+ eggs collected, 5,000+ young gharial released) initiated in India in 1975, the gharial is still in serious trouble. Compared to the many reserves that have been set aside for the tiger, breeding populations of the gharial survive in only three reserves in India, namely, Katerniaghat, Chambal and the Son, and one in Nepal at Chitawan. Despite these recovery efforts – once championed as one of the world's great conservation success stories - the gharial still faces a high probability of extinction in the wild. Apart from a period in the early phases of the Chambal Project, when population increases created the false impression that its survival had been secured, the status of gharial will likely swing between critically endangered and 'conservation dependent', and relict populations are probably the best that can be hoped for. Reports began surfacing in 2005 indicating that human

pressures had increased significantly in recent years and that enforcement to protect the sanctuaries was marginal and ineffective. The tri-state National Chambal Sanctuary has become increasingly lawless, with sand mining and turtle and fishing activities now being largely mafia controlled with little or no governmental enforcement. Until the Indian government steps up to address this problem, wild populations are at risk. Captive populations must be expanded accordingly.

The North American captive population currently consists of 19 (5.12.2) in 8 institutions. Of these, about 60% are of Nepalese origin. No reproduction has occurred in North American collections due to the immaturity of the population. Studbook first established in 1989 and is maintained by Kent Vliet (St. Augustine Alligator Farm).

RECOMMENDATIONS:
PMP (Current)

The gharial is highly recommended for exhibit and educational programs due to its endangered status, distinct appearance, taxonomic position, and conservation history.

Appendix I

Current CAG Officers and Steering Committee

Chairs (Vote of Confidence 2009)

Kent A. Vliet, University of Florida, kent.vliet@zoo.ufl.edu — Chair
John Groves, North Carolina Zoo, john.groves@ncmail.net — Vice-chair

Ends 2009 (Election 2010):

John Brueggen, St. Augustine Alligator Farm, jbrueggen1@aol.com — Secretary
Donal Boyer, San Diego Zoo, dboyer@sandiegozoo.org
Lonnie McCaskill, Disney's Animal Kingdom, Lonnie.mccaskill@disney.com
Joe Abene, Bronx Zoo, jabene@wcs.org
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Ends 2008 (Election 2009):

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Scott Pfaff, Riverbanks Zoo, spfaff@riverbanks.org
Bill McMahan, Louisville Zoo, bill.mcmahan@louisvilleky.gov
Andy Odum, Toledo Zoo, RAOdum@aol.com — Treasurer

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Greg Lepera, Jacksonville, leperag@jaxzoo.org
Steve Conners, Miami Metro Zoo, sconner@miamidade.gov
Jessi Krebs, Omaha's Henry Doorly Zoo, jkrebs@omahazoo.com
Dale Belcher, Rio Grande Zoo, dbelcher@cabq.gov

Appendix II

CAG Species Contacts

Contact information for persons identified in Table 4 as an AZA contact for crocodilian species.

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Appendix III

Results of the 2006 CAG Space Survey

Table 7. Space currently allocated to crocodilians and potential additional space that could be devoted to crocodilians in 67 institutions responding to the CAG space survey. The survey was conducted, compiled and organized by Jessi Krebs, Omaha's Henry Doorly Zoo.

2006 CAG Space Survey	CURRENT HOLDING						POTENTIAL ADDITIONAL HOLDING						
	ADULTS			JUVENILES			ADULTS			JUVENILES			
SPECIES	*Male*	*Female*	UNK	*Male*	*Female*	UNK	*Male*	*Female*	UNK	*Male*	*Female*	UNK	TOTAL
Alligator mississippiensis American alligator	*73*	*30*	27	6	6	98	49	33	20	6	3	76	**427**
Alligator sinensis Chinese alligator	*16*	*53*	0	0	0	4	14	12	5	0	0	60	**164**
Caiman crocodilus Common caiman	*5*	*4*	2							0	0	10	**21**
Caiman yacare Yacare caiman	*2*	*6*	0	0	0	0	0	0	0	0	0	10	**18**
Caiman latirostris Broad-snouted caiman	*3*	*2*	0	0	0	0	0	0	0	0	0	10	**15**
Melanosuchus niger Black caiman	*0*	*1*	0	0	2	0	0	0	0	0	0	10	**13**
Paleosuchus palpebrosus Dwarf caiman	*27*	*2*	0	0	2	6	10	14	4	1	3	14	**83**
Paleosuchus trigonatus Smooth- fronted caiman	*3*	*5*	0	0	0	0	2	4	2	1	3	24	**44**
Crocodylus acutus American crocodile	*4*	*6*	2	1	3	3	4	5	2	0	0	12	**42**
Mecistops cataphractus Slender-snouted crocodile	*2*	*6*	0	0	0	2	2	3	0	0	0	30	**45**
Crocodylus intermedius Orinoco crocodile	*1*	*2*	0	0	0	0	2	2	0	0	0	21	**28**
Crocodylus johnsoni Australian freshwater crocodile	*5*	*7*	0	1	2	4	0	0	3	0	0	10	**32**
Crocodylus moreletii Morelet's crocodile	*0*	*0*	1	0	0	0	0	0	0	0	0	10	**11**
Crocodylus niloticus Nile crocodile	*40*	*18*	0	1	1	3	9	15	0	0	0	14	**101**

2006 CAG Space Survey	CURRENT HOLDING						POTENTIAL ADDITIONAL HOLDING						
	ADULTS			JUVENILES			ADULTS			JUVENILES			
SPECIES	***Male***	***Female***	**UNK**	***Male***	***Female***	**UNK**	***Male***	***Female***	**UNK**	***Male***	***Female***	**UNK**	**TOTAL**
Crocodylus novaeguineae New Guinea crocodile	*0*	*0*	1	0	0	4	0	0	0	0	0	10	**15**
Crocodylus mindorensis Philippine crocodile	*2*	*0*	0	0	0	20	8	8	0	0	0	10	**48**
Crocodylus palustris Mugger crocodile	*1*	*1*	0	0	0	0	0	0	0	0	0	10	**12**
Crocodylus porosus Saltwater crocodile	*2*	*2*	0	0	0	7	1	2	0	0	0	16	**30**
Crocodylus porosus Saltwater crocodile hybrids	*1*	*2*	0	0	0	0	0	0	0	0	0	0	**3**
Crocodylus rhombifer Cuban crocodile	*5*	*17*	0	4	1	0	7	1	0	0	0	43	**78**
Crocodylus siamensis Siamese crocodile	*4*	*3*	0	0	2	15	2	6	0	0	0	11	**43**
Osteolaemus tetraspis African Dwarf crocodile	*10*	*14*	1	0	1	13	5	6	2	0	0	21	**73**
Tomistoma schlegelii Malay gharial	*7*	*9*	0	1	0	1	6	6	0	1	1	60	**92**
Gavialis gangeticus Indian gharial	*4*	*11*	2	0	0	0	2	4	0	0	0	14	**37**
TOTAL BY TYPE	**217**	**201**	**36**	**14**	**20**	**180**	**123**	**121**	**38**	**9**	**10**	**506**	**1475**

Table 8. Potential future crocodilian exhibit space, tabulated by size and zoogeographic categories, indicated by 67 institutions responding to the CAG space survey. The survey was conducted, compiled and organized by Jessi Krebs, Omaha's Henry Doorly Zoo.

2006 CAG Space Survey	POTENTIAL ADDITIONAL HOLDING						
	ADULTS			JUVENILES			
SPECIES	*Male*	*Female*	UNK	*Male*	*Female*	UNK	TOTAL
North America	1	9	0	0	0	10	20
Asian Small Species	5	7	4	6	0	16	38
Asian Large Species	3	4	0	0	0	10	17
Australian Large Species	0	0	2	0	0	10	12
Australian Small	0	0	2	0	0	10	12
Large African	2	3	2	0	0	10	17
Small African	0	0	5	0	0	14	19
Caribbean Large	1	1	0	0	0	10	12
Caribbean Small	0	0	5	0	0	10	15
Large South American	3	3	0	0	0	16	22
Small South American	8	6	26	1	2	14	57
Generic Large Crocodile Species	4	9	0	0	0	22	35
Generic Small Crocodile Species	0	0	4	0	0	10	14
Generic Large Alligatorid	1	4	0	0	0	10	15
Generic Small Alligatorid	1	1	6	0	0	28	36
Slender Snouted Species (Crocodile, Gharial, *or Tomistoma*)	7	11	0	0	0	22	40
TOTAL	36	58	56	7	2	222	381