THE POTENTIAL TO BREED APPENDIX-I REPTILES IN CAPTIVITY
A PRELIMINARY ASSESSMENT

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Background and Purpose

Article VII.4 of the Convention provides for specimens of Appendix I species that have been bred in captivity, or artificially propagated, to be deemed to be specimens of species included in Appendix-II for the purposes of exports for commercial purposes. Implementation of this provision of the Convention has required commercial captive breeding operations to be registered with the Secretariat. The registration process has entailed a complicated and sometimes lengthy process involving scrutiny of the application through correspondence by the Secretariat, relevant experts and the Parties. As a consequence, the extent to which Parties have adopted the registration procedure has been has been limited. Numerous Parties authorize exports of Captive-bred specimens of Appendix-I species in accordance with Article III, paragraph 3(a), of the Convention.

Resolution Conf. 11.14 (Gigiri, 2000) establishes a new approach to the registration process in an effort to streamline and simplify the procedure. Pursuant to Resolution Conf. 11.14, the Parties have agreed to compile an annex comprising *"a list of Appendix-I species that are critically endangered in the wild and/or difficult to keep or breed in captivity".* In the same Resolution, the Parties also agreed: *"that determination of whether or not to apply the exemptions of Article VII, paragraph 4, for the export of specimens of Appendix-I animals bred in captivity for commercial purposes, where the species are not included in Annex 3 to the Resolution, remains the responsibility of the Management Authority of the exporting Party on the advice of the Scientific Authority that each operation complies with the provisions of Resolution Conf. 10.16 (Rev.)."*

By a separate decision (Decision 11.101), the Conference of the Parties instructed the Animals Committee, in cooperation with experts in captive breeding where appropriate, to develop, for consideration at the 12th meeting of the Conference of the Parties, a list comprising Appendix-I species (or geographically separate populations thereof) that are:

a) critically endangered in the wild; and/or

b) known to be difficult to breed or keep in captivity

The CITES Animals Committee, at its 16th and 17th meetings, recognized the complexity of the issue and resolved to:

a) develop an objective approach to compiling the list of species in Annex 3 of the Resolution, using reptile species included in Appendix I as initial test subjects; and

b) recommend the Secretariat engage a consult to assist in the exercise.

The Secretariat contracted the IUCN/SSC Crocodile Specialist Group to undertake the project in collaboration with the Secretariat and other specialist groups, zoological institutions and private reptile breeders, in accordance with approach agreed by the Animals Committee at its 17th meeting., This report presents the results of the consultancy and suggests an approach to objectively compiling Annex 3 of Resolution Conf. 11.14 (for Appendix-I species of reptiles). The results do not address the relative conservation value of captive breeding versus other forms of *in-situ* management. The approach taken to identify Appendix-I reptile taxa has direct application to other Appendix-I species.

Rationale and Approach

The first step in the process required identifying all reptile taxa (including composite subspecies) presently included in Appendix-I of the Convention. Annex 1 lists all species and subspecies of reptiles listed in Appendix-I. The nomenclature used follows that of the CITES Checklist (UNEP-WCMC, 2000).

The taxa included in Annex 1 were then classified according to the three IUCN categories of threat that reflect greatest conservation concern – Critically Endangered, Endangered and Vulnerable (IUCN, 2000). The relationship between each Appendix-I species (and subspecies) and the IUCN classification of threat is presented in Annex 2.

The husbandry requirements and captive breeding achievements of all Appendix-I reptile taxa that have been accorded one of the foregoing IUCN categories of threat were examined against a set of parameters (see below) to determine the potential of each taxon to be successfully bred in captivity.

Reproduction in reptiles and other vertebrates is a process involving a complex sequence of inter-linked physiological and behavioural events that result in a fertilized ovum developing into a live offspring. This process comprises hundreds of steps involving an interaction between external physical factors (*e.g.* temperature, day length *etc*), internal factors (*e.g.* nutrition, age, sex ratio hormone production and production of gametes *etc*) and behavioural factors (*e.g.* social structure, mating rituals *etc*). These interact via internal chemical signals (hormones) that modulate external sensory stimuli (*e.g*. sights, smells) directly with the genetic material in cells that can be turned on and off to produce substances and structures involved in reproduction. For example, the sight of displaying and fighting males in *Anolis* lizards promotes the release of a hormone sequence in females that leads to ovulation and sexual receptivity. Some of these steps are common to many or all organisms (*e.g.* the universal effect of androgens on testicular development) but the exact sequence and many steps are species specific. Depending on the degree of reproductive specialization of a species, each step in this chain of events is necessary for the next to occur; so that the absence of any single step or process interrupts successful reproduction. The absence of one (or more) of these steps is less important for cosmopolitan species that are capable of adapting to changing environments. In the case of reproductive specialists, successful captive breeding depends on the extent to which husbandry techniques are able to replicate “natural” conditions such that the required sequence of interactive factors is not disrupted. It is therefore impractical to devise criteria or a definition that covers every contingency in the reproductive cascade. For this reason an operational definition based on observable endpoints is proposed.

Despite the complexity of the reproductive process, each generation of all organisms manages to fulfil it adequately, resulting in the inheritance of essential genetic material and perpetuation of the species. Successful reproduction under captive conditions may be compromised if one (or more) critical component(s) of the reproductive cascade are absent. Species that exhibit a high dependence on the suite of physical, intrinsic and behavioural conditions for successful reproduction in captivity may be difficult to breed in captivity. The difficulty of breeding these species in captivity may be compounded when the objective of an operation is the production of animals or products thereof for commercial purposes. In these cases, not only must captive breeding be successful, but, depending on the nature of the operation, management should seek to recover investment costs or to return a profit (by ensuring that the costs associated with producing offspring do not exceed their market value. A similar and closely related phenomenon occurs when a new species of reptile enters the specialist reptile trade. Wild-caught specimens of these species command a similarly high initial unit value amongst hobbyist and reptile enthusiasts until the formula for successful captive propagation is achieved and large numbers of captive specimens are produced to supply the trade. Internalizing the trade with captive specimens is generally characterized by a reduced demand over time and a decreased unit value of individual animals.

For these reasons, the commercial viability of management systems for successful captive breeding is not considered to be a relevant parameter for establishing a practical decision guide to determine whether or not a species is difficult to breed in captivity.

Theoretically, given the current state of knowledge of reproductive physiology, animal behaviour and practical husbandry, any reptile species can be induced to breed in captivity given sufficient research funds and facilities. In this regard, no species is impossible to breed in captivity, and potentially some reproduction could be achieved given sufficient effort. Therefore the mere production of offspring is not an adequate measure of ease or difficulty of breeding in captivity.

A further issue arises because for commercial purposes, the goal is production of offspring that can enter the commercial market. In the case of many reptiles, offspring are usually born/hatched in a precocial state and able to move and feed independent of any parental involvement. However, it is commonly observed in captivity that initiating feeding is difficult and early mortality is high. For this reason, the end-point by which to judge captive breeding is the sustained production of self sufficient, feeding offspring. This criterion applies regardless of whether the operation is producing live animals for trade or supplying derived products (*e.g.* skins, bones, meat *etc*). Exceptions to this general criterion are those cases involving trade in dead specimens or early life-stages (*e.g.* pupae) that may be destined for further processing after export. The same criterion holds true, in part, when evaluating captive breeding when re-introduction or wild population augmentation is the purpose. In this case there is greater emphasis on the production of disease- free, self-sufficient offspring, able to adapt to or become integrated into existing wild population(s). An improved conservation status of the wild population(s) is the principal criterion for judging a captive-breeding regime that is established as a conservation tool.

An additional complexity arises because sperm storage is common in reptiles and there are widespread observations of declining fertility in captive stocks as the parental generation ages and other nutritional and behavioral deficiencies reduce reproductive success.

Resolution Conference 10.16 (Rev) provides an agreed definition of “bred in captivity” as the term relates to species included in the appendices to the Convention. Safeguards against overlooking the two foregoing features of reptilian reproduction, (*viz*. high early mortality and decreasing fertility) are effectively accommodated by the requirement for the production of second generation (F_2) offspring in a controlled environment that is embodied in the definition contained in Resolution Conference 10.16 (Rev). The requirement for the production of second-generation offspring (or demonstration the management regime has been applied successfully elsewhere to the species or a biological analogue) is a criterion that applies to all captive breeding systems but does not speak to whether the process is difficult or not.

In considering a practical method for formulating a decision matrix for species that are “difficult” to breed in captivity we have decided to adopt the reverse approach to the problem. The following parameters represent readily recordable and objective end-point characteristics of species that are successfully bred in captivity, and thus provide a practical operational definition of “readily bred in captivity”.

- Frequency of offspring production under captive conditions reflects, or surpasses, natural reproduction;

- Numbers of offspring produced under captive conditions, relative to numbers of captive females, reflect or surpass natural production;

- Operation has succeeded in producing second generation offspring, or is managed in a manner demonstrated elsewhere to have produced second generation progeny; and

- Percentage of offspring surviving to an “exportable” age exceeds natural survivorship levels.

Demonstration that all three of the above conditions are satisfied provides an appropriate end point by which successful captive breeding can be judged. The extent to which a species’ biological and/or behavioural characteristics influences these three conditions being satisfied will obviously vary for different species. However, the foregoing three parameters can be assessed independently for each Appendix-I species of reptile. Species that do not satisfy the foregoing parameters are, *de facto*, difficult to breed in captivity.

The technology associated with captive husbandry and breeding of wild animals is a dynamic phenomenon. The ability to breed any wild species in captivity is an acquired skill. The technology required for being able to readily breed a species in captivity is, very often, a function of the length of time the species concerned has been held in captivity and the level of interest in producing offspring. The availability of wild-caught stock and level of demand for specimens stimulate captive production of animals. Commercial interests or the desire to conserve the wild resource by re-introduction strategies (or augmentation of wild populations) drive demand for captive-bred specimens.

Captive production of a species that is stimulated by commercial interests in responding to a market demand generally results in widespread and large scale captive propagation activities. This is particularly true for small to medium-sized species that are more easily accommodated by private keepers and reptile hobbyists.

Whether captive breeding operations are widespread and commonplace can be used as a parameter to gauge how readily a species may be bred in captivity has limited application. For instance the technology of crocodilian captive husbandry is well developed and is being successfully applied for the mass production of a number of species. However, it would not be possible to describe the captive breeding of *Crocodylus palustris* or *Crocodylus moreletii*, confined to a limited number of operations in India and Mexico respectively, as being widespread and commonplace. Accordingly, although this feature has been used in evaluating the Appendix-I reptiles, it has been accorded less importance relative to the other three conditions.

Methods

Lists of Appendix-I reptiles and of reptile species evaluated by the IUCN as being “Critically Endangered”, “Endangered” or “Vulnerable” categories of threat were obtained from the CITES and IUCN web pages. To assess ‘difficulty of breeding and/or keeping in captivity”, published sources, zoo records, ISIS records, taxon specialist groups and reptile breeders associations and amateur breeders throughout the world were consulted. Species were initially filtered to identify those for which there is documented evidence of being bred in captivity. Each of these species was subsequently evaluated on the basis of its biology and the technical difficulties in achieving compliance with the four parameters identified for successful captive propagation. Simplistically, species that fail to satisfy all three parameters can be defined (and categorized) as being difficult to breed in captivity.

There are two possibilities of dealing further with the species that do not meet the operational definition. These species may be genuinely difficult to breed in captivity and success has not yet been achieved, or alternatively, there has been no attempt to breed them in captivity. These two possibilities may be linked.

Species for which captive breeding has not been attempted may be further subdivided into:

a) Species (and subspecies) that are sufficiently similar to species that have been successfully bred in captivity that the expectation is they will also meet the operational definition of success;

b) Species that, because of their biology; the expectation is that they will be difficult to breed in captivity; and

c) Species for which no reasonable assessment can be made because of the absence of information on their biology or any attempt to breed them.

This apparently complex hierarchy is more easily appreciated visually (Figure 1.) and provides a simple decision tree by which those species currently thought to be difficult to breed in captivity can be identified. Table 1 presents a composite initial assessment of the captive breeding potential of Appendix-I reptiles, using information that has been gathered from available literature and contributions from corresponding experts in the field of reptile husbandry. Table 2 summarizes the information on Appendix I status, IUCN category and difficulty of breeding. Information obtained on each species is presented in summarized species accounts in Annex 3. A selected bibliography of further reading is at Annex 4.

Transition through the decision points of the tree have to be made using the available information from those sources familiar with each species and its breeding success. The results of applying this process are shown in the three lists required to fulfil this consultancy and the sources and details of the decision points presented in the appendices.

Figure 1. A hierachial decision tree to determine species thought difficult to breed in captivity, using an operational definition of breeding success (see text) and information from knowledgeable sources (see Annex 3).

1. Species satisfying the operational definition
Successfully commercial propagated. **Not Difficult**

2. Species that do not fully meet the operational definition but may be expected to meet operational definition if circumstances change. **Provisionally not difficult**

3. Species known to be difficult to breed
Operational definition not achieved. **Difficult**

4. Species similar/related to species in (3).
Expected not to meet the operational definition. **Provisionally difficult**

5. Species for which there is no basis to judge difficulty of captive breeding exists. **Unknown**

The precautionary principle will be applied by regarding species listed in categories 2, 3, 4 and 5 as ‘difficult to breed in captivity’. These are dynamic evaluations, particularly for those species listed provisionally. As additional information and the success or failure of captive breeding attempts become known, the evaluation of species may need to be adjusted. The most controversial category is likely to be Category 2, where the expectation is that the species will meet the operational definition for successful captive breeding, but have not yet done so. Adopting this approach (*viz.* requiring this demonstration, while in the meantime requiring more rigorous overview and permitting for trade in such species) is appropriate and cautionary. This places the responsibility on commercial operators and the relevant Management Authority to develop successful commercial captive breeding. This would not preclude international trade under CITES, but does require that the same standard of evaluation and permitting as for difficult-to-breed species is used.

Results and Analysis

The following species’ assessments and analyses are based on literature that could readily be accessed in the timeframe of the project. A large volume of information was obtained through correspondence with experts in the field of captive husbandry (zoological institutions and private keepers). In this respect, the information obtained is heavily biased towards North American perspectives. Unfortunately, despite numerous attempts to obtain information from European sources, the absence of useful responses from this important Region may have impaired the quality of information for some species. However, it is unlikely that the conclusions reached would be substantially different had responses from the European Region been more forthcoming.

Article I of the Convention defines “species” as any species, subspecies or geographically separate population thereof. The following analysis adopts this approach and treats, where possible, each subspecies as a separate entity, but applies the terms “taxon” or “taxa”. This approach is further justified because both the IUCN status and the difficulty of breeding are quite variable among subspecies within a species.

There are presently ninety-six (96) reptile taxa are included in Appendix I, of which nineteen (19) have not been categorized by the IUCN into any of the three categories of relevance to the present study *viz.* critically endangered, endangered or vulnerable (see Annex 2). The IUCN list subdivides several species into subspecies and many of these have been accorded different threat categories by IUCN. This includes:

i) twelve (12) subspecies of Galapagos tortoise, *Geochelone nigra,* three (3) of which are either extinct or extinct in the wild);

ii) thirteen (13) subspecies of Caribbean ground iguana, *Cyclura* spp;

iii) two (2) subspecies of Mona island Boa, *Epicrates monensis;* and

iv) six (6) subspecies of European viper, *Vipera ursinii*, four (4) of which are not considered by the IUCN to be threatened.

Furthermore, two (2) taxa, *Geochelone nigra galapagoensis* and *Bolyeria multocarinata* are categorized by IUCN as Extinct. These two taxa, together with the nineteen (19) taxa not categorized by the IUCN have not been included in the following analysis. As a consequence, the captive breeding characteristics of seventy-five (75) Appendix-I taxa have been assessed in the present report (see Table 1).

Table 1 presents the results of an evaluation of the difficulty, or otherwise, of breeding each taxon in captivity using the definitions and operational decision tree explained above. A summary of the information available and references for each taxon is presented in Annex 3. Table 2 displays the assessed degree of difficulty of captive breeding for each Appendix-I taxon together with its IUCN threat category.

With the exception of the two subspecies of *Geochelone nigra* that are classified as extinct in the wild, the remaining taxa are more or less equally distributed between Critically Endangered (25), Endangered (21) and Vulnerable (27).

Table 3 presents proportional comparisons within each group of reptiles between each IUCN category and captive breeding assessment. If the precautionary principle is applied and all provisional and unknown assessments are interpreted as being difficult to breed in captivity, forty-five (45) taxa are assessed as difficult to breed in captivity and thirty (30) are regarded as being easily bred in captivity.

In Table 4 the effect of considering different levels IUCN status as the criterion for careful scrutiny of captive breeding registration are shown. Using only “Critically Endangered”, 16 of 25 (64%) would require scrutiny; using “Critically Endangered and Endangered”, 27 of 46 (58.7%) and using all three IUCN levels (CR + EN + VU) 43 of 73 (58.9%) would require scrutiny.

Several general points emerged from an examination of the data:

Both endangered status and difficulty of captive breeding varies widely between closely related taxa (*e.g*. subspecies). Therefore it is hazardous to extrapolate from one taxon to another without corroborating data. This should be considered in generating lists for other groups of Appendix I species.

In general, he information on breeding tended to be widely scattered. Centralized data from zoo’s and other ‘official’ sources was often not accessible and incomplete. A great deal of very valuable information resides with individual researchers and with commercial and amateur breeders. Much of this information is not well-documented or published in peer reviewed sources. Nevertheless, this information was vital for completing this report. Therefore, similar attempts to assess Appendix-I species of other animal groups should utilize the broadest possible scope of sources. The IUCN specialist groups, official national and international breeder groups and amateur societies are significant sources of the information CITES required to fulfil the mandate of Res. Conf. 11.14 and Decision 11.101.

Based on an assessment of reptiles, it appears that the process of identifying species meeting criteria of endangerment and difficulty to breed will not substantially reduce the number of species requiring scrutiny by the Parties prior to registration of captive breeding facilities of Appendix I species.

This process is designed to facilitate implementation of the captive breeding provisions of the Convention. However, the results do not address the complex relationship between *ex-situ* captive production systems and *in-situ* conservation and management of the wild resource. The CITES Secretariat and Animals Committee are addressing this relationship as a separate exercise.

Table 1: Summary of Present Status of Appendix-I Reptiles in Captivity and Breeding Performance with a Provisional Assessment of Potential for Captive Breeding

Taxon	Present in Captivity	Limited Numbers	Substantial Numbers	Limited Captive Breeding	Extensive Breeding & Trade	F_2 Production	No Data	Assessment of Potential for Captive Breeding				
								not difficult for specialized operations	provisionally not difficult	difficult	Provisionally difficult	Unknown
Batagur baska	+	+		+					+			
Clemmys muhlenbergi	+	+			+	+		+				
Geoclemys hamiltoni	+	+		+							+	
Melanochelys tricarinata							+				+	
Morenia ocellata		+								+		
Terrapene coahuila	+	+		+				+				
Geochelone nigra abingdoni [EW]							+					+
nigra becki	+	+		+					+			
nigra darwini							+					+
nigra chathamensis							+					+
nigra ephippium [EW]							+					+
nigra guntheri	+	+		+					+			
nigra hoodensis	+	+		+				+				
nigra microphyes	+	+		+					+			
nigra porteri	+	+		+		+		+				
nigra vandenburghi							+					+
nigra vicina	+	+		+		+		+				
Geochelone radiata	+		+		+	+		+				
Geochelone yniphora	+	+		+				+				
Gopherus flavomarginatus	+	+		+							+	
Psammobates geometricus	+	+		+							+	
Testudo kleinmanni	+	+			+					+		
Caretta caretta	+	+		+							+	
Chelonia mydas	+		+		+ *	+			+			
Eretmochelys imbricata	+	+		+							+	
Lepidochelys kempii	+	+		+					+			
Lepidochelys olivacea	+	+		+							+	
Natator depressus							+					+
Dermochelys coriacea							+					+
Apalone ater							+				+	
Aspideretes gangeticus							+				+	
Aspideretes hurum							+				+	
Aspideretes nigricans							+				+	
Pseudemydura umbrina	+	+		+						+		

Taxon	Present in Captivity	Limited Numbers	Substantial Numbers	Limited Captive Breeding	Extensive Breeding & Trade	F_2 Production	No Data	Assessment of Potential for Captive Breeding				
								Not difficult for specialized operations	Provisionally not difficult	Difficult	Provisionally difficult	Unknown
Alligator sinensis	+		+		+	+		+				
Crocodylus acutus	+		+		+	+		+				
Crocodylus intermedius	+	+		+				+				
Crocodylus novaeguineae mindorensis	+		+		+	+		+				
Crocodylus palustris	+	+		+		+		+				
Crocodylus rhombifer	+	+		+		+		+				
Crocodylus siamensis	+		+		+	+		+				
Osteolaemus tetraspis	+	+		+				+				
Tomistoma schlegelii	+	+		+						+		
Gavialis gangeticus	+	+		+				+				
Sphenodon guntheri	+	+								+		
Sphenodon punctatus	+	+		+						+		
Brachylophus fasciatus	+	+		+		+		+				
Brachylophus vitiensis	+	+		+		+		+				
Cyclura carinata carinata							+					+
carinata bartschi							+					+
Cyclura collei	+	+								+		
Cyclura cornuta cornuta	+		+		+	+		+				
cornuta stejnegeri							+					+
Cyclura cychlura cychlura	+									+		
cychlura figginsi	+									+		
cychlura inornata	+									+		
Cyclura nubila nubila	+		+		+	+		+				
nubila caymanensis	+	+		+				+				
nubila lewisi	+	+		+				+				
Cyclura pinguis	+	+		+						+		
Cyclura ricordi	+	+								+		
Cyclura rileyi rileyi	+	+								+		
rileyi cristata	+	+								+		
rileyi nuchalis	+	+								+		
Gallotia simonyi	+	+		+				+				
Varanus komodoensis	+	+		+		+		+				
Acrantophis dumerili	+		+		+			+				
Acrantophis madagascariensis	+		+		+			+				

Taxon	Present in Captivity	Limited Numbers	Substantial Numbers	Limited Captive Breeding	Extensive Breeding & Trade	F_2 Production	No Data	Assessment of Potential for Captive Breeding				
								Not difficult for ecialized operations	Provisionally not difficult	Difficult	Provisionally difficult	Unknown
Epicrates monensis monensis	+	+		+		+		+				
monensis granti	+	+		+		+		+				
Epicrates subflavus	+		+		+	+		+				
Sanzinia madagascariensis	+		+		+	+		+				
Casarea dussumieri	+	+		+						+		
Vipera ursinii moldavica	+	+		+					+			
ursinii rakosiensis	+	+		+					+			

Footnote * *Chelonia mydas* is being bred in captivity in substantial numbers, however it is not subject to any international trade

Table 2. Reptile Species that are listed on Appendix I of CITES and categorized as Critical (CR), Endangered (EN) or Vulnerable (VU) on the IUCN Red List 2000 indicating if they are difficult to breed in captivity (from Table 1). D = Difficult to breed in captivity, N = Not difficult to breed in captivity, U = Unknown, —p = provisional

CITES Appendix-I Reptilia	IUCN Red List 2000	Breeding in Captivity D = difficult N = not difficult --p = provisionally U = unknown
TESTUDINATA		
Geochelone nigra abingdoni	EW	U
Geochelone nigra ephippium	EW	U
Chelonia mydas	CR [1]	Np
Eretmochelys imbricata	CR	Dp
Lepidochelys kempii	CR	Np
Pseudemydura umbrina	CR	D
Dermochelys coriacea	CR	U
Apalone ater	CR	Dp
Aspideretes nigricans	CR	Dp
Geochelone nigra hoodensis	CR	N
Batagur baska	CR	Np
Caretta caretta	EN	Dp
Lepidochelys olivacea	EN	Dp
Psammobates geometricus	EN	Dp
Testudo kleinmanni	EN	D
Clemmys muhlenbergi	EN	N
Terrapene coahuila	EN	N
Geochelone nigra porteri	EN	N
Geochelone nigra vicina	EN	N
Geochelone yniphora	EN	N
Geochelone nigra guntheri	EN	Np
Geochelone nigra darwini	EN	U
Geoclemys hamiltoni	VU	Dp
Gopherus flavomarginatus	VU	Dp
Natator depressus	VU[1]	U
Aspideretes gangeticus	VU	Dp
Aspideretes hurum	VU	Dp
Geochelone radiata	VU	N
Geochelone nigra becki	VU	Np
Geochelone nigra microphyes	VU	Np
Melanochelys tricarinata	VU	Dp
Morenia ocellata	VU	D
Geochelone nigra chathamensis	VU	U
Geochelone nigra vandenburghi	VU	U

CROCODYLIA

Gavialis gangeticus	CR	N
Alligator sinensis	CR	N
Crocodylus intermedius	CR	N
Crocodylus novaeguineae mindorensis	CR	N
Crocodylus siamensis	CR	N
Tomistoma schlegelii	EN	D
Crocodylus rhombifer	EN	N

CITES Appendix-I Reptilia	IUCN Red List 2000	Breeding in Captivity D = difficult N = not difficult --p = provisionally U = unknown
Crocodylus acutus	VU	N
Crocodylus palustris	VU	N
Osteolaemus tetraspis	VU	N
RHYNOCHEPHALIA		
Sphenodon guntheri	EN	D
Sphenodon punctatus	VU	D
SAURIA		
Cyclura collei	CR	D
Cyclura pinguis	CR	D
Cyclura ricordi	CR	D
Cyclura rileyi rileyi	CR	D
Cyclura rileyi nuchalis	CR	D
Brachylophus vitiensis	CR	N
Cyclura cornuta cornuta	CR	N
Gallotia simonyi	CR	N
Cyclura carinata carinata	CR	U
Cyclura carinata bartschi	CR	U
Cyclura rileyi cristata	EN	D
Brachylophus fasciatus	EN	N
Cyclura nubila nubila	EN	N
Cyclura cychlura cychlura	VU	D
Cyclura cychlura figginsi	VU	D
Cyclura cychlura inornata	VU	D
Cyclura nubila caymanensis	VU	N
Cyclura nubila lewisi	VU	N
Varanus komodoensis	VU	N
Cyclura cornuta stejnegeri	VU	U
SERPENTES		
Vipera ursinii moldavica	CR	Np
Vipera ursinii rakosiensis	EN	Np
Casarea dussumieri	EN	D
Epicrates monensis monensis	EN	N

Epicrates monensis granti	EN	N
Acrantophis dumerili	VU	N
Acrantophis madagascariensis	VU	N
Epicrates subflavus	VU	N
Sanzinia madagascariensis	VU	N

Footnote [1] - Category for *Natator depressus* subsequently revised by IUCN as "DATA DEFFICIENT"

The difficulty of captive breeding those Appendix-I species not categorized by the IUCN as "Critically Endangered", "Endangered" or "Vulnerable" has not been assessed (see Annex 2).

Table 3. Summary statistics derived from Table 2. Reptile species in CITES Appendix I and listed by IUCN Red List as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) grouped by difficulty to breed in captivity. D = Difficult to breed in captivity, N = Not difficult to breed in captivity.

	EW/D	EW/N	CR/D	CR/N	EN/D	EN/N	VU/D	VU/N	All D	All N
Testudinata	2	-	8	1	6	5	11	1	27	7
Crocodylia	-	-	-	5	1	1	-	3	1	9
Rhynchocephalia	-	-	-	-	1	-	1	-	2	-
Sauria	-	-	7	3	1	2	4	3	12	8
Serpentes	-	-	1	-	2	2	-	4	3	6
TOTALS	2	-	16	9	11	10	16	11	45	30

Footnote - The precautionary principle has been applied by including the two provisional assessments (Dp and Np) and UNKNOWN (U) rating into the DIFFICULT category.

Table 4. Summary statistics. Numbers of Endangered Appendix I Reptile species that would be listed and require careful scrutiny by the Parties to register captive breeding operations using different levels of IUCN Criteria. This analysis does not include the two subspecies of *Geochelone nigra* (*abingdoni* & *ephippium*) that are considered to be extinct in the wild.

	Critically Endangered only	Critically Endangered and Endangered	Critically endangered, Endangered and Vulnerable.
Difficult to breed in captivity	16	27	43
Not difficult to breed in captivity	9	19	30

CITES APPENDIX I

REPTILIA

TESTUDINATA

Emydidae	*Batagur baska*
	Clemmys muhlenbergi
	Geoclemys hamiltoni
	Kachuga tecta
	Melanochelys tricarinata
	Morenia ocellata
	Terrapene coahuila
Testudinidae	*Geochelone nigra*
	Geochelone radiata
	Geochelone yniphora
	Gopherus flavomarginatus
	Psammobates geometricus
	Testudo kleinmanni
Cheloniidae	*Caretta caretta*
Chelonia mydas	
	Eretmochelys imbricata
	Lepidochelys kempii
	Lepidochelys olivacea
	Natator depressus
Dermochelyidae	*Dermochelys coriacea*
Trionychidae	*Apalone ater*
	Asperidetes gangeticus
	Asperidetes hurum
	Asperidetes nigricans

Chelidae	*Pseudemydura umbrina*
CROCODYLIA	
Alligatoridae	*Alligator sinensis*
	Caiman crocodilus apaporiensis
	Caiman latirostris -110
	Melanosuchus niger -111
Crocodylidae	*Crocodylus acutus*
	Crocodylus cataphractus
	Crocodylus intermedius
	Crocodylus moreletii
	Crocodylus niloticus -112
	Crocodylus novaeguineae mindorensis
	Crocodylus palustris
	Crocodylus porosus -113
	Crocodylus rhombifer
	Crocodylus siamensis
	Osteolaemus tetraspis
	Tomistoma schlegelii
Gavialidae	*Gavialis gangeticus*
RHYNOCHEPHALIA	
Sphenodontidae	*Sphenodon guntheri*
	Sphenodon punctatus
SAURIA	
Iguanidae	*Brachylophus fasciatus*
	Brachylophus vitiensis
	Cyclura carinata
	Cyclura collei
	Cyclura cornuta
	Cyclura cychlura

	Cyclura nubila
	Cyclura pinguis
Cyclura ricordi	
	Cyclura rileyi
	Sauromalus varius
Lacertidae	*Gallotia simonyi*
Varanidae	*Varanus bengalensis*
	Varanus flavescens
	Varanus griseus
	Varanus komodoensis
SERPENTES	
Pythonidae	*Python molurus molurus*
Boidae	*Acrantophis dumerili*
Acrantophis madagascariensis	
	Boa constrictor occidentalis
	Epicrates inornatus
	Epicrates monensis
	Epicrates subflavus
	Sanzinia madagascariensis
Bolyeridae	*Bolyeria multocarinata*
	Casarea dussumieri
Viperidae	*Vipera ursinii* +216

Annotations

-110 excluding population of Argentina

-111 excluding population of Ecuador (that is subject to zero export quota pending approval of annual export quota approved by Secretariat and IUCN/SSC Crocodile Specialist Group

-112 excluding populations of Botswana, Ethiopia, Kenya, Madagascar, Malawi, Mozambique, South Africa, Uganda and United Republic of Tanzania.

-113 excluding populations of Australia, Indonesia and Papua New Guinea

+216 population of Europe, excluding the area formerly constituting the Union of Soviet Socialist Republics

Comparison of Appendix-I Reptiles and Corresponding IUCN Threat Categories (Critically Endangered, Endangered & Vulnerable)

CITES	IUCN RED LIST CATEGORIES		
Appendix-I Reptilia	Critically Endangered	Endangered	Vulnerable
TESTUDINATA			
Emydidae			
Batagur baska	●		
Clemmys muhlenbergi		●	
Geoclemys hamiltoni			●
Kachuga tecta			
Melanochelys tricarinata			●
Morenia ocellata			●
Terrapene coahuila		●	
Testudinidae			
Geochelone nigra			●
nigra abingdoni [EW]			
nigra becki			●
nigra darwini		●	
nigra chathamensis			●
nigra ephippium [EW]			
nigra galapagoensis [E]			
nigra guntheri		●	
nigra hoodensis	●		
nigra microphyes			●
nigra porteri		●	
nigra vandenburghi			●
nigra vicina		●	
Geochelone radiata			●
Geochelone yniphora		●	
Gopherus flavomarginatus			●
Psammobates geometricus		●	
Testudo kleinmanni		●	
Cheloniidae			
Caretta caretta		●	
Chelonia mydas	● [1]	●	
Eretmochelys imbricata	●		
Lepidochelys kempii	●		
Lepidochelys olivacea		●	
Natator depressus			●

Dermochelyidae			
Dermochelys coriacea	●		
Trionychidae			
Apalone ater	●		
Aspideretes gangeticus			●
Aspideretes hurum			●
Aspideretes nigricans	●		
Chelidae			
Pseudemydura umbrina	●		
CROCODYLIA			
Alligatoridae			
Alligator sinensis	●		
Caiman crocodilus apaporiensis			
Caiman latirostris –110			
Melanosuchus niger –111			
Crocodylidae			
Crocodylus acutus			●
Crocodylus cataphractus			
Crocodylus intermedius	●		
Crocodylus moreletii			
Crocodylus niloticus –112			
Crocodylus novaeguineae mindorensis	●		
Crocodylus palustris			●
Crocodylus porosus –113			
Crocodylus rhombifer		●	
Crocodylus siamensis	●		
Osteolaemus tetraspis			●
Tomistoma schlegelii		●	
Gavialidae			
Gavialis gangeticus		●	
RHYNOCHEPHALIA			
Sphenodontidae			
Sphenodon guntheri			●
Sphenodon punctatus			
SAURIA			
Iguanidae			
Brachylophus fasciatus		●	
Brachylophus vitiensis	●		
Cyclura carinata	●		
carinata carinata	●		
carinata bartschi	●		
Cyclura collei	●		
Cyclura cornuta			●

cornuta cornuta			●
cornuta stejnegeri		●	
Cyclura cychlura			●
cychlura cychlura			●
cychlura figginsi		●	
cychlura inornata		●	
Cyclura nubila			●
nubila nubila			●
nubia caymanensis	●		
nubia lewisi	●		
Cyclura pinguis	●		
Cyclura ricordi	●		
Cyclura rileyi		●	
rileyi rileyi	●		
rileyi cristata	●		
rileyi nuchalis		●	
Sauromalus varius			
Lacertidae			
Gallotia simonyi	●		
Varanidae			
Varanus bengalensis			
Varanus flavescens			
Varanus griseus			
Varanus komodoensis			●
SERPENTES			
Pythonidae			
Python molurus molurus			
Boidae			
Acrantophis dumerili			●
Acrantophis madagascariensis			●
Boa constrictor occidentalis			
Epicrates inornatus			
Epicrates monensis			
monensis monensis		●	
monensis granti		●	
Epicrates subflavus			●
Sanzinia madagascariensis			●
Bolyeridae			
Bolyeria multocarinata [E]			
Casarea dussumieri		●	
Viperidae			
Vipera ursinii + 216			
ursinii macrops			
ursinii moldavica	●		

ursinii rakosiensis		●	
ursinii renardi			
ursinii ursinii			
ursinii wettsteini			

Annotations

-110 Excluding population of Argentina

-111 Excluding population of Ecuador (that is subject to zero export quota pending approval of annual export quota approved by Secretariat and IUCN/SSC Crocodile Specialist Group

-112 Excluding populations of Botswana, Ethiopia, Kenya, Madagascar, Malawi, Mozambique, South Africa, Uganda and United Republic of Tanzania

-113 Excluding populations of Australia, Indonesia and Papua New Guinea

+216 Population of Europe, excluding the area formerly constituting the Union of Soviet Socialist Republics

Explanatory Notes for Superscripts

1. Mediterranean Sea sub-population

Appendix-I taxa NOT categorized by the IUCN Red List as "critically endangered", "endangered" or "vulnerable". The potential for breeding these taxa in captivity has NOT been assessed.

Kachuga tecta
Caiman crocodilus apaporiensis
Caiman latirostris
Melanosuchus niger
Crocodylus cataphractus
Crocodylus moreletii
Crocodylus niloticus
Crocodylus porosus
Sauromalus varius
Varanus bengalensis
Varanus flavescens
Varanus griseus
Boa constrictor occidentalis
Epicrates inornatus
Python molurus molurus
Vipera ursinii ursinii
Vipera ursinii macrops
Vipera ursinii renardi
Vipera ursinii wettsteini

Since its 2000 published lists, the IUCN has re-categorized *Natator depressus* as DATA DEFFICIENT. However, in order to adhere to the prescribed terms-of-reference of the project, the former VULNERABLE status has been recognized.

Species Accounts

TESTUDINATA

Batagur baska

Batagur baska is a large, long-lived freshwater turtle from Southeast Asia. Morphological criteria and dichromatic characters published by Moll *et al* (1981) provide a ready means of differentiating the sex of adult individuals.

Blanco *et al* (1991), in a report on the first successful captive breeding of *Batagur baska* at the Bronx Zoo, were of the view that there was no significant captive breeding program for this giant batagurine turtle at that time. Anon (1998a) notes a total of eighty-two (82) animals were represented, world wide, in six collections.

Based on body size and observed colour changes, Blanco *et al* (1991) estimate reproductive maturity, under captive conditions, being attained after approximately 10 years. In February 1990, one female is reported by Blanco *et al* (1991) to have laid, (with the assistance of oxytocin, a chemical stimulant), a total 33 eggs that produced six (three abnormal) hatchlings after 87 days at an incubation temperature range of 26-30^{O}C.

Assessment - PROVISIONALLY NOT DIFFICULT

Literature Cited

Anon, (1998a) – Census of Rare Animals in Captivity 1996-97, Int. Zoo Yearbook. vol.36 p560.
Blanco, S., Behler, J.L. and Ksotel, F (1991) – Propagation of the Batagurine Turtles *Batagur baska* and *Callagur borneoensis* at the Bronx Zoo. Proc. 1st Int. Symp. on Turtles & Tortoises: Conservation and Captive Husbandry. pp63-65
Moll, E.O., Matson, K.E. and Krehbiel, E.B. (1981) – Sexual and seasonal dichromatism in the Asian river turtle *Callagur borneoensis*. Herpetologica 37(4), pp181-194.

Clemmys muhlenbergi

Clemmys muhlenbergi is the smallest and rarest member of the eastern *Clemmys* group, occurring in disjunct populations in the northeastern United States from New York State to Georgia.

Herman (1991), during a survey of captive husbandry, noted that only twelve (12) zoological and private collections reported maintained a captive population of this species. Because of its protected status, Herman (1991) believed some under reporting of the species occurred. Herman (1987) and Tryon (1988, 1990) report that most *C. muhlenbergi* in captivity are derived from the same parental stock that was obtained for captive breeding and headstart programs.

C. muhlenbergi was first bred in captivity in 1973 (Anon, 1974). Since that time, there are numerous references to this species being bred at other zoos (Bowler, 1974; Tryon and Hulsey, 1977; Herman, 1980; Herman and George, 1986; Reininger, 1990 and Tryon, 1990) and private collections (Warner, 1974; Bartlett, 1990). Archibald (1990) reported the first captive production of second-generation offspring. Herman ((1991) provides a good summary of captive husbandry and reproductive requirements for *C. muhlenbergi* that are generally applied by all facilities that maintain and breed the species. *Clemmys. muhlenbergi* is generally regarded by specialist keepers to be a species that is easily maintained and bred in captivity.

Assessment - NOT DIFFICULT

Literature Cited

Anon (1974) – Rare bog turtles breeding at the Bronx Zoo. Def. Wildlife News 49(1), p64
Archibald, E. (1990) – Second generation bog turtles hatch. AAZPA Communique 9, p9.
Bartlett, R. D. (1990) – The bog turtle, *Clemmys muhlenbergi*. Vivarium 2(3), pp25-27.
Bowler, J. K. (1974) – Breeding report. Chelonia, 1(1), p9.
Herman, D. W. (1980) – Atlanta Zoo hatches rare bog turtles. AAZK Anim. Keeper's Forum. vol.7(9):198
Herman, D. W. (1991) – Captive Husbandry of the Eastern *Clemmys* Group at Zoo Atlanta. In Proc. Int. Symp. on Turtles and Tortoises: Conservation and Captive Husbandry. pp54-62.
Herman, D. W. (1987) – The diminutive bog turtle: A species headed for extinction? Zoo Magazine 1(1), pp4-5.
Herman, D. W. and G. A. George (1986) – Research, husbandry and propagation of the bog turtle *Clemmys muhlenbergi* (Schoepff) at the Atlanta Zoo. *In* Proc. 9th Int. Symp. Captive Propagation and Husbandry, Thurmont, MD.
Reininger, K. (1990) – New York endangered turtles hatch at Burnet Park Zoo. AAZPA Communique 5, p21.
Tryon, B. W. (1988) – The rare little bog turtle of East Tennessee. Tennessee Wildlife. 11(4), pp6-9.
Tryon, B. W. (1990) – Down in the bogs. Zoo Life 1(2), pp38-43.
Tryon, B. W. and T. G. Hulsey (1977) – Breeding and rearing the bog turtle *Clemmys muhlenbergi* at the Fort Worth Zoo. Int. Zoo Yearbook. Vol.17, pp125-130.
Warner, J. L. (1974) – Demise of the Muhlenberg? Connecticut Herpetol. Soc. Bull. Vol.4 pp1-2.

Morenia ocellata

Morenia ocellata is confined to southern Myanmar. No published information on the captive management of this species could be retrieved. One respondent with expertise in captive husbandry of freshwater turtles identified *Morenia ocellata* as difficult to breed in captivity (Pronk, pers. comm., 2002). McCord (pers. comm. 2002) has advised that very few keepers are able to keep either *Morenia* spp alive for more than 18 months, with most specimens dying within the first 4-6 months in captivity.

Assessment - DIFFICULT

Terrapene coahuila

Terrapene coahuila occurs in the Cuatro Cienegas Basin, Mexico. The species is present in numerous zoological collections in Europe and North America (Anon, 1994). Breeding has been achieved for this species for quite some time. Jersey Zoo received six (6) captive-bred neonates from Dallas Zoo in 1982 (Bloxam & Tonge, 1986). Anon (1998b) reports regular annual breeding of this species by a small number of zoos.

Assessment - NOT DIFFICULT

Literature Cited

Anon, (1994) – Census of Rare Animals in Captivity. Int. Zoo Yearbook. Vol.33, p412.

Anon, (1998b) – Reptiles Bred in Captivity and Multiple Generation Births 1995-1996. Int. Zoo Yearbook, vol.36, p384.
Bloxam, Q. M. C. & S. J. Tonge (1986) – Breeding programmes for reptiles and snails at Jersey Zoo: an appraisal. International Zoo Yearbook. Vol.24/25, pp49-56.

Geochelone nigra

The distribution of Geochelone nigra is confined to the Galapagos Islands. Within the species, in addition to the nominate form *nigra*, twelve (12) subspecies, *abingdoni* (EW), *becki, darwini*, *chathamensis*, *ephippium* (EW), *galapagoensis* (E), *guntheri, hoodensis, microphyes, porteri, vandenburghi* and *vicina* are recognized. Each subspecies is endemic to a particular island in the archipelago. The conservation status of the wild population of each extant subspecies, afforded by IUCN (2000), varies

Specimens of *Geochelone nigra* are kept and bred in a large number of zoological and private collections in many countries around the world (Bacon, 1980; Casares, 1995; Hairston & Burchfield, 1989; Noegel & Moss, 1989; and Throp, 1975). The subspecific identity of many specimens is uncertain (http://www.tortoise.org/archives/galopgee) and, for captive specimens in Australia, remains a priority for further research (Banks & Thomson, 1999).

Casares et al. (1995), in addition to providing useful information on captive management of the species, note that at least four subspecies, *guntheri, microphyes, porteri* and *vicina* have been bred in captivity – two of which (*porteri* and *vicina*) have been bred to the second generation. Anon (1994) reports the subspecies, *becki* bred in European and North American zoos.

Geochelone n. hoodensis has been successfully bred at the Breeding Centre on the Galapagos Islands. The first captive-breeding event occurred in the 1970-71 season. As of December 1994, a total of 664 captive-bred tortoises had been repatriated to Española Island. In 1991 the first live neonates were found (Gayot & Morillo in http://www.nytts.org/proceedings/cayot) on Española Island. In response to the 1998 eruption of Cerro Azul volcano, the Charles Darwin Research Institute, in collaboration with the Galapagos NP, has incorporated *Geochelone n. guntheri*, (the most endangered subspecies), into their captive breeding and repatriation program (Turtle Action News at http://www.tortoise.org/news). The first breeding success occurred in 2001, with the production of eighty-three (83) hatchlings from eighty-eight (88) eggs (http://www.galapagos-ch.org).

<u>Assessment</u> – The captive breeding potential of the eleven extant subspecies of *Geochelone nigra* may be summarized:

NOT DIFFICULT	*hoodensis, porteri, vicina*
POVISIONALLY NOT DIFFICULT	*becki, guntheri, microphyes*
UNKNOWN	*darwini, chathamensis, ephippium, galapagoensis, vandenburghi*

<u>Literature Cited</u>

Anon, (1994) – Census of Rare Animals in Captivity. Int. Zoo Yearbook. vol.33, p412
Bacon, J. P. (1980) – Some observations on the captive management of Galapagos tortoises. *In* Reproductive Biology and Diseases of Captive Reptiles. pp97-113; Murphy, J. B. & Collins, J. T. (*Eds*). SSAR, Contributions to Herpetology No.1.

Banks, C., Thomson, S. & E. Louis (1999) – Galapagos Giant Tortoise, *Geochelone elephantopus*. ASMP Status: Population Management Program; Management Level 1a. *In* http://www.arazpa.org.au/reptiles_t.html).
Casares, M., Honegger, R. & A. Rubel (1995) – Management of Giant Tortoises, *Geochelone elephantopus* and *Geochelone gigantea*, at Zurich Zoological Gardens. Int. Zoo Yearbook, **34**. pp135-143.
Hairston, C. & P. M. Burchfield (1989) – Management and reproduction of the Galapagos tortoise, *Geochelone elephantopus* at the Gladys Porter Zoo. Int. Zoo Yearbook. **28**, pp70-77.
Noegel, R. P. & G. A. Moss (1989) – Breeding the Galapagos tortoise, *Geochelone elephantopus* at the Life Fellowship bird Sanctuary, Seffner. Int. Zoo Yearbook, **28**, pp78-83.
Throp, J. L. (1975) – Note on the management and reproduction of the Galapagos tortoise at the Honolulu Zoo. *In* Breeding Endangered Species in Captivity; pp39-42. Martin, R. D. (*Ed*), Academic Press, London.

Geochelone radiata

This species is endemic to Madagascar with an introduced population on the nearby island of La Reunion.

On the basis of information reported in numerous volumes of the International Zoo Yearbook and other sources (Zovickian, 1973; Bloxam and Tonge, 1986), large numbers of *Geochelone radiata* have been represented and regularly propagated in numerous zoological and private collections in North America and Europe for many years. The species continues to be popular among reptile hobbyists and is successfully bred in private collections in Europe (Pauler, pers. comm. 2002), North America (Zovickian, 1973) and in Madagascar (Pronk, pers. comm. 2002; Jenkins, pers. obs. 2001). It can therefore be safely concluded that *G. radiata* adapts readily to, and is relatively easy to maintain and propagate in captivity.

Behler and Iaderosa (1991) describe the management arrangements for a captive colony of the species and document the husbandry requirements of the species. *G. radiata* is a highly fecund species, which, in captivity, is capable of regularly double-clutching and producing large numbers of offspring without the need for sophisticated technology. As a consequence, captive-bred specimens of *G. radiata* are frequently offered for sale in reptile trade magazines. Second generation captive-bred progeny have been produced (Zorvikian, 1973).

Assessment - NOT DIFFICULT

Literature Cited

Behler, J. L. & J. Iaderosa (1991) – A Review of the Captive Breeding Program for the Radiated Tortoise at the New York Zoological Society's Wildlife Survival Centre. In Proc. 1st Int. Symp. Turtles and Tortoises: Conservation Captive Husbandry. pp160-162
Bloxam, Q. M. C. & S. J. Tonge (1986) – Breeding programmes for reptiles and snails at Jersey Zoo. an appraisal. International Zoo Yearbook. vol.24/25, pp49-56.
Zovickian, W. H. (1973) – Captive reproduction of the Radiated Tortoise. HISS News Journal 1 (4), pp115-118.

Geochelone yniphora

Geochelone yniphora is a medium-sized, terrestrial tortoise endemic to Madagascar where it is confined to a small area in the north west of the Island.

Because of its extreme rarity, *G. yniphora* does not feature prominently in zoological or private collections. On the basis of its experience in maintaining a captive colony and attempts to breed the species, The Honolulu Zoo website (http://www.honoluluzoo.org/angonoka) provides some notes on general husbandry and reproductive biology of *G. yniphora*. Juvik et al. (1991) document, in some detail, attempts to breed the species using AI techniques. The Durrell Wildlife Conservation Trust, at its in situ breeding facility at Ampijoroa in northwestern Madagascar, has achieved the most successful captive breeding without using sophisticated equipment and technology. Established in 1986 in collaboration with the Malagasy Ministry of Water and Forests to facilitate recovery of the species, the Ampijoroa facility has achieved regular annual production of offspring. More than 100 offspring *G. yniphora* were produced in the first eight (8) years of its operation (Durrell, 1994). It could therefore be concluded that *G. yniphora*, with the necessary expertise and under appropriate conditions, can readily be bred in captivity – a view expressed by some individuals with experience in captive husbandry of tortoises.

Assessment - NOT DIFFICULT

Literature Cited

Durrell, L. (1994) – A is for Angonoka: The Ploughshare Tortoise Project and the ABCs of Species Conservation. Testudo, Vol.4 No.1

Juvik, J. O., Meier, D. E. and S. McKeown (1991) – Captive Husbandry and Conservation of the Madagascar Ploughshare Tortoise, *Geochelone yniphora*. In Proc. 1st Int. Symp. on Turtles & Tortoises: Conservation and Captive Husbandry. pp127-137.

Gopherus flavomarginatus

Gopherus flavomarginatus is endemic to Mexico. Reproduction in this species is not well known. Mexico and the United States are conducting studies on this species and captive breeding programs have been established in both countries (http://www.geocities.com/endangeredsp3/NamericaRA4a). Captive females have been known to produce three clutched in a year. In the wild, however, each clutch usually comprises a single egg. Anon (1998b) reports the species being successfully bred by one North American zoo in 1995 with the production of fourteen (14) hatchlings.

There are conflicting views among private keepers, being regarded by one respondent as difficult to keep in captivity (Pronk, pers. comm. 2002), whereas contrary advice (Vinke, pers. comm. 2002) was received from the German-based society, DGHT-AG Schildkröten.

Assessment - PROVISIONALLY DIFFICULT

Literature Cited

Anon, (1998b) – Reptiles Bred in Captivity and Multiple Generation Births 1995-1996. Int. Zoo Yearbook, vol.36. p385.

Psammobates geometricus

Psammobates geometricus has a restricted distribution in southwestern Cape Province, Republic of South Africa. Very little information is available on the captive management of this species. Anon (1997) reports the species being held and bred in at least one zoological collection

(Kraaifontein) in South Africa. Two respondents, with expertise in captive husbandry of freshwater turtles, classified *Psammobates geometricus* as very difficult to maintain and breed in captivity (Pronk & DGHT-AG Schildkröten pers. comm. 2002). Baard (pers. comm. 2002) reports that, although second-generation offspring have not yet been produced by captive animals, provided specimens are maintained in outdoor enclosures within their preferred habitat (coastal renosterveld), they are relatively easy to maintain and produce eggs regularly.

Assessment - PROVISIONALLY DIFFICULT

Literature Cited

Anon, (1997) – Reptile Bred in Captivity and Multiple Generation Births. Int. Zoo Yearbook. vol.35, p356.

Testudo kleinmanni

Testudo kleinmanni occurs along the North African coast from Libya to Israel.

The species is represented in numerous zoological collections in Europe and North America and is popular amongst reptile hobbyists. Until the 1940s *T. kleinmanni* was regularly bred at the Giza Zoo, however there is no longer any reproduction by this species and the captive population suffers from "wasting disease" and is continually replaced with wild-caught specimens (Buskirk, 1990).

Although *T. kleinmanni* is present in numerous zoological and private collections, principally in Europe and to a lesser extent, North America, captive breeding outside of its natural distribution has rarely been recorded (Highfield & Martin in http://www.tortoisetrust.org/articles/kleinmanni). A captive-breeding program established with the support of the Egyptian Government reported in 2000 that 200 offspring had been hatched from 300 eggs laid. Since then, the facility has constructed an additional two enclosures, each containing up to fifty (50) animals.

The Durrell Wildlife Conservation Trust achieved the first European captive breeding record in 1990 and the Tortoise Trust achieved what is believed to be the first mainland British captive breeding in 1994 (Highfield & Martin in http://www.tortoisetrust.org/articles/kleinmanni). An EEP for the species, coordinated jointly by Rotterdam and London Zoos, and involving other European zoos holding the species, was initiated in 2000 (http://www.zoonews.ws). Anon (1998b) reports successful captive breeding by seven zoological collections. Regarded by Lutzman (pers. comm. 2002) as a species that is bred regularly but with some difficulty.

Assessment - DIFFICULT

Literature Cited

Anon, (1998b) – Reptiles Bred in Captivity and Multiple Generation Births. Int. Zoo Yearbook, vol.36, p386.

Buskirk, J. (1990) – The plight of the Egyptian tortoise. Tortuga Gazette, **26** (6), pp7-8.

***Cheloniidae & Dermochelyidae* spp**

All seven (7) species of marine turtle are included in Appendix-I of the Convention and are afforded varying degrees of endangerment by IUCN (2000). There is limited published information on captive breeding of marine turtles. The absence of an extensive literature undoubtedly reflects the lack of interest in applying captive propagation as a management regime for the production, commercial or otherwise, of marine turtles. This lack of interest may be related to obvious technical difficulties, and hence associated operational and production costs, of applying closed-cycle captive breeding to a group of large-sized reptiles that:

i) are long-lived;
ii) do not breed annually; and
iii) exhibit varying degrees of migratory behaviour.

The *Chelonia mydas* breeding operation on Grand Cayman Island is the only known closed-cycle captive breeding operation for a species of marine turtle that has succeeded in achieving captive production on a regular annual basis over a sustained period of time. The Cayman Turtle Farm (CTF) commenced operation in 1968 under the name Mariculture Ltd., artificially incubating wild-harvested eggs (ranching). The first successful captive-breeding event occurred in 1975, and in 1978 the operation became totally dependent on the production of turtles from captive breeding in a system of closed tanks. Since that time, CTF has achieved the captive production of second-generation offspring (Parsons, pers. comm. 2002).

The Texas Parks and Wildlife Department (http://www.tpwd.state.tx.us) reports that attempts to breed *Dermochelys coriacea* in captivity have been largely unsuccessful. With the exception of the Cayman Turtle Farm, the successful captive propagation of marine turtles has been sporadic and infrequent, involving limited numbers of offspring. Anon (1994) reports that three North American zoos have successfully bred *C. mydas* and *Lepidochelys kempii*. Wood & Wood (1988) report the captive propagation of a small number of *L. kempii* at the Cayman Turtle Farm. The minimum age of reproductive maturity for *L. kempii* is reported to be five (5) years (Wood & Wood, *loc. citt*).

Himeji City Aquarium in Japan reports (http://www.zoonews.ws/IZN/313/Izn-313) the successful production of five (5) hatchling *Caretta caretta* in 2001 from a captive female that was hatched from a wild-harvested egg in 1983. Following its union, in 1992, with a wild-caught male, copulation commenced in 1995. Prior to the 2001 achievement, between 1995-1999, the female laid a total of 304 eggs in water, which resulted in one hatchling that died within a month.

The website (http://www.unimas.my/penyu) makes reference to the presentation of a conference paper on the captive breeding of *Lepidochelys olivacea* at the Phuket Marine Biological Centre, Thailand. The CTF also has also successfully raised and bred a small number of *Eretmochelys imbricata* (http://www.cites.org/eng/programme/HBT/bg/ranch_breed).

Ross (1999) reviewed the conservation, economic and social consequences of captive breeding of sea turtles and concludes that, despite the foregoing achievements, including the CTF *C. mydas* operation, captive breeding of marine turtles should be classified as technically difficult, and subject to scrutiny by the Parties to the Convention. However, on the basis of the technology that has been developed by the Cayman Turtle Farm and applied successfully to breed *C. mydas* and *L. kempii*, these two species may be assessed as provisionally not difficult. Except for a few isolated and serendipitous breeding events, the potential to breed the other species must be regarded as unknown.

Assessments - *Chelonia mydas* - PROVISIONALLY NOT DIFFICULT
Lepidochelys olivacea - UNKNOWN
Lepidochelys kempii - PROVISIONALLY NOT DIFFICULT

Caretta caretta - UNKNOWN
Natator depressus - UNKNOWN
Eretmochelys imbricata – UNKNOWN
Dermochelys coriacea - UNKNOWN

Literature Cited

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Ross J. P. (1999) – Ranching and captive breeding sea turtles: Evaluation as a conservation strategy. Pp. 197-201 In Eckert K., K. A. Bjorndal, F. A. Abreu-Grobois & M. Donnelly. Research and Management Techniques for the conservation of Sea Turtles. IUCN Marine Turtle Specialist group, Pub. No. 4.

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Geoclemys hamiltoni
Melanochelys tricarinata
Apalone ater
Aspideretes hurum
Aspideretes nigricans
Aspideretes gangeticus

Geoclemys hamiltoni is restricted to the Indus and Ganges River Basins of Pakistan, India, Nepal and Bangladesh. *Melanochelys tricarinata* occurs in the Ganges-Brahmaputra and adjacent river basins in eastern India, Bangladesh and (possibly) Nepal. *Apalone ater* is restricted to the Cuatro Cienegas Basin, Coahuila, Mexico. The three Indian soft-shelled turtles (*Aspideretes* spp) are distributed in:

i) the Indus and Ganges river basins in Pakistan, northern India, southern Nepal and Bangladesh (*A. gangeticus*);
ii) the Ganges-Brahmaputra River Basin in eastern India and Bangladesh (*A. hurum*); and
iii) a single enclosed pond near Chittagong, Bangladesh (*A. nigricans*).

Conflicting comments were received from several respondents on the potential to breed soft-shelled turtles in captivity. Large numbers of some species of soft-shelled turtles (*e.g. Pelodisens sinensis*) are produced in captivity, provided they are contained in appropriate water bodies with aquatic vegetation. Thomson (pers. comm. 2002) is of the opinion that soft-shelled turtles are "notoriously" difficult to breed in captivity where they form a component of the institution's public exhibits because the emphasis on husbandry is public exhibition not propagation. Other experienced keepers (Pronk, pers. comm. 2002) generally share Thomson's views. Other respondents (DGHT-AG Schildkröten, pers. comm. 2002) however, differentiated between the species, citing *Apalone ater* and *Aspideretes nigricans* as difficult to breed, but recognizing *Geoclemys hamiltoni, Melanochelys tricarinata, Aspideretes hurum* and *A. gangeticus* as easy to breed in captivity. However, no information was provided to support this claim.

Determining the extent to which *Apalone ater* is bred in captivity or potential for captive breeding to be achieved proved somewhat problematic. There are no records of captive specimen of *A. ater* present in any North American zoological collection. One of two possible reasons for this absence of records is apparent. Either the taxon is so rare, that it is not possible to obtain specimens for captive breeding, or alternately, and more likely, North American zoos apply nomenclature different to that of WCMC and CITES. *Apalone ater* is also regarded as a subspecies of *Apalone spinifera* (= *Trionyx spinifera*). Unfortunately, although *A. spinifera* features prominently in many North American zoological collections, inventories and breeding records contained in International Zoo Yearbooks do not identify the subspecies involved. It is quite possible that some collections include *Apalone ater*. *Apalone spinifera*, which comprises seven subspecies, has an extensive distribution in the United States and Mexico. As a consequence, the compilers of the International Zoo Yearbook do not include the taxon in the census of rare animals in captivity.

Some soft-shelled turtles are commercially bred in large numbers in the United States (*Apalone ferox*), Japan (*Apalone mutica*), China, Singapore, Viet Nam Thailand (*Pelodisens sinensis*), and are generally regarded as being easily propagated in captivity. On the basis of the ability to captive breed some *Apalone* spp, it could be concluded that congenerics may be expected to exhibit similar potential to be bred in captivity. However, Thomson (pers. comm. 2002) warns against drawing such a conclusion, advising that *A. spinifera* (= *A. ater*) has proven difficult to breed under captive conditions.

According to Thomson (pers. comm. 2002), advised that soft-shelled turtles exhibited in display tanks, in preference to large open water bodies, rarely breed. Enclosures designed to facilitate captive breeding by soft-shelled turtles are not appropriate as public exhibits. As a consequence, there is little interest by many zoological institutions to concentrate effort on captive breeding this group of reptiles.

Whittaker (pers. comm. 2002) reports there is no serious captive breeding of the three *Aspideretes* spp or *Geoclemys hamiltoni* in the Indian Sub-continent. Only one record of *G. hamiltoni* being successfully bred in captivity could be located – that being the Rotterdam Zoo (Zwartepoorte, 2000).

Anon (1990) reported that *A. gangeticus* has been bred at Madras Crocodile Bank. Whittaker (pers. comm. 2002) confirmed that a single female had produced fertile eggs continuously for approximately twelve years despite the absence of a mature male. Hatchlings are extremely difficult to rear and a high mortality is experienced because of the species' aggressive behaviour towards siblings.

Assessment - *Geoclemys hamiltoni* - PROVISIONALLY DIFFICULT
Melanochelys tricarinata - PROVISIONALLY DIFFICULT
Apalone ater - PROVISIONALLY DIFFICULT
Aspideretes hurum - PROVISIONALLY DIFFICULT
Aspideretes nigricans - PROVISIONALLY DIFFICULT
Aspideretes gangeticus - PROVISIONALLY DIFFICULT

Literature Cited

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Zwartepoorte, H. (20000 – in EAZA News. No.31, reported in http://www..xs4all/~cuora/eaza

Pseudemydura umbrina

Pseudemydura umbrina has a restricted distribution in southwestern Australia. Anon (1998a) reports a total of 185 animals in two (2) zoological collections (Perth Zoo, Australia and Kyoto Zoo, Japan) in 1997.

A captive colony was established at the Zoo in 1960. In 1988, with a diminishing wild population, very few (17) animals in captivity, sporadic breeding and low hatchling survivorship, a consortium of organizations, including Perth Zoo and the Western Australian conservation agency, initiated a rescue program for the species. A recovery program was commenced in 1991 that includes captive breeding as an element (Kuchling in http://nytts.org/proceedings/kuchling). The only successful captive-breeding program for *P. umbrina* is at Perth Zoo. Since its inception in 1988, the captive-breeding program has been producing increasing numbers of hatchling tortoises annually. Thirty-two (32) tortoises were born at Perth Zoo in 2000, bringing the total captive population to 244 animals. Fifty-three (53) captive-bred animals have been re-introduced into a protected area with suitable wetland habitat (http://www.perthzoo.wa.gov.au). Despite these successes Kuchling considers *Pseudemydura umbrina* technically difficult to breed in captivity (http://www.members.iinet.net.au).

Assessment - DIFFICULT

Literature Cited

Anon, (1998a) – Census of Rare Animals in Captivity 1996-1997. Int. Zoo Yearbook, vol.36. p562.

CROCODYLIA

Most crocodilians can be bred without difficulty in captivity when facilities of adequate size to support pairs or larger groups are available. However, because of their large size and difficulty of management, many exhibit facilities prefer not to attempt to breed crocodilians. Therefore the majority of zoo and exhibit holdings are of non-breeding specimens. However, the commercial development of captive breeding has been widespread with at least 10 species regularly achieving F2, high egg fertility and hatch success (60-90%) and good hatchling survival. Factors affecting successful breeding of crocodilians include a relatively long period to grow to maturity (6-15 years), aggression between adults and dietary requirements for reproduction. Crocodiles (genus *Crocodylus*) freely interbreed and form fertile hybrids and backcrosses in captivity and many zoo breedings are hybrid crosses. Hybridization within and between other crocodilian genera is unknown.

Alligator sinensis

Alligator sinensis is endemic to the People's Republic of China.

Although specimens of *A. sinensis* are present in a large number of zoological collections around the world (Anon, 1998a), with the exception of the Bronx Zoo, where significant numbers are produced regularly, very few institutions appear to have bred the species successfully (Anon, 1998b). A substantial captive-breeding program has been underway since the 1980s at the Anhui Research Centre for Chinese Alligator Reproduction (ARCCAR) in Anhui Province, China. The facilities have achieved the production of second-generation offspring and have been registered with the CITES Secretariat for commercial export. The present captive population at ARCCAR exceeds seven thousand animals. Animals have been sold for use in establishing commercial breeding farms elsewhere in southern China (Wang 2001).

A Studbook is maintained by the American Association of Zoos and Aquariums (AZA), and over 140 individuals are held in 14 institutions. Three institutions regularly produce captive offspring (CSG 1998 and refs therein). In the mid 90's there were seven individuals held in four European Zoos as well as private collections.

Assessment - NOT DIFFICULT

Literature Cited

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Anon, (1998b) – Reptiles Bred in Captivity and Multiple Generation Births. Int. Zoo Yearbook, vol.36, pp386-87.
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Wang, Weisheng. 2001 Introduction to Captive breeding and commerce management of Crocodylia in China. Presentation to International workshop on Crocodylia, Guangzhou, China Crocodile Specialist Group September 2001 (Proceedings in press)

Crocodylus acutus

Crocodylus acutus has a coastal distribution from the southeastern United States, through Central America, including some Caribbean Islands, and along the coastline of South America to Venezuela and Peru.

Captive breeding has been achieved at a commercial level in Honduras and the registered facility there holds approximately 400 breeding stock and regularly produces offspring. In Colombia, four commercial facilities are operating and hold a total of 439 breeders with a sex ratio of approximately 2 females:1 male and over 9,000 juveniles produced in farms. First reproduction was reported in 1987 and three facilities have produced F2 by 2001 (Rodriguez 2000). Hatchling mortalities are reported to be between 6.5% and 34.3% (Rodriguez 2000, de la Ossa 1997). Successful captive breeding facilities are also reported in Cuba (Soberon 2000), Panama (Venegas de Anaya 2000) and Peru (Carrion et al. 2000) but levels of production are low.

Assessment - NOT DIFFICULT

Literature Cited

Carrión, Z; O. Pérez & L. Lujan. 2002. Experiencias de la crianza de Crocodylus acutus en el Centro de Acuicultura La Tuna Carranza, Peru: Avances en la conservación de la especie. pp 401- 412. In: Crocodiles. Proceedings of the 15th Working Meeting of the Crocodile Specialist Group, UICN – The World Conservation Union, Gland, Switzerland and Cambridge, UK. ISBN 2-8317-0549.
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Venegas de Anaya, M. 2000. Zoocría y manejo de poblaciones silvestres de *Crocodylus acutus*. Indices reproductivos y comportamiento social. pp. 382-391. In: Crocodiles. Proceedings of the 15th Working Meeting of the Crocodile Specialist Group, UICN – The World Conservation Union, Gland, Switzerland and Cambridge, UK. ISBN 2-8317-0549.

Crocodylus intermedius

The Orinoco crocodile occurs in Orinoco river drainage in Venezuela and Colombia. The species is greatly depleted with just two self-sustaining wild populations in Venezuela and scattered sites in Colombia. *Crocodylus intermedius* is restricted to the Orinocco River system of Venezuela and Colombia, where there are several institutions carrying out captive breeding programs – Estacion Roberto Franco, Puerto Miranda, El Frio and UNELLEZ University. .

Outside the two range States, the species is poorly represented in zoological collections, being reported from only two facilities (Anon, 1995). In Venezuela, a program of captive breeding for re-introduction and conservation purposes has been underway since the late 70's. At present there are four facilities in Venezuela holding a total of 42 breeding adults and producing 400 – 500 hatchlings annually. F2 breeding has not been achieved. Hatchling mortality is reported to be in the order of 20%. In Colombia four facilities hold 113 non-hatchling stock. Breeding was accomplished at the Estacion de Biologia Tropical de Roberto Franco, Venezuela, in 1991 with an average annual production of 18 live hatchlings/year (11 years) and hatchling mortality is quite high at 58.4%. F2 production has not been achieved.

Assessment - NOT DIFFICULT

Literature Cited

Anon (1995) – Census of Rare Animals in Captivity 1995, Int. Zoo Yearbook. vol.35 p469.

Ardila-Robayo et al., 1999. Evaluación del crecimiento en C. intermedius nacidos en la Estación... Rev. Acad. Cienc... XXIII (Supl. Especial):425-435.

Arteaga, A., A. E. Seijas, C. Chávez, & J. Thorbjarnarson. 1994. Status and conservation of the Orinoco Crocodile: An update. pp 143-150. In: Crocodiles. Proceedings of the 12th Working Meeting of the Crocodile Specialist Group, UICN – The World Conservation Union, Gland, Switzerland. Volume 1. ISBN 2-8317-0238-0. xii + 309 p.

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Denis, M. 1993. Orinoco crocodile breeding. Crocodile Specialist Group Newsletter Vol 12(1): 22.

Ramírez, J. & C. Burbano. (en prensa). *Crocodylus intermedius* (Caimán llanero) *ex-situ* en la Estación de Biología Tropical Roberto Franco. En: Memorias del Taller sobre la Conservación del Caimán del Orinoco (*Crocodylus intermedius*) en Colombia y Venezuela. A. Velasco, G. Colomine, G. Villarroel & R. De Sola (Eds.).

Crocodylus novaeguineae mindorensis

The Philippine crocodile is now properly a separate species *Crocodilus mindorensis* (King and Burke 1989) but CITES terminology continues to refer to it as a subspecies of the New Guinea crocodile. The species is restricted to a few Islands in the Philippines and has a greatly reduced a fragmented distribution in the wild. The species is subject of a national recovery plan that has recently issued a review of captive breeding and conservation issues for the species. (Bank 2000). Silliman University initiated captive breeding in 1980 and at the Crocodile Farming Institute on Palawan (now called Palawan Wildlife Rescue and Conservation Centre) in 1992. The total founder population for the two facilities was 239 individuals. Captive breeding has been achieved at both facilities (Silliman 1 pair, PWRCC 36 breeders) and currently produces 200 – 250 hatchlings per year. Captive bred offspring at PWRCC showed courting behaviour in 1999 and F2 breeding is anticipated. Additional holdings are Manila Zoo (1 pair, occasional breeding), Gladys Porter Zoo USA (1 pair, breeding) and Melbourne Zoo Australia (single female). Initially great difficulty was experienced breeding this species because of high aggression of females to males. Careful introduction of pairs and recognition of compatible individuals have enabled mitigation of this problem. (Banks, in http://www.zoonews.ws/IZN/310/IZN-310). In captivity, the species is reported (http://www.flmnh.ufl.edu/natsci/herpetology/act-plan/cmind) to construct mound nests and lay twenty (20) eggs. Banks (http://www.zoonews.ws/IZN/310/IZN-310) considers the captive management of *mindorensis* as not differing greatly from that of most other *Crocodylus* spp.

Assessment - NOT DIFFICULT

Literature Cited

Banks C. 2000. National Recovery Plan for the Philippine crocodile, *Crocodylus mindorensis*. Melbourne Zoo, Australia and Dept. Environment and Natural Resources, Philippines.

Crocodylus palustris

This species occurs in India, Pakistan, Bangladesh, Nepal, Sri Lanka and eastern Iran. The majority of remaining wild populations occur in India and Sri Lanka. The species has been subject to intense captive breeding efforts in India since 1975. The program was reviewed in detail at a workshop in 1993 (Hutton 1993) and was the subject (with other Indian crocodiles) of a dedicated volume of the Journal of the Environmental Information Systems (ENVIS) Wildlife Institute of India in 1999. Ten breeding centres maintain approximately 12,000 specimens and produced thousands of offspring annually. Since the mid 1990's the facilities have been overwhelmed with specimens and breeding has been curtailed (CSG 1998) but the Indian experience confirms that the species is not difficult to maintain or breed in captivity. The species is poorly represented in zoological institutions around the world. Anon (1998a) reports less than 50 specimens in eight (8) collections, where only one establishment reported any captive breeding (Anon, 1998b).

Assessment - NOT DIFFICULT

Literature Cited

Anon, (1998a) – Census of Rare Animals in Captivity 1996-97, Int. Zoo Yearbook. vol.36 pp562-64.

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Hutton J. 1993. Crocodile conservation and management in India, Report of a CSG Workshop held at Madras Crocodile Bank, 1-3 march 1993. Africa Resources Trust, Zimbabwe 27 pp.

Crocodylus rhombifer

Crocodylus rhombifer, the Cuban crocodile, is restricted to two locations in Cuba, a natural population in the Zapata swamp and a population re-introduced to formerly occupied habitat in the Lanier swamp, Isle of Pines. Captive breeding was initiated in 1960 with a founder stock of several hundred wild specimens from the Zapata swamp. F2 production has been achieved.

Captive breeding was also successful at a captive facility in Isle of Pines that provided specimens for re-introduction. Detailed studies on reproduction of captive Cuban crocodiles have been conducted (Ramos 2000). Overall reproductive success (fertility and hatching) averaged 87.8% over 11 years of study of 100 females. Survival through the first year is around 50%.

Modelling of captive production and reintroduction indicated the following survival rates – 11% at age one-year, 66% at age two-years and 76% at age three-years (Anon 2000).

In 1985 the Cuban Government presented the Vietnamese Government with some *live C. rhombifer.* These animals were distributed to Saigon Zoo and other government-owned crocodile farms in southern and central Viet Nam where they have been maintained. Some of the recipient establishments (*viz.* Saigon Zoo and FORIMEX Crocodile Breeding Farm) have successfully bred this species on a regular basis. Some facilities have interbred *Crocodylus rhombifer* with the native species, *Crocodylus siamensis*, producing hybrid animals (Jenkins, pers. obs. 1998, 2001).

Small numbers (less than 50 animals) of this species are represented in 26 zoological collections worldwide (Anon, 1998a) with limited breeding being achieved (Anon, 1998b).

Assessment - NOT DIFFICULT

Literature Cited

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Anon, (1998b) – Reptiles Bred in Captivity and Multiple Generation Births. Int. Zoo Yearbook, vol.36, pp386-87.

Ramos R .T. 2000 Reproduccion en cautiverio del cocodrilo Cubano Crocodylus rhombifer en el zoocriadero de la Cienaga de Zapata, Provincia Granma, Cuba. Pp. 71-85 In Crocodioles, Proceedings of the 15th Working Meeting of the Crocodile Specialist Group, IUCN- World Conservation Union, Gland, Switzerland.

Crocodylus siamensis

Crocodylus siamensis is distributed throughout the Indo-Chinese Peninsula from Viet Nam in the east to Thailand and Myanmar. Although critically endangered throughout most of its range, there are well in excess of 100,000 animals captive in an extensive network of commercial farms in Thailand, Cambodia, Viet Nam and the People's Republic of China (Webb & Jenkins, 1991, Jenkins, pers. obs. 1998, 2001).

The species adapts well to captivity and breeds readily and regularly with little need for the application of sophisticated technology. The Samut Prakan Crocodile Farm in Thailand was the first operation to achieve the production of second-generation offspring. Since the early 1990s, numerous commercial farms in Thailand and Cambodia have been registered with the CITES Secretariat for the purposes of commercial exports. Anon (1998b) reports the captive production of limited numbers of the species by eight (8) zoological institutions around the world.

Assessment - NOT DIFFICULT

Literature Cited

Anon, (1998b) – Reptiles Bred in Captivity and Multiple Generation Births. Int. Zoo Yearbook, vol.36, pp386-87.

Webb, G. J. W. & R. W. G. Jenkins (1991) – Management of Crocodilians in Thailand (a Review with Recommendations). mimeo. report, 30pp.

Osteolaemus tetraspis

Osteolaemus tetraspis is a small crocodilian confined to Central and sub-Saharan West. Africa. The skin of *O. tetraspis* has little or no commercial value. As a consequence, there is no interest in breeding this species in large numbers. However, experimental introduction of artificial water bodies (plastic wading pools) into natural habitat in Gambia resulted in rapid colonization of the pools by breeding pairs and successful breeding (Jones, 1991) suggesting the species would not be difficult to breed.

The principal purpose for maintaining *O. tetraspis* in captivity is for public exhibition by zoological institutions. A 1995 census reported a total of seventy-seven (77) specimens of *O. tetraspis* represented in twenty-four (24) collections worldwide. However, Anon (1998b) reports the species present in only eight (8) collections, and no breeding was reported (Anon, 1998a). This absence of any breeding records may reflect a failure by zoos holding this species to report their breeding achievements for the year. A few institutions breed the species on a regular basis, albeit in limited numbers. Several accounts were retrieved of specific breeding events in a small number of North American zoos (http://www.aza.org/Publications/2000) and European zoos (http://www.zoonews.ws/IZN/289/IZN-289,& http://www.regionalist.cz/zoojihlava/). This species is the only crocodilian managed according to a conservation-breeding program by zoological institutions in the United Kingdom (http://www.zoonews.ws/IZN/289/IZN-289). The extent to which zoological institutions breed this, or any other, species is largely determined by the zoo's breeding policy. Exhibition space is critical and institutions that breed any species must be able to distribute the resulting offspring either for exhibition purposes or to other institutions that participate in an *ex situ* conservation-breeding program for the species concerned. It is apparent that, even though only relatively small numbers of offspring are produced, *O. tetraspis* adapts well to captivity and is capable of readily breeding in captivity.

Assessment - NOT DIFFICULT

Literature Cited

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Anon, (1998b) – Reptiles Bred in Captivity and Multiple Generation Births. Int. Zoo Yearbook, vol.36, pp386-87.

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Tomistoma schlegelii

Tomistoma schlegelii is restricted to Indonesia and Malaysia, where it is kept in numerous private collections and State-owned zoos. One Indonesian crocodile farm has been reported to have successfully bred this species (http://www.flmnh.ufl.edu/natsci/herpetology/act-plan/tschl).

Tomistoma schlegelii, the False gharial occurs in peninsula Malaya, Indonesia (Borneo and Sumatra) and the southern extremity of Thailand. The species is one of the few crocodilians that has proved difficult to breed in captivity. Breeding groups have been held in commercial farms in Thailand, in an exhibit in Sarawak (Malaysia) and several zoos in USA and Europe, but for many years no breeding was reported. In the USA, 11.17.2 False gharials are held in 11 facilities (Zeigler 1995). Since 1990 Miami metro zoo reported that Tomistoma will only breed in small groups (1 male) and in very undisturbed circumstances. The species has elaborate courting behaviour (Schwedick 2000) and aggression among pairs is also a problem Zeigler 1995). The species is slow growing and has to achieve large size (females 10 feet, males 12 feet) for maturity. Recent studies of the species in the field indicate that the natural distribution of the species may be in small groups occupying separate pools in their river and palm swamp habitat and nesting site requirements seem to be quite specific (Bezuijen et al 1998, 2001, Stuebing et al. 1998) . When these factors are addressed in captivity, breeding occurs and is now reported for Miami Zoo the Thailand (U. Youngprapakorn pers. Comm.) and Sarawak (Huchzermayer 2002) groups and a privately held captive pair in Florida (Shwedick 2001).

Anon (1998a) reports a total of seventy-eight (78) *T. schlegelii* present in sixteen (16) collections worldwide, but no recorded captive propagation. Anon (1995) reports the species being bred in captivity at Alborg Zoo, Denmark in 1994. Bristol Zoo lists *T. schlegelii* in its UK Joint Management of Species Program (http://www.bristolzoo.org.uk/conservation/breeding). In 1995 the Crocodilian Advisory Group of the American Association of Zoos and Aquaria recommended establishing a SSP Program for *T. schlegelii* that targeted American zoos.

Assessment - DIFFICULT

Literature Cited

Anon (1995) - Reptiles Bred in Captivity and Multiple Generation Births. Int. Zoo Yearbook, vol.35 p356

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Huchzermayer F. 2001. A visit to the Tomistoma breeding farm in Kuching, Sarawak, East Malaysia. Crocodile Specialist Group Newsletter Vol20(4):76-77.

Shwedick, B. 2000. Tomistoma hatched at Cypress gardens. Crocodile Specialist Group Newsletter Vol19(1):18-19.

Stuebing, R. B., E. Lading & Johnson Jong. 1998. The status of the false gharial in Sarawak. Pp. 1-9 In Crocodiles, Proceedings of the 14th Working Meeting of the Crocodile Specialist Group, IUCN-World Conservation Union, Gland.

Zeigler W.F. 1995. Regional studbook False gavial Tomistoma schlegelii., Miami Metrozoo Miami USA:

Gavialis gangeticus

Gavialis gangeticus is distributed in parts of northern India, Pakistan and Nepal.

Although moderate numbers are represented in numerous zoological collections worldwide (Anon, 1998a), there appears to be extremely limited captive propagation of the species. One zoo in Japan (Higashi-Izu Zoo) is reported to breed *G. gangeticus* on a regular basis (Anon, 1998b).

Egg incubation techniques are well understood for this species following a successful recovery program, managed by the Indian Government in the 1970s, that was based on an intensive collection and incubation of eggs and subsequent release of juveniles. The gharial is being bred in captivity for release at eight breeding centres and 31 zoos in India. However, increasing problems have been experienced with the high cost of captive breeding and the paucity of potential release sites. A Population and Habitat Viability Analysis in 1995 evaluated captive breeding success and modelled (Rao et al 1995).

Assessment - NOT DIFFICULT

Literature Cited

Anon, (1998a) – Census of Rare Animals in Captivity 1996-97, Int. Zoo Yearbook. vol.36 pp562-64.

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RYNCHOCEPHALIA

***Sphenodon* spp**

Although the CITES nomenclature currently only recognizes two species, *viz. Sphenodon guntheri* and *Sphenodon punctatus*, a third undescribed taxon, closely related to *S. punctatus*, has been identified. All three taxa are endemic to New Zealand and have been subject to intensive research, primarily for the purpose of securing the long-term conservation of populations in the wild. Relative to other terrestrial reptiles, the ecology and physiology of *Sphenodon* spp are quite different (Cree *et al.* 1994). However, for the purposes of the present exercise, the biology of all three species is considered sufficiently similar to enable them to be treated as a single taxon.

Cree and Daugherty (1990) provide the first comprehensive review of captive breeding of tuatara. Despite considerable numbers of adult tuatara being placed into captivity and numerous attempts to breed the species in captivity, no captive-bred juvenile tuatara had, at that time, been raised to sexual maturity. In that review, the authors recommended that further research in specified areas was required to improve the success of captive breeding. In a subsequent review, Cree *et al.* (1994) note that age to reproductive maturity and longevity of wild *S. guntheri* remain unknown, but *S. punctatus* from Stephens Island attain maturity at about 11-13 years. Cartland-Shaw *et al.* (1998), because of the presence of reabsorbing follicles, infer a reduced egg production and quality by captive adult females. Other data suggest that egg production and/or hatching rates in captivity have been low compared to the wild (Cree and Daugherty, 1990). Cree *et al.* (1994) suggest that, because the physiology and ecology of *Sphenodon* spp are sufficiently different to other reptiles, available general information on captive husbandry of reptiles may not be applicable. Therefore, specific research is required to provide solutions to husbandry problems of tuatara.

Cree and Daugherty (1990) identify several factors mitigating against successful captive husbandry, *viz.* low reproductive success, unacceptably high adult mortality and low numbers of juveniles hatched in captivity compared to that possible in the wild. As a consequence, the captive management component of the tuatara Recovery Plan has focused on the artificial incubation of eggs collected from the wild in preference to closed-cycle captive breeding. Incubation technology appears to have been largely overcome because in a subsequent review, Cree *et al*. (1994) note that; "Although *Sphenodon* eggs can be incubated in captivity with a high probability of hatching, success in rearing juveniles has not been good".

Blanchard (pers. comm., 2002), based on studbook data current to 2001, provides achievements in the captive production of tuataras. Five institutions presently breed the undescribed species from Cook Strait. In 2001, a captive population of 12 males and 10 females produced 104 neonates with 16.4 percent mortality (Blanchard, pers. comm., 2002). Three institutions currently breed *S. punctatus.* A total captive population of eleven pairs of adults, in 2001, produced 90 neonates with 8.9 percent mortality (Blanchard, pers. comm., 2002). There has been no captive production of *S. guntheri* as there remains only one specimen of this species in captivity in New Zealand. With the establishment, in 1995, of a captive population of *S. guntheri*, the San Diego Zoological Society became the only other facility to hold this species (http://www.sandiegozoo.org). *Sphenodon* spp are assessed as difficult to breed in captivity.

Assessment - DIFFICULT (both species)

Literature Cited

Cartland-Shaw, L. K., Cree, A. Skeaff, C. M. and Grimmond, N. M. (1998) – Differences in the dietary and plasma fatty acids between wild and captive populations of a rare reptile, the tuatara (*Sphenodon punctatus*). J. Comp. Physiol. B. **168**:569-580

Cree, A., and Daugherty, C. H. (1990) – Captive breeding of the New Zealand tuatara: past results and future directions. pp477-491. *In* B. L. Dresser, R. W. Reece and E. J. Maruska (*Eds*), Proceedings of the Fifth World Conference. on Breeding Endangered Species in Captivity. Cincinnati Zoo and Botanical Gardens, Cincinnati, Ohio

Cree, A., Daugherty, C. H. Towns, D. R. and Blanchard, B. (1994) – The Contribution of Captive Management to the Conservation of Tuatara (*Sphenodon*) in New Zealand. pp377-385. *In* J. B. Murphy, K. Adler and J. T. Collins (*Eds*) Captive Management and Conservation of Amphibians and Reptiles. Society for the Study of Amphibians and Reptiles, Ithaca (New York). Contributions to Herpetology, vol.11.

SAURIA

Brachylophus fasciatus

Brachylophus fasciatus is a medium-sized, oviparous lizard, with primarily arboreal habits, that is endemic to Fiji and Tonga. Captive colonies of *B. fasciatus* became established in the late 1970s as part of an *ex situ* conservation effort for the species. Since that time, numerous Australian, New Zealand and North American zoological collections feature captive populations of *B. fasciatus*. Taronga Zoo has succeeded in producing second-generation offspring (Harlow, pers. comm. 2002). The main goal of the *B. fasciatus* Conservation Management Plan (CMP) is to maintain existing populations in Australasian zoos for the purpose of providing an analogue species for zoos wishing to participate in the *Brachylophus vitiensis* CMP (http://www.arazpa.org.au/reptiles).

The species appears to adapt readily to captive conditions and reproduction in captivity appears to be a relatively straightforward process. The first reported captive production of a juvenile occurred in 1980 at Knoxville Zoo (http://www.halcyon.com/slavens), however the resulting animal did not survive. This animal was derived from the mating reported by Arnett (1979). Since that time, the production of captive-bred animals has become a regular annual event reported by zoological gardens (Anon, 1982, Boylen, 1989, Kinkaid, 1997 and Banks, pers comm. 2002) and private collections located in Europe (http://www.geocities.com/Petsburgh/9086/images/brachylophus2). The Zoological Society of San Diego manages the *Brachylophus fasciatus* Studbook and is actively remitting specimens to other zoos to establish breeding colonies (Dolan, 1999).

Assessment - NOT DIFFICULT

Literature Cited

Anon (1982) – Fijian iguana hatches. Zoonooz, **55** (1) pp4-15.

Arnett, J. R. (1979) – Breeding the Fijian Banded Iguana at the Knoxville Zoo. International Zoo Yearbook. **19** pp78-79.

Boylen, T. (1989) – Reproduction of the Fijian Banded Iguana at the Taronga Zoo, Sydney. International Zoo Yearbook. **28** pp126-130

Dolan, J. M. (1999) – Annual Report of the Zoological Society of San Diego (http://www.zoonews.ws).

Kinkaid, J. (1997) – Captive Breeding of the Fijian Banded Iguana. Vivarium Magazine, vol.8, no.5.

Brachylophus vitiensis

Brachylophus vitiensis is an extremely rare lizard that was first described in 1979 and is confined to a few small islands in the northwest of the Fiji Group. This species is almost exclusively arboreal, rarely descending to the forest floor except to lay eggs.

An *ex situ* conservation program for the species commenced in 1985 with the establishment of a captive colony at Taronga Zoo, Sydney. Taronga Zoo was also able to achieve a successful breeding event from this colony in the same year. Since that time captive-bred offspring have been produced regularly each year (http://www.halcyon.com/slavens) and second-generation offspring has been produced (Harlow, pers. comm. 2002). A captive-breeding colony of the species has also been established at Kula Eco Park, Fiji. At present, there are approximately 30 animals held in five (5) Australasian zoological collections, including Fiji (Banks, pers. comm. 2002).

Assessment - NOT DIFFICULT

Cyclura carinata

Cyclura carinata is confined to the Bahamas and comprises two subspecies; the nominate form, *carinata* (Turks and Caicos Is) and *bartschi* (Southern Bahamas Islands).

There is a historic record in the North American Studbook of eight (8), unsexed specimens of *C. carinata* (Gies, pers. comm. 2002). However, there are no legal specimens currently held in captivity in the United States, nor is there any coordinated breeding program for the species (http://www.cyclura.com, Hudson, pers. comm., 2002). Furthermore, Hudson (pres. comm.

2002) regards the validity of the two subspecies as doubtful. On the basis of the information obtained, the captive propagation potential of *Cyclura carinata* remains unknown.

Assessment - UNKNOWN (both subspecies)

Cyclura collei

Cyclura collei is confined to Jamaica. Hope Zoo in Jamaica has, for several years, managed a captive colony of more than 100 animals derived from a wild animal head-starting program. The facility has had little success at propagating the species (http://www.fortworthzoo.com). A single hatchling appeared in a head-start enclosure, apparently the result of unobserved mating and nesting. Breeding collections comprising twenty-three adults (eleven males and twelve females) are held in 6 US zoos. These animals were derived from two importations from Hope Zoo in 1994 and 1996 in an attempt to breed the species in captivity. At the time of compiling this report, *Cyclura collei* has not been successfully bred in captivity.

Assessment - DIFFICULT

Cyclura cornuta

Cyclura cornuta comprises two recognized subspecies. The nominate race, *cornuta* occurs on the island of Hispaniola (Dominican Republic and Haiti). The remaining subspecies, *stejnegeri* is confined to Mona Island.

Cyclura cornuta cornuta has been held and successfully bred for many years in Santo Domingo Zoo, Dominican Republic, where, over the period 1974-1994 an average of 100 offspring have been produced annually (http://www.scz.org/iguana). This subspecies has, and continues to be bred regularly without difficulty, through several generations, in approximately 20 *ex-situ* facilities in Australia, Europe and North America (Hudson, pers. comm. 2002). It is regarded as the most fecund *Cyclura* sp and many zoological institutions have ceased breeding programs involving *cornuta*, in favour of concentrating on more endangered forms of *Cyclura* (Grant, pers. comm. 2002). Taronga Zoo, Sydney, has successfully bred the subspecies *cornuta*, since 1978, having produced 142 offspring, many of which have been returned to the Dominican Republic (Dengate, 2000 in http://www.burkesbackyard.com.au). Numerous other successful breeding events are well documented in several issues of the International Zoo Yearbook. Specimens of this species are widely kept and bred in private collections in the United States and Europe. Regarded by most expert keepers (Hudson, pers comm. 2002) as being reliably and easily bred in captivity.

The remaining subspecies, *stejnegeri* is morphologically indistinguishable from the nominate race. As a consequence, there is some uncertainty about the validity of this subspecies, which may in fact simply represent a population of *Cyclura c. cornuta* introduced onto Mona Island (Hudson, pers comm. 2002). There are no known specimens of *Cyclura c. stejnegeri* held or bred in captivity, however, Hudson (pers. comm. 2002) suspects it highly likely that this form would be easy to breed in captivity.

Assessment - *Cyclura cornuta cornuta* - NOT DIFFICULT;
Cyclura cornuta stejnegeri - UNKNOWN

Cyclura cychlura

Cyclura cychlura comprises three subspecies, all of which are confined to the Bahamas. The nominate race, *cychlura* is restricted to Andros Island; *figginsi* occurs on Exuma Island and *inornata* on Allens Cay.

Very few specimens of any subspecies are held in captivity (Blair, 2000). *Cyclura c. figginsi is the only subspecies* rumoured to have been bred in captivity on one occasion in a private collection. However, there is some suspicion that this resulted from the illegal collection of a gravid female from the wild. Other than this doubtful record, there is no breeding program in the range State or any *ex situ* institution for any subspecies.

Attempts documented by Ardastra Zoo in the Bahamas to breed the subspecies, *cychlura* and *inornata* in the 1980s (http://www.halcyon.com/slavens/blizc) identified problems associated with egg fertility and/or egg incubation conditions (humidity and mold). Until such time as more recent information indicates otherwise, *Cyclura cychlura* (including all its composite subspecies) should be regarded as difficult to maintain and breed in captivity.

Assessment - DIFFICULT (all subspecies)

Cyclura nubila

Cyclura nubila comprises three subspecies. The nominate form, *nubila*, is endemic to Cuba. The remaining two subspecies are confined to the Cayman Islands. *Cyclura n. lewisi* occurs on Grand Cayman and *Cyclura n. caymanensis* occurs on Little Cayman and Cayman Brac.

In Cuba, *Cyclura nubila nubila* is held and bred extensively in captivity. There are "several hundred" in *ex situ* captivity and bred in North America and Europe (Blair, 2000). This subspecies, which is also bred professionally and made widely available to hobbyists, as well as *Cyclura n. lewisi*, is known to grow very fast for a *Cyclura,* reaching maturity at three years.

The total captive population of *Cyclura nubila lewisi* is thirty (30) males and twenty (20) females. A breeding facility for this subspecies was established on Grand Cayman in 1990. Managed by the Cayman Islands National Trust, the Centre achieved captive propagation in its first year of operation. The breeding adults comprise eight (8) males and five (5) females. With the exception of 2000 when all the eggs laid were infertile, neonates have been produced each year since 1990. the 2000 failure was dietary related which was addressed. As a result of the change in diet, the Centre achieved a record production of seventy (70) neonates in 2001 (Burton, pers. comm. 2002). The captive population of *Cyclura n. lewisi* in the United States presently stands at fourteen animals (8:6) distributed in five zoological collections. These animals have been derived from a pair of wild-caught founders. There are very few pure *caymanensis* held and bred in captivity in the United States (Blair, 2000). A national database on reptile breeding in the United States (http://www.halcyon.com/slavens) cites one private collection breeding significant numbers of *caymanensis*. Numerous US collections hold and breed *Cyclura lewisi-caymanensis* hybrids (http://members.aol.com/cyclura99, Hudson, pers. comm. 2002). Knapp (1993) reports on the successful production of second-generation specimens of *Cyclura nubila caymanensis*, however, it is not known whether the captive-bred parental animals, obtained from an institution in Florida, were hybrid animals. Hudson (pers. comm. 2002) presumes that all three subspecies are easy to breed in captivity. Burton (pers. comm. 2002) considers *lewisi* as an extremely easy species to breed in captivity.

Assessment - NOT DIFFICULT (all subspecies)

Literature Cited

Knapp, C. (1993) – Captive Husbandry and Reproduction of the Cayman Island Rock Iguana (*Cyclura nubila caymanensis*). Captive Breeding, vol.1 pp4-7 *et seq*.

Cyclura pinguis

Cyclura pinguis is endemic to Anegada Island in the British Virgin Islands. Very few specimens of this species are present in captive collections (Blair, 2000). There has been extremely limited breeding success with *C. pinguis*. The National Trust of the British Virgin Islands, with funding from US institutions, recently constructed a new captive facility where *C. pinguis* can be bred and reared for eventual release back into their native habitat (http://www.scz.org/iguanas/aneig).

A privately held breeding group in North America produced just a single hatchling, which subsequently died. Some of the animals that were part of this breeding group were transferred to San Diego Zoo, (where there exists considerable expertise in *Cyclura* captive breeding), which recently (December 2001) reported again the production of a single hatchling. Lemm, pers. comm. 2002) advised that San Diego Zoo that had recently succeeded in breeding the species. Until more is known on the captive husbandry of *Cyclura pinguis*, this species is regarded by Hudson (pers. comm., 2002) as difficult to breed in captivity despite considerable effort.

Assessment - DIFFICULT

Cyclura ricordi

Cyclura ricordi is confined to the island of Hispaniola (Dominican Republic and Haiti) where it is sympatric with *Cyclura c. cornuta*. There were fourteen (14) specimens of *C. ricordi* known to be held in captivity in 1995 (Blair, 2000).

A breeding group held for many years at ZooDom (Dominican Republic) produced a single offspring in 1980s, however there has been no further breeding event. The present status of captive breeding in the Dominican Republic facility may be doubtful in view of a recommendation by Blair (2000) that the captive-breeding program at ZooDom should be re-established. A captive group held in Indianapolis Zoo produces egg clutches with variable proportions of fertile eggs, that have not been able to be incubated successfully to produce hatchlings (http://www.halcyon.com/slavens/blizc). The limited numbers of offspring that have been produced have all died shortly after hatching (Hudson, pers. comm. 2002). On the basis of the breeding results achieved to date, Hudson (pers. comm., 2002) classifies *Cyclura ricordi* as a taxon that is difficult to breed in captivity.

Assessment - DIFFICULT

Cyclura rileyi

Cyclura rileyi comprises three subspecies, each of which is endemic to a particular island in the Bahamas; the nominate race, *rileyi* occurs on San Salvador Island; the subspecies, *cristata* on White Cay and *nuchalis* on Acklins Cay.

There is no organized captive-breeding program for this species in the Bahamas. A small number of animals are held illegally in Europe and the United States, but no successful breeding has been reported. One European respondent commented that *C. rileyi* is extremely aggressive species that is difficult to breed in captivity. Captive females produce very few eggs, some of which are invariably infertile. Hudson (pers. comm., 2002) considers that all subspecies of *C. rileyi* can be presumed to be difficult to breed in captivity.

As a general comment, Hudson (pers. comm., 2002) has expressed the view that there are significant differences in breeding biology between the different species of *Cyclura.* As a consequence, it is not possible to infer the ease or difficulty of breeding poorly known species in captivity from other better known species.

Assessment - DIFFICULT (all subspecies)

Literature Cited

Blair, D. W. (2000) – West Indian Iguanas of the Genus *Cyclura*, their Current Status in the Wild, Conservation Priorities and Efforts to Breed them in Captivity (http://images.cyclura.com).

Gallotia simonyi

Gallotia simonyi is a large-sized, terrestrial lizard endemic to the Spanish island of Hierro in the Canary Islands. In 1985 the Canary Islands Autonomous Government, with funding under the LIFE Program of the European Commission, has initiated the first phase of a "Plan for the Recovery of the Giant Lizard of El Hierro". One of the principal objectives of the first phase of the Plan entailed the establishment of a captive colony for the purpose of producing animals for use in a re-introduction program and re-establishing viable populations of the species in nature. Under the LIFE Program, two universities on the Canary Is collaborate with the European Herpetological Society in various studies to select appropriate release sites (http://www.islaelhierro.com/fauna/lagarto_salmor). However, it was not possible to obtain any information from this website, or other sources, whether the involvement of the European Herpetological Society in the Project included Society members maintaining and breeding *G. simonyi* to assist in producing captive-bred animals for re-introduction program.

A breeding centre has been constructed that is managed, and comprises facilities, for captive production of lizards as well as public exhibition. Very little detailed, published information has been readily available, however, it seems apparent that *G. simonyi* adapts well to captive conditions and is able to be readily induced to reproduce in artificial terraria. The first production, although not captive-bred, occurred in 1986 when twenty-one (21) juvenile lizards were born from two pregnant females that were captured a few months earlier. Since then, the number of captive-bred births has increased steadily and now exceeds 380 individuals (http://www.gobcan.es/medioambiente/eng/biodiversidad/)

Assessment - NOT DIFFICULT

Varanus komodoensis

Varanus komodoensis is endemic to the Indonesian Archipelago where it occurs on four (4) small islands. In 1998 (the most recent published information retrieved), a total global captive population of 272 (65:50:157) animals was reported in the International Species Inventory System (ISIS), housed in 49 Institutions (http://www.kingsnake.com/monitorfaq/species). Thirty-eight (38) of these animals were wild-caught specimens.

The first successful captive breeding of *V. komodoensis* occurred at the Gembira Loka Zoo in Yogyakarta, Indonesia in 1968 (Busono, 1974). In addition to Indonesia, the species is represented in two (2) zoos in Australia, two (2) in Asia (http://www.kingsnake.com/monitorfaq/species) and eight (8) zoological collections in Europe (http://www.zoonews.ws). As of 1998, the only successful captive breeding of *V. komodoensis* had occurred in the United States, where the species has been bred by the National Zoological Park, Washington DC (1982), Cincinnati Zoo (199?) and Miami Metro Zoo (1998). Since 1982 when the National Zoological Park first succeeded in breeding *Varanus komodoensis*, captive-bred juvenile Komodo Dragons have been distributed to a total of 25 zoological institutions around the world (http://www.abdn.ac.uk/~nhi770/komodoensis). In 2000 Gembira Loka Zoo at Yogyakarta produced second-generation captive-bred offspring of *Varanus komodoensis* and, according to available information, remains the only place to have achieved this feat.

Because of the large size reached by adults, captive husbandry and management of *Varanus komodoensis* presents special problems. The use of chemical restraints is important, if not essential, for the responsible and safe handling of large specimens. Experiences in the United States during the 1980s demonstrated that captive lizards do not adapt well to or breed in under-sized, sterile cages with limited heat sources (http://www.kingsnake.com/monitorfaq/species).

In addition to other unsourced expositions on the captive management of species in International Zoo Yearbooks, there is an extensive literature on the biology and husbandry of captive *V. komodoensis*. Detailed accounts may be found in Arnett and Bekiares (1998), Brongersma (1932), Busono (1974), Jones (1965), Tanzer and Van Heurn (1938), Lederer (1942), Oesman (1967), Galstaun (1973) and Lange (1989), Sudharto (1988) and Walsh et al. (1993, 1999)

In summary, although *V. komodoensis* is presently held in a large number of institutions around the world, successful captive breeding is somewhat more confined. Provided adequate facilities and management are adequate, the species appears to adapt well to captive conditions. Despite its large size and the need therefore to provide appropriate accommodation and associated husbandry requirements (*e.g*. food), *Varanus komodoensis* has been assessed as not difficult to maintain and breed in captivity.

Assessment - NOT DIFFICULT

Literature Cited

Arnett, J. & Bekiares, N. (1998) – International Studbook for the Komodo Dragon, *Varanus komodoensis*. Cincinnati Zoo, Cincinnati, Ohio 47pp.

Brongersma, L. D. (1932) – Uber die Eiablage und die Eier von *Varanus komodoensis*. Zool. Garten, **5** pp45-48

Busono, B. (1974) – Facts about *Varanus komodoensis* at the Gembira Loka Zoo at Yogyakarta. Zool. Garten, Leipzig, **4** (1/2) pp62-63.

Galstaun, B. (1973) – Eiablagen des Komodowarans (*Varanus komodoensis*) im Zoologischen und Botanischen Garten Jakarta. Zool. Garten NF **43** (2/3) pp136-139

Jones, M. L. (1965) – The Komodo Dragon Lizard, *Varanus (Placovaranus) komodoensis*, Owens 1912. Exhibition and Longevity in Captivity Unpubl. Manuscript 50pp and VIII Appendices.

Lange, S. (1989) – Observations on the Komodo Dragon in the Zoo-Aquarium Berlin. Int. Zoo Yearbook **28** pp151-153.
Lederer, G. (1942) – der Drachenwarane (*Varanus komodoensis*). der Zool. Garten NF **14** (5/6) pp227-244.
Oesman, H. (1967) – Breeding Behaviour of *Varanus komodoensis* at Yogyakarta Zoo. Int. Zoo Yearbook **7** pp10-11
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Walsh, T. Roscoe, R. and Birchard, G. F. (1993) – Dragon Tales : The History, Husbandry and Breeding of Komodo Monitors at the National Zoological Park. Vivarium Magazine, **4** (6) pp23-26.
Walsh, T. Chiszar, D., Wikramanayake, E., Smith, H. M. and Murphy, J. B. (1999) – The Thermal Biology of Captive and Free Ranging Wild Komodo Dragons, *Varanus komodoensis* (Reptilia: Sauria: *Varanidae*) Mertensiella, in press 8pp.

SERPENTES

Acrantophis dumerili

A medium-sized, terrestrial constricting snake, that is endemic to Madagascar. Adult specimens can reach lengths in excess of 2.5 metres, but are reproductively mature in captivity at 1.2-1.5 metres.

The species takes food readily and adapts well to captive conditions, being regarded generally as easy to keep and breed in captivity. Huff (1984) provides useful information on the husbandry requirements of the species under captive condition. Significant numbers are kept in captivity in zoological collections and amongst private breeders and reptile hobbyists in North America and Europe. Saint Louis Zoo reports that *Acrantophis dumerili* is subject to an AZA Species Survival Plan in which it participates with several other North American zoos (http://www.stlzoo.org). Captive-bred snakes are advertised on the internet (http://www.herpo.com/boas), (http://www.jsreptiles.com/body price) and (http://www.kingsnake.com/whri/whripric). Fogel (1997) notes that this species is bred in captivity more frequently that *A. madagascariensis.*

Assessment - NOT DIFFICULT

Literature Cited

Fogel, D. (1997) – Captive Husbandry and Propagation of the Boa Constrictors and Related Boas. Krieger Publishing Co. Florida 98pp.
Huff, T. A. (1984) – the Husbandry and Propagation of the Madagascar Ground Boa (*Acrantophis dumerili*) in Captivity. Acta Zoologica et Pathologica Antverpiensia. Bulletin de la Societe Royale de Zoologie d'Anvers, Antwerp. Nov.1984, No.78 pp255-270.

Acrantophis madagascariensis

A medium- to large-sized, arboreal snake, endemic to Madagascar. Although significant numbers of this species are present in zoological and private collections in North America and Europe, Fogel (1997) notes that *A. madagascariensis* is infrequently bred in captivity. Significant numbers of this species are kept in zoological collections and by private reptile hobbyists in North America and Europe. Branch and Erasmus (1976), Branch (1982), Huff (1984) and McKeown (1989) provide accounts on the husbandry requirements and reproduction by *A.*

madagascariensis in captivity. Captive-bred specimens are advertised for sale in the trade (http://www.natures-images.co.uk).

In December 1997, the CITES Management Authority of South Africa sought registration for a captive breeding program involving *A. madagascariensis* by the Transvaal Snake Park (Secretariat Notification No.1006 of 19 December 1997). Although the operation does not appear to have been registered, it does indicate that the species has been bred in captivity to the second generation. The species is common and regularly propagated in private collections in Antananarivo, Madagascar (Jenkins, pers. obs., 1998, 2001). Contrary to the remark by Fogel (1997), this species appears to adapt well to and breeds readily in captivity.

Assessment - NOT DIFFICULT

Literature Cited

Branch, w. R. (1982) – The status and captive breeding potential of African and Madagascan boids. In Proc. 6th Annual Reptile Symposium on Captive Propagation and Husbandry. pp224-247. Zoological Consortium Inc. Thurmont MD

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McKeown, S. (1989) – The First Captive Breeding of the Madagascar Ground Boa (*Acrantophis madagascariensis*) in North America from Long Term Adults. In Captive Propagation and Husbandry of Reptiles and Amphibians, pp69-76. Northern California Herp. Soc. Special Publication #5.

Epicrates monensis

The Mona/Virgin Islands Boa, *Epicrates monensis*, comprises two subspecies; the nominate subspecies *monensis,* occurs on Mona Island. The remaining subspecies, *granti,* is confined to Puerto Rico and St Thomas, US Virgin Islands.

Both subspecies appear to breed readily in captivity, however the species does not appear to be held in any significant numbers outside of North American zoological collections. Fogel (1997) and Tolson (1980, 1989, 1992 and1994) provide advice on husbandry requirements and captive propagation of *E. monensis* and other insular *Epicrates* spp. The two subspecies are the subject of Species Survival Plans in which several North American zoos are presently participating. The SSP for *E. monensis monensis* was initiated in 1994, whereas the captive population and breeding program for *E. monensis granti* was commenced several years earlier in 1990. Under the programs, both subspecies have bred regularly each year since their initial breeding event.

Assessment - NOT DIFFICULT

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Epicrates subflavus

Epicrates subflavus is a medium-sized, semi-arboreal snake that is endemic to Jamaica. Hope Zoo in Kingston, Jamaica maintains a breeding colony of the species and, although births occurred regularly, inadequate husbandry resulted in a high mortality rate among the neonates (Ettling, 1998). Training received from some North American zoos has addressed former husbandry deficiencies at Hope Zoo (Ettling, 1998). Bloxam (1977) and Fogel (1997) provide useful information on copulation and neonate feeding behaviour observed in captive specimens,

E. subflavus appears to adapt well to captive conditions and breeds readily in captivity. Specimens of this species are represented in numerous zoological and private collections in North America and Europe. Bloxam & Tonge (1986) report the production at Jersey Zoo of 233 offspring in an eight (8) year period (1976-1984), most of which entered trade and were sold to private collectors. The progeny of privately held, captive-bred *E. subflavus* are regularly advertised for sale on commercial websites (http://www.ncherps.com/available_now).

Assessment - NOT DIFFICULT

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Casarea dussumieri

Casarea dussumieri is a small terrestrial boid snake confined to Round Island in the West Indian Ocean, where it is critically endangered.

The largest known captive population of *C. dussumieri* is located at Jersey Zoo, where fourteen (14) animals have been held since being collected from the wild in 1977 and 1978. Certain other select zoological collections also contain the species (Fogel, 1997).

In 1998, twenty-six (26) offspring were produced from four clutches, thereby ending an eight-year absence of breeding (Gibson, 1998). Although the captive animals at Jersey Zoo bred sporadically during the 1980s, hatching success was always very low. Since 1990, all eggs produced were either infertile or failed to hatch for other reasons. Gibson (1998) attributes the recent breeding successes to dietary changes by supplementing mice with vitamin D_3 and additional calcium.

Bloxam (1980) reports that wild-caught specimens initially proved difficult to feed in captivity and would only accept house geckoes. It seems likely house geckoes provided an acceptable surrogate for their natural prey species, which comprises *Phelsuma guentheri* and *Leiolopisma telfairii* (Bloxam, 1984). *C. dussumieri* is the only oviparous boid snake, producing a clutch of 3-11 eggs (Bloxam and Tonge, 1986). Bloxam and Tonge (1986) have observed that neonate *C. dussumieri* (because of the small size) are difficult to rear in captivity and providing an acceptable diet proves challenging. Bloxam (pers. comm. in Fogel, 1997) reports a reduction in reproductive vigour of captive snakes.

Assessment - DIFFICULT

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Sanzinia madagascariensis

The Malagasy tree boa (*Sanzinia madagascariensis*) is endemic to Madagascar. Specimens of this attractive snake are widely kept in private and zoological collections in Europe and North America. Gibson (1998) reports that the Jersey Wildlife Preservation Trust has maintained two (2) wild-caught pairs of the species since 1991. Shortly after their arrival at Jersey Zoo, one of the females gave birth to eight (8) offspring. In the same report, Gibson (1998) considers this species to be difficult to maintain in captivity, noting, that since the initial captive birth at Jersey Zoo, the species has been bred by a British zoo on only one (1) occasion. By comparison, captive propagation of this species appears to be more commonly achieved in zoological and private collections in North America (Groves and Mellendick, 1973 and McLain, 1984). The presence of captive-bred specimens of *S. madagascariensis* being advertised through a UK-based website (http://www.natures-image.co.uk) appears to contradict Gibson's (1998) observation on breeding this species in captivity.

Assessment - NOT DIFFICULT

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Vipera ursinii

The present subspecific taxonomy of *Vipera ursinii* is unclear. The following subspecies, occurring in different arts of Europe, are generally recognized as valid taxa, *viz. wettsteini* (France), *ursinii* (Italy), *rakosiensis* (Austria, Romania, Hungary and Bulgaria), *moldavica*

(Romania), *macrops* (Yugoslavia and Greece [= *graeca*] and Albania) and *renardi* (Turkey [= *anatolica*] and Romania). Only two subspecies (*rakosiensis* and *moldavica*) are recognized by the IUCN as threatened.

The subspecies occurring in various parts of western Europe appear to be held extensively among private collectors and are reported to breed readily in captivity. Pronk (pers. comm. 2002) reports breeding *Vipera u. renardi* (obtained from the Moscow Zoo) to the third generation. The lowland forms from temperate regions (*rakosiensis, moldavica* and *renardi*) are generally believed to breed readily in captivity provided animals are healthy, well fed (especially females) and are permitted to hibernate and receive periods of gradual "post-hibernation" warming.

Assessment - PROVISIONALLY NOT DIFFICULT

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Addendum

Taking into account that both Resolution Conf. 11.14 and Decision 11.101 both refer to a list or Annex 3 defined by species;

a) critically endangered in the wild and/or,

b) known to be difficult to breed in captivity,

it is clear that the Annex 3 list can be compiled using one or the other or both the criteria.

Accordingly, taking into account the list or taxa presented in table 2 of the report and using either of the criteria, there are 53 of the 75 taxa considered that might be listed on Annex 3 as critically endangered or difficult to breed.

Additionally, the 'difficult to breed in captivity' could be applied to the 19 species on Appendix I that have not been assigned IUCN categories. A preliminary evaluation (without any new data) suggests that nine of these might be classed as difficult to breed; and added to the Annex 3 list.