CONSERVATION ASSESSMENT AND MANAGEMENT PLAN FOR IGUANIDAE AND VARANIDAE

WORKING DOCUMENT

December 1994

Report from the workshop held
1-3 September 1992

Edited by
Rick Hudson, Allison Alberts, Susie Ellis, Onnie Byers

Compiled by the Workshop Participants

A Collaborative Workshop

AZA Lizard Taxon Advisory Group

IUCN/SSC Conservation Breeding Specialist Group

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1 December 1994

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Though the Iguanid & Varanid CAMP workshop was conducted in September 1992, the review and update process has been ongoing for two years in an effort to produce an accurate account. It is the hope of the compilers that this document reflects the current state of knowledge of the conservation status of these two important groups of lizards.

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IGUANIDAE
CONSERVATION ASSESSMENT AND MANAGEMENT PLAN

EXECUTIVE SUMMARY

Iguanid taxa were reviewed taxon-by-taxon to assign a category of threat and to recommend intensive conservation action. The recommendations contained in the Iguanid Conservation Assessment and Management Plan are based only on conservation criteria; adjustments for political and other constraints will be the responsibility of regional plans.

For this exercise, 67 distinct taxa (subspecies or species if no subspecies are contained therein) of iguanas were considered. Forty-eight of the 67 taxa (72%) were assigned to one of three categories of threat, based on the Mace-Lande criteria:

Critical	3 taxa
Endangered	12 taxa
Vulnerable	21 taxa
Susceptible	12 taxa

Seventeen taxa were assigned to the Secure category, according to Mace-Lande criteria. An additional two taxa were not assigned to a category of threat because of insufficient information.

Twenty-six of the 67 taxa (39%) were recommended for Population and Habitat Viability Assessment workshops.

Research or management was recommended in the following categories:

Survey	58 taxa
Wild management	42 taxa
Taxonomic research	40 taxa
Husbandry research	28 taxa

Thirty-three of the 67 Iguanid taxa (49%) were recommended for one of three captive program levels (based in part on Mace-Lande criteria):

Level 1	14 taxa
Level 2	17 taxa
Level 3	2 taxa

For 20 taxa, a decision on a captive program will depend upon further data either from a PHVA, a survey, or existing identified sources to be queried.

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Varanid taxa were reviewed taxon-by-taxon to assign a category of threat and to recommend intensive conservation action. The recommendations contained in the Varanid Conservation Assessment and Management Plan are based only on conservation criteria; adjustments for political and other constraints will be the responsibility of regional plans.

For this exercise, 66 distinct taxa (subspecies or species if no subspecies are contained therein) of varanids were considered. Nineteen of the 66 taxa (28%) were assigned to one of three categories of threat, based on the Mace-Lande criteria:

Critical	0 taxa
Endangered	0 taxa
Vulnerable	19 taxa

Thirty-seven taxa were assigned to the Secure category, according to Mace-Lande criteria. An additional 10 taxa were not assigned to a category of threat because of insufficient information.

Two of the 66 taxa (3%) were recommended for Population and Habitat Viability Assessment workshops.

Research or management was recommended in the following categories:

Survey	43 taxa
Wild management	22 taxa
Taxonomic research	46 taxa
Husbandry research	30 taxa

Eighteen of the 66 Varanid taxa (27%) were recommended for one of three captive program levels (based in part on Mace-Lande criteria):

Level 1	0 taxa
Level 2	3 taxa
Level 3	15 taxa

For 10 taxa, a decision on a captive program will depend upon further data either from a PHVA, a survey, or existing identified sources to be queried.

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SECTION 1

WORKSHOP SUMMARY AND RECOMMENDATIONS

STATUS: IUCN:**ENDFIELD**
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IGUANIDAE AND VARANIDAE
CONSERVATION ASSESSMENT AND MANAGEMENT PLAN

Introduction

Reduction and fragmentation of wildlife populations and habitat is occurring at a rapid and accelerating rate. For an increasing number of taxa, the results are small and isolated populations at the risk of extinction. A rapidly expanding human population, now estimated at 5.25 billion, is expected to increase to 8 billion by the year 2025. This expansion and concomitant utilization of resources has momentum that will not be quelled, and which will lead to a decreased capacity for all other species on the planet.

As wildlife populations diminish in their natural habitat, wildlife managers realize that management strategies must be adopted that will reduce the risk of extinction. These strategies will be global in nature and will include habitat preservation, intensified information gathering, and in some cases, scientifically managed captive populations that can interact genetically and demographically with wild populations.

The successful preservation of wild species and ecosystems necessitates development and implementation of active management programs by people and governments living within the range area of the species in question. The recommendations contained within this document are based on conservation need only; adjustments for political and other constraints are the responsibility of regional governmental agencies charged with the preservation of flora and fauna within their respective countries.

Conservation Assessment and Management Plans (CAMPs)

Within the Species Survival Commission (SSC) of IUCN-The World Conservation Union, the primary goal of the Conservation Breeding Specialist Group (CBSG) is to contribute to the development of holistic and viable conservation strategies and management action plans. Toward this goal, CBSG is collaborating with agencies and other Specialist Groups worldwide in the development of Conservation Assessment and Management Plans (CAMPs), both on a global and a regional basis, with the goal of facilitating an integrated approach to species management for conservation.

CAMPs provide strategic guidance for the application of intensive management techniques that are increasingly required for survival and recovery of threatened taxa. CAMPs are also one means of testing the applicability of the Mace-Lande criteria for threat as well as the scope of its applicability. Additionally, CAMPs are an attempt to produce ongoing summaries of current data for groups of taxa, providing a mechanism for recording and tracking of species status.

In addition to management in the natural habitat, conservation programs leading to viable populations of threatened species may sometimes need a captive component. In general, captive populations and programs can serve several roles in holistic conservation: 1) as genetic and demographic reservoirs that can be used to reinforce wild populations wither by revitalizing populations that are languishing in natural habitats or by re-establishing by translocation populations that have become depleted or extinct; 2) by providing scientific resources for information and technology that can be used to protect and manage wild populations; and 3) as living ambassadors that can educate the public as well as generate funds for *in situ* conservation.

It is proposed that, when captive populations can assist species conservation, captive and wild populations should, and can be, intensively and interactively managed with interchanges of animals occurring as needed and as feasible. Captive populations should be a support, not a substitute for wild populations. There may be problems with interchange between captive and wild populations with regard to disease, logistics, and financial limitations. In the face of the immense extinction crisis facing many insular taxa, these issues must be addressed and resolved within the next several years.

The first Conservation Assessment and Management Plan (CAMP) workshop for lizards was conducted in Vancouver, BC on 1-3 September 1992. This CAMP examined two very important families, the Varanidae (monitors) and Iguanidae (large iguanines). These two groups were chosen for evaluation based on a number of factors, primarily their high degree of visibility combined with a high percentage of taxa under some degree of threat.

Conservation concerns

Although only 60 of the approximately 3,000 species of extant lizards attain an adult body mass greater than 1 kg, large lizards represent over 60% of lizard species considered threatened or endangered (IUCN 1994). There are several reasons why large lizards have been more adversely affected than small lizards. Small lizards generally have modest-sized home ranges and are able to adapt to the presence of human intervention. Many anoles, geckos, fence lizards, and lacertids actually flourish in urban and suburban situations. In addition, many large lizards are hunted either for food or skins, a problem not experienced by smaller species (Fitch et al. 1982). Most large lizards belong to two families, the Iguanidae or the Varanidae. Even though large iguanas and monitor lizards are only distantly related, many management and conservation protocols may be applicable to both groups because they share the common features of prominent size, human exploitation, and the need for sizable tracts of undisturbed habitat.

The majority of reptile extinctions over the last 10,000 years have occurred on islands, and have been the direct result of human disturbance (Case & Bolger 1991; Case et al. 1992). Because of their low metabolic rates and naturally high population densities, lizards in many mainland habitats are relatively resistant to extinction. However, due to their restricted ranges and small population sizes, lizards on islands are susceptible to a variety of threats. Primary among these are introduced predators and competitors, habitat alteration and fragmentation, over hunting, loss of genetic diversity, and increased susceptibility to natural disasters, particularly to fires and tropical storms. Because reptiles are generally poor over-water dispersers, recolonization following local extirpation on islands is rare. The increased vulnerability of island forms makes it extremely important that they be monitored regularly.

Habitat fragmentation

Extensive habitat fragmentation now exists in most regions of the world. In general, extinction risk increases with the degree of habitat fragmentation (Soulé et al. 1992). Because of their proximity to human influence, habitat fragments are particularly susceptible to fire, higher rates of hunting and poaching, and greater intensities of predation and parasitism. As the distance between remnant habitat patches increases, dispersal becomes restricted, limiting opportunities for recolonization and preventing genetic exchange between isolated subpopulations. Reptiles are especially vulnerable to habitat fragmentation and local extirpation because many are ecological specialists and exhibit little migratory behavior, especially through suboptimal habitats.

For conservation assessment purposes, habitat fragmentation also potentially induces a serious error in range estimates. Overestimates of current geographical ranges may occur when species with historically large, continuous ranges experience habitat modification or fragmentation. In these cases, local extinctions may raise only minimal concern if it is erroneously assumed that the species is still abundant elsewhere and can recolonize depleted or regionally extinct populations. In fact, recolonization by reptiles is difficult at best, and in many cases impossible without active management efforts.

Genetic diversity

Small populations lose genetic variation as a consequence of genetic drift more rapidly than large populations (Franklin 1980; Lacy 1987). Loss of genetic variation results in higher levels of homozygosity, associated with poor growth, higher frequencies of disease, and decreased survival during periods of stress (Soulé & Simberloff 1986). Over the long term, depletion of genetic variation in small populations can lead to an inability to adapt to changing environmental conditions, and ultimately to population extinction (Lacy 1987; Lande & Barrowclough 1987).

For vertebrates in general, a minimum effective population size of 500 individuals is considered essential to maintain quantitative genetic variation in wild populations (Franklin 1980). Recommended numbers for captive populations, based on the retention of 90% of genetic variation for 200 years, are generally lower than this (Foose et al. 1986). Studies are needed to estimate the relationship between effective population sizes and actual population numbers in reptiles. Demographic data, studies on loss of genetic variation in captive populations over time, and information on genetic drift in wild populations can be useful in this regard. Investigations of genetic variation in lizard populations are increasing (Soulé & Yang 1972; Soulé et al. 1973; Gorrnan et al. 1975; Adest 1977; Bock & McCracken 1988; Moritz et al. 1990; Dessauer and Cole 1991; Lamb et al. 1992; Arevalo et al., in press), but more information would be of value, especially to document the degree of differentiation among local populations (suspected to be greater than in mammals and birds), to discover cryptic species, and to resolve taxonomic uncertainties.

Increased levels of inbreeding reduce reproductive performance, resulting in increased infertility, stillbirths, a higher frequency of juvenile mortality, physical abnormalities, slower growth rates, poorer male mating ability, skewed sex ratios, and greater susceptibility to disease (Wright 1977; Ralls et al. 1988; Falconer 1989). Data are lacking, but anecdotal evidence suggests that reptiles suffer inbreeding depression in a similar manner to other species. Clearing of habitat and other human activities increase the vulnerability of local populations to inbreeding depression. In these cases, translocation of individuals between populations may need to be carried out to avoid genetic problems. Experimental data on the natural migration potential of various lizard species would be of value in assessing the need for active management in order to retain adequate levels of genetic diversity and avoid deleterious effects of inbreeding.

Research priorities

Field Surveys

For many, if not most, large lizards, geographic ranges are inadequately documented. More field work is needed to determine not only the limits of species' distributions, but also the relative densities of lizard populations within those limits. For in situ conservation purposes, differentiating between areas of prime habitat, where lizard densities are high, and marginal habitat, where lizard densities can be substantially lower, is imperative in order to identify sites that can potentially serve as reserves. Such information will be especially useful for wide ranging species for which management over the entire geographical range may be logistically impractical or politically unfeasible.

Demographic data regarding sex ratios, age structure, and variance in reproductive success, combined with information on the degree of population fragmentation and animal movement patterns, will be important for assessing the relative vulnerability of different large lizard taxa. Together with reliable population estimates, such data will provide the basis for the strategic allocation of the limited captive resources currently available for lizard conservation programs. Use of quantitative methodology in population surveys (transect data and/or mark-recapture techniques, for example) is recommended whenever possible to permit objective comparisons among species. Because activity and movement patterns of lizards often vary seasonally, multiple surveys at different times of year are advisable to ensure the accuracy of density estimates.

Taxonomic studies

As with most other vertebrates, current taxonomy of lizards is based primarily on studies of morphology, which may or may not reflect significant genetic differentiation between populations. Incorrect taxonomy may result in inappropriate management, including inadvertent hybridizations or failure to recognize distinct forms (Daugherty et al. 1990). In particular, lizard species with wide geographical ranges (green iguanas, Iguana iguana, and Nile monitors, Varanus nflotisus, are notable examples) should be examined for the existence of unidentified subspecies. The availability of recently developed molecular techniques for genetic analysis, including mitochondrial DNA sequence analysis and characterization of hypervariable microsatellites, should help resolve some of these problems. Currently, these technologies are being applied to determining the number of founders represented in captive groups of the highly endangered Jamaican iguana (Cyclura collei), as well as to resolving hybridization problems within the captive population of Grand Cayman iguanas (C. nubila lewisi).

Where there is no genetic basis for the assignment of subspecific status, lizard populations both in captivity and in the wild should be managed as metapopulations. Although management of distinct forms will help guarantee that genetic variation within species is maintained, there may be instances in which populations have declined such that genetic fitness of the species as a whole is compromised without interbreeding of as many individuals as possible. Because a variety of factors enter into the decision whether or not to manage subpopulations separately in captivity, this issue needs to be evaluated individually for each species. Studies should be undertaken to assess the degree of hybridization that may already exist in both wild and captive lizard populations, as this information will have important implications for future management decisions.

Husbandry research

Whenever possible, dietary requirements, home range or territory sizes, and mating systems should be determined through field studies in natural habitats. Information gained through field studies will comprise the basic elements necessary to develop comprehensive conservation plans for managing both wild and captive populations. For some lizard species, populations in the wild may be so depleted that such studies are either impractical, or the manipulations required to carry them out would be detrimental. In such cases, examination of a closely related species with similar ecological requirements may prove useful.

Studies of reproductive hormone cycles in free-ranging lizards are also needed. Data from natural populations are especially germane in this regard because the physiological stress involved with captive, high-density situations can lead to reproductive dysfunction (Alberts 1994). Aberrant hormone cycles can be important initial indicators of abnormal reproductive cycling (Lance 1990), and as such, can point to areas where additional active management may be necessary.

Finally, there is a need to develop standardized artificial egg incubation techniques to permit comparisons between lizard propagation programs at different institutions and among different lizard species. If a standard range of temperatures and hydric conditions can be identified and utilized experimentally, then it should be possible to determine the optimum incubation parameters for each species in question. Once sufficient data are available, the use of species-specific incubation techniques that produce the healthiest, most viable hatchlings should be utilized, particularly if reintroduction is the ultimate goal.

The Iguanid and Varanid CAMP Process

The CAMP process assembles expertise on wild and captive management for the taxonomic group under review in an intensive and interactive workshop format. The purpose of the Iguanid and Varanid Conservation Assessment and Management Plan (CAMP) workshop was to assist in the development of a conservation strategy for Iguanidae and Varanidae, and to continue to test the applicability of the Mace-Lande criteria. On 1-3 September 1992, six individuals met in Vancouver, British Colombia to review, refine, and develop further conservation strategies for iguanas and monitor lizards. This group was self-selected from some 75 individuals invited to attend a CAMP workshop for Varanidae, Iguanidae, Boidae, and Pythonidae and represented field biologists, wildlife experts, conservation biologists, academic scientists, and captive managers. Participants are listed in Section 9.

Participants worked together to: 1) determine best estimates of the status of all iguanas and monitors; 2) assign each taxon to a Mace-Lande category of threat; and 3) identify areas of action and information needed for conservation and management purposes.

The assessments and recommendations of each of the working groups for each taxon were circulated to the entire group prior to final consensus by all participants, as represented in this document. Summary recommendations concerning research management, assignment of all taxa to threatened status, and captive breeding were supported by the workshop participants.

CAMP Workshop Goals

The goals of the Iguanid and Varanid CAMP workshop were:
1) To review the population status and demographic trends for iguanids and varanids, to test the applicability of the Mace-Lande criteria for threat, and to discuss management options for iguanid and varanid taxa.

2) To provide recommendations for *in situ* and *ex situ* management, research and information-gathering for all iguanid and varanid taxa, including: recommendations for PHVA workshops; more intensive management in the wild; taxonomic research, survey, monitoring, investigation of limiting factors, taxonomy, or other specific research.

3) Produce a discussion draft Conservation Assessment and Management Plan for Iguanidae and Varanidae, presenting the recommendations from the workshop, for distribution to and review by workshop participants and all parties interested in Iguanid and Varanid conservation.

Assignment to Mace-Lande Categories of Threat

All iguanid and varanid taxa were evaluated on a taxon-by-taxon basis in terms of their current and projected status in the wild to assign priorities for conservation action or information-gathering activities. The workshop participants applied the criteria proposed for the redefinition of the IUCN Red Data Categories proposed by Mace and Lande in their 1991 paper (Section 4, Appendix II). The Mace-Lande scheme assesses threat in terms of a likelihood of extinction within a specified period of time (Table 1). The system defines three categories for threatened taxa:

Critical 50% probability of extinction within five years or two generations, whichever is longer.

Endangered 20% probability of extinction within 20 years or 10 generations, whichever is longer.

Vulnerable 10% probability of extinction within 100 years.

Definitions of these criteria are based on population viability theory. To assist in making recommendations, participants in the workshop were encouraged to be as quantitative or numerate as possible for two reasons: 1) Conservation Assessment and Management Plans ultimately must establish numerical objectives for viable population sizes and distributions; 2) numbers provide for more objectivity, less ambiguity, more comparability, better communication, and hence cooperation. During the workshop, there were many attempts to estimate if the total population of each taxon was greater or less than the numerical thresholds for the three Mace-lande categories of threat. In many cases, current population estimates for iguanid taxa were not available or were available for taxa within a limited part of their distribution. In all cases, conservative numerical estimates were used. **Where population numbers are estimated, these estimates represent first-attempt, order-of-magnitude guesstimates that are hypotheses for falsification. As such, the workshop participants emphasize that these guesstimates should not be used as an authoritative estimate for any other purpose than was intended by this process.**

Table 1. MACE-LANDE CATEGORIES AND CRITERIA FOR THREAT

POPULATION TRAIT	CRITICAL	ENDANGERED	VULNERABLE
Probability of extinction	50% within 5 years or 2 generations, whichever is longer	20% within 20 years or 10 generations, whichever is longer	10% within 100 years
	OR	**OR**	**OR**
	Any 2 of the following criteria:	Any 2 of following criteria or any 1 CRITICAL criterion	Any 2 of following criteria or any 1 ENDANGERED criterion
Effective population N_e	$N_e < 50$	$N_e < 500$	$N_e < 2{,}000$
Total population N	N < 250	N < 2,500	N < 10,000
Subpopulations	≤ 2 with $N_e > 25$, N > 125 with immigration < 1/generation	≤ 5 with $N_e > 100$, N > 500 or ≤ 2 with $N_e > 250$, N > 1,250 with immigration < 1/gen.	≤ 5 with $N_e > 500$, N > 2,500 or ≤ 2 with $N_e > 1{,}000$, N > 5,000 with immigration < 1/gen.
Population Decline	> 20%/yr. for last 2 yrs. or > 50% in last generation	> 5%/yr. for last 5 years or > 10%/gen. for last 2 years	> 1%/yr. for last 10 years
Catastrophe: rate and effect	> 50% decline per 5-10 yrs. or 2-4 generations; subpops. highly correlated	> 20% decline/5-10 yrs, 2-4 gen > 50% decline/10-20 yrs, 5-10 gen with subpops. highly correlated	> 10% decline/5-10 yrs. > 20% decline/10-20 yrs. or > 50% decline/50 yrs. with subpops. correlated
OR			
Habitat Change	resulting in above pop. effects	resulting in above pop. effects	resulting in above pop. effects
OR			
Commercial exploitation or Interaction/introduced taxa	resulting in above pop. effects	resulting in above pop. effects	resulting in above pop. effects

In assessing threat according to Mace-Lande criteria, workshop participants also used information on the status and interaction of habitat and other characteristics. Information about population trends, fragmentation, range, and stochastic environmental events, real and potential, were also considered.

Numerical information alone was not sufficient for assignment to one of the Mace-Lande categories of threat. For example, based solely on numbers, a taxon might be assigned to the Vulnerable or Secure category. Knowledge of the current and predicted threats or fragmentation of remaining natural habitat, however, may lead to assignment to a higher category of threat.

In several cases, there was not enough information available for assignment to one of the three categories of threat; these taxa are listed as unknown or questionable. Assignment to Mace-Lande categories of threat for the 67 Iguanid taxa and 66 Varanid taxa examined during this CAMP exercise are presented in Tables 2 and 3. Specific taxa within each category are presented the spreadsheets in Sections 3 and 6. Taxon data sheets for each threatened taxa can be found in Section 4 and 7.

Table 2. Threatened Iguanid Taxa - Mace-Lande Categories of Threat

MACE-LANDE CATEGORY	NUMBER OF TAXA	PERCENT OF TOTAL
Critical	3	5%
Endangered	12	18%
Vulnerable	21	32%
Secure	17	24%
Susceptible	12	18%
Unknown/ questionable	2	3%
TOTAL	67	100%

Table 3. Threatened Varanid Taxa - Mace-Lande Categories of Threat

MACE-LANDE CATEGORY	NUMBER OF TAXA	PERCENT OF TOTAL
Critical	0	0%
Endangered	0	0%
Vulnerable	19	29%
Secure	37	56%
Susceptible	0	0%
Unknown/ questionable	10	15%
TOTAL	66	100%

Recommendations for Intensive Management and Research Actions

Following standard CBSG criteria, recommendations have been listed for research in three main areas: survey, taxonomy, and husbandry. However, it is important to note that research in natural history is also a major need for many threatened taxa. Field information on natural history is lacking for many species and it would materially assist captive breeding programs to have this information available at the inception of captive management. Of particular importance is information on life history parameters (e.g., life span, time to reach sexual maturity, reproduction information such as seasonal reproductive cycles and reproductive rates, diet, habitat requirements, and interspecific interactions such as predation, competition, and co-evolutionary mutualisms. The rarer a taxon becomes in the wild, the more difficult it becomes to obtain such information for reproducing wild populations. It should be a priority to obtain such information for species listed as Vulnerable before they shift to Endangered or Critical status.

For all taxa, recommendations were generated for the kinds of intensive actions that were felt to be necessary for conservation. These recommendations, summarized in Tables 4 and 5, were: Population and Habitat Viability Assessment (PHVA) workshops; wild management; survey; taxonomic research; and husbandry research. PHVA workshops provide a means of assembling available detailed biological information on the respective taxa, evaluating the threats to their habitat, development of management scenarios with immediate and 100-year time-scales, and the formulation of specific adaptive management plans with the aid of simulation models. In many cases, workshop participants determined that the current level of information for a taxa was not adequate for conduction of a PHVA; in those cases, recommendations are listed as "PHVA Pending."

Workshop participants attempted to develop an integrated approach to management and research actions needed for the conservation of iguanid taxa. In all cases, an attempt was made to make management and research recommendations based on the various levels of threat impinging on the taxa. For the purposes of the CAMP process, threats were defined as "immediate or predicted events that are or may cause significant population declines." Recommendations are summarized in Tables 4 and 5.

Table 4. Iguanidae management and research recommendations

MACE-LANDE	PHVA	WILD MANAGEMENT	SURVEY	TAXONOMIC RESEARCH	HUSBANDRY RESEARCH
Critical	3	3	3	2	3
Endangered	11	12	12	9	10
Vulnerable	9	19	19	12	11
Secure	0	3	11	9	1
Susceptible	2	1	2	1	1
Unknown	1	4	11	8	2
TOTAL	26	42	58	40	28

Table 5. Varanidae management and research recommendations

MACE-LANDE	PHVA	WILD MANAGEMENT	SURVEY	TAXONOMIC RESEARCH	HUSBANDRY RESEARCH
Critical	0	0	0	0	0
Endangered	0	0	0	0	0
Vulnerable	2	14	17	12	12
Secure	0	6	16	24	16
Susceptible	0	0	0	0	0
Unknown	0	10	10	10	2
TOTAL	2	43	46	46	30

Captive Program Recommendations

For some of the Iguanidae and Varanidae taxa, it was determined that a captive component would be necessary to contribute to the maintenance of long-term viable populations. It is proposed that, when captive populations can assist species conservation, captive and wild populations should be intensively and interactively managed with interchanges of animals occurring as needed and as feasible. There may be problems with interchange between captive and wild populations with regard to disease, logistics, and financial limitations.

For captive recommendations generated during the CAMP workshop, the level of captive program is defined by genetic and demographic objectives and subsequently the target population required to achieve these objectives.

Level 1 (1) - A captive population is recommended as a component of a conservation program. This program has a tentative goal of developing and managing a population sufficient to preserve 90% of the genetic diversity of a population for 100 years (90%/100). The program should be further defined with a species management plan encompassing the wild and captive populations and implemented immediately with available stock in captivity. If the current stock is insufficient to meet program goals, a species management plan should be developed to specify the need for additional founder stock. If no stock is present in captivity then the program should be developed collaboratively with appropriate wildlife agencies, SSC Specialist Groups, and cooperating institutions.

Level 2 (2) - Similar to the above except a species/subspecies management plan would include periodic reinforcement of captive population with new genetic material from the wild. The levels and amount of genetic exchange needed should be defined in terms of the program goals, a population model, and species management plan. It is anticipated that periodic supplementation with new genetic material will allow management of a smaller captive population. The time period for implementation of a Level 2 program will depend on recommendations made at the CAMP workshop.

Level 3 (3) - A captive program is not currently recommended as a demographic or genetic contribution to the conservation of the species/subspecies but is recommended for education, research, or husbandry.

Other captive recommendations include:

No (N) - A captive program is not currently recommended as a demographic or genetic contribution to the conservation of the species/subspecies. Taxa already held in captivity may be included in this category. In this case species/subspecies should be evaluated either for management toward a decrease in numbers or for complete elimination from captive programs as part of a strategy to accommodate as many species/subspecies as possible of higher conservation priority as identified in the CAMP or in SSC Action Plans.

Pending (P) - A decision on a captive program will depend upon further data either from a PHVA, a survey, or existing identified sources to be queried.

During the CAMP workshop, all iguanid and varanid taxa were evaluated relative to their current need for captive propagation. Recommendations were based upon a number of variables, including: immediate need for conservation (population size, Mace-Lande status, population trend), need for or suitability as a surrogate species, need for research populations to establish husbandry and management guidelines, as components of head-start/recovery programs. Based on all of the above considerations, in addition to threats, recommendations for captive programs were made. These recommendations, by Mace-Lande category of threat, are presented in Tables 6 and 7.

Table 6. Captive program recommendations for Iguanids by Mace-Lande threat category.

MACE-LANDE	Level 1	Level 2	Level 3	No	Pending
Critical	3	0	0	0	0
Endangered	11	0	0	0	1
Vulnerable	0	13	0	0	8
Secure	0	0	1	12	4
Susceptible	0	4	1	2	5
Unknown	0	0	0	0	2
TOTAL	14	17	2	14	20

Table 7. Captive program recommendations for Varanids by Mace-Lande threat category.

MACE-LANDE	Level 1	Level 2	Level 3	No	Pending
Critical	0	0	0	0	0
Endangered	0	0	0	0	0
Vulnerable	0	3	8	3	3
Secure	0	0	6	28	5
Susceptible	0	0	0	0	0
Unknown	0	0	1	7	2
TOTAL	0	3	15	37	10

The participants in and reviewers of the Iguanidae and Varanidae CAMP workshop wish to emphasize that we do not view the recommendations of this document as "stand-alone" initiatives. Rather, the reader is encouraged to see these activities as components of the overall need for the conservation of ecosystems in which iguanas and monitor lizards are found. The Iguanidae and Varanidae are excellent candidates (as bio-indicators, key species or flagships) to help facilitate larger-scale conservation programs. We therefore urge their inclusion in the planning stages of projects related to research, monitoring, and management of protected areas and other natural ecosystems.

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WORKING DOCUMENT

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Compiled by the Workshop Participants

SECTION 2

SUMMARY OF IGUANID INFORMATION

ENDFIELD
ENDRECORD

Summary of Iguanid Information
by
Allison Alberts, Co-Chair
AZA Lizard Advisory Group
Zoological Society of San Diego

For the most part, the family Iguanidae is a New World group of lizards, with the majority of taxa occurring in North, Central, and South America, the Galapagos Islands, and the Antilles. However, there are two notable exceptions, a single genus on Fiji and Tonga, and two genera on Madagascar. The South Pacific iguanas (genus *Brachylophus*), which have clear affinities to other iguanids, are thought to have arrived from the Americas via natural rafting on floating vegetation (Cogger 1974; Gibbons 1982). The Malagasy forms *Chalarodon* and *Oplurus* together form a natural group, but their relationship to other iguanids is ancient and ambiguous. Evidence from plate tectonics theory suggests that this group may have descended from early stock differentiating in South America that reached Madagascar via Antarctica during the breakup of Gondwanaland (Blanc 1982).

A large proportion of extant iguanids inhabit islands, with every genus represented by at least one insular form. Several iguanid genera are restricted entirely to islands (*Amblyrhynchus, Brachylophus, Conolophus, Cyclura, Chalarodon, Oplurus*). Because of their limited distribution and the fragility of the habitats in which they occur, most iguanids on islands are threatened or endangered, some critically so. Predation by feral cats, dogs, and mongooses undoubtedly constitutes the greatest threat, although competition with goats for food and consumption of eggs by feral pigs are also significant problems. For mainland populations, habitat loss and hunting for food pose the most serious dangers. Illicit trade is also becoming a conservation concern for certain highly attractive forms regardless of distribution, including *Ctenosaura palearis, Cyclura cychlura figginsi, C. ricordi, C. rileyi cristata, Sauromalus varius, and Oplurus fierinensis.*

The majority of the iguanids are slow growing, long-lived, and have a primarily herbivorous diet. Although occasionally two or three species of iguanids may overlap in distribution, usually only a single species is represented in any given area. When more than one species does occur, there is often a separation by habitat type, frequently into moist and dry environments. Despite those specializations, indigenous iguanids often represent the predominating vertebrate species with respect to biomass in undisturbed habitats, particularly on islands (Iverson 1979; Case 1982). However, in disturbed habitats, populations may be severely depleted relative to the expected carrying capacity. Because iguanid lizards are potentially important seed dispersers for many native plants (Iverson 1985), their loss has serious consequences for the ecosystems they inhabit.

It was the purpose of this Conservation Assessment and Management Plan Workshop to review the conservation status of iguanid lizards as comprehensively as possible. From this information, recommendations for conservation action were developed, including the need for active management of the wild population, the utility of formal population and habitat viability analyses

(PHVA), identification of gaps in knowledge where additional research would be of value, and the potential role of captive propagation programs in population preservation and recovery.

Of the iguanid taxa ranked as critical or endangered, all were insular forms, underscoring the extreme vulnerability of island taxa to human disturbance. Prevalent among this group were the West Indian iguanas, genus *Cyclura* and *Iguana delicatissima*, reflecting the fact that most of the larger islands in the Caribbean archipelago are densely populated by people and suffer from extensive environmental degradation and the ill effects of introduced species. Although estimated population numbers for *I. delicatissima* were higher than for other endangered iguanids, this species is undergoing an extremely rapid rate of decline as a result of habitat loss and fragmentation, competition with introduced goats, predation by exotics, and hybridization with *I. iguana*.

A susceptible category was utilized to highlight taxa that are not currently threatened, but may be at future risk because of their restricted geographic range and/or sensitivity to human activities (Mace et al. 1993). Several taxa consisting of less than 10,000 individuals on a single island were given this designation. Even in the absence of anthropogenic threats, as a result of their limited distribution these taxa are vulnerable to natural disasters such as fires and tropical storms. *Brachylophus fasciatus*, which has declined precipitously on many islands as a result of forest destruction and mongoose predation, was also designated susceptible. Likewise, although *Iguana iguana* occupies an immense geographic range, many local populations have undergone serious declines due to over hunting and extensive habitat fragmentation.

For all iguanid lizard taxa except those designated as secure and those for which it would be logistically unfeasible, active management of the wild population was recommended. Although in most cases this designation simply reflected the need for greater in situ protection and monitoring of key populations, active repatriation programs are underway for certain species and planned for others that will form an important part of overall conservation efforts for these taxa (e.g., *Conolophus subcristatus, Cyclura collei, C. nubila lewisi, and C. pinguis*). PHVA workshops were recommended for many of the more vulnerable forms, including both species of *Brachylophus*, several of the declining *Ctenosaura, Oplurus cuvieri comorensis*, and all of the West Indian iguanas. Although quantitative data are scanty for many species, the success of the recent PHVA for the Jamaican iguana underscored the value of these workshops for bringing together expertise on particular taxa and focusing international attention on their conservation needs.

Research recommendations for iguanid lizards fell into three categories, including the need to resolve taxonomic uncertainties, the need for more intensive surveys of wild populations, and the need to develop suitable husbandry protocols. Within the iguanids, many taxonomic groups are still not well defined, particularly the radiations of *Ctenosaura* on the Central American mainland, the insular chuckwallas (*Sauromalus*), and *Cyclura* throughout the West Indies. Molecular genetic assessment of all island populations of the marine iguana, *Amblyrhynchus cristatus*, would also be of value (Patton 1984). *Iguana iguana* exhibits extensive phenotypic and ecological variation across its range and should probably be examined for the existence of unrecognized subspecies. Further research is needed to confirm the genetic distinctiveness of the two species of *Brachylophus*, as well as their potential for hybridization in nature (Zug 1991).

Survey work was recommended for the majority of taxa, except in cases where populations were thought to be accurately estimated and relatively safe. Only two taxa were deemed insufficiently known to designate Mace/Lande status (*Ctenosaura similis multipunstata* and *Sauromalus obesus multiforminatus*), indicating that further survey work is needed for these forms. Before captive programs can be implemented, basic husbandry parameters will also need to be developed and refined for several iguanid taxa. However, in several cases it was stressed that development of on-site management programs for wild populations should occur prior to initiation of captive programs.

In general, Level 1 captive programs were recommended for those iguanid taxa ranked as critical or endangered. The vulnerability of these taxa to extirpation in the wild necessitates the development of captive programs as a hedge against extinction. A recent space survey completed by the AZA Lizard TAG yielded promising results in terms of the number of institutions willing and able to adequately house large iguanids, particularly *Cyclura*. The success of institutions currently holding *Cyclura* bodes well for initiation of future programs with other species in this genus. The recent formulation of a captive management strategy for the critically endangered Jamaican iguana should serve as a model for the implementation of genetically sound captive breeding programs for other rare iguanids (Hudson 1993).

Recommendations for Level 2 captive programs were generally given for vulnerable or susceptible taxa. Because their situation in the wild is not as precarious, these programs need not be developed as quickly as Level 1 programs. Nevertheless, it was felt that captive programs formed a valuable component of overall conservation efforts for these taxa. Level 3 programs were recommended for a few taxa with educational and research value already existing in sizable numbers in zoos. Although Galapagos marine iguanas are severely threatened by feral cats on several islands, recommendations for captive programs are pending development of on-site management strategies and a better understanding of the husbandry requirements of this physiologically unique species.

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SECTION 3

SPREADSHEET CATEGORY DEFINITIONS AND SPREADSHEETS FOR ALL IGUANID TAXA

IGUANIDAE AND VARANIDAE
CONSERVATION ASSESSMENT AND MANAGEMENT PLAN (CAMP)
SPREADSHEET CATEGORIES

The Conservation Assessment and Management Plan (CAMP) spreadsheet is a working document that provides information that can be used to assess the degree of threat and recommend conservation action.

The first part of the spreadsheet summarizes information on the status of the wild and captive populations of each taxon. It contains taxonomic, distributional, and demographic information useful in determining which taxa are under greatest threat of extinction. This information can be used to identify priorities for intensive management action for taxa.

1) SCIENTIFIC NAME: Sources for Iguanids: Burghardt, G.M. and A.S. Rand. 1982. Iguanas of the World. Noyes, Park Ridge, NJ. Sources for Varanids: Checklists from Bohme (1982, 1988) and Hudson (1992; see unpublished checklist and bibliography, this publication).

2) RANGE: Information obtained from a wide variety of published sources.

3) ESTIMATED NUMBER: Obtained from either workers in the field or published reports. When these were unavailable, best guesses were made. Although admittedly flawed, this methodology was the most practical alternative given the lack of current data available for many of the species surveyed. In almost all cases, further systematic field surveys are required in order to refine population estimates. In a few cases, divergent population estimates were obtained from different investigators. The most recent estimates available were used in these instances. When known the year(s) the survey was made was indicated.

4) SUBPOPULATIONS: For purposes of this review, most mainland forms are considered to exist as a single contiguous population, unless otherwise known contain to geographically isolated populations. Island populations were considered as distinct subpopulations in all cases. Although not taken into account in our designation of subpopulation number, we recognize the fact that habitat fragmentation is resulting in formerly widespread species being broken up into numerous subpopulations, and that this process has important conservation implications (see discussion).

5) TRENDS: The S (stable), D (declining), and I (increasing) designations were used. Species from areas known to be undergoing extensive habitat destruction/alteration, known to be heavily exploited for the pet or hide trade, or known to be heavily hunted were assumed to be declining. In a few instances, an S designation was assigned if the population had been known to persist at low yet stable numbers over a long period of time.

6) AREA: The area categories that were originally included in the review materials were modified. Former categories were designed for mammal populations and for purposes of this exercise were found to be too large to apply to reptile populations. In addition, four new categories were created to deal with small island populations. The modified scale is below:

A: < 5,000 sq km
AA: < 5,000 sq km but on a geographic island
AA1: < 1,000 sq km but on a geographic island
AA2: < 100 sq km but on a geographic island
AA3: < 10 sq km but on a geographic island
AAA: > 5,000 sq km on a geographic island
B: 5,000 - 9,999 sq km
C: 10,000 - 49,999 sq km
D: 50,000 - 99,999 sq km
E: 100,000 - 499,999 sq km
F: 500,000 - 999,999 sq km
G: > 1,000,000 sq km

Areas are admittedly overestimated because they are based on the total known range rather than habitat actually occupied. For insular taxa, we listed the entire island range but recognize that species may not occupy this entire area. For example, marine iguanas live only in coastal areas.

7) MACE-LANDE STATUS: Each taxon was classified as S (safe), V (vulnerable), E (endangered), or C (critical) based on the criteria described earlier (see section). For purposes of this review, if a population was estimated at <10,000 and felt to be in decline and/or occurred only as a single isolated population, it was classified as vulnerable. However a "susceptible" category was later added in order to highlight taxa that are not currently threatened but may be at future risk because of their small range and susceptibility to human activities (Mace et al., 1993, Species 19:16-23). Detailed taxon reports were compiled on any taxon classified as V, E, or C and are contained in this report.

8) THREATS: The following designations were utilized which include four new categories not included in the original review document:

D = Disease
H = Hunting for food and/or other purposes
L = Loss of habitat
P = Predation
T = Trade for live animal or skin trade
Pe = Predation by exotics (cats, dogs, mongooses)
Ic = Interspecific competition (feral ungulates)
Fr = Habitat fragmentation
El = El Nino effects (for marine iguanas)

9) PHVA WORKSHOP: We were conservative in our recommendation of PHVA's and restricted this designation to those taxa that had M/L status designations of V, E, or C, and for which sufficient data and resources exist to conduct a meaningful workshop. Factors such as biological uniqueness (Gray's monitor), or ability to serve as a flagship or environmental indicator species (Komodo dragon, Fiji iguana) were also taken into consideration.

10) WILD MANAGEMENT: Wild management was recommended for all taxa listed as V, E, or C, and in every case where there was known exploitation (hunting, hide or pet trade) and some form of regulation (quotas, take limits, designated collecting seasons) was indicated. Minimally, this should imply ongoing population monitoring and survey work.

11) RESEARCH: Research of three types was recommended.

A. Survey: Field surveys were recommended when either the range, trend, or numbers were questionable.

B. Taxonomic: Taxonomic studies were recommended whenever there were taxonomic problems to be rectified (species vs subspecies) or where questions existed; was also recommended for species having extensive geographic ranges and for which the possibility of cryptic or unrecognized forms may exist (green iguana, Nile monitor).

C. Husbandry: Husbandry research was recommended for those taxa that either now or at some point in the future were felt to be in need of captive management, and for which the requirements are poorly known or are recognized as difficult to maintain or reproduce in captivity.

12) CAPTIVE PROGRAM: For purposes of this review, the numbers are based primarily on those listed in ISIS abstracts (current June 1994) unless supplemental information was available at the time of compilation. For Australian monitors, numbers are based on those reported in the Australian Species Management Plan (ASMP) Taxon Advisory Group Action Plan for Reptiles & Amphibians in Australian Zoos (current June 1994). In some cases, substantial numbers of some taxa exist in the private sector (Savannah and Nile monitors, for example), but these were not included because they are not available for captive management.

13) CAPTIVE RECOMMENDATION:

Definitions for the 4 population categories are as follows:

Level 1 (1) - A captive population is recommended as a component of a conservation program. This program has a tentative goal of developing and managing a population sufficient to preserve 90% of the genetic diversity of a population for 100 years (90%/100). This program should be further defined with a species management plan encompassing the wild and captive populations and implemented immediately with available stock in captivity. If the current stock is insufficient to meet program goals, a species management plan should be developed to specify the need for additional founder stock. If no stock is present in captivity then the program should be developed collaboratively with appropriate wildlife agencies, SSC Specialist Groups, and cooperating institutions.

Level 2 (2) - Similar to the above except a species/subspecies management plan would include periodic reinforcement of captive populations with new genetic material from the wild. The levels and amount of genetic exchange needed should be defined in terms of the program goals, a population model, and species management plan. It is anticipated that periodic supplementation with new genetic material will allow management of a smaller captive population. The time period for implementation of a Level 2 program will depend on recommendations made at the CAMP workshop.

Level 3 (3) - A captive program is not currently recommended as a demographic or genetic contribution to the conservation of the species/subspecies but is recommended for education, research, or husbandry. For example, species for which husbandry, and in some cases taxonomic, research was recommended, Level 3 populations are ideally suited for these purposes. As envisioned here, the primary function of these populations is to conduct pilot programs to determine husbandry and management procedures for taxa that may require assistance from captive programs in the forseeable future. This type of population can also be utilized for short-term reintroduction projects.

No (N) - A captive program is not currently recommended as a demographic or genetic contribution to the conservation of the species/subspecies. Taxa already held in captivity may be included in this category. In this case species/subspecies should be evaluated either for management toward a decrease in numbers or for complete elimination from captive programs as part of a strategy to accommodate as many species/subspecies as possible of higher conservation priority as identified in the CAMP or in SSC Action Plans.

Pending (P) - A decision on a captive program will depend upon further data either from a PHVA, a survey, or existing identified sources to be queried.

In many situations, a captive program recommendation can not be made until taxonomic problems are resolved or additional survey work is completed. In some cases species that were considered safe were nevertheless recommended for captive programs based on the following:

1) a perceived future threat/vulnerability;
2) ability to serve as a flagship species;
3) degree of biological uniqueness;
4) the need to establish captive management guidelines or gain husbandry experience.

Each taxon was evaluated independently and on its own merit, and captive recommendations were based on need rather than the current allocation f captive resources.

Table 8. Critical and Endangered Iguanid taxa according to Mace-Lande criteria.

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
16.2	Cyclura	c.bartschi	Booby Cay (Bahamas)	200-300 '80s	1-2	D	AA-3	C	H,L,Pe,Ic	Y	Y	S,T,H	0	1
17	Cyclura	collei	Jamaica	<100 '90	1	D	AA-3	C	L,Pe	Y	Y	S,H	40	1
20.3	Cyclura	n.lewisi	Grand Cayman Is. (Cayman Islands)	<250 '80s	1	D	AA-3	C	Pe,L, O(genetics)	Y	Y	S,T,H	38-45	1
1.4	Amblyrhynchus	c.mertensi	San Cristobal Is. and Santiago Is. (Galapagos)	≤2,500	2	D	AA-2/1	E	El Niño, Pe	N	Y	S,T,H	0	PEND
18.3	Cyclura	c.stejnegeri	Mona Is.	2,000-4,000 '80s	1	S	AA-2	E	Pe,Ic	Y	Y	S,T	1	1
19.2	Cyclura	c.figginsi	Exuma Cays (Bahamas)	<1,000 '91	7	D	AA-2	E	H,Pe,L	Y	Y	S,T,H	30-40	1
19.3	Cyclura	c.inornata	U. Cay & Leaf Cay, possibly Allan's Cay (Bahamas)	400-500 '80s	2-3	S	AA-3	E	H	Y	Y	S,T,H	0	1
20.2	Cyclura	n.caymanensis	Cayman Islands, Cayman Brac and Little Cayman	<1,000 '80s	2	D	AA-2	E	H,Pe,L, D(road kills)	Y	Y	S,H,T	<20	1
21	Cyclura	pinguis	Anegada Is. and Guana Cay (introd. pop.)(British Virgin Is.)	<1,500 '88-92	2	D	AA-3	E	H,Pe,L,Ic	Y	Y	S,H	0	1
22	Cyclura	ricordii	Hispaniola	<2,500 '80s	2	D	AA	E	H,Pe,L	Y	Y	S,0	≤25	1
23.1	Cyclura	r.rileyi	C Bahamas	500-1,500 '80s	9+	D	AA-2	E	D,H,L,Pe	Y	Y	S,H	2-3	1
23.2	Cyclura	r.cristata	White Cay (Bahamas)	250-500 '87	1	S	AA-3	E	H,L,Pe	Y	Y	S,T,H	0	1
23.3	Cyclura	r.nuchalis	Crooked-Acklin's Group (Bahamas)	600 '80s	2	D	AA-1	E	H	Y	Y	S,T,H	1-2	1
25	Iguana	delicatissima	Lesser Antilles	<10,000 '80s	10	D	AA	E	H,L,Pe,Fr,Ic, O(hybridization)	Y	Y	S,T,H	9	1
34.2	Oplurus	c.comorensis	Grand Comoro Is. (Comoros)	<2,500 '80s	1	D	AA-3	E	L	Y	Y	S,T,H	0	1

Working Document

Table 9. Vulnerable Iguanid taxa according to Mace-Lande criteria.

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
1.1	Amblyrhynchus	c.cristatus	Fernandina Is. (Galapagos)	≤10,000 '91	1	D	AA-1	V	El Niño	N	Y	S,T,H	0	PEND
1.2	Amblyrhynchus	c.albemarlensis	Isabella Is. (Galapagos)	≤10,000 '91	1	D	AA/AAA	V	El Niño, Pe	N	Y	S,T,H	0	PEND
1.3	Amblyrhynchus	c.hassi	Santa Cruz Is. (Galapagos)	≤10,000 '91	1	D	AA-1	V	El Niño, Pe, I	N	Y	S,T,H	0	PEND
1.5	Amblyrhynchus	c.nanus	Genovesa Is. (Galapagos)	≤10,000 '91	1	D	AA-2	V	El Niño	N	Y	S,T,H	0	PEND
1.6	Amblyrhynchus	c.sielmanni	Pinta Is. (Galapagos)	UNK	1	D	AA-2	V	El Niño	N	Y	S,T,H	0	PEND
1.7	Amblyrhynchus	c.venustissimus	Espanola Is. and Gardner Is. (Galapagos)	≤10,000 '91	2	D	AA-1	V	El Niño	N	Y	S,T,H	0	PEND
3	Brachylophus	vitiensis	Yaduataba Is. (Fiji)	6,000-8,000	10+	D	AA-3	V	Pe,L,I, O (fire)	Y	Y	S,H,T	25-30	2
4	Conolophus	pallidus	Santa Fe Is. (Galapagos)	1,500-2,000	1	S	AA-2	V	NONE	N	N	S	0	PEND
5	Conolophus	subcristatus	Galapagos Archipelago, Fernandina, Isabela, Santa Cruz, Plaza Sur, Baltra, N. Seymour	UNK	6	UNK	AAA	V	Pe, Ic	N	Y	S	0	PEND
7	Ctenosaura	bakeri	Isla Utila (Honduras)	5,000-8,000	1	S	AA-3	V	H,L	Y	Y	T	0	2
8	Ctenosaura	clarki	Michoacan (Mexico)	>10,000 '82	1	S?	A	V	P,L	N	Y	S	3 not on ISIS	2
9	Ctenosaura	defensor	Campeche & Yucatan (Mexico)	>10,000 '80s	1	S?	A	V	T,P,Fr	N	Y	S	0	2
10.3	Ctenosaura	h.insulana	Cerralvo Is. (Mexico)	<10,000	1	S	AA-3	V	Ic, L	Y	Y	S	0	2
11	Ctenosaura	oedirhina	Roatan Is. (Honduras)	<10,000 '87	1	S	AA-2	V	P,L	Y, PEND TAX	Y	T	0	2
12	Ctenosaura	palearis	SE Guatemala & Isla de Chahinos (N Honduras)	<10,000 '87	3	D	A/AA-3	V	H,L,P,T	Y	Y	S,T,H	0 ISIS 5 other	2
16.1	Cyclura	c.carinata	Turks & Caicos, Smaller Cays only	<10,000 1975-92	15-20	D	AA-1	V	H,L,Pe	Y	Y	S	0	2

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
18.1	Cyclura	c.cornuta	Hispaniola; Tortue, Gonave, Petit Gonave, Grande Cayemite, Beata, Saoma Is.	< 10,000 '80s	10+	0	AA	V	H,L,Pe,Fr	Y	Y	S,O	353	2
19.1	Cyclura	c.cychlura	Andros Is. (Bahamas)	2,500-5,000 '80s	$\geq$3	0	AA	V	H,Pe,L,Ic	Y	Y	S,T,H	< 10	2
20.1	Cyclura	n.nubila	Cuba, Is. Maguayes, P.R.	> 10,000 '80s	50+	D	AA	V	Pe,L,Fr,O(fire)	Y	Y	S,H,T	40	2
32	Sauromalus	varius	Gulf of California isl. (Mexico)	< 10,000 '80s	1	S	AA-2	V	D,T,Pe	N	Y	S,H	124	2
36	Oplurus	fierinensis	SW Madagascar	< 10,000 '80s	1	D	AA	V	L,Fr	N	N	S	0	2

Table 10. Susceptible and Unknown Iguanid taxa according to Mace-Lande criteria.

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
2	Brachylophus	fasciatus	Fiji, Tonga, & Wallis, Vanuatu	>10,000 '82	29+	D	AA-1	Sus	Pe,L,I,Fr	Y	Y	S,H	100	2
10.2	Ctenosaura	h.conspicuosa '87	Cholludo Is., San Esteban Is. (Mexico)	<10,000 '87	2	S	AA-2	Sus	T	N	Y	T	0?	2
10.5	Ctenosaura	h.nolascensis	San Pedro Nolasco Is. (Mexico)	<10,000 '87	1	S	AA-2	Sus	NONE	N	N	S,T	0	2
24.2	Dipsosaurus	d.catalinensis	Santa Catalina Is. (Mexico)	<10,000	1	S	AA-3	Sus	NONE	N	N	S,T	0	PEND
26	Iguana	iguana	Mexico to S Brazil & Paraguay	>10,000 '80s	>10 0	D	E	Sus	H,L,T,Fr	N	Y	S,T	349	3
27.1	Sauromalus	a.ater	Gulf of California isl. (Mexico)	<10,000	9	S	AA-3	Sus	NONE	N	N	S,T	0	PEND
27.2	Sauromalus	a.klauberi	Santa Catalina Is. (Mexico)	<10,000	1	S	AA-3	Sus	NONE	N	N	S,T	0	PEND
27.3	Sauromalus	a.shawi	San Marcos Is. (Mexico)	<10,000	1	S	AA-3	Sus	L	N	N	S,T	0	PEND
29	Sauromalus	hispidus	Gulf of California isl. (Mexico)	>10,000 '80s	12	D	AA	Sus	D,T	N	Y	S,H	20	2
31	Sauromalus	slevini	Gulf of California isl. (Monserrat, Coronados, Carmen) (Mexico)	<10,000	3	S	AA-3	Sus	NONE	N	N	S,T	0	PEND
37	Oplurus	grandidieri	SC Madagascar	>10,000 '80s	1	D	AA	Sus	L,Fr	N	N	S	0	NO
39	Oplurus	saxicola	SC Tulear Province (Madagascar)	>10,000 '80s	1	D	AAA	Sus	L,Fr	N	N	S	0	NO
15.2	Ctenosaura	s.multipunctata	Providencia Is. (Colombia)	UNK	1	UNK	AA-3	UNK	UNK	UNK	Y	S,T,H	UNK	NUC I PEND TAX
30.2	Sauromalus	o.multiforminatu s	N Arizona & S Utah (U.S.A.)	UNK	1	UNK	A	UNK	UNK	UNK	UNK	S,T	0	PEND SURV,TAX

Table 11. Secure Iguanid taxa according to Mace-Lande criteria.

	TAXON		WILD POPULATION										RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
6	Ctenosaura	acanthura	Tamaulipas to Oaxaca (Mexico)	>10,000 '80s	>100	S	E	S	H,Pe,L,Fr	N	N	N	4	NO
10.1	Ctenosaura	h.hemilopha '87	S Baja California (Mexico)	>10,000 '87	1	S	C	S	H,P,L,Fr	N	N	S,T	4 unk subspp	NO
10.4	Ctenosaura	h.macrolopha	C Sonora to N Sinaloa (Mexico)	>10,000	1	S	D	S	Ic,H	N	N	T	30	3
13	Ctenosaura	pectinata	W Mexico + Tres Marias Islands	>10,000 '87	2	S	E/AA-2	S	H,T,P,Fr	N	Y	T	9	NO
14	Ctenosaura	quinquecarinata	S Mexico to Costa Rica	>10,000 '87	5	S?	B	S	P,T	N	Y	S	0	NO
15.1	Ctenosaura	s.similis	S Mexico to Panama	>10,000 '80s	1	S	E	S	H,P,T,Fr	N	Y	S,T	UNK	NO
24.1	Dipsosaurus	d.dorsalis	Angel and San Luis Is., SW United States & NW Mexico	>10,000 '80s	3	S	E	S	T,L,Fr	N	N	H	64	NO
24.3	Dipsosaurus	d.lucasensis	S Baja & Gulf of California Is (Montserrate,San Jose,Cerralvo Is,Espiritu Santo,Magdalena,San Marcos,Petida Sur, Sanya Margerita)	<10,000	9	S	A+AA-3	S	NONE	N	N	S,T	0	PEND
24.4	Dipsosaurus	d. carmenensis	Islas Carmen & Coronados	>10,000	2	s	AA-3	S	NONE	N	N	S,T	0	PEND
28	Sauromalus	australis	SE Baja California (Mexico)	>10,000	4	S	B+AA-3	S	NONE	N	N	S,T	0	PEND
30.1	Sauromalus	o.obesus	SW United States, Baja CA, Gulf Is.	>10,000 '80s	3	S	E	S	T	N	N	N	106	NO
30.3	Sauromalus	o.townsendi	W Sonora (Mexico), Tiburon Is.	>10,000	2	S	C	S	NONE	N	N	S,T	0	PEND
30.4	Sauromalus	o.tumidus	SW Arizona & NW Sonora	>10,000 '80s	1	S	D	S	T	N	N	N	12	NO
33	Chalarodon	madagascariensis	SW Madagascar	>10,000 '80s	1	S	AAA	S	NONE	N	N	S	0	NO
34.1	Oplurus	c.cuvieri	NW Madagascar	>10,000 '80s	2	I	AAA	S	L,Fr	N	N	S	10	NO
35	Oplurus	cyclurus	SW Madagascar	>10,000 '80s	1	D	AAA	S	L,Fr	N	N	S,T	4	NO
38	Oplurus	quadrimaculatus	C & S Madagascar	>10,000 '80s	1	D	AAA	S	NONE	N	N	S	0	NO

Table 12. All iguanid taxa.

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
	SQUAMATA													
	SAURIA													
	IGUANIDAE													
	IGUANINAE													
1	Amblyrhynchus	cristatus	Galapagos Archipelago											
1.1	Amblyrhynchus	c.cristatus	Fernandina Is. (Galapagos)	≤10,000 '91	1	D	AA-1	V	El Niño	N	Y	S,T,H	0	PEND
1.2	Amblyrhynchus	c.albemarlensis	Isabella Is. (Galapagos)	≤10,000 '91	1	D	AA/AAA	V	El Niño, Pe	N	Y	S,T,H	0	PEND
1.3	Amblyrhynchus	c.hassi	Santa Cruz Is. (Galapagos)	≤10,000 '91	1	D	AA-1	V	El Niño, Pe, I	N	Y	S,T,H	0	PEND
1.4	Amblyrhynchus	c.mertensi	San Cristobal Is. and Santiago Is. (Galapagos)	≤2,500	2	D	AA-2/1	E	El Niño, Pe	N	Y	S,T,H	0	PEND
1.5	Amblyrhynchus	c.nanus	Genovesa Is. (Galapagos)	≤10,000 '91	1	D	AA-2	V	El Niño	N	Y	S,T,H	0	PEND
1.6	Amblyrhynchus	c.sielmanni	Pinta Is. (Galapagos)	UNK	1	D	AA-2	V	El Niño	N	Y	S,T,H	0	PEND
1.7	Amblyrhynchus	c.venustissimus	Espanola Is. and Gardner Is. (Galapagos)	≤10,000 '91	2	D	AA-1	V	El Niño	N	Y	S,T,H	0	PEND
2	Brachylophus	fasciatus	Fiji, Tonga, & Wallis, Vanuatu	>10,000 '82	29+	D	AA-1	Sus	Pe,L,I,Fr	Y	Y	S,H	100	2
3	Brachylophus	vitiensis	Yaduataba Is. (Fiji)	6,000-8,000	10+	D	AA-3	V	Pe,L,I, D (fire)	Y	Y	S,H,T	25-30	2
4	Conolophus	pallidus	Santa Fe Is. (Galapagos)	1,500-2,000	1	S	AA-2	V	NDNE	N	N	S	0	PEND
5	Conolophus	subcristatus	Galapagos Archipelago, Fernandina, Isabela, Santa Cruz, Plaza Sur, Baltra, N. Seymour	UNK	6	UNK	AAA	V	Pe, Ic	N	Y	S	0	PEND

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
6	Ctenosaura	acanthura	Tamaulipas to Oaxaca (Mexico)	>10,000 '80s	>10 0	S	E	S	H,Pe,L,Fr	N	N	N	4	NO
7	Ctenosaura	bakeri	Isla Utila (Honduras)	5,000-8,000	1	S	AA-3	V	H,L	Y	Y	T	0	2
8	Ctenosaura	clarki	Michoacan (Mexico)	>10,000 '82	1	S?	A	V	P,L	N	Y	S	3 not on ISIS	2
9	Ctenosaura	defensor	Campeche & Yucatan (Mexico)	>10,000 '80s	1	S?	A	V	T,P,Fr	N	Y	S	0	2
10	Ctenosaura	hemilopha	NW Mexico											
10.1	Ctenosaura	h.hemilopha '87	S Baja California (Mexico)	>10,000 '87	1	S	C	S	H,P,L,Fr	N	N	S,T	4 unk subspp	NO
10.2	Ctenosaura	h.conspicuosa '87	Cholludo Is., San Esteban Is. (Mexico)	<10,000 '87	2	S	AA-2	Sus	T	N	Y	T	0?	2
10.3	Ctenosaura	h.insulana	Cerralvo Is. (Mexico)	<10,000	1	S	AA-3	V	Ic, L	Y	Y	S	0	2
10.4	Ctenosaura	h.macrolopha	C Sonora to N Sinaloa (Mexico)	>10,000	1	S	D	S	Ic,H	N	N	T	30	3
10.5	Ctenosaura	h.nolascensis	San Pedro Nolasco Is. (Mexico)	<10,000 '87	1	S	AA-2	Sus	NONE	N	N	S,T	0	2
11	Ctenosaura	oedirhina	Roatan Is. (Honduras)	<10,000 '87	1	S	AA-2	V	P,L	Y, PEND TAX	Y	T	0	2
12	Ctenosaura	palearis	SE Guatemala & Isla de Chahinos (N Honduras)	<10,000 '87	3	D	A/AA-3	V	H,L,P,T	Y	Y	S,T,H	0 ISIS 5 other	2
13	Ctenosaura	pectinata	W Mexico + Tres Marias Islands	>10,000 '87	2	S	E/AA-2	S	H,T,P,Fr	N	Y	T	9	NO
14	Ctenosaura	quinquecarinata	S Mexico to Costa Rica	>10,000 '871	5	S?	B	S	P,T	N	Y	S	0	NO
15	Ctenosaura	similis	S Mexico to Panama										2	
15.1	Ctenosaura	s.similis	S Mexico to Panama	>10,000 '80s	1	S	E	S	H,P,T,Fr	N	Y	S,T	UNK	NO
15.2	Ctenosaura	s.multipunctata	Providencia Is. (Colombia)	UNK	1	UNK	AA-3	UNK	UNK	UNK	Y	S,T,H	UNK	2
16	Cyclura	carinata	Turks & Caicos & E Bahamas											

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
16.1	Cyclura	c.carinata	Turks & Caicos, Smaller Cays only	<10,000 1975-92	15-20	D	AA-1	V	H,L,Pe	Y	Y	S	0	2
16.2	Cyclura	c.bartschi	Booby Cay (Bahamas)	200-300 '80s	1-2	D	AA-3	C	H,L,Pe,Ic	Y	Y	S,T,H	0	1
17	Cyclura	collei	Jamaica	<100 '90	1	D	AA-3	C	L,Pe	Y	Y	S,H	40	1
18	Cyclura	cornuta	Hispaniola, Mona, & Navassa Is.											
18.1	Cyclura	c.cornuta	Hispaniola; Tortue, Gonave, Petit Gonave, Grande Cayemite, Beata, Saoma Is.	<10,000 '80s	10+	D	AA	V	H,L,Pe,Fr	Y	Y	S,O	353	2
18.2	Cyclura	c.onchiopsis	Navassa Is.	Extinct '91										
18.3	Cyclura	c.stejnegeri	Mona Is.	2,000-4,000 '80s	1	S	AA-2	E	Pe,Ic	Y	Y	S,T	1	1
19	Cyclura	cychlura	W Bahamas											
19.1	Cyclura	c.cychlura	Andros Is. (Bahamas)	2,500-5,000 '80s	≥3	D	AA	V	H,Pe,L,Ic	Y	Y	S,T,H	<10	2
19.2	Cyclura	c.figginsi	Exuma Cays (Bahamas)	<1,000 '91	7	D	AA-2	E	H,Pe,L	Y	Y	S,T,H	30-40	1
19.3	Cyclura	c.inornata	U. Cay & Leaf Cay, possibly Allan's Cay (Bahamas)	400-500 '80s	2-3	S	AA-3	E	H	Y	Y	S,T,H	0	1
20	Cyclura	nubila	Cuba & Cayman Islands											
20.1	Cyclura	n.nubila	Cuba, Is. Maguayes, P.R.	>10,000 '80s	50+	D	AA	V	Pe,L,Fr,O(fire)	Y	Y	S,H,T	40	2
20.2	Cyclura	n.caymanensis	Cayman Islands, Cayman Brac and Little Cayman	<1,000 '80s	2	D	AA-2	E	H,Pe,L,O(road kills)	Y	Y	S,H,T	<20	1
20.3	Cyclura	n.lewisi	Grand Cayman Is. (Cayman Islands)	<250 '80s	1	D	AA-3	C	Pe,L,O(genetics)	Y	Y	S,T,H	38-45	1
21	Cyclura	pinguis	Anegada Is. and Guana Cay (introd. pop.)(British Virgin Is.)	<1,500 '88-92	2	D	AA-3	E	H,Pe,L,Ic	Y	Y	S,H	0	1
22	Cyclura	ricordii	Hispaniola	<2,500 '80s	2	D	AA	E	H,Pe,L	Y	Y	S,O	≤25	1
23	Cyclura	rileyi	C Bahamas											
23.1	Cyclura	r.rileyi	C Bahamas	500-1,500 '80s	9+	D	AA-2	E	D,H,L,Pe	Y	Y	S,H	2-3	1

	TAXON		WILD POPULATION								RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
23.2	Cyclura	r.cristata	White Cay (Bahamas)	250-500 '87	1	S	AA-3	E	H,L,Pe	Y	Y	S,T,H	0	1
23.3	Cyclura	r.nuchalis	Crooked-Acklin's Group (Bahamas)	600 '80s	2	D	AA-1	E	H	Y	Y	S,T,H	1-2	1
24	Dipsosaurus	dorsalis	SW United States & NW Mexico											
24.1	Dipsosaurus	d.dorsalis	Angel and San Luis Is., SW United States & NW Mexico	>10,000 '80s	3	S	E	S	T,L,Fr	N	N	H	64	NO
24.2	Dipsosaurus	d.catalinensis	Santa Catalina Is. (Mexico)	<10,000	1	S	AA-3	Sus	NONE	N	N	S,T	0	PEND
24.3	Oipsosaurus	d.lucasensis	S Baja & Gulf of California Is (Montserrate,San Jose,Cerralvo Is, Espiritu Santo, Magdalena, San marcos, Petida Sur, Sanya Margerita)	<10,000	9	S	A+AA-3	S	NONE	N	N	S,T	0	PEND
24.4	Dipsosaurus	d. carmenensis	Islas Carmen & Coronados	>10,000	2	s	AA-3	S	NONE	N	N	S,T	0	PEND
25	Iguana	delicatissima	Lesser Antilles	<10,000 '80s	10	D	AA	E	H,L,Pe,Fr,Ic, O(hybridization)	Y	Y	S,T,H	9	1
26	Iguana	iguana	Mexico to S Brazil & Paraguay	>10,000 '80s	>10 0	D	E	Sus	H,L,T,Fr	N	Y	S,T	349	3
27	Sauromalus	ater	Gulf of California isl. (Mexico)											
27.1	Sauromalus	a.ater	Gulf of California isl. (Mexico)	<10,000	9	S	AA-3	Sus	NDNE	N	N	S,T	0	PEND
27.2	Sauromalus	a.klauberi	Santa Catalina Is. (Mexico)	<10,000	1	S	AA-3	Sus	NONE	N	N	S,T	0	PEND
27.3	Sauromalus	a.shawi	San Marcos Is. (Mexico)	<10,000	1	S	AA-3	Sus	L	N	N	S,T	0	PEND
28	Sauromalus	australis	SE Baja California (Mexico)	>10,000	4	S	B+AA-3	S	NONE	N	N	S,T	0	PEND
29	Sauromalus	hispidus	Gulf of California isl. (Mexico)	>10,000 '80s	12	D	AA	Sus	D,T	N	Y	S,H	20	2
30	Sauromalus	obesus	SW United States & NW Mexico											
30.1	Sauromalus	o.obesus	SW United States, Baja CA, Gulf Is.	>10,000 '80s	3	S	E	S	T	N	N	N	106	NO
30.2	Sauromalus	o.multiforminatu s	N Arizona & S Utah (U.S.A.)	UNK	1	UNK	A	UNK	UNK	UNK	UNK	S,T	0	PEND
30.3	Sauromalus	o.townsendi	W Sonora (Mexico), Tiburon Is.	>10,000	2	S	C	S	NONE	N	N	S,T	0	PEND
30.4	Sauromalus	o.tumidus	SW Arizona & NW Sonora	>10,000 '80s	1	S	D	S	T	N	N	N	12	NO

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
31	Sauromalus	slevini	Gulf of California isl. (Monserrat, Coronados, Carmen) (Mexico)	< 10,000	3	S	AA-3	Sus	NONE	N	N	S,T	0	PEND
32	Sauromalus	varius	Gulf of California isl. (Mexico)	< 10,000 '80s	1	S	AA-2	V	D,T,Pe	N	Y	S,H	124	2
33	Chalarodon	madagascariensi s	SW Madagascar	> 10,000 '80s	1	S	AAA	S	NONE	N	N	S	0	NO
34	Oplurus	cuvieri	NW Madagascar & Grand Comoro Is.											
34.1	Oplurus	c.cuvieri	NW Madagascar	> 10,000 '80s	2	I	AAA	S	L,Fr	N	N	S	10	NO
34.2	Oplurus	c.comorensis	Grand Comoro Is. (Comoros)	< 2,500 '80s	1	D	AA-3	E	L	Y	Y	S,T,H	0	1
35	Oplurus	cyclurus	SW Madagascar	> 10,000 '80s	1	D	AAA	S	L,Fr	N	N	S,T	4	NO
36	Oplurus	fierinensis	SW Madagascar	< 10,000 '80s	1	D	AA	V	L,Fr	N	N	S	0	2
37	Oplurus	grandidieri	SC Madagascar	> 10,000 '80s	1	D	AA	Sus	L,Fr	N	N	S	0	NO
38	Oplurus	quadrimaculatus	C & S Madagascar	> 10,000 '80s	1	0	AAA	S	NONE	N	N	S	0	NO
39	Oplurus	saxicola	SC Tulear Province (Madagascar)	> 10,000 '80s	1	D	AAA	Sus	L,Fr	N	N	S	0	NO

CONSERVATION ASSESSMENT AND MANAGEMENT PLAN FOR IGUANIDAE AND VARANIDAE

WORKING DOCUMENT

December 1994

Report from the workshop held
1-3 September 1992

Edited by
Rick Hudson, Allison Alberts, Susie Ellis, Onnie Byers

Compiled by the Workshop Participants

SECTION 4

IGUANIDAE TAXON REPORTS

Mace-Lande: Ameacada (ambas as subespecies no Paraguai**ENDFIELD**
Bolivia e Nordeste da Argentina (i.e. Parque do Iguazu); P. o. palustris esta ameacada na Argentina; Existem populacoes criticas de Panthera onca onca na Mata Atantica no Brasil e na Argentina; P. o .palustris e vulneravel no Pantanal do Brasil e critica no sudoeste do Brasil (cerrado).**ENDFIELD**
ENDRECORD

IGUANID CAMP TAXON REPORTS

TAXON: *Amblyrhynchus cristatus* Galápagos marine iguana

STATUS:

Mace-Lande:	Vulnerable *(A.c. cristatus, A.c. albemarlensis, A.c. hassi, A.c. nanus, A.c. sielmanni, A.c. venustissimus);* Endangered *(A.c. mertensi)*
USFW:	No listing
CITES:	Appendix II
Other:	Locally protected (National Park and Marine Reserve)

Taxonomic status: 7 subspecies

Distribution: Galápagos Islands; distributed throughout the archipelago

Wild Population: Large populations of marine iguanas occur on Fernandina and Santa Fe. Although healthy populations occur on islands without feral cats and on offshore islets, populations on islands with feral cats appear to be severely threatened (Isabela, Santa Cruz, Floreana, and San Cristóbal) (Laurie, 1983). Very few *A. c. mertensi* are left on San Cristóbal.

Field Studies: Census of iguanas throughout the archipelago in 1981-1982 (Laurie, 1983); long-term study initiated in 1980 on Santa Fe (A. Laurie) has recently been continued by T. Dellinger, M. Wikelski, and V. Carrillo (Max Planck Institute); current study on Genovesa (M. Wikelski, 1993); current genetics study (K. Rassman).

Threats: A major threat to marine iguanas is predation by feral cats. Apparently there has been little recruitment to the majority of populations on islands with cats since the El Niño of 1982-83. Mortality of marine iguanas during the El Niño was as high as 60% on Santa Fe and potentially as high on other islands (Merlen, 1985). Although the majority of animals apparently died of starvation due to changes in algal abundance, the role of stress and disease associated with malnutrition has not been studied. It is possible that iguanas will have difficulty recovering from such a strong El Niño combined with high levels of cat predation on juveniles. Marine iguanas are particularly vulnerable to predation by introduced animals as a result of their low inherent reproductive rate (clutches of 1 to 3; Trillmich, 1979). Because they depend on red and green algae of the intertidal and upper subtidal zones, marine iguanas may also be highly sensitive to marine pollution (Laurie, 1987).

Comments: Before any captive programs are attempted, on-site management programs need to be developed. It is important to note that marine iguanas are so different from other iguanas in terms of their physiology that husbandry information for other iguanid species may not be appropriate for this species.

Recommendations:

Research: Survey of iguana populations on islands with cats; Taxonomy; Husbandry
PHVA: No
Other: Studies are needed to assess the potential use of cat control in iguana nesting zones. After the completion of censuses and genetic studies, an intensive management program for threatened populations should be developed.

Captive Populations: None

Captive Programs: Pending

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Wikelski, M. 1993. Diving dragons. *Wildlife Conservation 96:* 45-52.

Reviewers:

Linda Cayot, Estación Cientifica Charles Darwin, Apartado 17-01-3891, Quito, Ecuador

IGUANID CAMP TAXON REPORTS

TAXON *Brachylophus fasciatus* South Pacific banded iguana
STATUS:

Mace-Lande:	Susceptible
USFW:	Endangered
CITES:	Appendix I

Taxonomic Status: Species

Distribution: Fiji and Tonga Island Groups, feral population at Efate, Vanuatu

Wild Population: > 10,000; distributed in at least 29 distinct subpopulations

Field Studies: Gibbons and Watkins (1982)

Threats: Threats include predation by exotics (cats and mongooses), habitat loss, and human interference. Hunting does not appear to be a threat.

Comments: Probably all populations have undergone serious decline, but banded iguanas can still be found at low densities on many islands with suitable forest. The populations on Viti Levu and Vanua Levu are almost extirpated despite large areas of remaining forest, reflecting the decisive predatory role of the introduced mongoose.

Recommendations:

Research:	Survey; Husbandry (with emphasis on reproduction)
PHVA:	Yes
Other:	More intensive wild management

Captive Populations: 100

Captive Programs: Level 2

References:
Gibbons, J.R.H., and I.F. Watkins. 1982. Behavior, ecology, and conservation of South Pacific banded iguanas, *Brachylophus,* including a newly discovered species. Pages 418-441 in G.M. Burghardt and A.S. Rand, eds. *Iguanas of the World.* Noyes, Park Ridge, NJ.

Zug, G.R. 1991. The lizards of Fiji: natural history and systematics. *Bishop Museum Bulletin in Zoology 2:* 1-136.

Reviewers: Dick Watling, Environmental Consultants (Fiji) Ltd., Box 2041 Government Buildings, Suva, Fiji

IGUANID CAMP TAXON REPORTS

TAXON *Brachylophus vitiensis* Fijian crested iguana

STATUS:

Mace-Lande:	Vulnerable
USFW:	Endangered
CITES:	Appendix I

Taxonomic Status: Species, but apparently heterogenous with the strong possibility of a cline radiating out from Yaduataba population.

Distribution: Fiji, dry leeward islands off Viti Levu and Vanua Levu; Mamanucas; Yasawas to Mali islands off Vanua Levu; Macuata Island off Viti Levu

Wild Population: 6,000-8,000 in at least 10 (probably more) distinct subpopulations. Densities may reach 140 per hectare on Yaduataba Island, the primary population. Nowhere else have densities this high been reported. Populations appear to be restricted to dry rainshadow islands.

Field Studies: Basic survey work and a project related to iguana protection on Yaduataba Island have been proposed by J. Juvik (University of Hawaii at Hilo). D. Watling (Environmental Consultants, Fiji) is currently preparing a management plan for Yaduataba on behalf of the National Trust for Fiji, commissioned by the World Wildlife Fund. However, no extensive research or field studies have been conducted to date.

Threats: A major threat is the further possible introduction of exotic predators, including mongooses, feral cats, dogs, and pigs. Wildfire is the principal agent responsible for loss of iguana habitat. Introduced goats are a secondary threat. Crested iguanas do not appear significantly threatened by hunting in any part of their range.

Comments: Although some of the larger islands still have enough forest remaining to support very small populations, they have little conservation potential without major intervention. Only on Yaduataba is there a real chance for long term conservation. However, the tenure and protection status of Yaduataba is not secure at the present time. A sanctuary has been established on Yaduataba with a national park designation, but there are still eight goats on the island and a very real fire threat. The iguana's rapid decline or disappearance with the introduction of alien predators and/or vegetation-destroying herbivores is borne out by its total absence from other nearby islands such as Tavua and Yanuya, where a long history of human settlement has led to nearly complete deforestation.

Recommendations:

Research: Taxonomy; Survey; Husbandry

PHVA: Yes
Other: More intensive wild management

Captive Populations: 25-30

Captive Programs: Level 2

References:

Cogger, H. and R. Sadlier. 1986. Population size and structure in the Fiji crested iguana. Pages 507-512 in Z. Rocek, ed. *Studies in Herpetology.* Charles University Press, Prague.

Juvik, J. and B. Singh. 1989. Conservation of the Fijian Crested Iguana: A Progress Report. Prepared for the Fourth South Pacific Conference on Nature Conservation and Protected Areas, Port Vila, Vanuatu.

Laurie, W., H. Uryu, and D. Watling. 1987. A faunal survey of Yaduataba island reserve with particular reference to the crested iguana. *Domodomo (Fiji Museum) 1:16-28.*

Reviewers:
Dick Watling, Environmental Consultants (Fiji) Ltd., Box 2041 Government Buildings, Suva, Fiji

IGUANID CAMP TAXON REPORTS

TAXON *Conolophus pallidus* Santa Fe Island iguana

STATUS:

Mace-Lande:	Vulnerable
USFW:	Endangered
CITES:	Appendix II
Other:	Locally protected (National Park)

Taxonomic Status: Species

Distribution: Santa Fe Island, Galápagos

Wild Population: Estimated in 1970's at 1500-2000 individuals; healthy population

Field Studies: Field studies, 1978-79 (K. Christian); current genetic study (K. Rassmann)

Threats: Historically threatened by humans and goats, although goats were eliminated in the 1970's. No significant threats at present. However, the population should be considered vulnerable because of its small size and restricted distribution. Potential threats include rats, cats, or other mammals (competitors and/or predators) should they be introduced onto this island.

Comments: This taxon has never been managed either *in situ* or in captivity.

Recommendations:

Research:	Survey
PHVA:	No
Other:	Yearly or biannual monitoring of the population to provide baseline data in case of future introductions of competitors and/or predators.

Captive Populations: None

Captive Programs: Pending

Reviewers:
Linda Cayot, Estación Cientifica Charles Darwin, Apartado 17-01-3891, Quito, Ecuador

IGUANID CAMP TAXON REPORTS

TAXON *Conolophus subcristatus* Galápagos land iguana

STATUS:

Mace-Lande:	Vulnerable
USFW:	No listing
CITES:	Appendix II
Other:	Locally protected (National Park)

Taxonomic Status: Species

Distribution: Galápagos Archipelago. Native to 5 islands (Fernandina, Isabela, Santa Cruz, Baltra, and Plaza Sur); introduced on North Seymour; extinct on Santiago

Wild Population: In general, population numbers are unknown.
Fernandina. Healthy, undisturbed population; potential problems with reproduction in recent years as a result of relatively frequent volcanic activity in one of the major nesting zones (T. de Roy, personal communication).
Plaza Sur. Healthy, undisturbed population; population reduction following the El Niño of 1982-83 as a result of high mortality of Opuntia on the island (a major food resource during droughts).
Isabela. Nearly extinct in southern Isabela, consisting of only 2 to 3 relict populations of no more than a few hundred individuals; status of northern Isabela populations unknown.
Santa Cruz. All populations but one extinct; two populations known to have disappeared within the last 20 years.
Baltra. Population disappeared in the late 1940's; repatriation program began in 1991 (Cayot and Menoscal, 1992).
North Seymour. Land iguanas from Baltra introduced to North Seymour in 1932. However, by 1979, only 20 surviving adults remained (Snell and Snell, 1979). Currently there is a small population of approximately 50 individuals which has shown minimal reproduction (Reynolds, 1981).

Field Studies: Current genetic study (K. Rassmann).
Fernandina. Studied by D. Werner, 1977-1979.
Plaza Sur. Ongoing, long-term study since 1979 (H. Snell).
Isabela. Intensive study of Cartago population, 1986-87 (M. Hoyos); annual monitoring; little known of other populations.
Santa Cruz. Population monitored annually.
Baltra. Population monitored several times per year.
North Seymour. Intensive study in 1989-90 (A. Izurieta).

Threats:
Fernandina. Potential introductions of exotic predators and competitors.
Plaza Sur. Potential introductions of exotic predators and competitors.

Isabela. Dogs are nearly eliminated (Reynolds, 1982), but cats appear to be a serious threat to hatchling survival. Potential problems with burros (trampling nests) and goats (habitat destruction).
Santa Cruz. Dogs are nearly eliminated, but cats appear to be a serious threat to hatchling survival. Potential problems with burros trampling nests.
Baltra. Predation by feral cats and competition with introduced goats.
North Seymour. Potential introductions of exotic predators and competitors.

Recommendations:

Research: Survey (re-census all populations to determine current status, especially Isabela)

PHVA: No

Other: Continued monitoring of threatened and vulnerable populations. Once genetics work is completed, re-evaluate management program.

Captive Populations: None outside of Galápagos; currently individuals from Santa Cruz and Baltra/North Seymour are in captivity at the Breeding and Rearing Center of the Charles Darwin Research Station and the Galápagos National Park Service. There is also a semi-captive population on Venecia, a small island north of Santa Cruz. The objective of both programs is the repatriation of iguanas to their islands of origin (Marquez et al., 1986). To date, more than 600 individuals have been successfully repatriated.

Captive Programs: Pending

References:
Cayot, L.J. and R. Menoscal. 1992. Land iguanas return to Baltra. *Noticias de Galápagos 51:* 11-13.

Marquez, C., H. Snell, H. Snell, S. Rea, M. Wilson, and F. Cepeda. 1986. The ten year struggle to save the endangered land iguanas. *Noticias de Galápagos 44:* 9-11.

Reynolds, R.P. 1981. Land iguanas (*Conolophus subcristatus)* on North Seymour Island. *Noticias de Galápagos 34:* 17-18.

Reynolds, R.P. 1982. Experimental repatriation of captive-reared land iguanas (Conolophus subcristatus) at Cartago Bay, Isabela. *Noticias de Galápagos 36:* 13-14.

Snell, H. and H. Snell. 1979. Land iguana conservation program. *Annual Report of the Charles Darwin Research Station, 1979:* 36-51.

Reviewers:

Linda Cayot, Estación Cientifica Charles Darwin, Apartado 17-01-3891, Quito, Ecuador

IGUANID CAMP TAXON REPORTS

TAXON *Ctenosaura bakeri* Utila Island spiny-tailed iguana
STATUS:

Mace-Lande:	Vulnerable
USFW:	No listing
CITES:	No listing

Taxonomic Status: Species

Distribution: Isla Utila (Islas de la Bahia, Honduras)

Wild Population: 5,000-8,000 (1980's)

Field Studies: Survey work within the last 5 years (R. Axtell)

Threats: Predation, possibly habitat loss and hunting. Islanders consider iguanas a delicacy and even children hunt them frequently. R. Axtell and L. Buckley attempted some local education along these lines when they were conducting their studies. In general, there seems to be a compatible existence between islanders and lizards and the main iguana habitats near the coast are still reasonably safe.

Comments: de Quieroz (1990) reported that few adults were seen on survey. Together with its restricted distribution and the presence of human settlements on Utila, this suggests a potential threat to the persistence of the species. However, populations are currently presumed to be stable, in part because they occupy exposed fossil coral reefs that provide refuge sites. Although both *C. bakeri* and *C. similis* are on the island, *C. bakeri* is by far the most common.

Recommendations:

Research:	Taxonomy (with reference to *C. oedirhina)*
PHVA:	Yes
Other:	More intensive wild management in collaboration with islanders to reduce hunting

Captive Populations: None

Captive Programs: Level 2

References:

de Quieroz, K. 1987. A new spiny-tailed iguana from Honduras, with comments on relationships within *Ctenosaura* (Squamata; Iguania). *Copeia 1987:* 892-902.

de Quieroz, K. 1990. *Ctenosaura bakeri. SSAR Catalog of American Amphibians and Reptiles.*

Reviewers:
Ralph Axtell, Southern Illinois University, Edwardsville, Illinois 62026 USA
Larry David Wilson, Miami-Dade Community College, Miami, Florida 33176 USA

IGUANID CAMP TAXON REPORTS

TAXON *Ctenosaura clarki* Balsas Armed Lizard

STATUS:

Mace-Lande:	Vulnerable
USFW:	No listing
CITES:	No listing

Taxonomic Status: Species

Distribution: Michoacan, México

Wild Population: >10,000

Field Studies: Unaware of current efforts; studied by Duellman and Duellman (1959)

Threats: This species is threatened by predation and habitat loss.

Comments: History of habitat alteration combined with limited geographic distribution makes this species vulnerable.

Recommendations:

Research:	Survey
PHVA:	No
Other:	Possible wild management

Captive Populations: 3

Captive Programs: Level 2

References:

Duellman, W.E. and A.S. Duellman. 1959. Variation, distribution, and ecology of the iguanid lizard *Enyaliosaurus clarki* of Michoacan, México. *Occasional Papers of the Museum of Zoology, University of Michigan 598:* 1-10.

Reviewers:

Ralph Axtell, Southern Illinois University, Edwardsville, Illinois 62026 USA

IGUANID CAMP TAXON REPORTS

TAXON *Ctenosaura defensor* Yucatan Armed Lizard

STATUS:

Mace-Lande:	Vulnerable
USFW:	No listing
CITES:	No listing

Taxonomic Status: Species

Distribution: Campeche and Yucatan, México

Wild Population: >10,000

Field Studies: Unaware of current efforts; studied by Duellman (1965)

Threats: Potential threats include predation and trade.

Comments: History of habitat alteration combined with limited geographic distribution makes this species vulnerable. However, abandoned plantations appear to be reverting to natural vegetation.

Recommendations:

Research:	Survey
PHVA:	No
Other:	Possible wild management

Captive Populations: None

Captive Programs: Level 2

References:

Duellman, W.E. 1965. Amphibians and reptiles from the Yucatan peninsula, México. *University of Kansas Publications of the Museum of Natural History 15:* 577-614.

Reviewers:

Ralph Axtell, Southern Illinois University, Edwardsville, Illinois 62026 USA

IGUANID CAMP TAXON REPORTS

TAXON *Ctenosaura oedirhina* Roatan Island spiny-tailed iguana

STATUS:

Mace-Lande:	Vulnerable
USFW:	No listing
CITES:	No listing

Taxonomic Status: Species

Distribution: Roatan Island, Honduras (de Quieroz, 1990)

Wild Population: < 10,000; Are very common on the island where emergent reefs or other rocky retreats occur

Field Studies: Sporadic field assessments (R. Axtell, G. Ferguson)

Threats: This species is threatened by habitat loss, predation, and some hunting. However, most people do not hunt this form because it is black. They fear the iguanas (taboo?) and few people will eat them.

Comments: Although habitat loss caused by exponential human population growth and development of Roatan as a tourist center can be expected to impact these lizards negatively, iguanas may still find refuge in the exposed fossil reefs that occur along much of the island's coastline.

Recommendations:

Research:	Taxonomy (with reference to *C. bakeri)*
PHVA:	Yes, pending taxonomic research (R. Axtell)
Other:	Monitoring of wild populations

Captive Populations: None

Captive Programs: Level 2, pending taxonomic research findings

References:

de Quieroz, K. 1987. A new spiny-tailed iguana from Honduras, with comments on relationships within *Ctenosaura* (Squamata; Iguania). *Copeia 1987:* 892-902.

de Quieroz, K. 1990. *Ctenosaura oedirhina. SSAR Catalog of American Amphibians and Reptiles.*

Reviewers:

Ralph Axtell, Southern Illinois University, Edwardsville, Illinois 62026 USA
Larry David Wilson, Miami-Dade Community College, Miami, Florida 33176 USA

IGUANID CAMP TAXON REPORTS

TAXON *Ctenosaura palearis* Paleate spiny-tailed iguana
STATUS:

Mace-Lande:	Vulnerable
USFW:	No listing
CITES:	No listing

Taxonomic Status: Species

Distribution: Southeast Guatemala and Northern Honduras; Island population on Cayos Cochinos; distributed in 3 subpopulations (Buckey and Axtell, 1990)

Wild Population: <10,000

Field Studies: R. Axtell, L.D. Wilson

Threats: This species is threatened by hunting, habitat loss, predation, and trade. Although this is the most common lizard on the Cochinos, it appeared in the reptile trade around 1988 when several were collected by a single individual. Tourist diving boats frequently stop and send employees to the islands to get enough iguanas for food (considered a delicacy) for the passengers. This practice could potentially be halted by contacting boat operators.

Comments: The population may be stable in Honduras, but is reported to be declining in Guatemala. The Cayos Cochinos population is particularly vulnerable due to the small size of the islands and the presence of a growing human population. These iguanas appear to be relatively easy to raise in captivity in southern outdoor facilities.

Recommendations:

Research:	Survey; Taxonomy; Husbandry
PHVA:	Yes
Other:	More intensive wild management; habitat protection

Captive Populations: None on ISIS; five or more in other collections
Captive Programs: Level 2

References:

Buckley, L.J. and R.W. Axtell. 1990. *Ctenosaura palearis. SSAR Catalog of American Amphibians and Reptiles.*

Wilson, L.D. and G.C. Cruz Diaz. In press. The herpetofauna of the Cayos Cochinos, Honduras. *Herpetological Natural History.*

Reviewers:

Ralph Axtell, Southern Illinois University, Edwardsville, Illinois 62026 USA

Larry David Wilson, Miami-Dade Community College, Miami, Florida 33176 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura carinata carinata* Turks Island ground iguana

STATUS:

Mace-Lande:	Vulnerable
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Turks and Caicos Islands

Wild Population: < 10,000; distributed in 15-20 populations

Field Studies: Iverson (1978, 1979)

Threats: Threats include predation by exotics (cats and dogs), habitat loss, and hunting.

Comments: This subspecies is probably restricted to smaller cays. Overall, the population is declining. It has been extirpated from many of the larger Turks as well as Caicos Islands. Domestic dogs and cats reduced the population (estimated at 5500 individuals) on Pine Cay almost to extinction in three years following construction of a hotel and tourist facility (Iverson, 1978; Smith, 1992).

Recommendations:

Research:	Survey
PHVA:	Yes
Other:	More intensive wild management; exclude feral animals from small islands

Captive Populations: None

Captive Programs: Level 2

References:

Iverson, J.B. 1978. The impact of feral cats and dogs on populations of the West Indian rock iguana, *Cyclura carinata. Biological Conservation 14:* 63-73.

Iverson, J.B. 1979. Behavior and ecology of the rock iguana, *Cyclura carinata. Bulletin of the Florida State Museum of Biological Sciences 24:* 175-358.

Norton, R.L. and N.V. Clarke. 1992. Notes on the rock iguana *(Cyclura carinata)* of the Caicos Islands. *Florida Field Naturalist 20:* 45-46.

Smith, G.R. 1992. Return of *Cyclura carinata* to Pine Cay, Turks and Caicos Islands, BWI. *Herpetological Review* 23: 21-23.

Reviewers:
John Iverson, Department of Biology, Earlham College, Richmond, Indiana 47374 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura carinata bartschi* Booby Cay ground iguana

STATUS:

Mace-Lande:	Critical
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Booby Cay, Bahamas

Wild Population: Estimate of 200-300 with gravid females and juveniles still present in 1988; possibly distributed in two subpopulations

Field Studies: Unaware of specific efforts, but visited briefly by D. Blair in 1988

Threats: This subspecies is threatened by habitat loss, hunting, predation by exotics, and overgrazing by goats (Blair, 1991).

Comments: Very little is known about this taxon, although the population is thought to be declining. There may be some animals on the southeastern end of Mayaguana. All of Booby Cay, which is small and uninhabited, should be protected.

Recommendations:

Research:	Taxonomy; Husbandry; Priority is for immediate survey work on both Booby Cay and Mayaguana
PHVA:	Yes
Other:	More intensive wild management; herds of goats now present should be removed.

Captive Populations: None

Captive Programs: Level 1

References:

Blair, D.W. 1991. West Indian rock iguanas: their status in the wild and efforts to breed them in captivity. Northern California Herpetological Society Captive Propagation and Husbandry Conference, 1991.

Reviewers: David Blair, Cyclura Research Center, 316 W. Mission #17, Escondido, California 92025 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura collei* Jamaican iguana

STATUS:

Mace-Lande:	Critical
USFW:	Endangered
CITES:	Appendix I

Taxonomic Status: Species

Distribution: Hellshire Hills region, Jamaica

Wild Population: Probably < 100 adults (P. Vogel, 1992)

Field Studies: Field studies by the Jamaican Iguana Research and Conservation Group (P. Vogel) have been ongoing since the rediscovery of the species in 1990. Protection of known nesting sites and a head-starting program for hatchlings are being implemented to aid in the recovery of this species.

Threats: Threats to this species include habitat loss, predation by exotics (primarily mongooses and dogs), encroachment and disturbance from charcoal burners.

Comments: There may be as little as a few dozen adults remaining in the wild. The apparent lack of juveniles, which suggests minimal recruitment, is also a major concern. The population is declining and headed for extinction if corrective measures are not implemented in the very near future. Nesting areas should be under constant surveillance from egg-laying through hatching. A hardening facility should be constructed in the Hellshire Hills in order to acclimate head-started offspring prior to release, and survival of head-started animals should be monitored by radiotracking.

Recommendations:

Research:	Survey; Husbandry; Life history; Genetics
PHVA:	Conducted February, 1993
Other:	More intensive wild management. A headstart/release program, a predator control and a constant field presence (field station) need to be implemented as soon as possible. A wild subpopulation should be established if a suitable location can be identified.

Captive Populations: 96 offspring hatched wild nests in 1991-94 are being reared at Hope Zoo, Kingston. An ex-situ population has been established at 3 U.S. zoos with 12 imported progeny from this group. An additional 12, selected on the basis of ongoing genetics research, will be imported in 1994-95. This founder nucleus will be distributed among 6 zoos to prevent the chance of catastrophic loss. This population is expected to begin reproducing in 1995 and should be expanded to 50.50.100 as soon as possible.

Captive Programs: Level 1

References:

Kerr, R. 1990. Iguanas not extinct: but habitat protection vital. *Jamaican Geographer 3:* 1.

Vogel, P. and R. Kerr. 1992. The conservation status of the Jamaican iguana. *Jamaica Naturalist 2:* 11-16.

Woodley, J.D. 1968. A history of the Jamaican iguana. *Jamaica Journal 2:* 14-20.

Woodley, J.D. 1980. Survival of the Jamaican iguana, *Cyclura collei. Journal of Herpetology 14:* 45-49.

Reviewers:

Peter Vogel, Department of Biology, University of the West Indies, Kingston 7, Jamaica

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura cornuta cornuta* Rhinoceros iguana

STATUS:

Mace-Lande:	Vulnerable
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Hispaniola (Dominican Republic and Haiti, including offshore islands)

Wild Population: Numbers unknown, but < 10,000 (Ottenwalder, 1980's); distributed in 10 subpopulations (Ottenwalder et al., in press)

Field Studies: Planned by J. Ottenwalder (funding required)

Threats: Threats to this taxon include habitat loss, hunting, and predation by exotics. Trade of wild animals continues from Haiti, whereas from Dominican Republic, trade is now almost restricted to captive-bred individuals.

Comments: Rhinoceros iguanas still occur over a fairly wide area, but their distribution is somewhat fragmented. With few exceptions, most known populations appear to be declining; habitat remains undisturbed in only two areas.

Recommendations:

Research:	Surveys; Ecological studies (life history, reproductive biology, habitat analysis, species-habitat relationships)
PHVA:	Yes
Other:	Development of conservation and management plans for wild populations and their habitats; enforcement of protective legislation; monitoring of populations in protected areas; educational programs; assessment of the effects of illegal harvest.

Captive Populations: 40.33.280 (as of February, 1993, Zoodom has > 283 individuals plus > 20 free-ranging breeding animals within zoo grounds. Elsewhere (J. Duval, personal communication), captive population is about 28.23.27.

Captive Programs: Level 2

References:

Boylan, T. 1985. Captive management of a population of rhinoceros iguanas *Cyclura cornuta cornuta* at Taronga Zoo, Sydney. Pages 491-494 in G. Grigg, R. Shine, and H. Ehmann, eds. *Biology of Australian Frogs and Reptiles.* Royal Zool. Society, Sydney.

Duval, J. 1976. Las iguanas dominicas. *Zoodom 1:* 19-23.

Reviewers:
José Ottenwalder, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611 USA

REPTILE CAMP TAXON REPORTS

TAXON *Cyclura cornuta stejnegeri* Mona Island iguana

STATUS:

Mace-Lande:	Endangered
USFW:	Threatened
CITES:	Appendix I
Other:	Locally threatened (Commonwealth of Puerto Rico)

Taxonomic Status: Subspecies, although time of nesting, clutch size, and hatchling size are significantly different between the Mona and Hispaniolan populations

Distribution: Mona Island, Puerto Rico

Wild Population: 2000-4000

Field Studies: Wiewandt (1977)

Threats: Feral pigs prey on iguana eggs, goats are keeping favored food plants from reproducing, and feral cats are significant predators on hatchlings. Hunters do not appear to be a serious threat, except that they lobby for keeping large feral pig and goat populations on Mona for easy sport hunting.

Comments: The population is currently smaller than the habitat could support, but appears reasonably stable. Although predation on some nesting sites by pigs is currently controlled by fencing, suitable nesting areas appear limited. New nest areas may need to be created if population numbers are to reach carrying capacity. The Chelonia-Herpetological Society of the Universidad Metropolitana has begun a small-scale nest site restoration project. At present, captive husbandry should be secondary to protection/restoration of wild habitats.

Recommendations:

Research:	Survey; Taxonomy
PHVA:	Yes
Other:	More intensive wild management, especially implementation of a cat control program.

Captive Population: 1

Captive Programs: Level 1

References:

Wiewandt, T.A. 1977. Ecology, behavior, and management of the Mona Island ground iguana, *Cyclura stejnegeri.* Ph.D. Thesis. Cornell University.

Wiewandt, T.A. 1979. La gran iguana de Mona. *Natural History 88:* 57-65.

Reviewers:

Miguel Garcia, Department of Natural Resources, Apartado 5887, San Juan, Puerto Rico 00906

Thomas Wiewandt, Wild Horizons, Inc., P.O. Box 5118, Tucson, Arizona 85703 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura cychlura cychlura* Andros Island ground iguana

STATUS:

Mace-Lande:	Vulnerable
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Andros Island, western Bahamas

Wild Population: 2,500 to 5,000; distributed in > 3 subpopulations (1980's)

Field Studies: Unaware of specific efforts, but visited briefly by D. Blair (1984) and R. Ehrig (1991)

Threats: Predation by exotics, hunting, habitat loss, and competition with introduced grazing animals are the major threats to this subspecies.

Comments: The population has been reported to be declining (J. Iverson and D. Blair). This trend has been confirmed by local residents. Presently animals are most abundant on the scattered uninhabited cays of western South Andros. This area could be set aside as a preserve with a resident warden to enforce protection.

Recommendations:

Research:	Survey; Taxonomy; Husbandry
PHVA:	Yes
Other:	More intensive wild management

Captive Populations: < 10 (not on ISIS); 1-2 at Ardastra Gardens, Nassau

Captive Programs: Level 2

References:

Blair, D.W. 1991. West Indian rock iguanas: their status in the wild and efforts to breed them in captivity. Northern California Herpetological Society Captive Propagation and Husbandry Conference, 1991.

Reviewers:

David Blair, Cyclura Research Center, 316 W. Mission #17, Escondido, California 92025 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura cychlura figginsi* Exuma Island ground iguana
STATUS:

Mace-Lande:	Endangered
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Exuma Cays, Bahamas

Wild Population: < 1,000 (Blair, 1991)

Field Studies: Visited briefly by D. Blair (1984); S. Windrow, Master's Thesis (1977). Recent visit by members of the International Iguana Society (R. Ehrig)

Threats: Threats to this subspecies include hunting, habitat loss, and predation.

Comments: The population is thought to be declining. Of the seven known populations, five were stable in 1980, while two were definitely declining. All uninhabited cays could be incorporated into the Exuma Land and Sea Park system, thereby affording the iguanas some degree of protection.

Recommendations:

Research:	Survey; Taxonomy; Husbandry
PHVA:	Yes
Other:	More intensive wild management

Captive Populations: Approximately 30-40 (U.S.)

Captive Programs: Level 1

References:
Blair, D.W. 1991. West Indian rock iguanas: their status in the wild and efforts to breed them in captivity. Northern California Hepetological Society Captive Propagation and Husbandry Conference, 1991.

Carey, W.M. 1976. Iguanas of the Exumas. *Wildlife 18:* 59-61.

Wilcox, K., J.Y. Carter, and L.V. Wilcox., Jr. 1973. Range extension of *Cyclura figginsi* Barbour in the Bahamas. *Caribbean Journal of Science 13:* 211-213.

Windrow, S.L. 1977. Winter activity and behavior of the Exuman rock iguana, *Cyclura cychlura figginsi.* Master's Thesis. Rutgers University.

Reviewers:
David Blair, Cyclura Research Center, 316 W. Mission #17, Escondido, California 92025 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura cychlura inornata* Allan's Cay ground iguana
STATUS:

Mace-Lande:	Endangered
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Allan's Cay and two other small cays, Bahamas

Wild Population: 400-500; two of the three small cays support fairly dense populations; only a few individuals remain on Allan's Cay.

Field Studies: Survivorship and population size data over the past 12 years (J. Iverson and associates).

Threats: This subspecies is threatened by hunting and disturbance from visiting yachts. Introduced non-native trees are threatening nesting areas and should be removed (Blair, 1991).

Comments: Populations are basically stable, although one population suffered a large removal in the early 1980's (apparently by poachers). The cold winter of 1989-90 had negative effects on the health and weight of many larger individuals, but most recovered. The islands where these iguanas occur are privately owned and a popular yachting destination from Nassau. There are often a dozen or more boats anchored in the small harbor (Blair, 1991).

Recommendations:

Research:	Survey; Taxonomy; Husbandry
PHVA:	Yes
Other:	Forbid feral animals; perhaps incorporate as protected area under the Bahamas National Trust

Captive Populations: None

Captive Programs: Level 1

References:

Blair, D.W. 1991. West Indian rock iguanas: their status in the wild and efforts to breed them in captivity. Northern California Herpetological Society Captive Propagation and Husbandry Conference, 1991.

Iverson, J.B. and M.R. Mamula. 1989. Natural growth in the Bahaman iguana, *Cyclura cychlura. Copeia 1989:* 502-505.

Reviewers:

John Iverson, Department of Biology, Earlham College, Richmond, Indiana 47374 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura nubila nubila* Cuban ground iguana

STATUS:

Mace-Lande:	Vulnerable
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Cuba, potentially including more than 4,000 surrounding islets; this subspecies has also been introduced to Isla Magueyes, southwest of Puerto Rico (Christian, 1987). By far the largest distribution of any member of the genus.

Wild Population: > 10,000 (perhaps many times greater); distributed in > 50 subpopulations Populations on the mainland have decreased dramatically or disappeared in most areas since the end of the last century. Populations on many islets are still relatively safe, but are under increasing pressure from development. As of 1992, the population on Isla Magueyes appeared to consist mostly of older adults (D. Blair). Several cats seen on the island may be responsible for recent population declines.

Field Studies: Research/Management program (Empresa Naciónal para la Protección de la Flora y la Fauna; Havana University); ecology and systematics study (Institute of Ecology and Systematics, Cuban Academy of Sciences).

Threats: Habitat transformation and loss and human disturbances are the major threats to the Cuban iguana. Predation by wild and domestic dogs on adults and juveniles, predation by cats on juveniles, and predation on eggs by pigs are also important threats. Ant predation may be a secondary source of egg mortality. Hunting is not a major threat because there is not a tradition of consumption of iguanas.

Comments: In general, the population is declining, most strongly on the mainland. Loss of this subspecies in disturbed areas has been very rapid (> 1% per year for the last ten years). Iguanas are now absent from the northeastern Havana coast, the Hicacos peninsula, and Key Largo, where they were very abundant 30-40 years ago. Whereas habitat transformation and disturbance on the mainland seem to be responsible for local extinctions, populations still appear to be stable on many untouched islands and islets.

Recommendations:

Research:	Survey; Taxonomy; Husbandry
PHVA:	Yes
Other:	More intensive wild management; thorough population surveys needed; basic ecological data are needed in order to institute recovery programs; the taxonomic status of populations from islets should be examined.

Captive Populations: 40

Captive Programs: Level 2

References:

Berovides, V. 1980. Notas sobre la ecologia de la iguana (*Cyclura nubila)* en Cayo Rosario. *Ciencias Biologicas 5:* 112-115.

Christian, K. 1987. Aspects of the life history of Cuban iguanas on Isla Magueyes, Puerto Rico. *Caribbean Journal Science 22:* 159-164.

Duval, J.J. and W.D. Christie. 1990. Husbandry of the Cuban ground iguana, *Cyclura n. nubila,* at the Indianapolis Zoo. *International Zoo Yearbook 29:* 65-69.

Perera, A. 1985a. Datos sobre abundancia y actividad de *Cyclura nubila* (Sauria: Iguanidae) en los alrededores de Cayo Largo del Sur, Cuba. *Poeyana 288:* 1-17.

Perera, A. 1985b. Datos sobre la dieta de *Cyclura nubila* (Sauria: Iguanidae) en los alrededores de Cayo Largo del Sur, Cuba. *Poeyana 291:* 1-12.

Reviewers:

Antonio Perera, Comisión Rectora Gran Parque Nacional Sierra Maestra, Ave. 42 No. 514 e/5aB y 7a, Miramar, Playa, La Habana, Cuba

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura nubila caymanensis* Cayman Island ground iguana

STATUS:

Mace-Lande:	Endangered
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Cayman Brac and Little Cayman Island, Cayman Islands

Wild Population: < 1,000; distributed in 2 subpopulations

Field Studies: A. Echternacht (1988-1993); F. Burton (1990's); intensive field study currently underway on Little Cayman by G. Gerber (1993-1994).

Threats: On Cayman Brac, threats include predation by exotics (primarily cats), habitat loss, and hunting or removal by farmers who consider iguanas a putative pest species. On Little Cayman, threats include predation by exotics (primarily cats), habitat loss, and road kills.

Comments: In general, populations are thought to be declining. Little is known of the population on Cayman Brac, which is apparently small and fragmented in distribution. The population on Little Cayman is somewhat more robust, but the island is being developed, and site preparation and construction for private and commercial structures since 1981 has led to increased habitat destruction. An increase in the number of visitors and residents on the island, together with the construction of new roads, paving of existing roads, and an increase in vehicular traffic has dramatically increased mortality due to road kills. In some areas, especially around dwellings, hatchling mortality due to cat predation appears to approach 100%.

Recommendations:

Research:	Survey; Taxonomy; Husbandry
PHVA:	Yes
Other:	More intensive wild management, including a predator control program for feral cats

Captive Populations: < 20, some of which may be hybrids between *C. n. lewisi* and *C. n. caymanensis*

Captive Programs: Level 1

References:

Blair, D.W. 1983. Dragons of Cayman: rock iguanas cling to their islands. *Oceans 16:* 31-33.

Carey, W.M. 1966. Observations of the ground iguana *Cyclura macleayi caymanensis* on Cayman Brac, British West Indies. *Herpetologica 22:* 265-268.

Knapp, C. 1993. Captive husbandry and reproduction of the Cayman Island rock iguana *(Cyclura nubila caymanensis). Captive Breeding 1:* 4-9.

Townson, S. 1980. West Indian iguanas of the genus *Cyclura:* the threat of habitat destruction in the Cayman Islands. *British Journal of Herpetology 6:* 101-104.

Reviewers:
Sandy Echternacht, Department of Zoology, University of Tennessee, Knoxville, Tennessee 37996 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura nubila lewisi* Grand Cayman iguana

STATUS:

Mace-Lande: Critical
USFW: Endangered
CITES: Appendix I

Taxonomic Status: Subspecies

Distribution: Grand Cayman Island, Cayman Islands

Wild Population: < 250; possibly 50-100

Field Studies: Ongoing work by the National Trust for the Cayman Islands (F. Burton)

Threats: Threats include predation by feral cats and domestic dogs, habitat loss, road kills, and genetic problems within the captive population (hybridization between *C. n. lewisi* and *C. n. caymanensis).* Although native people fear the iguanas, they generally do not harm them.

Comments: The population exists at very low density, well below what the habitat could support, and may have been this way for many years (Grant, 1940). Genetic studies are underway to differentiate *C. nubila* subspecies and to identify hybrids in captive collections (S. Davis). In July, 1993, a monitored release of captive-bred, sterilized hybrids into protected habitat occurred. Data on these individuals will be critical to designing an effective reintroduction protocol for pure-bred individuals. A small-scale education program has begun to educate local people about iguanas and their habitat. Iguanas feed mostly on leaves of weeds and fallen fruits from wild trees; it appears that their damage to farmer's crops has been exaggerated.

Recommendations:

Research: Survey; Taxonomy; Husbandry
PHVA: Yes
Other: More intensive wild management, including establishment of an additional population in a protected area (Salina Reserve; National Trust Botanic Park); genetic survey of captive population must continue to identify potential hybrids; a predator control program needs to be instituted.

Captive Populations: 38-45, on both Grand Cayman (18 pure individuals) and in the U.S. (20 pure individuals). More pure individuals may be identified as genetic testing progresses. Captive breeding has occurred at Life Fellowship, Seffner, Florida, and recently at the Cayman Islands National Trust breeding facility.

Captive Program: Level 1

References:

Blair, D. 1983. Dragons of Cayman: rock iguanas cling to their islands. *Oceans 16:* 31-33.

Grant, C. 1940. The herpetology of the Cayman Islands. *Bulletin of the Institute of Jamaica, Science Series 2:* 1-65.

Noegel, R.P. 1989. Husbandry of West Indian rock iguanas, *Cyclura,* at Life Fellowship Bird Sanctuary, Seffner. *International Zoo Yearbook 28:* 131-135.

Reviewers:

Fred Burton, National Trust for the Cayman Islands, P.O. Box 10, G.T., Grand Cayman, Cayman Islands

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura pinguis* Anegada Island ground iguana

STATUS:

Mace-Lande: Endangered
USFW: Endangered
CITES: Appendix I

Taxonomic Status: Species

Distribution: < 1,500 adults on Anegada Island, British Virgin Islands; also introduced to Guana Island

Wild Population: < 1,500 adults on Anegada Island (Goodyear, 1988-92); approximately 20 adults on Guana Island.

Field Studies: W. Carey, 1968; Ongoing field studies on Anegada Island (N. Goodyear); 1992 study of relocated iguanas on Guana Island (N. Goodyear and J. Lazell).

Threats: This species is threatened by interspecific competition for food by feral ungulates, predation on juveniles by feral cats, predation on adults by dogs, hunting, and habitat loss.

Comments: The population is declining. The introduced population on Guana Island is breeding successfully, but recruitment appears to be low. Although funding was recently received from the World Wildlife Fund to design a National Park for Anegada, more funds will be required to fully implement the design. Over the past 20 years, since domestic stock were released to breed freely island-wide, grazing pressure by goats, sheep, burrows, and cattle has radically changed the vegetational composition of Anegada. The diet of *C. pinguis* now seems to be comprised mainly of plant species rejected by feral ungulates.

Recommendations:

Research: Survey; Husbandry
PHVA: Yes
Other: More intensive wild management, including predator control and management/control of feral ungulates

Captive Populations: 0

Captive Programs: Level 1

References:

Carey, W.M. 1975. The rock iguana, *Cyclura pinguis,* on Anegada, British Virgin Islands, with notes on *Cyclura ricordi* and *Cyclura cornuta* on Hispaniola. Bulletin of the Florida Museum of Biological Sciences 19: 189-224.

Goodyear, N.C. and J. Lazell. Status of a relocated population of endangered *Iguana pinguis* on Guana Island, British Virgin Islands. Submitted to Restoration Ecology.

Reviewers:

Numi Goodyear, The Conservation Agency, 97B Howland Avenue, Jamestown, Rhode Island 02835 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura ricordi* Ricord's ground iguana

STATUS:

Mace-Lande:	Endangered
USFW:	Not listed
CITES:	Appendix I

Taxonomic Status: Species

Distribution: Hispaniola, Dominican Republic only, restricted to Valle de Neiba (Isla Cabritos and southern shore of Lake Enriquillo) and Península de Barahona

Wild Population: Numbers unknown but < 2,500; distributed in 2 subpopulations

Field Studies: None at present, but planned if funding can be obtained (J. Ottenwalder)

Threats: Threats include habitat loss, hunting, and predation. Control of trade appears effective in Dominican Republic, but illegal export of animals from Haiti indicates that some smuggling occurs across the border between the two countries. Despite this, little trade has been reported to CITES over the last 15 years (Ottenwalder et al., in press).

Comments: Estimated at almost 5,000 individuals in 1970, the population is declining and is currently far below that level. Because C. ricordi is a habitat specialist, it occurs over a narrow range and has a limited distribution. Although Isla Cabritos in Lago Enriquillo is isolated and difficult to reach, the remaining natural habitat of this species is under constant pressure; the situation may become critical if pressures are not alleviated.

Recommendations:

Research:	Surveys; Genetic and ecological studies (life history, reproductive biology, habitat analysis, species-habitat relationships)
PHVA:	Yes
Other:	Development of conservation and management plans for wild populations and their habitats; studies of the effects of illegal harvest and other threats on populations; assessment of status of critical habitat

Captive Populations: < 25, from only a few founders. Breeding has occurred at Indianapolis Zoo and a private facility in California, but poor hatching success and survivorship of young hampers the expansion of the captive population. The breeding program at ZOODOM, Dominican Republic, was set to resume in 1993.

Captive Programs: Level 1

References:

Carey, W.M. 1975. The rock iguana, *Cyclura pinguis,* on Anegada, British Virgin Islands, with notes on Cyclura ricordi and Cyclura cornuta on Hispaniola. *Bulletin of the Florida Museum of Biological Sciences 19:* 189-224.

Duval, J. 1976. Las iguanas dominicas. *Zoodom 1:* 19-23.

Reviewers:

José Ottenwalder, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611 USA

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura rileyi rileyi* San Salvador ground iguana
STATUS:

Mace-Lande:	Endangered
USFW:	Endangered
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Central Bahamas, including San Salvador Island and several small cays

Wild Population: Potentially as many as 1,500, but probably less than 500; at least 9 different subpopulations known

Field Studies: Gicca (1974); Auffenberg (1980-82); Blair (1990); Ostrander (1983)

Threats: Threats include disease, habitat loss, hunting, and predation by exotics.

Comments: Overall, the population may be declining. Populations are dense on some of the cays of San Salvador, while others are very sparse. *C. r. rileyi* has been extirpated on several cays which in recent years supported substantial populations of iguanas.

Recommendations:

Research:	Survey; Husbandry
PHVA:	Yes
Other:	More intensive wild management; access to cays where iguanas still occur should be limited to prevent the introduction of feral animals; protection should be considered for at least some of the cays.

Captive Populations: 2-3 at Ardastra Gardens, Nassau; 2-3 in U.S.

Captive Programs: Level 1

References:
Blair, D.W. 1991. West Indian rock iguanas: their status in the wild and efforts to breed them in captivity. Northern California Herpetological Society Captive Propagation and Husbandry Conference, 1991.

Gicca, D. 1980. The status and distribution of *Cyclura r. rileyi* (Reptilia: Iguanidae), a Bahamian rock iguana. *Caribbean Journal of Science 16:* 9-12.

Reviewers: David Blair, Cyclura Research Center, 316 W. Mission #17, Escondido, CA 92025

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura rileyi cristata* White Cay ground iguana

STATUS:

Mace-Lande:	Endangered
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: White Cay, southern Exuma Islands, Bahamas

Wild Population: 250-500, probably < 400

Field Studies: Unaware of specific efforts, although both D. Blair (1984) and J. Iverson have visited White Cay within the last ten years

Threats: Threats include predation, hunting, habitat loss, and trash dumping by visiting yachts.

Comments: The population is thought to be stable, although especially vulnerable due to the low elevation of the island, the small size of the iguana population, and the small size of the island itself. A scarcity of juveniles in 1984 (D. Blair) may indicate reduced recruitment. The cay is apparently sometimes used as a trash dump by passing boats.

Recommendations:

Research:	Survey; Taxonomy; Husbandry
PHVA:	Yes
Other:	More intensive wild management; visiting yachts should be alerted not to bring dogs or cats ashore; protection for the population on White Cay would be beneficial; establishment of additional subpopulations is recommended.

Captive Populations: None

Captive Programs: Level 1

References:

Blair, D.W. 1991. West Indian rock iguanas: their status in the wild and efforts to breed them in captivity. Northern California Herpetological Society Captive Propagation and Husbandry Conference, 1991.

Reviewers: David Blair, Cyclura Research Center, 316 W. Mission #17, Escondido, CA 92025

IGUANID CAMP TAXON REPORTS

TAXON *Cyclura rileyi nuchalis* Acklins ground iguana

STATUS:

Mace-Lande:	Endangered
USFW:	Threatened
CITES:	Appendix I

Taxonomic Status: Subspecies

Distribution: Islands and Cays in the Crooked Acklins groups, southern Bahamas.

Wild Population: Probably close to 600 remaining

Field Studies: The International Iguana Society is currently sponsoring a study

Threats: Threats include habitat loss and potential danger of cats or rats being introduced by visiting yachts. Although all iguanas in the Bahamas are protected by law, enforcement throughout the islands has been lacking. Small cays such as these remain very vulnerable to disturbances without a warden present to enforce protection.

Comments: The populations on certain islands have been greatly reduced if any remain at all. Although very small in area, at least one cay apparently still supports a fairly dense population of iguanas. The populations on other cays have been quite variable over the last few years, with only a few young animals present.

Recommendations:

Research:	Survey; Taxonomy; Husbandry
PHVA:	Yes
Other:	More intensive wild management, including reintroduction of iguana onto other cays in the bight of Acklins

Captive Populations: 1-2 at Ardastra Gardens, Nassau

Captive Programs: Level 1

References:

Blair, D.W. 1991. West Indian rock iguanas: their status in the wild and efforts to breed them in captivity. Northern California Herpetological Society Captive Propagation and Husbandry Conference, 1991.

Reviewers: David Blair, Cyclura Research Center, 316 W. Mission #17, Escondido, CA 92025

IGUANID CAMP TAXON REPORTS

TAXON *Iguana delicatissima* Lesser Antilles iguana

STATUS:

Mace-Lande:	Endangered
USFW:	No listing
CITES:	Appendix II

Taxonomic Status: Species

Distribution: Lesser Antilles, including Anguilla, St. Martin (possibly extinct), St. Barthelemy (extinct on Ile Fourchue), St. Eustatius, Antigua (possibly extinct), Guadeloupe, Las Desirade, Iles de la Petite Terre, Iles des Saintes, Dominica, and Martinique; extinct on St. Kitts, Nevis, Barbuda, and Marie Galante

Wild Population: < 10,000

Field Studies: J. Lazell (1960's) studied general ecology, generic systematics, and inter-island variation; M. Day is currently conducting studies of population systematics, genetics, and inter- and intra-island variation in general ecology and habitat use; M. Breuil is examining the distribution of iguanas over the Guadeloupean archipelago.

Threats: Threats include habitat loss, competition with introduced goats, predation by mongooses, cats, and dogs, hunting (especially on St. Eustatius, where iguanas are hunted and sold to restaurants on St. Martin), roadkills, and hybridization with I. iguana. Extinction through hybridization appears to have been extremely rapid in Les Isles des Saintes (surveys reveal no pure individuals), and therefore, any introduction of I. iguana to populations of *I. delicatissima* are of extreme concern (e.g., Antigua, Guadeloupe, Martinique).

Comments: All populations are documented to be undergoing appreciable decline. Populations on Anguilla, St. Barthelemy, Antigua, Les Saintes, Martinique, St. Martin, and Guadeloupe are all in critical condition, with several supporting fewer than a hundred individuals. The population on Dominica should be considered vulnerable, and that on La Desirade endangered. Although there are no previous records of *I. delicatissima* from Iles de la Petite Terre, two uninhabited islands at present support an estimated population of 5,000 individuals. In conjunction with the Paris Museum of Natural History and the Guadeloupean National Parks Service, these two islands have been proposed as nature reserves. Within the entire range of the species, Cabrits National Park in Dominica represents the only formally protected area at present known to contain *I. delicatissima.* However, local authorities have proposed the establishment of a nature reserve for a population of approximately 50 individuals on Ilet Chancel off Martinique. In addition, the owner of Ile Fregate north of St. Barthelemy has requested an ecological restoration program for the island and the establishment of a nature reserve specifically for I. delicatissima, which was known to occur there in the 1960's prior to devastation by goats.

Recommendations:

Research: Further survey work is needed, especially for Anguilla, Antigua, St. Martin, and St. Barthelemy, Taxonomic studies underway, Husbandry

PHVA: Yes

Other: More intensive wild management; priorities for protection include Iles de la Petite Terre and Katouche Bay, Anguilla; in situ captive breeding programs are urgently required in order to maximize the reproductive potential of critical populations, headstart juveniles vulnerable to predation, and make juveniles available for reintroduction, especially to offshore islets

Captive Populations: 3.4 at Memphis Zoo and 1.1 at Jersey Wildlife Preservation Trust (all from Dominica)

Captive Programs: Level 1

References:

Lazell, J.D., Jr. 1973. The lizard genus *Iguana* in the Lesser Antilles. *Bulletin of the Museum of Comparative Zoology 145:* 1-28.

Reviewers:

Mark Day, Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB9 2TN, United Kingdom

IGUANID CAMP TAXON REPORTS

TAXON *Sauromalus hispidus* Angel Island chuckwalla
STATUS:

Mace-Lande:	Susceptible
USFW:	No listing
CITES:	No listing

Taxonomic Status: Species
Distribution: Angel de la Guarda Island and several other islands in the Gulf of California, México

Wild Population: > 10,000; distributed in approximately 12 subpopulations

Field Studies: Case (1980's) and Lawler (1980's)

Threats: Potential threats include disease and trade. Although some of the fishermen at Puerto Refugio occasionally eat these lizards, this level of hunting does not appear to pose a significant threat to the population.

Comments: Population size varies as a result of fluctuations in available food supply. Although recently subject to a prolonged drought, populations appear to back to normal levels at present.

Recommendations:

Research:	Survey; Husbandry
PHVA:	No
Other:	More intensive wild management

Captive Populations: 20

Captive Programs: Level 2

References:
Case, T.J. 1982. Ecology and evolution of the insular gigantic chuckawallas, *Sauromalus hispidus* and *Sauromalus varius.* Pages 184-212 in G.M. Burghardt and A.S. Rand, eds. *Iguanas of the World.* Noyes, Park Ridge, NJ.

Reviewers:
Ted Case, Department of Biology, University of California at San Diego, La Jolla, CA 92093 USA

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IGUANID CAMP TAXON REPORTS

TAXON *Sauromalus varius* San Esteban chuckwalla

STATUS:

Mace-Lande:	Vulnerable
USFW:	Endangered
CITES:	Appendix I
Other:	Endangered in the Republic of México

Taxonomic Status: Species

Distribution: San Esteban Island in the Gulf of California, México; also reported from Isla Alcatraz and Isla Lobos (Etheridge, 1982), where it was probably introduced for food by Seri Indian or Méxican fishermen

Wild Population: < 10,000 (1980's)

Field Studies: Case (1980's); ongoing studies by H. Lawler

Threats: Introduced black rats are potential predators on eggs and young. Although historically used for food, current hunting levels do not pose a significant threat. However, the lizards' lack of wariness and limited distribution make them particularly vulnerable to exploitation. Probably the greatest threat is from illegal trade.

Comments: On San Esteban, adults tend to congregate in arroyos above steep coastal cliffs along the western and northern shores. In contrast, the few juveniles that have been observed have been on sparsely vegetated slopes. A healthy, genetically managed captive population exists at the Arizona-Sonora Desert Museum.

Recommendations:

Research:	Survey; Husbandry
PHVA:	No
Other:	More intensive wild management, including protection from illegal collecting

Captive Populations: 124

Captive Programs: Level 2

References:

Case, T.J. 1982. Ecology and evolution of the insular gigantic chuckawallas, *Sauromalus hispidus* and *Sauromalus varius.* Pages 184-212 in G.M. Burghardt and A.S. Rand, eds. *Iguanas* *of the World.* Noyes, Park Ridge, NJ.

Dodd, C.K., Jr. 1979. Review of the status of the San Esteban Island chuckwalla. *Federal Register 44* (45): 12391.

Etheridge, R. 1982. Checklist of the iguanine and Malagasy iguanid lizards. Pages 7-37 in G.M. Burghardt and A.S. Rand, eds., *Iguanas of the World.* Noyes, Park Ridge, NJ.

Reviewers:

Ted Case, Department of Biology, University of California at San Diego, La Jolla, CA 92093 USA

Lee Grismer, Department of Biology, San Diego State University, San Diego, CA 92182 USA

Howard Lawler, Arizona-Sonora Desert Museum, 2021 N. Kinney Rd., Tucson, AZ 85743 USA

Ken Petren, Department of Biology, University of California at San Diego, La Jolla, CA 92093 USA

IGUANID CAMP TAXON REPORTS

TAXON *Oplurus cuvieri comoroensis*

STATUS:

Mace-Lande:	Endangered
USFW:	No listing
CITES:	No listing

Taxonomic Status: Subspecies

Distribution: Grand Comoro Island, Comoros

Wild Population: < 2,500

Field Studies: Unaware of current efforts; field surveys by C. Blanc (1970's)

Threats: Habitat loss constitutes the major threat to this taxon.

Comments: This arboreal subspecies appears to be declining, and is quite vulnerable because it is restricted to only a small part of Grand Comoro Island.

Recommendations:

Research:	Survey; Taxonomy; Husbandry
PHVA:	Yes
Other:	More intensive wild management

Captive Populations: None

Captive Programs: Level 1

References:

Blanc, C.P. 1977. Reptiles sauriens Iguanidae. *Faune de Madagascar 45:* 1-195.

Glaw, F. and M. Vences. 1992. *A Field Guide to the Amphibians and Reptiles of Madagascar.* Moos-Druck, Leverkusen, Germany.

Reviewers:

Charles Blanc, Laboratoire de Zoogeographie, Université Montpellier 3, B.P. 5043, F-34032 Montpellier, Cedex 1, France

Christopher Raxworthy, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 48109 USA

December 1994

IGUANID CAMP TAXON REPORTS

TAXON *Oplurus fierinensis*

STATUS:

Mace-Lande:	Vulnerable
USFW:	No listing
CITES:	No listing

Taxonomic Status: Species

Distribution: Southwest Madagascar, restricted to areas around Toliara at elevations of up to 200 m; a slight extension of the range up to Tsimanampetsotsa has been described

Wild Population: < 10,000

Field Studies: Unaware of specific efforts

Threats: This species is threatened by habitat loss due to slashing and burning of vegetation, which decreases the available food supply by reducing local insect abundance. Although only small numbers appear to be in trade, collecting may pose a significant threat to this species due to its limited distribution and specific habitat requirements. This taxon should be considered potentially sensitive to over-exploitation (IUCN/SSC, 1993).

Comments: This is a relatively rare species, known only from small populations with low densities (Glaw and Vences, 1992). It is a riverine forest species, preferring spiny thickets on bluish gray rocks, and may be the rarest *Oplurus* in Madagascar (Meier, 1981). Trade levels are unknown, although 30 individuals are believed to have been exported from Madagascar during the first six months of 1991 (IUCN/SSC, 1993).

Recommendations:

Research:	Survey
PHVA:	No

Captive Populations: None

Captive Programs: Level 2

References:

Blanc, C.P. 1977. Reptiles sauriens Iguanidae. *Faune de Madagascar 45:* 1-195.

Glaw, F. and M. Vences. 1992. *A Field Guide to the Amphibians and Reptiles of Madagascar.* Moos-Druck, Leverkusen, Germany.

IUCN/SSC Trade and Madagascar Reptile and Amphibian Specialist Groups. 1993. *A preliminary review of the status and distribution of reptile and amphibian species exported from Madagascar.* IUCN/BIODEV Joint Nature Conservation Committee.

Meier, H. 1981. Zur Okologie, ethologie, und taxonomie einiger arten der gattung Oplurus auf Madagaskar. *Salamandra 17:* 43-54.

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IGUANID CAMP TAXON REPORTS

TAXON *Oplurus grandidieri*

STATUS:

Mace-Lande:	Susceptible
USFW:	No listing
CITES:	No listing

Taxonomic Status: Species

Distribution: South central Madagascar, abundant between Ihosy and Ambalavao; east to Ikongo and Vivanitelo, west to the border of the western slopes

Wild Population: > 10,000

Field Studies: Unaware of specific efforts

Threats: The major threat to this species is habitat loss. Although trade and status information is scanty, collection probably does not currently pose a significant threat to this species at this time (IUCN/SSC, 1993).

Comments: Although populations are still abundant south of the central regions, they may be declining in some areas. Within its geographic range, *O. grandidieri* is restricted to altitudes between 200 and 1200 m (Blanc, 1977). This species is a riverine forest dweller, but its preferred habitat varies from scelerophyll vegetation in the west to tropical vegetation in the Haut Bassin at Mangoky (IUCN/SSC, 1993).

Recommendations:

Research:	Survey
PHVA:	No

Captive Populations: None

Captive Programs: No

References:

Blanc, C.P. 1977. Reptiles sauriens Iguanidae. *Faune de Madagascar 45:* 1-195.

Glaw, F. and M. Vences. 1992. *A Field Guide to the Amphibians and Reptiles of Madagascar.* Moos-Druck, Leverkusen, Germany.

IUCN/SSC Trade and Madagascar Reptile and Amphibian Specialist Groups. 1993. *A* *preliminary review of the status and distribution of reptile and amphibian species exported from Madagascar.* IUCN/BIODEV Joint Nature Conservation Committee.

Reviewers:

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IGUANID CAMP TAXON REPORTS

TAXON *Oplurus saxicola*
STATUS:

Mace-Lande: Susceptible
USFW: No listing
CITES: No listing

Taxonomic Status: Species

Distribution: South central Tulear Province, Madagascar; also found on the Ivohibe massif at 775-2060 m elevation

Wild Population: > 10,000

Field Studies: Fieldwork in the Tolagnaro region (southeast) in 1990 by Nussbaum and Raxworthy.

Threats: This species is threatened by habitat loss. Although data on trade are lacking, there is no evidence that collecting poses a threat for this species (IUCN/SSC, 1993).

Comments: Although abundant between Beraketa, Antanimora, Tsihombe, and Ejeda (Blanc, 1977), the population is thought to be declining in some areas. This species is a riverine dweller and is found primarily on large, sparsely vegetated horizontal outcrops. In xerophytic forests, *O. saxicola* is sympatric with *O. quadrimaculatus.*

Recommendations:

Research: Survey
PHVA: No

Captive Populations: None

Captive Programs: No recommendation

References:

Blanc, C.P. 1977. Reptiles sauriens Iguanidae. *Faune de Madagascar 45:* 1-195.

Glaw, F. and M. Vences. 1992. *A Field Guide to the Amphibians and Reptiles of Madagascar.* Moos-Druck, Leverkusen, Germany.

IUCN/SSC Trade and Madagascar Reptile and Amphibian Specialist Groups. 1993. *A preliminary review of the status and distribution of reptile and amphibian species exported from Madagascar.* IUCN/BIODEV Joint Nature Conservation Committee.

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CONSERVATION ASSESSMENT AND MANAGEMENT PLAN FOR IGUANIDAE AND VARANIDAE

WORKING DOCUMENT

December 1994

Report from the workshop held
1-3 September 1992

Edited by
Rick Hudson, Allison Alberts, Susie Ellis, Onnie Byers

Compiled by the Workshop Participants

SECTION 5

SUMMARY OF VARANID INFORMATION

ENDFIELD
ENDRECORD

Summary of Varanid Information
by
Rick Hudson, Chair
AZA Lizard Advisory Group
Fort Worth Zoological Park

Varanid lizards are considered one of the most conspicuous groups of extant lizards, and are often highly visible components of their ecosystems. The group comprises some 44 species distributed over Africa, Asia and Australia. Recently, due to heavy impact of man on natural populations, varanids have been of particular interest with regard to worldwide conservation measures. Major threats to the survival of monitor lizard populations are habitat destruction and the international skin trade.

In general monitors are a highly successful group of lizards. Exploiting a wide range of habitats types over a large part of the southern hemisphere, monitors exist in a variety of shapes and sizes ranging from the diminutive *Varanus brevicauda* (0.21 meters; 17 grams) to the giant Komodo dragon, *V. komodoensis* (3 meters; 70-100 kilograms). Some are wide-ranging habitat generalists, e.g. *V. bengalensis*, and are able to survive in a variety of habitats, often existing alongside human habitation. Others are habitat specialists, e.g. *V. olivaceus*, that are tightly tied to a specific environment, or have very restricted ranges, e.g. *V. komodoensis*, factors that render them particularly vulnerable to the destructive forces of mankind.

Varanid lizards are among the most heavily exploited and commercially important of reptile species. Millions of skins are exported and traded annually representing primarily three wide-ranging species: the Asian water monitor, *V. salvator*, and the African Nile and Savanna monitors, *V. niloticus* and *V. albigularis/exanthematicus*, respectively. And though there is no clear evidence that any of these species is truly threatened, continued heavy exploitation may lead to local extinctions. The fact that these lizards can withstand such pressures is evidence of their ability to adapt under adverse circumstances.

Evaluating the conservation status of the family Varanidae has proved to be a frustrating task for a variety of reasons. Currently undergoing considerable systematic revision, monitor lizard taxonomy is in a state of flux, and numerous nomenclatural changes have occurred recently (for a review, see Sprackland, 1993). For several of the taxa under review, e.g. *Varanus (indicus) spinulosus*, taxonomic questions need to be resolved before a meaningful conservation assessment can be made. Moreover, for a large number of varanid lizards, there is a total lack of published information on distribution, wild population status and natural history. For some species, e.g. *V. (prasinus) bogerti*, the only literature account is the original scientific description. Other taxa simply exist as a dot or shaded area on a distribution map, or were only recently described, e.g. *V. yemenensis* (Bohme, 1988).

In general the family Varanidae contains some of the most popular and best known lizards in the world, several of which have been the subjects of extensive scientific investigations resulting in complete volumes (Auffenberg, 1981, 1988, 1994). Conversely it includes some extremely poorly studied lizards for which precious little information exists. The paucity of information and reliable field data on these lizards became clearly evident in several key groups. In particular, the monitors of SE Asia and Indonesia are poorly studied, and our knowledge of the distribution patterns, habitat requirements, and status of most of the specialized forest dwelling forms, e.g. *V. prasinus, V. rudicollis, V. dumerili, V. salvadorii, V. jobiensis*, is especially lacking. And though more extensively studied (Shine, 1986; Green & King, 1993) our basic understanding of most Australian monitor populations, likewise, has much room to expand. Fortunately Australia monitors (accounting for about 25 of the world's approximately 44 species) are protected from commercial exploitation (though not habitat destruction), and for this reason alone were ranked as "Safe". It should be stressed that this ranking was based on speculation, however flawed, rather than a clear understanding of the species actual status in nature.

It is the hope of the organizers of this CAMP workshop that this document will accurately reflect the conservation status of the family Varanidae, and that it will assist in the prioritization process of monitor species selected for captive programs. Though fortunately there are no varanid lizards currently recognized as critically endangered, or that urgently require captive breeding as a means of preventing extinction, captive programs should nevertheless be developed for a number of taxa. Monitor lizards have historically fared poorly under artificial conditions, and captive breedings have been notable exceptions. Fortunately, this trend is beginning to change, and reproduction has increased dramatically within the past five years, particularly in European collections (Horn, 1989) and in U.S. zoos (Hudson, 1994). Much of this success can be attributed to improved husbandry based on a clearer understanding of the species' natural history, as well as improved sexing techniques (Card & Kluge, in press). Increasingly, zoos are beginning to commit more resources to maintaining monitors in captivity, as reflected in the number of new outdoor off-exhibit breeding enclosures constructed in recent years, and dedicated largely to varanids. The American Zoo Association (AZA) Lizard Advisory Group has focused special attention on the specialized forest monitors of Indonesia and SE Asia by organizing pilot husbandry programs. A regional studbook has also been compiled (Winston Card/Dallas Zoo) for this group to assist in their captive management. A Komodo monitor studbook is likewise under development (Johnny Arnette/Cincinnati Zoo) in order to manage the burgeoning U.S. captive population.

Though improved as these circumstances may be, the dismal fact remains that there are presently few, if any, self-sustaining captive populations of monitor lizards worldwide. Unless this situation can be dramatically improved, zoos and captive managers will remain poorly prepared to utilize captive breeding as a viable tool in the overall conservation strategy for endangered varanids. Reversing this trend will require increased commitment and concerted efforts that focus on those taxa that are predicted to require assistance from captive management as a hedge against possible extinction. Fortunately, there are no monitor lizards currently is such a predicament, but captive managers must ultimately prepare for that eventuality. Decisions will need to be made concerning the direction taken and the taxa selected for management. Hopefully this document will provide a rational basis on which to base those decisions.

In order to assist this process, recommendations for the type of captive programs, if any, were made based on the wild population status and survival threats to the various species. Most of the taxa designated for captive management are for "Level 2" or "Level 3" populations, which are, with respect to varanid lizards, research populations. Such populations, though not perceived as having real conservation impact on the overall survival strategy of wild populations currently, may well prove extremely beneficial in the future. We envision that these research populations will provide the husbandry and management experience necessary to enable captive managers to maintain and breed these remarkable lizards on a regular basis. We sincerely hope that this exercise has not been a futile one, and that it will signal the beginning of a new era in captive breeding and cooperative research designed to better understand and preserve these fascinating and charismatic lizards.

CHECKLIST OF THE LIZARD FAMILY VARANIDAE

Rick Hudson

GENUS VARANUS:

SPECIES	DISTRIBUTION
acanthurus acanthurus	NW Australia
acanthurus brachyurus	Remaining mainland range
acanthurus insulanicus	Groote Eylandt
albigularis albigularis	South and SE Africa
albigularis angolensis	Angola and adjacent Zaire
albigularis microstictus	East Africa to Somalia
beccarii	Indonesia (Aru Islands)
baritji	NE NT and NW Qld
bengalensis bengalensis	Pakistan, northern India, Nepal, Burma, Iran & Afghanistan
bengalensis nebulosus	Southern Burma, Thailand, western Malaysia, Vietnam & Indonesia (Java)
bogerti	Papua New Guinea (d'Entrecasteaux, Trobriand, and Louisiade Archipel)
brevicauda	Arid regions of northern WA and southern NT to western Qld (Australia)
caudolineatus	Coast and interior of WA
dumerili dumerili	Indonesia (Sumatra, southern Borneo, Riou Archipelago, Batu, Banka and Billton), Thailand, peninsula Malaysia
eremius	Central coastal regions of WA to desert areas of SA and the NT

exanthematicus	West Africa
flavescens	Pakistan, northern India and Bangladesh
flavirufus	Arid interior of Australia
giganteus	Arid interior of Australia from far western Qld through central Australia to the coast of WA
gilleni	Desert areas of SA and the NT through the interior of WA to the north-west coast
glauerti	Known only from the Kimberley region of WA
glebopalma	Tropical north of Australia, from the Kimberley region of WA to western Qld
gouldii gouldii* (sp. panoptes invalid)	Continental Australia except arid interior
gouldii horni	New Guinea
gouldii rubidus	Pilbara and adjacent arid regions of WA
griseus griseus	Western Sahara and Mauritania east to Sudan and Egypt
griseus caspius	Northern Pakistan, Afghanistan, Iran, and USSR
griseus koniecznyi	Southern Pakistan and northwest India
indicus indicus*	Indonesia (Talaud, Timor, Irian Jaya), Papua New Guinea (including Bismark Archipelago), coastal northern Australia and Solomon Islands
indicus kalabeck*	Indonesia (Waigeu northwest of Irian Jaya)
indicus spinulosus* (spinulosus-full sp.)	George and Ysabel Island, Solomons
jobiensis* (formerly karlschmidti)	New Guinea
kingorum	Known only from small area in the east Kimberley region of WA

	and adjacent part of northwest NT
komodoensis	Indonesia (Komodo, Rintja, Flores)
mertensi	Coastal and inland waters of far northern Australia, from north-western Australia to central QLD and western side of Cape York Peninsula
mitchelli	Aquatic habitats throughout the northern parts of NT and northern WA
niloticus niloticus	South Africa north to Egypt in the east and Liberia in the west
niloticus ornatus	Zaire and West Africa
olivaceus	Philippine Islands
pilbarensis	Pilbara region, WA
prasinus*	Lowland forests of New Guinea
primordius	Far north of NT
rosenbergi	Far south of WA and SA
rudicollis	Burma, Thailand, western Malaysia, Indonesia (Riou Archipelago, Sumatra, Banka, Borneo)
salvadorii	New Guinea
salvator salvator	Sri Lanka and India (including Nicobar islands) east to southern China (and Hainan) south through southeast Asia, Indonesia (Sumatra Nias, Engano, Banka, Borneo and Sulawesi)
salvator andamenensis*	India (Andamen Islands)
salvator bivittatus	Indonesia (Java, Bali, Lombok, Sumbawa, Flores, Wetar)
salvator cumingi	Philippine Islands (Mindanao, Leyte, Cebu, Samar)
salvator marmoratus	Philippine Islands (Luzon, Culion, Palawan)
salvator nuchalis	Philippine Islands (Negros, Guimares, Masbate, Visayan islands)

salvator togianus	Indonesia (Timotto north of Sulawesi)
scalaris	Northwestern Australia
semiremex	Coast and adjacent river systems, eastern and northern Qld Australia
spenceri	Black soil plains of northwestern Qld, extending across the Barkly Tableland to the eastern parts of the NT, Australia
storri storri*	Queensland, Australia
storri ocreatus*	Kimberleys, WA and adjacent parts of NT
telenesetes	Roussell Island, Papua New Guinea
teriae	Cape York Peninsula, Qld Australia
timorensis timorensis	Indonesia (Timor)
timorensis similis* (similis full sp.?)	Southern New Guinea and northern Australia (NT and Qld)
tristis tristis	Western and central Australia
tristis orientalis	Northern and northeastern Australia
varius	Coasts, ranges, slopes and adj. plains of eastern and southeastern Australia, from southeast SA to Cape York
Peninsula.	
yemenensis	Yemen

* The family Varanidae is currently undergoing considerable systematic revision and thus the taxonomy is in a state of flux. New taxa are being described at an accelerating rate, many nomenclatural changes have recently occurred and others are expected. Species designated with an asterisk indicate that an upcoming change is anticipated, and that work is either in preparation, under review or already in press.

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WORKING DOCUMENT

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Compiled by the Workshop Participants

SECTION 6

SPREADSHEET CATEGORY DEFINITIONS AND SPREADSHEETS FOR ALL VARANID TAXA

ENDFIELD
ENDRECORD

IGUANIDAE AND VARANIDAE
CONSERVATION ASSESSMENT AND MANAGEMENT PLAN (CAMP)
SPREADSHEET CATEGORIES

The Conservation Assessment and Management Plan (CAMP) spreadsheet is a working document that provides information that can be used to assess the degree of threat and recommend conservation action.

The first part of the spreadsheet summarizes information on the status of the wild and captive populations of each taxon. It contains taxonomic, distributional, and demographic information useful in determining which taxa are under greatest threat of extinction. This information can be used to identify priorities for intensive management action for taxa.

1) SCIENTIFIC NAME: Sources for Iguanids: Burghardt, G.M. and A.S. Rand. 1982. Iguanas of the World. Noyes, Park Ridge, NJ. Sources for Varanids: Checklists from Bohme (1982, 1988) and Hudson (1992; see unpublished checklist and bibliography, this publication).

2) RANGE: Information obtained from a wide variety of published sources.

3) ESTIMATED NUMBER: Obtained from either workers in the field or published reports. When these were unavailable, best guesses were made. Although admittedly flawed, this methodology was the most practical alternative given the lack of current data available for many of the species surveyed. In almost all cases, further systematic field surveys are required in order to refine population estimates. In a few cases, divergent population estimates were obtained from different investigators. The most recent estimates available were used in these instances. When known the year(s) the survey was made was indicated.

4) SUBPOPULATIONS: For purposes of this review, most mainland forms are considered to exist as a single contiguous population, unless otherwise known contain to geographically isolated populations. Island populations were considered as distinct subpopulations in all cases. Although not taken into account in our designation of subpopulation number, we recognize the fact that habitat fragmentation is resulting in formerly widespread species being broken up into numerous subpopulations, and that this process has important conservation implications (see discussion).

5) TRENDS: The S (stable), D (declining), and I (increasing) designations were used. Species from areas known to be undergoing extensive habitat destruction/alteration, known to be heavily exploited for the pet or hide trade, or known to be heavily hunted were assumed to be declining. In a few instances, an S designation was assigned if the population had been known to persist at low yet stable numbers over a long period of time.

6) AREA: The area categories that were originally included in the review materials were modified. Former categories were designed for mammal populations and for purposes of this exercise were found to be too large to apply to reptile populations. In addition, four new categories were created to deal with small island populations. The modified scale is below:

A: < 5,000 sq km
AA: < 5,000 sq km but on a geographic island
AA1: < 1,000 sq km but on a geographic island
AA2: < 100 sq km but on a geographic island
AA3: < 10 sq km but on a geographic island
AAA: > 5,000 sq km on a geographic island
B: 5,000 - 9,999 sq km
C: 10,000 - 49,999 sq km
D: 50,000 - 99,999 sq km
E: 100,000 - 499,999 sq km
F: 500,000 - 999,999 sq km
G: > 1,000,000 sq km

Areas are admittedly overestimated because they are based on the total known range rather than habitat actually occupied. For insular taxa, we listed the entire island range but recognize that species may not occupy this entire area. For example, marine iguanas live only in coastal areas.

7) MACE-LANDE STATUS: Each taxon was classified as S (safe), V (vulnerable), E (endangered), or C (critical) based on the criteria described earlier (see section). For purposes of this review, if a population was estimated at <10,000 and felt to be in decline and/or occurred only as a single isolated population, it was classified as vulnerable. However a "susceptible" category was later added in order to highlight taxa that are not currently threatened but may be at future risk because of their small range and susceptibility to human activities (Mace et al., 1993, Species 19:16-23). Detailed taxon reports were compiled on any taxon classified as V, E, or C and are contained in this report.

8) THREATS: The following designations were utilized which include four new categories not included in the original review document:

D = Disease
H = Hunting for food and/or other purposes
L = Loss of habitat
P = Predation
T = Trade for live animal or skin trade
Pe = Predation by exotics (cats, dogs, mongooses)
Ic = Interspecific competition (feral ungulates)
Fr = Habitat fragmentation
El = El Nino effects (for marine iguanas)

9) PHVA WORKSHOP: We were conservative in our recommendation of PHVA's and restricted this designation to those taxa that had M/L status designations of V, E, or C, and for which sufficient data and resources exist to conduct a meaningful workshop. Factors such as biological uniqueness (Gray's monitor), or ability to serve as a flagship or environmental indicator species (Komodo dragon, Fiji iguana) were also taken into consideration.

10) WILD MANAGEMENT: Wild management was recommended for all taxa listed as V, E, or C, and in every case where there was known exploitation (hunting, hide or pet trade) and some form of regulation (quotas, take limits, designated collecting seasons) was indicated. Minimally, this should imply ongoing population monitoring and survey work.

11) RESEARCH: Research of three types was recommended.

A. Survey: Field surveys were recommended when either the range, trend, or numbers were questionable.

B. Taxonomic: Taxonomic studies were recommended whenever there were taxonomic problems to be rectified (species vs subspecies) or where questions existed; was also recommended for species having extensive geographic ranges and for which the possibility of cryptic or unrecognized forms may exist (green iguana, Nile monitor).

C. Husbandry: Husbandry research was recommended for those taxa that either now or at some point in the future were felt to be in need of captive management, and for which the requirements are poorly known or are recognized as difficult to maintain or reproduce in captivity.

12) CAPTIVE PROGRAM: For purposes of this review, the numbers are based primarily on those listed in ISIS abstracts (current June 1994) unless supplemental information was available at the time of compilation. For Australian monitors, numbers are based on those reported in the Australian Species Management Plan (ASMP) Taxon Advisory Group Action Plan for Reptiles & Amphibians in Australian Zoos (current June 1994). In some cases, substantial numbers of some taxa exist in the private sector (Savannah and Nile monitors, for example), but these were not included because they are not available for captive management.

13) CAPTIVE RECOMMENDATION: Definitions for the 4 population categories are as follows:

Level 1 (1) - A captive population is recommended as a component of a conservation program. This program has a tentative goal of developing and managing a population sufficient to preserve 90% of the genetic diversity of a population for 100 years (90%/100). This program should be further defined with a species management plan encompassing the wild and captive populations and implemented immediately with available stock in captivity. If the current stock is insufficient to meet program goals, a species management plan should be developed to specify the need for additional founder stock. If no stock is present in captivity then the program should be developed collaboratively with appropriate wildlife agencies, SSC Specialist Groups, and cooperating institutions.

Level 2 (2) - Similar to the above except a species/subspecies management plan would include periodic reinforcement of captive populations with new genetic material from the wild. The levels and amount of genetic exchange needed should be defined in terms of the program goals, a population model, and species management plan. It is anticipated that periodic supplementation with new genetic material will allow management of a smaller captive population. The time period for implementation of a Level 2 program will depend on recommendations made at the CAMP workshop.

Level 3 (3) - A captive program is not currently recommended as a demographic or genetic contribution to the conservation of the species/subspecies but is recommended for education, research, or husbandry. For example, species for which husbandry, and in some cases taxonomic, research was recommended, Level 3 populations are ideally suited for these purposes. As envisioned here, the primary function of these populations is to conduct pilot programs to determine husbandry and management procedures for taxa that may require assistance from captive programs in the forseeable future. This type of population can also be utilized for short-term reintroduction projects.

No (N) - A captive program is not currently recommended as a demographic or genetic contribution to the conservation of the species/subspecies. Taxa already held in captivity may be included in this category. In this case species/subspecies should be evaluated either for management toward a decrease in numbers or for complete elimination from captive programs as part of a strategy to accommodate as many species/subspecies as possible of higher conservation priority as identified in the CAMP or in SSC Action Plans.

Pending (P) - A decision on a captive program will depend upon further data either from a PHVA, a survey, or existing identified sources to be queried.

In many situations, a captive program recommendation can not be made until taxonomic problems are resolved or additional survey work is completed. In some cases species that were considered safe were nevertheless recommended for captive programs based on the following:

1) a perceived future threat/vulnerability;
2) ability to serve as a flagship species;
3) degree of biological uniqueness;
4) the need to establish captive management guidelines or gain husbandry experience.

Each taxon was evaluated independently and on its own merit, and captive recommendations were based on need rather than the current allocation of captive resources.

Table 13. Vulnerable Varanid taxa according to Mace-Lande criteria.

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
	REPTILIA													
	SQUAMATA													
	SAURIA													
	VARANIDAE													
3	Varanus	beccarri	Indonesia (Aru Island)	UNK	1	D?	AAA	V/S	T,L	PEND SURV	PEND SURV	T,S,H	26	3
5.1		b. bengalensis	Pakistan, N. India, Nepal, Burma, Iran, & Afghanistan	>10,000	1	S	G	V/S	L,T,H	N	Y	S,H	22	3
5.2		b. nebulosus	S. Burma, Thailand, W. Malaysia, Vietnam & Indonesia (Java)	>10,000	1	S	G	V	L,T,H	N	Y	S,H	4	3
9	Varanus	dumerili	Indonesia (Sumatra, S. Borneo, Riou Archipelago, Batu, Banka, & Billton) , Thailand, Malaysia, Burma	>10,000	>10	D?	G	V	T,H,L,Fr	N	Y	S,T,H	24	3
11	Varanus	exanthematicus	West Africa	>10,000	1	D	G	V	T,H,L.Fr	N	Y	S,H,T	66	N
12	Varanus	flavescens	Pakistan, N. India, and Bangladesh	>10,000	1	D	G	V	T,L,H,Fr	N	Y	S,H	2	2
19.2		g. caspius	Northern Pakistan, Afghanistan, Iran, and former USSR	>10,000	1	D	U	V	H,L	N	Y	S,T,H	0	3
20.3		i. spinulosus	George Island, Solomons	UNK	2	UNK	AA-3	V	UNK	N	PEND SURV, TAX	S,T,H	2	3
24	Varanus	komodoensis	Komodo,Flores & Rinca Island	3,000-5,000		S	AA-1	V	L,Pe	Y	Y	H,S	75	2
27.2		n. ornatus	Rain forests of Zaire and west Africa	>10,000	1	D	G	V	Fr,L,H	N	Y	S,T,H	0	3/PEND

Working Document

	TAXON		WILD POPULATION								RSRCH		CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
28	Varanus	olivaceus	Philippine Islands (Luzon+Camarines Norte)	< 10,000	2	D	AA	V	L,H,Fr	Y	Y	S,H	5	2
30	Varanus	prasinus	Lowland forests of New Guinea	> 10,000	1	D?	AAA	V/S	L,T,Fr	N	Y	S,T,H	51	3
33	Varanus	rudicollis	Burma, Thailand, W. Malaysia, Indonesia (Riou Archipelago, Sumatra, Banka, Borneo)	> 10,000	> 10	D?	G+AAA	V	Fr,L,T	N	Y	S,T,H	20	3
34	Varanaus	salvadorii	New Guinea	> 10,000	1	D?	AAA	V/S	Fr,L,T	N	Y	S,H	50	3
35.4		salvator cumingi	Philippine Islands (Mindanao, Leyte, Samar)	UNK	6	D?	AAA	V?	H,Fr,L,T	N	Y	T,S	7	PEND
35.5		s. marmoratus	Philippine Islands (Luzon, Culoin, Palawan, Mindoro, Calimian)	UNK	> 5	D?	AAA	V?	H,Fr,L,T	N	Y	T,S	0	N
35.6		s. nuchalis	Philippine Islands (Negros, Guimaras, Masbate, Panay, Cebu, Visayan islands)	UNK	6	D?	AAA	V?	H,Fr,L,T	N	Y	S,T	0	PEND
35.7		s. togianus	Indonesia (Timotto north of Sulawesi)	UNK	U	D?		V?	L,T	N	Y	S,T	0	PEND
40	Varanus	telenesetes	Roussell Island, Paupa New Guinea	UNK	UNK	UNK	AA-3	V?	UNK	UNK	UNK	S,T	0	N

Table 14. Secure Varanid taxa according to Mace-Lande criteria.

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
	REPTILIA													
	SQUAMATA													
	SAURIA													
	VARANIDAE													
1.1		a. acanthurus	NW Australia	>10,000 80's	1	S	E	S	NONE	N	N	T	38	N
1.2		a. brachyurus	remaining mainland range	>10,000 80's	1	S	G	S	NONE	N	N	T	0	N
1.3		a. insulanicus	Groote Eylandt (Australia)	<10,000 80's	1	S	AA-2?	S	NONE	N	N	T	0	N
2.1		a. albigularis	South and SE Africa	>10,000	1	D	C	S	H,L,Fr,T	N	N	S,T,H	42	N
2.2		a.angolensis	Angola and adjacent Zaire	>10,000	1	D	C	S	L,T,H,Fr	N	PEND SURV	S,T	0	PEND
2.3		a. microtictus	East Africa and Somalia	>10,000	1	D	C	S	H,L,Fr,T	N	PEND SURV, TAX	T,S	0	PEND
	Varanus	baritji	NE NT and NW Qld	>10,000	1	S	O	S	NONE	N	N	NONE	0	N
7	Varanus	brevicauda	Arid regions of northern WA and southern NT to W. Qld. (Australia)	>10,000	1	S	G	S	NONE	N	N	N	0	N
8	Varanus	caudolineatus	Coast and interior of WA	>10,000	1	S	G	S	NONE	N	N	N	20	N
10	Varanus	eremius	Central coastal regions of WA to desert regions of SA and the NT	>10,000	1	S	G	S	NONE	N	N		1	N
13	Varanus	flavirufus	Arid interior of Australia	>10,000	1	S	G	S	NONE	N	N	T,H	0	N
14	Varanus	giganteus	Arid interior of Austr. from far W. Qld. through central Austr.to the coast of WA	>10,000	1	S	G	S	NONE	N	N	H	35	3

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
15	Varnaus	gilleni	Desert areas of SA & the NT through the interior of WA to the NW coast	>10,000	1	S	G	S	NONE	N	N	NONE	20	N
16	Varanus	glauerti	known only from the Kimberley region of WA + Arnhemland, NT (Aust)	<10,000	2	S?	E	S?	UNK	N	PEND SURV	S,H	0	Pending
17	Varanus	glebopalma	Tropical north of Austr. from the Kimberly region of WA to Qld	>10,000	1	S	D	S	NONE	N	N	H	0	N
18.1		gouldii gouldii	Continental Australia except arid interior	>10,000	1	S	G	S	NONE	N	N	T	61	N
18.3		g. rubidus	Pilbara and adjacent arid regions of WA	>10,000	1	S	D	S	NONE	N	N	T	2	N
19.1		griseus griseus	Western Sahara and Mauritania east to Sudan and Egypt	>10,000	1	D?	G	S	H,L,T	N	Y	S,T,H	40	3
19.3		g. koniecznyi	Southern Pakistan and Northwest India	>10,000	1	D?	U	S	L,H	n	y	S,T,H	2	3
20.1		i. indicus	Indonesia (Talaud, Timor, Irian Jaya), Paupa New Guinea (including Bismark Archipelago), coastal northern Australia and Solomon Islands	>10,000	>50	S	AA + A	S	T,H,L	N	PEND SURV, TAX	S,T,H	46	N
23	Varanus	kingorum	Known only from small area in the east Kimberley region of WA and adjacent part of northwest NT	<2,500?	1	S	A?	S?	NONE	N	PEND SURV	S,H	1	PEND
25	Varanus	mertensi	Coastal and inland waters of far northern Austr., from NW Austr. to central QLD. and west side of Cape York Pen	>10,000	1	S	F	S	NONE	N	N	H	17	N
26	Varanus	mitchelli	Aquatic habitats throughout the northern parts of NT and northern WA	>10,000	1	S	D	S	NONE	N	N	H	2	N
27.1		n. niloticus	South Africa north to Egypt in the east and Liberia in the west	>10,000	1	D	G	S glob V? loc	Fr,T,H,L	N	Y	S,T,H	34	N
29	Varanus	pilbarensis	Pilbara region, WA	<2,500	1	S	E	S?	NONE	N	PEND SURV	S,T	0	PEND
31	Varanus	primordius	Far north of NT	<10,000	1	S	C	S?	UNK	N	PEND SURV	S,H	0	N

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
32	Varanus	rosenbergi	Far south of WA and SA	>10,000	1	S	D	S	NONE	N	N	NONE	0	N
35.1		s. salvator	Sri Lanka and India (including Nicobar islands) east to southern China (and Hainan) south through SE Asia, Indonesia (Sumatra Nias, Engano, Banka, Borneo, and Sulawesi)	>10,000	>50	D	G+AAA	S glob V loc	H,T,Fr,L	N	Y	S,T	70	N
36	Varanus	scalaris	Northwestern Australia	>10,000	1	S	F	S	NONE	N	N	S,T	3	N
37	Varanus	semiremix	Coast and adjacent river systems eastern and northern Qld.	<10,000	1	S	D	S?	UNK	N	N	S,T	1	N
38	Varanus	spenceri	Black soil plains of NW Qld., extending across the Barkly Tableland to the eastern parts of the NT	>10,000	1	S	E	S	NONE	N	N	NONE	8	N
39.1		s. storri	Queensland	>10,000	1	S	E	S	NONE	N	N	T	21	N
39.2		s. ocreatus	Kimberleys, WA and adjacent parts of NT	<10,000	1	S	D	S	NONE	N	N	T	0	N
43.1		t. tristis	Western and central Australia	>10,000	1	S	G	S	NONE	N	N	T	3	N
43.2		t. orientalis	Northern and northeastern Australia	>10,000	1	S	G	S	NONE	N	N	T	>3	N
44	Varanus	varius	Coasts, ranges, slopes and adjacent plains of eastern and SE Australia, from southeast SA to Cape York Peninsula	>10,000	1	S	G	S	NONE	N	N	T	50	N

Table 15. Unknown Varanid taxa according to Mace-Lande criteria.

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
	REPTILIA													
	SQUAMATA													
	SAURIA													
	VARANIDAE													
6	Varanus	bogerti	Papua New Guinea (d'Entrecasteaux, Trobriand, and Louisiade Archipel)	UNK	>3	UNK	AA-2	UNK	UNK	PEND SURV	PEND SURV	S,T,H	0	PEND
18.2		g. horni	New Guinea	>10,000	1	UNK	UNK	UNK	T,L,H	N	PEND SURV	S,T	0	N
20.2		i. kalabeck	Indonesia (Waigeu northwest of Irian Jaya)	UNK	UNK	UNK	UNK	UNK	UNK	N	PEND SURV, TAX	S,T		PEND
22	Varanus	jobiensis (=karlschmidti)	New Guinea	UNK	1	UNK	AAA	UNK	L,T?	N	PEND SURV, TAX	S,T,H	4	3/PEND
35.2		s. andamenensis	India (Andamen Islands)	UNK	U	U		UNK	L,T	N	Y	S,T	0	N
35.3		s. bivittatus	Indonesia (Java, Bali, Lombok, Sumbawa, Flores, Wetar)	UNK	U	U		UNK	L,T	N	Y	T,S	0	N
41	Varanus	teriae (=prasinus Australia)	Cape York Peninsula, Qld	UNK	1	S	A	UNK	UNK	N	N	S,T	2	N
42.1		t. timorensis	Indonesia (Timor)	UNK	U	U	AAA	UNK	T	N	UNK	S,T	11	N
42.2		t. similis	Southern New Guinea and northern Australia (NT and Qld)	UNK	U	U	U	UNK	UNK	N	U	T,S	0	N
45	Varanus	yemenensis	Yemen and adjacent Saudi Arabia	UNK	1	UNK	UNK	UNK	UNK	UNK	UNK	S,T	0	N

Table 16. All Varanid taxa.

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
	REPTILIA													
	SQUAMATA													
	SAURIA													
	VARANIDAE													
1	Varanus	acanthurus												
1.1		a. acanthurus	NW Australia	>10,000 80's	1	S	E	S	NONE	N	N	T	38	N
1.2		a. brachyurus	remaining mainland range	>10,000 80's	1	S	G	S	NONE	N	N	T	0	N
1.3		a. insulanicus	Groote Eylandt (Australia)	<10,000 80's	1	S	AA-2?	S	NONE	N	N	T	0	N
2	Varanus	albigularis											1	
2.1		a. albigularis	South and SE Africa	>10,000	1	D	C	S	H,L,Fr,T	N	N	S,T,H	42	N
2.2		a.angolensis	Angola and adjacent Zaire	>10,000	1	D	C	S	L,T,H,Fr	N	PEND SURV	S,T	0	N
2.3		a. microtictus	East Africa and Somalia	>10,000	1	D	C	S	H,L,Fr,T	N	PEND SURV, TAX	T,S	0	N
3	Varanus	beccarri	Indonesia (Aru Island)	UNK	1	D?	AAA	V/S	T,L	PEND SURV	PEND SURV	T,S	26	3
	Varanus	baritji	NE NT and NW Qld	>10,000	1	S	D	S	NONE	N	N	NONE	0	N
5	Varanus	bengalensis												
5.1		b. bengalensis	Pakistan, N. India, Nepal, Burma, Iran, & Afghanistan	>10,000	1	S	G	V/S	L,T,H	N	Y	S,H	22	3

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
5.2		b. nebulosus	S. Burma, Thailand, W. Malaysia, Vietnam & Indonesia (Java)	>10,000	1	S	G	V	L,T,H	N	Y	S,H	4	3
6	Varanus	bogerti	Papua New Guinea (d'Entrecasteaux, Trobriand, and Louisiade Archipel)	UNK	>3	UNK	AA-2	UNK	UNK	PEND SURV	PEND SURV	S,T,H	0	PEND
7	Varanus	brevicauda	Arid regions of northern WA and southern NT to W. Qld. (Australia)	>10,000	1	S	G	S	NONE	N	N	N	0	N
8	Varanus	caudolineatus	Coast and interior of WA	>10,000	1	S	G	S	NONE	N	N	N	20	N
9	Varanus	dumerili	Indonesia (Sumatra, S. Borneo, Riou Archipelago, Batu, Banka, & Billton) , Thailand, Malaysia, Burma	>10,000	>10	D?	G	V	T,H,L,Fr	N	Y	S,T,H	24	3
9.1		d. dumerili												
10	Varanus	eremius	Central coastal regions of WA to desert regions of SA and the NT	>10,000	1	S	G	S	NONE	N	N		1	N
11	Varanus	exanthematicus	West Africa	>10,000	1	D	G	V	T,H,L.Fr	N	Y	S,H,T	66	N
12	Varanus	flavescens	Pakistan, N. India, and Bangladesh	>10,000	1	D	G	V	T,L,H,Fr	N	Y	S,H	2	2
13	Varanus	flavirufus	Arid interior of Australia	>10,000	1	S	G	S	NONE	N	N	T,H	0	N
14	Varanus	giganteus	Arid interior of Austr. from far W. Qld. through central Austr.to the coast of WA	>10,000	1	S	G	S	NONE	N	N	H	35	3
15	Varnaus	gilleni	Desert areas of SA & the NT through the interior of WA to the NW coast	>10,000	1	S	G	S	NONE	N	N	NONE	20	N
16	Varanus	glauerti	known only from the Kimberley region of WA + Arnhemland, NT (Aust)	<10,000	2	S?	E	S?	UNK	N	PEND SURV	S,H	0	Pending
17	Varanus	glebopalma	Tropical north of Austr. from the Kimberly region of WA to Qld	>10,000	1	S	D	S	NONE	N	N	H	0	N
18	Varanus	gouldii												
18.1		g. gouldii	Continental Australia except arid interior	>10,000	1	S	G	S	NONE	N	N	T	61	N
18.2		g. horni	New Guinea	>10,000	1	UNK	UNK	UNK	T,L,H	N	PEND SURV	S,T	0	N

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
18.3		g. rubidus	Pilbara and adjacent arid regions of WA	>10,000	1	S	D	S	NONE	N	N	T	2	N
19	Varanus	griseus												
19.1		g. griseus	Western Sahara and Mauritania east to Sudan and Egypt	>10,000	1	D?	G	S	H,L,T	N	Y	S,T,H	40	3
19.2		g. caspius	Northern Pakistan, Afghanistan, Iran, and former USSR	>10,000	1	D	U	V	H,L	N	Y	S,T,H	0	3
19.3		g. koniecznyi	Southern Pakistan and Northwest India	>10,000	1	D?	U	S	L,H	n	y	S,T,H	2	3
20	Varanus	indicus											17	
20.1		i. indicus	Indonesia (Talaud, Timor, Irian Jaya), Paupa New Guinea (including Bismark Archipelago), coastal northern Australia and Solomon Islands	>10,000	>50	S	AA + A	S	T,H,L	N	PEND SURV, TAX	S,T,H	46	N
20.2		i. kalabeck	Indonesia (Waigeu northwest of Irian Jaya)	UNK	UNK	UNK	UNK	UNK	UNK	N	PEND SURV, TAX	S,T		PEND
20.3		i. spinulosus	George Island, Solomons	UNK	2	UNK	AA-3	V	UNK	N	PEND SURV, TAX	S,T,H	2	3
22	Varanus	jobiensis (=karlschmidti)	New Guinea	UNK	1	UNK	AAA	UNK	L,T?	N	PEND SURV, TAX	S,T,H	4	3/PEND
23	Varanus	kingorum	Known only from small area in the east Kimberley region of WA and adjacent part of northwest NT	<2,500?	1	S	A?	S?	NONE	N	PEND SURV	S,H	1	3/PEND
24	Varanus	komodoensis	Komodo,Flores & Rinca Island	3,000-5,000		S	AA-1	V	L,Pe		Y	H,S	75	2
25	Varanus	mertensi	Coastal and inland waters of far northern Austr., from NW Austr. to central QLD. and west side of Cape York Pen	>10,000	1	S	F	S	NONE	N	N	H	17	N
26	Varanus	mitchelli	Aquatic habitats throughout the northern parts of NT and northern WA	>10,000	1	S	D	S	NONE	N	N	H	2	N
27	Varanus	niloticus												

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
27.1		n. niloticus	South Africa north to Egypt in the east and Liberia in the west	>10,000	1	D	G	S glob V? loc	Fr,T,H,L	N	Y	S,T,H	34	N
27.2		n. ornatus	Rain forests of Zaire and west Africa	>10,000	1	D	G	V	Fr,L,H	N	Y	S,T,H	0	3/PEND
28	Varanus	olivaceus	Philippine Islands (Luzon+Camarines Norte)	<10,000	2	D	AA	V	L,H,Fr	Y	Y	S,H	5	2
29	Varanus	pilbarensis	Pilbara region, WA	<2,500	1	S	E	S?	NONE	N	PEND SURV	S,T	0	PEND
30	Varanus	prasinus	Lowland forests of New Guinea	>10,000	1	D?	AAA	S/V	L,T,Fr	N	Y	S,T,H	51	3
31	Varanus	primordius	Far north of NT	<10,000	1	S	C	S?	UNK	N	PEND SURV	S,H	0	N
32	Varanus	rosenbergi	Far south of WA and SA	>10,000	1	S	D	S	NONE	N	N	NONE	0	N
33	Varanus	rudicollis	Burma, Thailand, W. Malaysia, Indonesia (Riou Archipelago, Sumatra, Banka, Borneo)	>10,000	>10	D?	G+AAA	V	Fr,L,T	N	Y	S,T,H	20	3
34	Varanaus	salvadorii	New Guinea	>10,000	1	D?	AAA	S/V	Fr,L,T	N	Y	S,H	50	3
35	Varanus	salvator												
35.1		s. salvator	Sri Lanka and India (including Nicobar islands) east to southern China (and Hainan) south through SE Asia, Indonesia (Sumatra Nias, Engano, Banka, Borneo, and Sulawesi)	>10,000	>50	D	G+AAA	S glob V loc	H,T,Fr,L	N	Y	S,T	70	N
35.2		s. andamenensis	India (Andamen Islands)	UNK	U	U		U	L,T	N	Y	S,T	0	N
35.3		s. bivittatus	Indonesia (Java, Bali, Lombok, Sumbawa, Flores, Wetar)	UNK	U	U		U	L,T	N	Y	T,S	0	N
35.4		s. cumingi	Philippine Islands (Mindanao, Leyte, Samar)	UNK	6	D?	AAA	V?	H,Fr,L,T	N	Y	T,S	7	PEND
35.5		s. marmoratus	Philippine Islands (Luzon, Culoin, Palawan, Mindoro, Calimian)	UNK	>5	D?	AAA	V?	H,Fr,L,T	N	Y	T,S	0	N
35.6		s. nuchalis	Philippine Islands (Negros, Guimaras, Masbate, Panay, Cebu, Visayan islands)	UNK	6	D?	AAA	V?	H,Fr,L,T	N	Y	S,T	0	PEND

	TAXON		WILD POPULATION									RSRCH	CAPTIVE PROGRAM	
	SCIENTIFIC NAME		RANGE	EST#	SUB POP	TRND	AREA	M/L STS	THRTS	PVA/ WKSP	WILD MGMT	TAX/SRV/ HUSB	ISIS NUM	CAP REC
35.7		s. togianus	Indonesia (Timotto north of Sulawesi)	UNK	U	D?		V?	L,T	N	Y	S,T	0	PEND
36	Varanus	scalaris	Northwestern Australia	>10,000	1	S	F	S	NONE	N	N	S,T	3	N
37	Varanus	semiremix	Coast and adjacent river systems eastern and northern Qld.	<10,000	1	S	D	S?	UNK	N	N	S,T	1	N
38	Varanus	spenceri	Black soil plains of NW Qld., extending across the Barkly Tableland to the eastern parts of the NT	>10,000	1	S	E	S	NONE	N	N	NONE	8	
39	Varanus	storri												
39.1		s. storri	Queensland	>10,000	1	S	E	S	NONE	N	N	T	21	N
39.2		s. ocreatus	Kimberleys, WA and adjacent parts of NT	<10,000	1	S	0	S	NONE	N	N	T	0	N
40	Varanus	telenesetes	Roussell Island, Paupa New Guinea	UNK	UNK	UNK	AA-3	V?	UNK	UNK	UNK	S,T	0	N
41	Varanus	teriae (=prasinus Australia)	Cape York Peninsula, Qld	UNK	1	S	A	UNK	UNK	N	N	S,T	2	N PEND TAX, SURV
42	Varanus	timorensis												
42.1		t. timorensis	Indonesia (Timor)	UNK	U	U	AAA	UNK	T	N	UNK	S,T	11	N
42.2		t. similis	Southern New Guinea and northern Australia (NT and Qld)	UNK	U	U	U	UNK	UNK	N	U	T,S	0	N
43	Varanus	tristis												
43.1		t. tristis	Western and central Australia	>10,000	1	S	G	S	NONE	N	N	T	3	N
43.2		t. orientalis	Northern and northeastern Australia	>10,000	1	S	G	S	NONE	N	N	T	>3	N
44	Varanus	varius	Coasts, ranges, slopes and adjacent plains of eastern and SE Australia, from southeast SA to Cape York Peninsula	>10,000	1	S	G	S	NONE	N	N	T	50	N
45	Varanus	yemenensis	Yemen and adjacent Saudi Arabia	UNK	1	UNK	UNK	UNK	UNK	UNK	UNK	S,T	0	N

CONSERVATION ASSESSMENT AND MANAGEMENT PLAN FOR IGUANIDAE AND VARANIDAE

WORKING DOCUMENT

December 1994

Report from the workshop held
1-3 September 1992

Edited by
Rick Hudson, Allison Alberts, Susie Ellis, Onnie Byers

Compiled by the Workshop Participants

SECTION 7

VARANIDAE TAXON SHEETS

ENDFIELD
ENDRECORD

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus albigularis* White-throat Monitor

STATUS:

Mace-Lande: Safe to Vulnerable
USFWS:
CITES: Appendix II
Other:

Taxonomic Status: Has three recognized subspecies, albigularis, angolensis and microstictus, which are in need of systematic review and clarification.

Distribution: Egypt, Sudan, Djibouti, Somalia, Kenya, Uganda, southern Zaire, Tanzania, Zambia, Angola, Namibia, Botswana, Zimbabwe, Mozambique, Zanzibar and Pemba islands, South Africa, Swaziland and Zululand

Wild Population: > 1,000,000

Field Studies: Andy Philips (San Diego Zoo CRES) conducted an 18 month field research/radio tracking project in Namibia (Etosha National Park) during early 1990s.

Threats: Habitat loss, hunting and skin trade.

Comments: Research may reveal that subspecies are actually clinal variants. Populations are presumed to be declining. Occurs over a wide-range of habitats throughout Africa, avoiding extreme desert conditions.

Recommendations:

Research: Population status surveys, taxonomy, husbandry
PHVA: No
Other: Impact of trade should be monitored.

Captive Populations: A research population is maintained at San Diego Zoo Center for Reproduction of Endangered Species (CRES). Results will have implications for management of all large varanids in captivity.

Captive Programs: No

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus (prasinus) beccarri* Black Tree Monitor

STATUS:

Mace-Lande: Susceptible
USFWS:
CITES: Appendix II
Other:

Taxonomic Status: Recently assigned full species status (Sprackland, 1990). Systematics of *prasinus* complex in question. Needs clarification.

Distribution: Aru Island (Indonesia)

Wild Population: Status unknown

Field Studies: Unaware of specific efforts

Threats: Trade, habitat loss

Comments: Involved in live animal trade since about 1985.

Recommendations:

Research: Field survey, habitat requirements, impact of trade.
PHVA: No
Other:

Captive Populations: 26 in 7 N.A. collections (1994 ISIS data); has reproduced in three U.S. zoos and two German facilities since 1991. Included in AZA regional studbook (Winston Card/Dallas Zoo) for Asian forest monitors.

Captive Programs: Level 3

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus bengalensis bengalensis* Bengal Monitor
STATUS:
Mace-Lande: Vulnerable to safe
USFWS: Endangered
CITES: Appendix I
Other:

Taxonomic Status: Nominate species with one subspecies.

Distribution: Pakistan, India, Sri Lanka, Nepal, Myanmar, Bangladesh, Iran and Afghanistan.

Wild Population: >1,000,000

Field Studies: Auffenberg conducted field work over much of species' range from 1974-1987 (see Auffenberg et al, 1991, 1994). Gupta (1993, unpublished report) provides density data from the Uttar Pradesh based on field work and interviews in 1991-92. Khan (1988) provides data on population density, habitat preference and distribution in Bangladesh.

Threats: Habitat destruction, skin trade, hunting for food, road kills

Comments: The natural history, biology, conservation and taxonomic status of this taxa are detailed in a recent book by Auffenberg (1994). A generalized species, they are widely distributed and found in a great diversity of habitats. Rom Whitaker reports that they are still quite common in parts of India. Highest abundance in areas of high productivity (those with permanent water) in India. Popular in the skin trade during the 1970s, exports were reduced to a trickle by 1980 due to CITES I listing. However, some illegal hunting and export still occurs in India and Pakistan (Auffenberg, 1989). DeSilva (1993) states that *V. bengalensis* is killed extensively in large numbers for its flesh, and feels that it is "vulnerable or commercially threatened" according to the IUCN Threat Categories. Another recent threat in Sri Lanka is the destruction of its favored nesting sites (termite mounds) during clearing of land for agriculture, settlements and roads. According to Auffenberg (1994) "*Varanus bengalensis* is a widespread, highly adaptable, and often numerically abundant species. While there is no doubt that some populations have already been destroyed, the presumption of general widespread population decline cannot presently be supported by any firm field data. There is no justification for considering this species as being threatened with extinction, in spite of this listing in Appendix I of Cites since 1975. Yet.......is common in what remains of its natural habitat. Even in environmentally degraded lands population densities may be quite high, for its habitat requirements are not tightly structured. Viable, reproducing populations are able to survive in many disturbed situations if not regularly hunted or persecuted."

Recommendations:

Research: Population monitoring, husbandry, impact of skin trade and hunting.
PHVA: No
Other:

Captive Populations: 14 of unknown subspecies (1994 ISIS data); unknown number in Indian collections (Madras Snake Park, Crocodile Bank, and Dhaka Zoo); 8 in N.A zoos. Has not reproduced in zoos but has been bred in captivity by Auffenberg (1970's) and D. Gorman (1993 VaraNews).

Captive Programs: Level 3

References:

Auffenberg, W., Q. Arain & N. Khurshid, 1991. Preferred Habitat, Home Range and Movement Patterns of *Varanus bengalensis* in Southern Pakistan. MERTENSIELLA 2, Advances in monitor research, Bohme & Horn, editors. pp. 7-27.

Auffenberg, W. 1994. The Bengal Monitor. The University Press of Florida, 1-560.

Auffenberg, W. 1989. Utilization of Monitor Lizards in Pakistan. Journal of the International TRAFFIC Network. Vol. 11, No. 1.

Luxmore, R. & B. Groombridge (1989): Asian monitor lizards. A review of distribution, status, exploitation and trade in four selected species.--A draft report to the CITES Secretariat. World Conservation & Monitoring Centre, Cambridge.

Khan, A.R. 1988. A Report on the Survey of the Biological and Trade Status of *Varanus bengalensis, Varanus flavescens*, and *Varanus salvator* in Bangladesh. Unpublished report for Nature Conservation Movement, Bangladesh.

This report reviewed by Walt Auffenberg, Brij Gupta and Rom Whitaker, April 1993.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus bengalensis nebulosus* Clouded Monitor
STATUS:

Mace-Lande: Vulnerable
USFWS: Endangered
CITES: Appendix I
Other:

Taxonomic Status: Recognized subspecies.

Distribution: Thailand, W. Malaysia, Laos, Cambodia, Vietnam and Indonesia (Java, Natuna Islands, and possibly an isolated population in Sumatra).

Wild Population: Status unknown

Field Studies: Auffenberg studied populations in W. Malaysia and Thailand during the period 1974-1987.

Threats: Habitat destruction, hunting.

Comments: Considered common in W. Malaysia (C. Koh Shin/Zoo Negara, pers comm.).

Recommendations:

Research: Distribution/population survey, husbandry.
PHVA: No
Other:

Captive Populations: 10 in Malaysian and U.S. zoos. Has reproduced in private sector in U.S., (D. Gorman, VaraNews, Aug. 1993).

Captive Programs: Level 3

References:

Auffenberg, W. 1994. The Bengal Monitor. The University Press of Florida, 1-560.

Luxmore, R. & B. Groombridge (1989): Asian monitor lizards. A review of distribution, status, exploitation and trade in four selected species.--A draft report to the CITES Secretariat. World Conservation & Monitoring Centre, Cambridge.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus (prasinus) bogerti* Bogert's Black Monitor

STATUS:

Mace-Lande: Unknown
USFWS:
CITES: Appendix II
Other:

Taxonomic Status: Species in question. The *prasinus* complex of four subspecies was recently elevated to full species status (Sprackland, 1990). Needs clarification.

Distribution: d'Entrecasteaux, Trobriand, and Louisade Archipelago (Papua New Guinea).

Wild Population: Unknown.

Field Studies: Unaware of specific efforts

Threats: Unknown

Comments: Population status is unknown. Not yet seen in commercial pet trade.

Recommendations:

Research: Distribution survey, taxonomy, husbandry
PHVA: No
Other:

Captive Populations: None known.

Captive Programs: Pending

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus dumerili* Dumeril's/Forest Monitor

STATUS:

Mace-Lande:	Vulnerable
USFWS:	
CITES:	Appendix II
Other:	

Taxonomic Status: Species with one poorly defined subspecies, *heteropholis* (now possibly suppressed). Needs clarification.

Distribution: Thailand through peninsular Malaysia, southern Burma, Borneo, Sumatra, Java and nearby small islands of Batu, Bangka, and Belitung (Indonesia).

Wild Population: > 10,000; numerous subpopulations.

Field Studies: Auffenberg has studied various wild populations in the 1980's; unaware of specific recent efforts.

Threats: habitat loss, trade, hunting, habitat fragmentation

Comments: Populations are presumed to be declining. Variations in size and morphology exist between some populations. A specialized crab feeder, they prefer mangrove habitats.

Recommendations:

Research:	Distribution survey, taxonomy, husbandry
PHVA:	No
Other:	Investigations into variation (genetic, morphological) among isolated (insular vs. mainland) populations.

Captive Population: 25 (1994 ISIS data) ; has reproduced twice in captivity in North America; unknown elsewhere. Included in AZA regional studbook (Winston Card/Dallas Zoo) for Asian forest monitors.

Captive Programs: Level 3

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus exanthematicus* Bosc's Monitor

STATUS:

Mace-Lande:	Vulnerable
USFWS:	
CITES:	Appendix II
Other:	

Taxonomic Status: Species. Now considered taxonomically distinct from the larger "savanna-type" monitor, *V. albigularis*. Needs clarification.

Distribution: West Africa (Senegal to Lake Chad); along Nile estuaries in Sudan, northern Ethiopia.

Wild Population: > 1,000,000 in numerous subpopulations.

Field Studies: Unaware of specific efforts; M. Bayless ongoing zoogeographical studies.

Threats: Skin trade primarily.

Comments: This species is widespread and heavily exploited for the skin and pet trade. Micropopulations becoming locally extinct due to overcollecting. Large numbers of hatchlings appear in the pet trade reportedly captive bred from "farms" in Benin, West Africa. These should be investigated. Extensively involved in the skin trade

Recommendations:

Research:	Distribution survey, population density, impact of trade, habitat requirements
PHVA:	No
Other:	Regulation and monitoring of trade. Potential for farming should be investigated.

Captive Populations: 1500 estimated in private sector; 75 in zoos (1994 ISIS data).

Captive Programs: No

Inskipp, T. 1984. World Trade in Monitor Skins 1977-1982. Traffic Bulletin, Vol. VI, Nos. 3/4.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus flavescens* Yellow Monitor

STATUS:

Mace-Lande:	Vulnerable
USFWS:	Endangered
CITES:	Appendix I
Other:	Indeterminate-IUCN 1990 Red List

Taxonomic Status: Well-defined species with no subspecies.

Distribution: Pakistan, India, and Bangladesh

Wild Population: > 100,000

Field Studies: See Luxmore & Groombridge (1989); Auffenberg, et al (1989); Gupta (1993) provides information on status, distribution and trade in India, and Khan (1988) provides similar data for Bangladesh including population density estimates and habitat preferences.

Threats: Habitat loss (primary), skin trade, and hunting.

Comments: Population is reportedly declining as it lives in areas where habitat is being converted to agriculture. In India this species is most often found in the marshy borders of shallow lakes which are the habitats most drastically modified through agriculture-particularly rice culture in the high-density human population areas of the lower Gangetic river plain. Thus they have been largely extirpated throughout most of its former range. Whitaker recommends that a survey is urgently needed to assess distribution, status and habitat requirements and availability. Of the four Indian monitors, flavescens has the most dense populations, albeit the smallest and most restricted range (Gupta, pers. comm.). According to Khan (1988), flavescens is extensively involved in the skin trade, both legally in Bangladesh and illegally in India with smuggled hides. Luxmore et al (1989) report that "although good numbers remain in Bangladesh, the species appears to be highly threatened on a world scale, and certainly in India."

Recommendations:

Research:	Distribution/status survey, habitat requirements/availability, husbandry
PHVA:	Yes, pending survey.
Other:	Effects of habitat modification on population viability; impact of exploitation for skin trade.

Captive Populations: 5 in facilities outside India; holdings in Indian zoos unknown. Has reproduced once worldwide in captivity at the Rotterdam Zoo in 1983. Captive groups should be established soon to begin pilot husbandry programs.

Captive Programs: Level 2 pending husbandry research

References:

Auffenberg, W., Rahman, H., Iffat, F. and Preveen, Z. 1989. A study of Varanus flavescens. Jour. of the Bombay Natl. Hist. Soc. 80: 286-307.

Gupta, Brij. 1993. Utilization of Monitor Lizards in India. Unpublished report to IUCN.

Khan, A.R. 1988. A Report on the Survey of the Biological and Trade Status of *Varanus bengalensis, Varanus flavescens*, and *Varanus salvator* in Bangladesh. Unpublished report for Nature Conservation Movement, Bangladesh.

Luxmore, R. & B. Groombridge (1989): Asian monitor lizards. A review of distribution, status, exploitation and trade in four selected species.--A draft report to the CITES Secretariat. World Conservation & Monitoring Centre, Cambridge.

Reviewed by Walt Auffenberg, Brij Gupta and Rom Whitaker, April 1993.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus glauteri* Long-tailed Rock Monitor

STATUS:

Mace-Lande:	Safe to vulnerable
USFWS:	
CITES:	Appendix II
Other:	

Taxonomic Status: Well-defined species

Distribution: Known from the Kimberley region of WA and Arnhemland, NT (Australia)

Wild Population: > 10,000

Field Studies: Paul Horner (NT Museum of Arts and Sciences) considers it rare because of low or localized populations; in the NT he knows of it only from the western Arnhem Land escarpment, in areas which are either conservation reserves or Aboriginal land.

Threats: Unknown

Comments: Population is presumed to be stable.

Recommendations:

Research:	Distribution/status survey, husbandry, basic biology
PHVA:	No
Other:	

Captive Populations: None known.

Captive Programs: Pending

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus griseus* Desert Monitor

STATUS:

Mace-Lande: Vulnerable
USFWS: Endangered
CITES: Appendix I
Other: Vulnerable (*caspius*)-IUCN 1990 Red List

Taxonomic Status: Three subspecies-*V. g. griseus, caspius*, and *konieczynyi*.

Distribution: Western Sahara and Mauritania east to Sudan and Egypt to approximately eastern Iran (*griseus*); western shores of the Caspian Sea, Turkman and the Iranian Plateau eastward through the USSR, western Afghanistan and Baluchistan to western Sinkiang Province, China (*caspius*); and from eastern Afghanistan through Pakistan to north-central India (*konieczyni*).

Wild Population: > 1,000,000; most widespread extant monitor.

Field Studies: India and Pakistan (Auffenberg, 1980's), Israel (Stanner and Mendelssohn, 1980's)

Threats: Hunting, trade, and habitat loss

Comments: Populations reportedly declining is some areas but this remains to be documented. Densities are generally reported as stable in many areas based on frequency of sightings, but in decline in others due to agricultural clearing (*caspius*). Auffenberg (1988) reports there is no clear evidence that this monitor (*konieczyni*) is regularly (if at all) hunted for its leather. He observed that it is rather common in appropriate habitats, and in general, through both India and Pakistan much of the original preferred habitat of this subspecies remains intact. Whitaker states that there is still much good habitat left in India, but the impact from the skin industry and hunting for meat and medicine needs assessment. Some illegal trade noted in the U.S. in 1993-1994.

Recommendations:

Research: Distribution survey, impact of trade, husbandry
PHVA: No
Other:

Captive Populations: 8 (unknown subspecies); 40 (*griseus griseus*); 0 (*caspius*); 2 (*konieczyni*) (1994 ISIS data). An unknown number in range zoos.

Captive Programs: Level 3

References:

Auffenberg, W., et al. 1989. Notes on the Biology of *Varanus griseus koniecznyi*. Journal, Bombay Natural History Society, Vol 87, pp. 26-35.

Luxmore, R. & B. Groombridge (1989): Asian monitor lizards. A review of distribution, status, exploitation and trade in four selected species.--A draft report to the CITES Secretariat. World Conservation & Monitoring Centre, Cambridge.

Edited by Walt Auffenberg, Brij Gupta and Rom Whitaker, April 1993.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus griseus caspius* Caspian Desert Monitor
STATUS:

Mace-Lande: Vulnerable
USFWS: Endangered
CITES: Appendix I
Other:

Taxonomic Status: one of three recognized subspecies, *caspius* is distinctive in its larger size and compressed tail.

Distribution: eastern coast of Caspian Sea, south Kazakstan, Uzbekistan, to middle Asia, Iran and Afghanistan into N. Baluchistan.

Wild Population: Declining. Density and distribution varies depending on the availability of rodents and refuges (burrows). For a review of distribution, habitat and population densities in the Soviet Union, see Bennett and Shimanskaya, 1991.

Field Studies: D. Grechanichenko of Alma-Ata Zoo, Uzbekistan has been conducting research over the past 12 years on the ecology, reproduction, conservation and reintroduction of this taxon back into native habitat. Well studied, however most information published on its ecology is in Russian, contributing to its poorly known status elsewhere in the world. See Bennett and Shimanskaya (1991) for review.

Threats: Primary threat is human encroachment and habitat conversion for agriculture, habitat fragmentation, hunting.

Comments: Population has reportedly been greatly reduced due to economic development in some areas; 90% reduction has been estimated in some districts of Uzbekistan, and supposedly on the verge of elimination in others.

Recommendations:

Research: Distribution/population status surveys, husbandry
PHVA: Pending survey
Other:

Captive Populations: Captive breeding program in Alma-Ata Zoo; 17 produced 1990-93.

Captive Programs: Level 3

References:

Bennett, D. and M. Shimanskaya, 1991. A Review of Some Soviet Literature Concerning the Grey Monitor Lizard, *Varanus griseus caspius*. VaraNews, Vol. 1, No. 8, pp. 5-7.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus (indicus) spinulosus* Solomans Keeled Monitor
STATUS:

Mace-Lande: Vulnerable
USFWS:
CITES: Appendix II
Other:

Taxonomic Status: Subspecies; may be elevated to full species status. Needs taxonomic clarification.

Distribution: St. George and Ysabel Islands, Solomon Islands

Wild Population: Unknown

Field Studies: Unaware of specific efforts

Threats: Unknown.

Comments: Population status and numbers are unknown. Some authorities consider this a full species. If this is true, then *spinulosus* assumes a higher conservation priority due to the apparent rarity and highly restricted range. The relationship with sympatric *indicus indicus* needs investigation.

Recommendations:

Research: Distribution survey, habitat requirements, husbandry, threats
PHVA: Possibly, pending field survey and taxonomic results
Other:

Captive Populations: 2 in one U.S. zoo (Baltimore).

Captive Programs: Level 2 pending survey and taxonomy

References:

Sprackland, R.G., 1992. Rediscovery of a Solomon Islands Monitor (*Varanus indicus spinulosus*) Mertens, 1941. The Vivarium, Vol. , No. , pp. 25-27.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus komodoensis* Komodo Monitor
STATUS:

Mace-Lande:	Vulnerable
USFWS:	Endangered
CITES:	Appendix I
Other:	Protected under Indonesian law (1931, 1990) and Ministerial Decree (1991)

Taxonomic Status: Well-defined species with no subspecies.

Distribution: Islands of Komodo, Rinca and Gili Motang in Komodo National Park (KNP). Extinct on Padar. Also scattered populations on W. coast of Flores (including Wai Wuul Reserve), and along N. coast of Flores to Riung. Flores populations are not in Komodo National Park, except in Wai Wuul, which is poorly patrolled.

Wild Population: Estimated at 5,000 (Auffenberg, 1980); 3,336 (PHPA 1994 census results). Divided among 4 island subpopulations. Total population figures not known at this time. Flores populations have reportedly declined markedly in past few years (R. Lilley, 1994).

Field Studies: Auffenberg, 1981. Other population surveys by PHPA (National Park) staff within KNP.

Threats: Human interference, habitat alteration and destruction, encroachment from human population and logging concessions (especially on Flores), wild dogs and fires (everywhere within range, including KNP).

Comments: Population within KNP is considered to be stable, but there are no reliable data to substantiate this. The sex ratio is markedly skewed towards males (3.4 : 1). Largest varanid, it apparently has the smallest distribution of any monitor species. Some are collected for Indonesian Zoos. Historically, they have been heavily collected. Results of genetic studies on relationships amount island populations should be available soon.

Recommendations:

Research: Husbandry, ecology, reproductive biology, population dynamics and the effects of tourism.

PHVA: Yes

Other: Restoration and monitoring of Padar population; studies on prey species and active deer management program within KNP; fire management program for KNP; long-term monitoring of egg-laying and hatching, especially in relation to mound-building Megapode birds.

Captive Populations: > 75 in U.S., Indonesia, Japan, Australia and Europe. Has reproduced in captivity in Indonesia at three zoos, and in the U.S. at two, National and Cincinnati. Four clutches resulting in 55 progeny were produced from 1992-1994 (2 at each zoo), which now reside in 18 U.S. zoos. All U.S. progeny are, however, descended from only 1 female. A regional studbook is being developed by Johnny Arnette/Cincinnati Zoo. Encourage exchange of bloodlines between Indonesian and U.S. zoos, and greater cooperation between institutions holding dragons. Transfer of technological assistance, i.e. husbandry and veterinary information, captive management techniques, etc., is essential if Indonesian zoos are to play an active role in the overall conservation strategy for Komodo dragons in captivity.

Captive Programs: Level 2

References:

Auffenberg, W. 1981. The Behavioral Ecology of the Komodo Monitor. Univ. Florida Press, 1-406.

Edited by Ron Lilley, December, 1994.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus niloticus niloticus* Nile Monitor
STATUS:
Mace-Lande: Safe globally; Vulnerable locally
USFWS:
CITES: Appendix II
Other: Partially or fully protected in about half of countries where it occurs.

Taxonomic Status: Nominate species with one subspecies. Needs clarification.

Distribution: Occurs throughout sub-Saharan Africa with the exception of Burundi; extends north to Egypt, west to Senegal and through South Africa.

Wild Population: >1,000,000

Field Studies: Chris Wild (Gambia and Cameroon); Mike Griffin (Namibia).

Threats: Skin trade primarily, hunting and loss of wetlands habitat.

Comments: Population is thought to be relatively stable, though McLachlan (1978) regards it as vulnerable outside of game reserves in South Africa. Has a former widespread distribution. Species is vulnerable due to loss of wetland habitat (Namibia) in some areas. Agricultural practices and human activities may result in population declines, but is still locally abundant in suburban and rural degraded habitats, regularly frequenting human habitations (Gambia). This monitor is extensively involved in the skin trade, and over 1 million whole skins were exported during the five year period, 1977-1982 (Inskipp, 1984).

Recommendations:
Research: Population survey/status, taxonomy (possibility of genetically distinct populations due to extensive range over the majority of African continent), husbandry; impact of trade.
PHVA: No
Other:

Captive Population: 34 (1994 ISIS data); >1500 in private sector in U.S. Captive breeding in private sector.

Captive Programs: No

References:

McLachlan, G.R. 1978. South African Red Data Book - reptiles and amphibians. South African National Scientific Programmes Report No. 23.

Inskipp, T. 1984. World Trade in Monitor Skins 1977-1982. Traffic Bulletin, Vol. VI, Nos. 3/4.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus niloticus ornatus* Ornate Nile Monitor
STATUS:

Mace-Lande:	Vulnerable
USFWS:	
CITES:	Appendix II
Other:	

Taxonomic Status: Poorly defined subspecies. Needs clarification.

Distribution: Zaire and west Africa. Occurs in a variety of habitats from primary forests to mixed farmbush and monoculture plantations.

Wild Population: > 100,000

Field Studies: Populations in Cameroon surveyed in 1990-1992 by Chris Wild.

Threats: Hunting and possible competition and genetic swamping with *V. n. niloticus*, skin trade.

Comments: A locally important source of protein for rural and forest people, it is killed whenever encountered. Shy and infrequently seen. Present in degraded habitat, there may be a potential threat from *V. n. niloticus* invading from savanna areas into the farmbush areas and challenging the niche of *ornatus*.

Recommendations:

Research:	Distribution/habitat survey, taxonomy, husbandry
PHVA:	No
Other:	

Captive Population: Breeding group in California (G. Naclerio)

Captive Programs: Level 3 pending survey

Edited by Chris Wild, April 1993.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus olivaceus* Gray's Monitor
STATUS:

Mace-Lande:	Vulnerable
USFWS:	
CITES:	Appendix II
Other:	Rare-IUCN 1990 Red List

Taxonomic Status: A unique and well-defined species.

Distribution: Northern Philippine Islands; primary population is on Luzon, smaller populations on Catanduanes & Polillo Islands; total known range is 5,000 sq km (Auffenberg, 1987)

Wild Population: < 10,000

Field Studies: Auffenberg (1976-83)

Threats: Hunting, habitat destruction, habitat fragmentation and small range

Comments: Known only from a preserved juvenile and the cleaned skull of an adult, and considered exceedingly rare for many years (actually thought extinct by some), this elusive lizard was rediscovered and brought to the forefront of the scientific community by Walter Auffenberg in 1976. Gray's monitor has the second smallest reported range of any monitor species; however, within this small range the species is common so it is in no danger of imminent extinction. But according to Aufenberg (1988), the situation is bound to deteriorate. Dogs are used to hunt this lizard for human consumption. A specialized feeder, this lizard eats fruit and seeds (the only frugivorous species in an otherwise carnivorous family) as well as molluscs. (Auffenberg, 1988). Fortunately the species can survive and reproduce even in disturbed forested situations. Due to its taxonomic uniqueness, the Gray's monitor is of particular conservation concern. Immediate measures must be taken to prevent their rapid decline and extinction. Additional protection in the Philippines is urgently needed. According to Auffenberg (1988) "The small range, constant pursuit by hunters, and an alarmingly fast rate of destruction of its habitat dictates a vigilant and aggressive policy of protection for the next several decades."

Recommendations:

Research:	Distribution and population/status survey, husbandry.
PHVA:	Yes
Other:	Protected habitat reserve

Captive Populations: 5 (1994 ISIS data); has not reproduced in captivity though fertile eggs were laid in 1992 at Dallas (1 hatch but DNS) and Riverbanks Zoos. Included in AZA regional studbook (Winston Card/Dallas Zoo) for Asian forest monitors.

Captive Programs: Level 2 pending husbandry research

References:

Auffenberg, W. 1988. Gray's Monitor Lizard. Univ. Florida Press, 1-419.

Reviewed by W. Auffenberg, April 1993.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus prasinus* Green Tree Monitor
STATUS:
Mace-Lande: Vulnerable/Safe
USFWS:
CITES: Appendix II
Other:

Taxonomic Status: Once contained 4 subspecies; Sprackland (1990) has synonomized *prasinus prasinus* and *prasinus kordensis*. Subspecies need review and clarification.

Distribution: Lowland forests of New Guinea and N. Australia.

Wild Population: > 10,000

Field Studies: Unaware of specific efforts

Threats: Trade, habitat loss, habitat fragmentation.

Comments: Population status is unknown. A specialized orthopteran feeder (Losos & Greene, 1988), the biology and natural history of this small arboreal monitor is poorly known.

Recommendations:
Research: Distribution survey, taxonomy, husbandry
PHVA: No
Other:

Captive Populations: > 50; has reproduced three times in captivity in U.S. zoos; in three facilities in Germany; approximately 75 in private collections. Included in AZA regional studbook (Winston Card/Dallas Zoo) for Asian forest monitors.

Captive Programs: Level 3

References:

Losos, J.B. & Greene, H.W. 1988. Ecological and evolutionary implications of diet in monitor lizards. Biological Journal of the Linnean Society, No. 35, pp. 379-407.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus rudicollis* Rough-necked Monitor
STATUS:

Mace-Lande: Vulnerable
USFWS:
CITES: Appendix II
Other:

Taxonomic Status: Well-defined species; however, highly variable populations exist than need investigation and clarification.

Distribution: Burma, Thailand, peninsular Malaysia, Indonesia (Riou Archipelago, Sumatra, Banka, Kalimantan), Singapore.

Wild Population: > 10,000

Field Studies: Unaware of specific efforts

Threats: Habitat loss, habitat fragmentation, trade

Comments: Population is thought to be declining, but there is no evidence to confirm this. Variations in size and coloration exist between some populations which need investigation. Natural history and biology poorly known. Highly arboreal.

Recommendations:

Research: Distribution/population status survey, taxonomy, husbandry.
PHVA: No
Other: Genetics associated with population variations.

Captive Populations: 19 (1994 ISIS data); has reproduced twice in captivity at one U.S. zoo (Nashville) and in private sector; unknown number held in private sector; additional captive groups should be established for pilot husbandry program. Included in AZA regional studbook (Winston Card/Dallas Zoo) for Asian forest monitors.

Captive Programs: Level 3

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus salvadorii* New Guinea Crocodile Monitor
STATUS:

Mace-Lande:	Vulnerable/Safe
USFWS:	
CITES:	Appendix II
Other:	

Taxonomic Status: Well-defined species.

Distribution: New Guinea

Wild Population: > 10,000

Field Studies: Unaware of specific efforts

Threats: Habitat fragmentation, habitat loss, skin trade

Comments: Graham Webb discussed this species during a recent CITES/IUCN review committee visit to Irian Jaya and states that "they appear to be quite common." Occur over a wide range in West Irian and PNG containing vast tract of undisturbed forests. A specialized feeder on birds and their eggs (Auffenberg, 1981), their biology and natural history remain poorly known. Appearing frequently in the pet trade.

Recommendations:

Research:	Distribution/population status surveys, husbandry
PHVA:	No
Other:	Natural history and biology.

Captive Populations: 50 (1994 ISIS data); has reproduced once in captivity at Gladys Porter Zoo in 1992; unknown number in private sector. Included in AZA regional studbook (Winston Card/Dallas Zoo) for Asian forest monitors.

Captive Programs: Level 3

References:

Auffenberg, W. 1981. The Behavioral Ecology of the Komodo Monitor. Univ. Florida Press, 1-406.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus salvator* Asian Water Monitor
STATUS:

Mace-Lande:	Safe globally; Vulnerable locally.
USFWS:	
CITES:	Appendix II
Other:	Nominal protection in several range countries.

Taxonomic Status: 7 subspecies are recognized; however systematics need investigation and clarification.

Distribution: Sri Lanka and India, Bangladesh, east to southern China, south through SE Asia, Indonesia, India, Philippines. Widespread with numerous subpopulations.

Wild Population: >1,000,000

Field Studies: Gaulke (1991) has been conducting field work with the three Philippine subspecies. Auffenberg conducted field work throughout the 1980's. Populations in southern Sumatra were studied by Erdelen (1991), and information on Bangladesh populations is provided by Khan (1988).

Threats: Hunting and skin trade primarily; habitat loss and fragmentation secondarily. Trade in skins is estimated to range between 1-1.5 million per year (Luxmore & Groombridge, 1989) and the most important countries of origin are Indonesia, followed by Thailand, Malaysia and the Philippines.

Comments: Second largest extant varanid, this is a widespread species with numerous populations exhibiting considerable geographic variation. Under tremendous pressure throughout much of the range due to hunting for the skin trade. Some populations are subject to local extirpation, while others are becoming vulnerable due to a number of factors. Though still abundant in some areas, the population densities are declining in all areas investigated. According to Erdelen (1991), "if present trends continue the future for this species in Indonesia does not look too promising. In particular, the increase in numbers of export products and the discrepancies between quotas and actual export figures, are alarming." The potential for farming/breeding operations should be explored. Sustainable yield harvesting systems must be developed.

Recommendations:

Research:	Distribution/population surveys, taxonomy, husbandry/farming potential, reproductive biology, population ecology and impact of hunting.
PHVA:	No

Other: Trade monitoring and regulation; encourage management of wild populations.

Captive Populations: 70 (1994 ISIS data); 100s of unknown subspecies held worldwide. Reproduces well under captive conditions, and has bred ten times in the U.S. and in good numbers in India (Madras Croc Bank).

Captive Programs: No

References:

Erdelen, W. 1991. Conservation and Population Ecology of Monitor Lizards: the Water Monitor *Varanus salvator* in South Sumatra. Mertensiella, No. 2: Advances in monitor research.

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Luxmore, R. & B. Groombridge (1989): Asian monitor lizards. A review of distribution, status, exploitation and trade in four selected species.--A draft report to the CITES Secretariat. World Conservation & Monitoring Centre, Cambridge.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus salvator nuchalis*

STATUS:

Mace-Lande:	Vulnerable
USFWS:	
CITES:	CITES II
Other:	Protected by Philippine law in past years

Taxonomic Status: Clearly differentiated from all other subspecies by its strongly enlarged nuchal scales and some color features. Two forms: typical and melanistic.

Distribution: Philippines. Typical form: Negros, Cebu, Panay, Guimaras, Siquijor. Melanistic form: Masbate, Ticao, Borocay.

Wild Population: Unknown.

Field Studies: Conducted by Gaulke (1986-1992) throughout their distribution, most intensively on Negros Oriental and Masbate.

Threats: Commercial and subsistence hunting and habitat destruction. Pressure will increase due to rapidly growing human population. Very restricted range.

Comments: Relatively common in parts of its distribution, but declining according to all observations. Regarded as a pest (chicken predator) by inhabitants throughout its range making enforcement of a wild management program difficult. Its beneficial role in controlling rats and rice field pest and as scavenger should be promoted.

Recommendations:

Research:	Distribution/population surveys
PHVA:	No
Other:	

Captive Populations: Small captive group in Germany

Captive Programs: Level 3/Pending

References:

Gaulke, Maren. 1992. Taxonomy and Biology of Philippine Water Monitors (*Varanus salvator*). The Philippine Journal of Science, Vol. 121, No. 4.

Gaulke, M. 1991. Systematic Relationships of the Philippine Water Monitors as Compared with *Varanus s. salvator*, with a Discussion of Dispersal Routes. Mertensiella, No. 2: Advances in monitor research.

Edited by Maren Gaulke, August 1993.

VARANID CAMP TAXON REPORTS

SPECIES: *Varanus salvator cumingi*

STATUS:

Mace-Lande:	Vulnerable
USFWS:	
CITES:	Appendix II
Other:	Protected by Philippine law in past years.

Taxonomic Status: Probably the most derived of all Asian water monitors subspecies. Clearly differentiated by coloration and pholidosis. Two distinct forms (see Gaulke, 1991, 1992)

Distribution: Philippines. Typical form on Mindanao. Atypical form (possibly an interbreed with *V. s. marmoratus*) on Samar, Leyte, Bohol, Basilan.

Wild Population: Unknown, but rapidly declining on Mindanao according to observations.

Field Studies: Conducted by Gaulke on different parts of Mindanao with inconclusive results concerning abundance. Seems to be fairly common on Basilan.

Threats: Restricted range; threatened through commercial and subsistence hunting, and habitat destruction. Pressure on this form will increase due to the rapidly growing human population.

Comments: More intensive research on this taxon is needed especially with regards to taxonomic status. Present studies indicate behavioral differences between this and other *salvator* subspecies.

Recommendations:

Research:	Population status/surveys, taxonomy, husbandry.
PHVA:	Yes, pending survey
Other:	Expand captive holdings of typical Mindanao form

Captive Populations: 7 in Germany; has reproduced once.

Captive Programs: Level 3/pending

References:

Gaulke, M. 1991. Systematic Relationships of the Philippine Water Monitors as Compared with *Varanus s. salvator*, with a Discussion of Dispersal Routes. Mertensiella, No. 2: Advances in

monitor research.

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Edited by Maren Gaulke, August, 1993.

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SECTION 8

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SECTION 10

APPENDIX

FICHA DE DADOS DE TAXONOMIA**ENDFIELD**
ENDRECORD

come but it represents our present knowledge accurately and therefore it is useful now and will be useful for a long time. The table below includes a breakdown of the 30 iguanine species and their distribution. The numerous subspecies listed for *Cyclura* indicate that this island group's taxonomy is unstable, and it may never be resolved as extinction closes in on these remarkable animals.

The Iguanine Genera

Genus	Common Name	Number of Species[1]	Recognized Subspecies[1]	Geographic Range[1]
Amblyrhynchus	Marine Iguanas	1	3	Galápagos Islands
Brachylophus	Banded Iguanas	2[2]	0	Fiji and Tonga Island groups
Conolophus	Land Iguanas	2	0	Galápagos Islands
Ctenosaura	Spiny-tailed Iguanas	9	7	Mexico to Panama, Colombian Islands
Cyclura	Ground Iguanas	7	14	Greater Antilles and Bahamas
Dipsosaurus	Desert Iguana	1	3	Southwestern U.S., Mexico, islands in the Gulf of California
Iguana	Green Iguanas	2	0	Mexico to southern Brazil and Paraguay, Lesser Antilles
Sauromalus	Chuckawallas	6	7	Southwestern U.S., Mexico, islands in the Gulf of California
		30		

[1] Based on Etheridge, Chapter 1
[2] See also Gibbons and Watkins, Chapter 23

Blanc's contribution on the biogeography of the Malagasy lizards (Chapter 2) bears directly on the origin of the family Iguanidae and its past distribution, and thus on the early history of the iguanines. As Blanc points out, the presence of iguanids in Madagascar and their absence in Africa and Asia is one of the paradoxes in classic biogeography. Calling on the currently accepted concepts of plate tectonics and shifting continents, Blanc suggests that iguanids evolved in South America, reached Madagascar via Antarctica when they were much closer together, and may never have occurred in Asia, Africa and Australia at all.

Representatives of all the iguanine and Malagasy iguanid genera are depicted in the color plates of the frontispiece. The end paper map may prove useful in quickly locating geographically the various kinds of iguanas.

1

Checklist of the Iguanine and Malagasy Iguanid Lizards

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INTRODUCTION

A checklist is included in this volume to provide those interested in or working on iguanine and Malagasy iguanid lizards with a ready guide to the taxonomic literature of the group, and reasonably detailed distributions for each taxon. The group of genera referred to here as iguanines is not now recognized as a formal taxonomic unit, i.e., subfamily. Nevertheless iguanines are easily distinguished from other iguanid lizards, and very probably form a natural, monophyletic group. They share a large number of derived anatomical and behavioral characteristics, the most notable being specializations of the skull, dentition, and gut adaptive for an herbivorous diet, as well as a distinctive condition of the caudal vertebrae, presumably not functionally related to herbivory, which is unique within the family. The relationships of the iguanine genera, however, remain unclear, as does the position of the group within the family as a whole. There is much work to be done on the evolutionary and biogeographic history of the group.

Cope (1886) was apparently the first to use the term Iguaninae in a more or less formal sense. He included the genera *Cyclura, Ctenosaura, Brachylophus, Cachryx (= Enyaliosaurus), Iguana, Conolophus* and *Amblyrhynchus*. The North American genera *Dipsosaurus* and *Sauromalus* were not included. Previously Boulenger (1885) in his *Catalogue of the Lizards in the British Museum* had listed these same genera in sequence (including *Metapoceros* for *Cyclura cornuta*), implying perhaps his belief in their affinity. In 1890 Boulenger provided a brief description of the skulls of these genera, again considering *Metapoceros* as distinct but failing to recognize the validity of *Cachryx*. In 1900 Cope presented a revised formal classification of iguanid subfamilies, but in this work his Iguaninae was quite different from the group he recognized under that name in 1886. Cope proposed the subfamilies Anolinae, Basiliscinae and

Iguaninae, the latter being defined merely as lacking the diagnostic features of the first two subfamilies, and thus including all of the iguanid genera not assigned to the Anolinae and Basiliscinae.

Subsequently various authors have offered comments on the possible relationships of iguanine genera, but without proposing their formal recognition as a taxonomic unit. On the basis of musculature Camp (1923:416) stated that "*Holbrookia* and other North American iguanids are regarded as primitive, *Iguana, Cyclura, Dipsosaurus* and *Amblyrhynchus* as central, *Basiliscus* and *Anolis* as offshoots of the latter," and that "the Fijian *Brachylophus* is closely related to *Ctenosaura* and *Cyclura*." In his review of the genus *Urosaurus* Mittleman (1942: 112-113; Fig. 1) briefly considered the phylogeny and relationships of all North American iguanid genera except *Anolis*, implying that they form a monophyletic group, with *Ctenosaura* basal to the remaining genera. He stated: "*Dipsosaurus* is probably the most primitive of the North American Iguanidae (excepting *Ctenosaura*, which is properly a Central and South American form), and possesses several points in common with *Ctenosaura*, most easily observed of which is the dorsal crest; the genera further show their relationship in the similarity of cephalic scutellation. *Sauromalus* is considered a specialized offshoot of *Crotaphytus*, or more properly pre-*Crotaphytus* stock, by reason of its solid sternum, as well as the five-lobed teeth; the simple type of cephalic scalation indicates its affinity with the more primitive *Dipsosaurus-Ctenosaura* stock." Smith (1946: Fig. 92) apparently accepted Mittleman's view that all North American iguanids except *Anolis* form a monophyletic group, in which he also included the West Indian *Leiocephalus*. Following Mittleman, he placed *Ctenosaura, Dipsosaurus* and *Sauromalus* near the base of the group. However, Smith (1946: 101) apparently recognized the broader affinities of the North American iguanines, for under the heading "The Herbivore Section," he included *Iguana, Amblyrhynchus, Conolophus, Dipsosaurus, Sauromalus, Ctenosaura* and *Cyclura*.

Savage (1958: 48-49) questioned the assumption that North American iguanids form a natural, inter-related group, stating: "Insofar as can be determined at this time, the so-called Nearctic iguanids form two diverse groups that can be only distantly related. These two sections are distinguished by marked differences in vertebral and nasal structures, and include several genera not usually recognized as being allied to Nearctic forms." Savage then defined as one of the primary divisions of the Iguanidae a group of ten genera, informally referred to as the "Iguanine group": *Amblyrhynchus, Brachylophus, Conolophus, Crotaphytus, Ctenosaura, Cyclura, Dipsosaurus, Enyaliosaurus, Iguana* and *Sauromalus*. He characterized the group by the presence of zygosphenes and zygantra on each dorsal vertebra, and a nasal organ of the relatively simple S-shaped type with a concha present (= *Dipsosaurus*-type of Stebbins 1948: 209). Other skeletal and integumentary characters present in the majority of these genera were also listed. In a study of sceloporine lizards Etheridge (1964: 628-629) pointed out that zygosphenes and zygantra are poorly developed in *Crotaphytus*, but well developed in several non-iguanine genera, apparently their presence being correlated with large body size, and also that the *Dipsosaurus*-type nasal structure may be found in non-iguanine genera as well. It was also shown, however, that if *Crotaphytus* is removed from the list of iguanine genera, then the latter all share a number of skeletal and integumentary characters, some of which are clearly derived, implying a natural, monophyletic group. Thus the iguanine group as redefined by Etheridge includes the genera *Amblyrhynchus, Brachylophus, Conolophus, Ctenosaura, Cyclura, Dipsosaurus, Enyaliosaurus, Iguana* and *Sauromalus*.

Subsequent to Etheridge's redefinition of the iguanine group there has been but one attempt to determine the evolutionary relationships within the group, that of Avery and Tanner (1971). Their work included the Malagasy genera *Oplurus* and *Chalarodon* along with the iguanines, and contains descriptions and measurements of parts of the skeleton, the musculature of the head and neck, the tongue and hemipenes. Length-width measurements of bones and bone shapes were utilized to analyze the osteological relationships between the genera, those genera sharing the most characters in common being considered the most closely related. No consideration was given to ontogenetic changes in proportions due to allometric growth, and there was no discussion of the polarities of character states. A "phylogenetic chart" was provided, but without an indication as to how the chart was constructed. It is not certain why *Chalarodon* and *Oplurus*, rather than some other iguanid genera, were chosen for comparison with iguanines. The Malagasy genera themselves form an anatomically distinctive group of iguanids, but one not especially close to the iguanines.

The individual iguanine genera have received unequal treatment in the taxonomic literature. Little attention has been paid to *Conolophus*, and Van Denburgh and Slevin's (1913) brief descriptions of the two species seem to be the most recent. Eibl-Eibesfeldt (1962) described the geographic variation in *Amblyrhynchus*, and provided figures and descriptions of the subspecies, but no key. Gibbons and Watkins (this volume) discuss the distribution of *Brachylophus fasciatus*, and describe, informally, a new species (subsequently described as *B. vitiensis* Gibbons, 1981). They provide evidence for the restriction of the type locality of *B. fasciatus* to Tongatapu in the Tonga Island Group, and for the synonymy of *B. brevicephalus* with *B. fasciatus*.

Lazell (1973) studied the two species of *Iguana* as they occur in the Lesser Antilles, where *I. delicatissima* is confined to that region while *I. iguana* occurs over a vast area on the mainland as well. Lazell included in his studies of geographic variation in *Iguana iguana* samples from mainland populations as well, and found no geographically consistant pattern, either on the islands or mainland, of the enlargement and alignment of the median scales on the snout, a character used by Dunn (1934) and other to distinguish the subspecies *I. i. iguana* from *I. i. rhinolopha*. Accordingly I have placed the latter in the synonymy of the former in this list. In the same work, Lazell (1973) designated a neotype for *Lacerta iguana* Linnaeus 1758, and restricted the type locality to the island of Terre de Haut. However, Hoogmoed (1973) pointed out that the specimens upon which Linnaeus based his description are still extant in Stockholm and Uppsala, and furthermore there is a good reason to believe these specimens came from Paramaribo, at the confluence of the Cottica River and Perica Creek in Surinam.

The most recent taxonomic revision and key for the genus *Ctenosaura* is that of Bailey (1928), but several important papers on individual species or groups of species have appeared subsequently. Bailey recognized 13 species, including those forms with a relatively small body size and a short, strongly spinose tail referred by some authors to *Enyaliosaurus*. Following Gray's (1845) description of *Enyaliosaurus* the name was seldom used until its revival by Smith and Taylor (1950: 75). In this work the species *clarki, defensor, erythromelas, palearis* and *quinquecarinata* were allocated to *Enyaliosaurus,* but no justification was provided for the revival of the genus. Duellman (1965: 599), followed Smith and Taylor in recognizing the validity of *Enyaliosaurus,* placed *erythromelas* in the synonymy of *defensor,* provided a key to the species, and suggested that: "*Enyaliosaurus* doubtless is a derivative of *Ctenosaura,* all species of which are larger and have relatively longer tails and less well-developed spines than *Enyaliosaurus.*" Meyer and Wilson (1973) referred *Ctenosaura bakeri* to *Enyaliosaurus,* but Wilson and Hahn (1973: 114-5) returned *bakeri* to *Ctenosaura,* commenting that: "John R. Meyer is currently studying the problems of the relationship of the species now grouped in *Enyaliosaurus* to those now grouped in *Ctenosaura.* He (pers. comm.) advised us that he considers the two genera inseparable, and that *bakeri* appears to be closely related to both *palearis* (now in *Enyaliosaurus*) and *similis* (now in *Ctenosaura*)." In addition, Ernest Williams of Harvard University has informed me (pers. comm.) that based on an unpublished study of the group by him and Clayton Ray, he does not believe the recognition of *Enyaliosaurus* is warranted. At the present time, the problem of the relationships of *Ctenosaura* and *Enyaliosaurus* are under study by Diderot Gicca of the Florida State Museum. With one exception, the remaining long-tailed species of *Ctenosaura* have received little attention in recent years; Smith (1972) reviewed geographic variation in *Ctenosaura hemilopha,* discussed the zone of overlap between this species and *C. pectinata,* thought by Smith to be ancestral to *hemilopha,* and provided a key to *C. pectinata* and the subspecies of *C. hemilopha.*

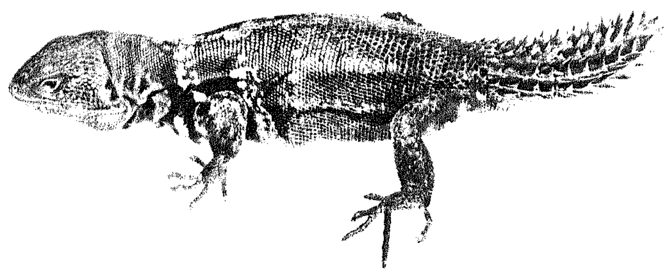


Figure 1.1: The spiny tail of *Ctenosaura* is clearly evident in this *Ctenosaura defensor* captured in Piste, Yucatan, Mexico by Charles H. Lowe (photo by T.A. Wiewandt).

Schwartz and Carey (1977) have published a thorough revision of the genus *Cyclura,* together with a key to the species and subspecies and a discussion of their possible relationships and biogeographic history. *Cyclura* is said to be most similar to *Ctenosaura,* from which it differs in having short series, or "combs," of enlarged, fused, ventrolateral subdigital scales on the hind feet, and it was suggested that *Cyclura* probably originated on Hispaniola following an invasion of pre-*Ctenosaura* stock from the mainland. *Cyclura carinata* and *C. ricordii* are considered basal members of the genus, most closely related to *Ctenosaura* by virtue of their possession of enlarged scales setting off the caudal verticils, absent in other species of *Cyclura.* Following a study of the fossil lizards of Puerto Rico, Gregory Pregill (unpubl.) now considers the extinct *Cyclura mattea* from St. Thomas and *C. portoricensis* to be synonyms of *C. pinguis,* now living on Anegada Island.

As yet no comprehensive study of the genus *Dipsosaurus* has been published. Van Denburgh (1922: 71) provides a good description of the genus, followed by detailed descriptions of the forms recognized at that time. In their study of the lizards on the islands in the Gulf of California, Soulé and Sloan (1966) listed *Dipsosaurus catalinensis* as a subspecies of *D. dorsalis,* and implied the synonymy of *D. carmenensis* with *D. dorsalis lucasensis* by listing the island of Carmen within the range of the latter. I have followed these arrangements although no formal justification for them was provided by the authors.

In his revision of *Sauromalus,* Shaw (1945) recognized two species groups: a coarse-scaled group consisting of *hispidis, slevini, klauberi, ater* and *australis,* and another group with relatively less spinose scalation including *varius* and *obesus* (including *townsendi* and *tumidus*). Shaw felt (1945: 277) that the separation of the Gulf of California was the original factor in separating the genus, and that *hispidus* and *varius* were the oldest forms of the genus, "their differentiation occurring before that of other species, through early breaking off, by faulting, of the islands upon which they now occur, *hispidus* being derived from a peninsular population, while *varius* was derived from a Sonoran population." Shaw also included a diagram of his ideas of the phylogeny of the genus. Subsequently Cliff (1958) described *S. shawi,* Tanner and Avery (1964) described a new subspecies of *S. obesus,* and Soulé and Sloan (1966) listed *S. klauberi* and *S. shawi* as subspecies of *S. ater.* (See also Robinson, 1972.)

The citations provided here include the original descriptions of all taxa, all references that involve nomenclatorial changes, restricted type localities, and the designations of neotypes and lectotypes. In addition the most recent taxonomic revisions, as well as published illustrations, are included. The orthography of scientific names is reproduced here as used in the reference cited, and all type localities have been copied as originally stated. Some of the type specimens listed here as "not located" may eventually be identified. Specimens formerly in the collection of Thomas Bell were deposited in the British Museum, and in the zoological collections of Oxford and Cambridge Universities. It is possible that the specimens used by Gray (1831) in his descriptions of *Ctenosaura armata, C. belli, C. similis, Amblyrhynchus ater,* and *Conolophus subcristatus* may eventually be discovered among these specimens. The material upon which Laurenti (1768) based *Iguana delicatissima, I. minima,* and *I. tuberculata* may have at one time been in the Museum of Zoology of the University of Torino, but a search of that collection by me in 1969 failed to discover them. The types of *Brachylophus fasciatus* (Brongniart 1800) and *Cyclura cornuta* (Bonnaterre 1789) may eventually be identified in the Natural History Museum in Paris. Harlan's (1824) type of *Cyclura carinata* may have at one time been in the Academy of Natural Sciences of Philadelphia, but if so is almost certainly now lost. Merrem (1820) referred to earlier published accounts, but listed no specimens in his description of *Oplurus cyclurus;* quite possibly no type has ever existed.

In most cases the arrangement of species and subspecies and their synonymies follows their most recent taxonomic revisions, but there are a few exceptions.

Museum Abbreviations. *Acad. Nat. Sci. Philad.:* Academy of Natural Sciences of Philadelphia, Nineteenth and the Parkway, Philadelphia, Pennsylvania 19103, U.S.A.; *Amer. Mus. Nat. Hist.:* American Museum of Natural History, Central Park West at 79th Street, New York, New York 10002, U.S.A.; *Brig. Young Univ.:* Brigham Young University, Provo, Utah 84103, U.S.A.; *Brit. Mus. Nat. Hist.:* British Museum (Natural History), Cromwell Road, London S.W. 7, England; *Calif. Acad. Sci.:* California Academy of Sciences, Golden Gate Park, San Francisco, California 94118, U.S.A.; *Eibl-Eibesfeldt private coll.:* private collection of Irenäus Eibl-Eibesfeldt, location not known; *Field Mus. Nat. Hist.:* Field Museum of Natural History, Roosevelt Road at Lake Shore Drive, Chicago, Illinois 60605, U.S.A.; *Mus. Comp. Zool.:* Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts 02138, U.S.A.; *Mus. Hist. Nat. Paris:* Muséum National d'Histoire Naturelle, 57, rue Cuvier, 75005 Paris, France; *Nat. Ricksmus. Stockholm:* Naturhistoriska Ricksmuseet, Vertebratavdeiningen, Stockholm 50, Sweden; *Oxf. Univ. Mus.:* The Zoological Collections, University Museum, Oxford University, Park Road, Oxford, England; *San Diego Soc. Nat. Hist.:* Natural History Museum, The San Diego Society of Natural History, P.O. Box 1390, San Diego, California 92112, U.S.A.; *Senck. Mus. Frankfurt:* Natur-Museum und Forschungs-Institut Senckenberg der Senckenbergischen Naturforschenden Gesellschaft, 6 Frankfurt, 1, Senckenberg Anlage 25, Germany; *Stanford Univ. Mus.:* Natural History Museum, Stanford University, Palo Alto, California 94305, U.S.A.; *U.S. Natn. Mus.:* United States National Museum of Natural History (Smithsonian Institution), Washington, D.C. 20560, U.S.A.; *Univ. Colo. Mus.:* University of Colorado Museum, Boulder, Colorado 80302, U.S.A.; *Zool. Inst. Univ. Uppsala:* Zoological Institute, University of Uppsala, Uppsala, Sweden; *Zool. StSamm. München:* Zoologisches Sammlung des Bayerischen Staates, Schloss Nymphenburg, Nordflügel, München 19, Germany; *Zool. Mus. Berlin:* Institut für Spezielle Zoologie und Zoologisches Museum der Humboldt-Universität zu Berlin, 104 Berlin, den Invalidenstr. 43, Democratic Republic of Germany; *Zool. Mus. Hamburg:* Zoologisches Staatsinstitut und Zoologisches Museum, 2000 Hamburg, den Von-Melle-Park, Germany; *Zool. Mus. Torino:* Istituto e Museo di Zoologia della Universita de Torino, Via Accademia Albertina, 17, Torino, Italy.

IGUANINES

Amblyrhynchus Bell

1825 *Amblyrhynchus* Bell, Zool. Jr., London, *2:* 206. – **Type species** (by monotypy): *Amblyrhynchus cristatus* Bell 1825.

1843 *Hypsilophus (Amblyrhynchus)* – Fitzinger, Syst. Rept., Wien, *1:* 55.

1845 *Oreocephalus* Gray – Cat. Spec. Liz. Coll. Brit. Mus., London, 189. – **Type species** (by monotypy): *Amblyrhynchus cristatus* Bell 1825.

1885 *Amblyrhynchus* – Boulenger, Cat. Liz. Brit. Mus., London, *2:* 185.

Range: Rocky coasts of various islands of the Galápagos Archipelago, Ecuador.

Amblyrhynchus cristatus Bell

1825 *Amblyrhynchus cristatus* Bell, Zool. Jr., London, *2*: 206. – **Type locality:** Mexico (**Holotype:** Oxf. Univ. Mus. Ref. No. 6176). – **Restricted type locality** (Eibl-Eibesfeldt 1956): Narborough (Fernandina).

1831 *Iguana (A. [mblyrhynchus]) Cristatus* – Gray *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 37.

1831 *Iguana (A. [mblyrhynchus]) Ater* Gray (*syn. fide* Gray 1845), *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 37 – *Type locality:* Galápagos (**Holotype:** not located).

1843 *Hypsilophus (Amblyrhynchus) cristatus* – Fitzinger, Syst. Rept., Wien, *1:* 55.

1843 *Hypsilophus (Amblyrhynchus) ater* – Fitzinger, Syst. Rept., Wien, *1:* 55.

1845 *Oreocephalus cristatus* – Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 189.

1876 *Amblyrhynchus cristatus* – Steindachner, Festshr. zool.-bot. Ges., Wien, 316; Pl. 3, 7.

1885 *Amblyrhynchus cristatus* – Boulenger, Cat. Liz. Brit. Mus., London, *2:* 185.

Range: Galápagos Archipelago.

Amblyrhynchus cristatus cristatus Bell

1956 *Amblyrhynchus cristatus cristatus* – Eibl-Eibesfeldt, Senckenberg., Biol., Frankfurt a. M., *37:* 88; Pl. 9, Fig. 1, 2a-b; Fig. 1a, 2.

Range: Narborough (= Fernandina) Island, Galápagos Archipelago.

Amblyrhynchus cristatus albemarlensis Eibl-Eibesfeldt

1962 *Amblyrhynchus cristatus albemarlensis* Eibl-Eibesfeldt, Senckenberg., Biol., Frankfurt a. M., *43* 3: 184; Pl. 14, Fig. 2; Fig. 2f. – **Type locality:** Insel Albemarle (Isabella) (**Holotype:** Eibl-Eibesfeldt private coll.).

Range: Albermarle (= Isabella) Island, Galápagos Archipelago.

Amblyrhynchus cristatus hassi Eibl-Eibesfeldt

1962 *Amblyrhynchus cristatus hassi* Eibl-Eibesfeldt, Senckenberg., Biol., Frankfurt a. M., *43* 3: 181; Pl. 15, Fig. 4; Fig. 2e, 3b. – **Type locality:** Indefatigable Südküste, westliche Akademiebucht . . . .Indefatigable (Santa Cruz), Galápagos-Inseln (**Holotype:** Senck. Mus. Frankfurt No. 57407).

Range: Indefatigable (= Santa Cruz) Island, Galápagos Archipelago.

Amblyrhynchus cristatus mertensi Eibl-Eibesfeldt

1962 *Amblyrhynchus cristatus mertensi* Eibl-Eibesfeldt, Senckenberg., Biol., Frankfurt a. M., *43* 3: 185; Fig. 3c-d, 3d-e, – **Type locality:** etwa 3 km südwestlich der Wrack-Buct der insel Chatham (S. Cristobal), Galápagos Insel. (**Holotype:** Senck. Mus. Frankfurt No. 57430).

Range: Chatham (= San Cristobal) and James (= Santiago) Islands, Galápagos Archipelago.

Amblyrhynchus cristatus nanus Garman

1892 *Amblyrhynchus nanus* Garman, Bull. Essex Inst., Salem, *24*: 8. – **Type locality:** Tower Island (**Holotype:** Brit. Mus. Nat. Hist. No. 99.5.4 [RR 1946.8.30.20]).

1962 *Amblyrhynchus cristatus nanus* – Eibl-Eibesfeldt, Senckenberg., Biol., Frankfurt a. M., *43* 3: 189; Pl. 15, Fig. 6; Fig. 2b, 3g.

Range: Tower (= Genovesa) Island, Galápagos Archipelago.

Amblyrhynchus cristatus sielmanni Eibl-Eibesfeldt

1962 *Amblyrhynchus cristatus sielmanni* Eibl-Eibesfeldt, Senckenberg., Biol., Frankfurt a. M., *43* 3: 188; Fig. 2h, 3f. – **Type locality:** Westküst der Insel Abington (**Holotype:** Senck. Mus. Frankfurt No. 57417).

Range: Abington (= Pinta) Island, Galápagos Archipelago.

Amblyrhynchus cristatus venustissimus Eibl-Eibesfeldt

1956 *Amblyrhynchus cristatus venustissimus* Eibl-Eibesfeldt, Senckenberg., Biol., Frankfurt a. M., *37:* 89. – **Type locality:** Nordküste der Insel Hood (Española) (**Holotype:** Senck. Mus. Frankfurt No. 49851).

Range: Hood (= Española) and Gardner Islands, Galápagos Archipelago.

Brachylophus Cuvier

1829 *Brachylophus* Cuvier *in* Guérin-Ménville, Icon. Règ. Anim., Paris, 1; Pl. 9, Fig. 1. – **Type species** (by monotypy): *Iguana fasciata* Brongniart 1800.

1831 *Iguana (Brachylophus)* – Gray *in* Cuvier *edit.* Griffith, Anim. Kingd. London, *9:* 37.

1862 *Chloroscrates* Günther, Proc. Zool. Soc. Lond., 189. – **Type species** (by monotypy): *Chloroscartes fasciatus* Günther 1862 (*non* Brongniart 1800).

1885 *Brachylophus* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 192.

Range: Numerous islands of the Fiji Island Group, Tongatapu and perhaps other islands of the Tonga (= Friendly) Island Group, and Îles Wallis northeast of Fiji, all in the southwestern Pacific Ocean.

Brachylophus fasciatus (Brongniart)

1800 *Iguana fasciata* Brongniart, Bull. Soc. Philom., Paris, *2:* 90; Pl. 6, Fig. 1. – **Type locality:** none given; probably Tongatapu in the Tonga Islands *fide* Gibbons 1981 (**Holotype:** none designated).

1802 *Agama fasciata* – Daudin, Hist. Nat. Rept., Paris, *3:* 352.

1829 *Brachylophus fasciatus* – Cuvier *in* Guérin-Ménville, Icon. Règ. Anim., Paris, *1:* 9, Pl. 9, Fig. 1, 1a-c.

1831 *Iguana (Brachylophus) fasciatus* – Gray *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 37.

1843 *Hypsilophus (Brachylophus) fasciatus* – Fitzinger, Syst. Rept., Wien, *1:* 55.

1862 *Chloroscartes fasciatus* Günther, Proc. Zool. Soc. Lond., 189; Pl. 25. – **Type locality:** Feegee Islands (**Syntypes:** Brit. Mus. Nat. Hist. No. 55.8.13.1-2 [RR 1946.8.3.83-84]).

1885 *Brachylophus fasciatus* – Boulenger, Cat. Liz. Brit. Mus., London, *2:* 192.

1970 *Brachylophus brevicephalus* Avery & Tanner (*syn. fide* Gibbons 1981).

Gt. Basin Nat., Provo, *30* 3: 167. – **Type locality:** Nukalofa, Tongatabu Island, Friendly Islands (**Holotype:** Brig. Young Univ. No. 32662).

1981 *Brachylophus fasciatus* – Gibbons, J. Herpet., *15* 3: 255.

Range: In the Fiji Island Group recorded from the islands of Viti Levu, Wakaya, Ovalau, Moturiki, Gau, Beqa, Vatuele, Kandavu Ono, Dravuni, Taveuni, Nggamea, Vanua, Balavu, Avea, Vatu Vara, Lakeba, Aiwa, Oneata, Vanua Levu, Vanua Vatu, Totoya, Kabara and Fulaga; records from Cikobia, Koro, Naviti and Yasawa, as well as other records from Viti Levu are likely to be of this species; in the Tonga Island Group known definitely only from the island of Tongatapu, but likely to occur elsewhere; also recorded from Îles Wallis northeast of Fiji, and from Efate Island in the New Hebrides, where it may have recently been introduced.

Brachylophus vitiensis (Gibbons)

1981 *Brachylophus vitiensis* Gibbons, J. Herpet., *15* 3: 257; Pl. I, IIa, c-d; Fig. 2, 4a, 5a. – **Type locality:** Yaduataba island (16°50′S; 178°20′E), Fiji (**Holotype:** Mus. Comp. Zool. No. 157192).

Range: Known only from the type locality in the Fiji Island Group.

Conolophus Fitzinger

1834 *Hypsilophus (Conolophus)* Fitzinger, Syst. Rept., Wien, *1:* 55. – **Type species** (by original designation): *Amblyrhynchus demarlii* Duméril & Bibron 1837 = *Amblyrhynchus subcristatus* Gray 1831.

1845 *Trachycephalus* Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 188. – **Type species** (by monotypy): *Amblyrhynchus subcristatus* Gray 1831.

1885 *Conolophus* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 186.

Range: The Galápagos Archipelago.

Conolophus pallidus Heller

1903 *Conolophus pallidus* Heller, Proc. Wash. Acad. Sci., Washington, D.C. *5:* 87. – **Type locality:** Barrington Island, Galápagos (**Holotype:** Stanford Univ. Mus. No. 4749).

1913 *Conolophus pallidus* – Van Denburgh & Slevin, Proc. Calif. Acad. Sci., San Francisco, *2:* 190.

Range: Barrington (= Santa Fe) Island, Galápagos Archipelago.

Conolophus subcristatus (Gray)

1831 *Amb. [lyrhynchus] subcristatus* Gray, Zool. Misc., London, *1831:* 6. – **Type locality:** Galápagos? (**Holotype:** not located).

1837 *Amblyrhynchus Demarlii* Duméril & Bibron (*syn. fide* Gray 1845), Erpét. Gén., Paris, *4:* 197. – **Type locality:** inconnue (**Holotype:** not located).

1843 *Hypsilophus (Conolophus) demarlii* – Fitzinger, Syst. Rept., Wien, *1*: 55.

1845 *Trachycephalus subcristatus* – Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 188.

1876 *Conolophus subcristatus* – Steindachner, Festr. zool.-bot. Ges. Wien, 22; Pl. 4; P. 7, Fig. 5.

1899 *Conolophus subcristatus pictus* Rothschild & Hartert (*syn. fide* Van Denburgh & Slevin 1913) Novit. Zool., London, *6:* 102. – **Type locality:** Narborough (**Syntypes:** Brit. Mus. Nat. Hist. No. 99.5.6.41-44).

1913 *Conolophus subcristatus* – Van Denburgh & Slevin, Proc. Calif. Acad. Sci., San Francisco, *2:* 188.

Range: The islands of James (= Santiago), Indefatigable (= Santa Cruz), Albermarle (= Isabella), Narborough (= Fernandina), and South Seymour, Galápagos Archipelago.

Ctenosaura Wiegmann

1828 *Ctenosaura* Wiegmann, Isis (von Oken), Leipzig, *21*: 371. – **Type species** (subsequent designation by Fitzinger 1843): *Ctenosaura cycluroides* Wiegmann 1828 = *Lacerta acanthura* Shaw 1802.

1845 *Enyaliosaurus* Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 192. – **Type species** (by monotypy): *Cyclura quinquecarinata* Gray 1842.

1866 *Cachryx* Cope, Proc. Acad. Nat. Sci. Philad., *18:* 124. – **Type species** (by monotypy): *Cachryx defensor* Cope 1866.

1928 *Ctenosaura* – Bailey, Proc. U.S. Natn. Mus., Washington, *73* 12: 7.

Range: Arid and subhumid lowlands of México and Central America, from southeastern Baja California and the vicinity of Hermosillo, Sonora, in western México, and from near the Tropic of Cancer in Tamaulipas, eastern México, southward along both the Atlantic and Pacific versants through most of Central America to Panamá, in the vicinity of Colón on the north, and Panamá on the south, as well as on various off-shore islands and the Colombian islands of the western Caribbean.

Ctenosaura acanthura (Shaw)

1802 *Lacerta Acanthura* Shaw, Gen. Zool., London, *3* 1: 216. – **Type locality:** not given (**Holotype:** Brit. Mus. Nat. Hist. No. xxii 20a [RR 1946.8.30.19]). – **Restricted type locality** (Bailey 1928): Tampico, Tamaulipas, Mexico.

1820 *Uromastyx acanthurus* – Merrem, Tent. Syst. Amphib., Marburg, 56.

1825 *Cyclura teres* Harlan (*syn. fide* Boulenger 1885), Proc. Acad. Nat. Sci. Philad., *4*: 250; Pl. 16. – **Type locality:** Tampico (**Holotype:** Acad. Nat. Sci. Philad., now lost).

1828 *Ct.[enosaura] cycluroides* Wiegmann (*syn. fide* Boulenger 1885), Isis (von Oken), Leipzig, *21:* 371. – **Type locality:** Tampico (**Syntypes:** Zool. Mus. Berlin No. 576, 578; Mus. Comp. Zool. No. 2253). – **Restricted type locality** (Smith & Taylor 1950): Veracruz, Veracruz.

1831 *Iguana (Ctenosaura) Cycluroides* – Gray *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 37.

1831 *Iguana (Ctenosaura) Acanthura* – Gray *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 38.

1831 *Cyclura Shawii* Gray (substitute name for *Lacerta acanthura* Shaw 1802), *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 38.

1831 *Iguana (Ctenosaura) Armata* Gray (*syn. fide* Boulenger 1885) *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 38. – **Type locality:** not given (**Holotype:** not located). – **Restricted type locality** (Smith & Taylor 1950): Tampico, Tamaulipas.

1831 *Iguana (Ctenosaura) Lanceolata* Gray (*syn. fide* Boulenger 1885) in *Cuvier edit.* Griffith, Anim. Kingd., London, *9:* 38. – **Type locality:** not given (**Holotype:** not located). – **Restricted type locality** (Smith & Taylor 1950): Tampico, Tamaulipas.

1831 *Iguana (Ctenosaura) Bellii* Gray (*syn. fide* Boulenger 1885) *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 38. – **Type locality:** not given (**Holotype:** not located). – **Restricted type locality** (Smith & Taylor 1950): Tampico, Tamaulipas.

1831 *Iguana (Cyclura) Teres* – Gray *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 39.

1834 *C.[yclura] articulata* Wiegmann (substitute name for *Iguana (Ctenosaura) armata* Gray 1831), Herp. Mex., Saur. Spec., Berlin, *1:* 43.

1834 *C.[yclura] denticulata* Wiegmann (substitute name for *Ctenosaura cycluroides* Wiegmann 1828), Herp. Mex., Saur. Spec., Berlin, *1:* 43; Pl. 3.

1843 *Cyclura (Ctenosaura) denticulata* – Fitzinger, Syst. Rept., Wien, *1:* 56.

1843 *Cyclura semicristata* Fitzinger (substitute name for *Cyclura denticulata* Wiegmann 1834), Syst. Rept., Wien, *1*: 56.

1843 *Cyclura (Ctenosaura) articulata* – Fitzinger, Syst. Rept., Wien, *1:* 56.

1843 *Cyclura (Ctenosaura) Shawii* – Fitzinger, Syst. Rept., Wien, *1:* 56.

1843 *Cyclura (Ctenosaura) Bellii* – Fitzinger, Syst. Rept., Wien, *1:* 56.

1845 *Ctenosaura acanthura* – Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 191.

1855 *Cyclura denticulata* – Hallowell, J. Acad. Nat. Sci. Philad., (2) *3:* 36.

1869 *Cyclura (Ctenosaura) acanthura* – Cope, Proc. Am. Philos. Soc., Philadelphia, *6:* 161.

1874 *Ctenosaura teres* – Bocourt *in* Duméril & Bocourt, Miss. Sci. Mex., Paris, *3:* 142.

1885 *Ctenosaura acanthura* – Boulenger, Cat. Liz. Brit. Mus., London, *2:* 195.

1886 *Ctenosaura multispinis* Cope (*syn. fide* Bailey 1928), Proc. Am. Philos. Soc., Philadelphia, *23:* 267. – **Type locality:** Dondomingovillo, in the state of Oaxaca (**Holotype:** U.S. Natn. Mus. No. 72737).

1928 *Ctenosaura acanthura* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 9; Pl. 1-4.

1950 *Ctenosaura acanthura* – Smith & Taylor, Bull. U.S. Natn. Mus., Washington, D.C. *199:* 74.

Range: Eastern México, from Liera and Tepehuaje de Arriba near the Tropic of Cancer in Tamaulipas southward to the Isthmus of Tehuantepec in southeastern Veracruz and eastern Oaxaca, at elevations below 360 meters.

Ctenosaura bakeri Stejneger

1901 *Ctenosaura bakeri* Stejneger, Proc. U.S. Natn. Mus., Washington, D.C. *23:* 467. – **Type locality:** Utilla Island, Honduras (**Holotype:** U.S. Natn. Mus. No. 26317).

1928 *Ctenosaura bakeri* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 38; Pl. 21-22.

1973 *Enyaliosaurus bakeri* – Meyer & Wilson, L. A. Co. Nat. Hist. Mus. Contrib. Sci., Los Angeles, *244:* 24.

1973 *Ctenosaura bakeri* – Wilson & Hahn, Bull. Fla. St. Mus., Biol. Sci., Gainesville, *17* 2: 114.

Range: Isla de Utilla, Isla de Roatán and Isla de Santa Elena of the Islas de la Bahía off the northern coast of Honduras.

Ctenosaura clarki Bailey

1928 *Ctenosaura clarki* Bailey, Proc. U.S. Natn. Mus., Washington, *73* 12: 44; Pl. 27. – **Type locality:** Ovopeo, Michoacan, Mexico (**Holotype:** Mus. Comp. Zool. No. 22454). – **Corrected type locality** (Duellman & Duellman 1959): Oropeo . . . ., at an elevation of about 1000 feet in the Tepalcatepec Valley about 8 miles south of La Huacana.
1959 *Enyaliosaurus clarki* – Duellman & Duellman, Occ. Pap. Mus. Zool. Univ. Mich., Ann Arbor, 598: 1 Fig. 1; Pl. 1.
Range: Western México in the valley of the Río Tepalcatepec, Michoacán, between 200 and 510 meters.

Ctenosaura defensor (Cope)

1866 *Cachryx defensor* Cope, Proc. Acad. Nat. Sci. Philad., *18:* 124. – **Type locality:** Yucatan (**Syntypes:** U.S. Natn. Mus. No. 12282 [3]). – **Restricted type locality** (Bailey 1928): Chichén Itzá, Yucatan, Mexico.
1886 *Ctenosaura erythromelas* Boulenger (*syn. fide* Duellman 1965), Proc. Zool. Soc. London, *1886:* 241; Pl. 23. – **Type locality:** not given (**Holotype:** Brit. Mus. Nat. Hist. No. 86.8.9.1 [RR 1946.8.30.18]). – **Restricted type locality** (Smith & Taylor 1950): Balchacaj, Campeche.
1887 *Cachryx erythromelas* – Cope, Bull. U.S. Natn. Mus., Washington, D.C. *32:* 43.
1890 *Ctenosaura defensor* – Günther, Biol. Cent. Amer., Rept. & Batr., 58.
1911 *Ctenosaura (Cachryx) annectens* Werner (*syn. fide* Bailey 1928), Jb. Hamb. Wiss. Anst., Hamburg, *27* 2: 25. – **Type locality:** not given (**Holotype:** Zool. Mus. Hamburg, destroyed).
1928 *Ctenosaura erythromelas* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 46; Pl. 28-29.
1928 *Ctenosaura defensor* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 48; Pl. 30.
1950 *Enyaliosaurus erythromelas* – Smith & Taylor, Bull. U.S. Natn. Mus., Washington, D.C. *199:* 77.
1965 *Enyaliosaurus defensor* – Duellman, Univ. Kans. Publ. Mus. Nat. Hist., Lawrence, *15* 12: 598.
Range: Southern México in the states of Campeche and Yucatán.

Ctenosaura hemilopha Cope

1863 *Cyclura (Ctenosaura) hemilopha* Cope, Proc. Acad. Nat. Sci. Philad., *15:* 105. – **Type locality:** Cape St. Lucas (**Syntypes:** U.S. Natn. Mus. No. 529 [4]).
1866 *Ctenosaura hemilopha* – Cope, Proc. Acad. Nat. Sci. Philad., *18*: 312.
1928 *Ctenosaura hemilopha* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 17; Pl. 5.
1969 *Ctenosaura hemilopha* – Hardy & McDiarmid, Univ. Kans. Publ. Mus. Nat. Hist., Lawrence, *18* 3: 119.
Range: Northwestern México, including southeastern Baja California, various islands in the Gulf of California, and on the mainland from the vicinity of Hermosillo, Sonora, southward to the northern third of Sinaloa, and inland at low elevations to extreme western Chihuahua.

Ctenosaura hemilopha hemilopha Cope

1882 *Ctenosaura interrupta* Bocourt (*syn. fide* Boulenger 1885), Le Naturaliste, Paris, *2:* 47. – **Type locality:** California (**Syntypes:** Mus. Hist. Nat. Paris No. 2243, 2245, 2843; Brit. Mus. Nat. Hist. No. 85.11.2.1 [RR 1946.8.3.85]). – **Restricted type locality** (Smith & Taylor 1950): Cape San Lucas.
1972 *Ctenosaura hemilopha hemilopha* – Smith, Gt. Basin Nat., Provo, *32* 2: 104.
Range: The southern part of the Peninsula of Baja California south of La Paz, extending northward on the lower eastern slopes of the Sierra de Giganta at least as far as Loreto, and perhaps as far north as Santa Rosalía.

Ctenosaura hemilopha conspicuosa Dickerson

1919 *Ctenosaura conspicuosa* Dickerson, Bull. Am. Mus. Nat. Hist., New York, *41* 10: 461. – **Type locality:** San Esteban Island, Gulf of California, Mexico (**Holotype:** Amer. Mus. Nat. Hist. No. 5027).
1955 *Ctenosaura hemilopha conspicuosa* – Lowe & Norris, Herpetologica, *11*: 89.
Range: Isla San Esteban, and possibly Isla Lobos just south of Isla Tiburon, in the Gulf of California, México.

Ctenosaura hemilopha insulana Dickerson

1919 *Ctenosaura insulana* Dickerson, Bull. Am. Mus. Nat. Hist., New York, *41* 10: 462. – **Type locality:** Cerralvo Island, Gulf of California, Mexico (**Holotype:** Amer. Mus. Nat. Hist. No. 2694).
1955 *Ctenosaura hemilopha insulana* – Lowe & Norris, Herpetologica, *11*: 90.
Range: Isla Cerralvo, just east of La Paz, in the southern Gulf of California, México.

Ctenosaura hemilopha macrolopha Smith

1972 *Ctenosaura hemilopha macrolopha* Smith, Gt. Basin Nat., Provo, *32* 2: 104. – **Type locality:** La Posa, San Carlos Bay, 10 mi NW Guaymas, Sonora (**Holotype:** Field Mus. Nat. Hist. No. 108705).
Range: Northwestern México from the vicinity of Hermosillo, Sonora, southward through the northern third of Sinaloa, and inland at low elevations to extreme western Chihuahua.

Ctenosaura hemilopha nolascensis Smith

1972 *Ctenosaura hemilopha nolascensis* Smith, Gt. Basin Nat., Provo, *32* 2: 107. – **Type locality:** Isla San Pedro Nolasco, Sonora (**Holotype:** Univ. Colo. Mus. No. 26391).
Range: Isla San Pedro Nolasco in the Gulf of California, México.

Ctenosaura palearis Stejneger

1899 *Ctenosaura palearis* Stejneger, Proc. U.S. Natn. Mus., Washington, D.C. *21*: 381. – **Type locality:** Gualan, Guatemala (**Holotype:** U.S. Natn. Mus. No. 22703).

1928 *Ctenosaura palearis* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 40; Pl. 22-23.
1963 *Enyaliosaurus palearis* – Stuart, Misc. Publ. Mus. Zool. Univ. Mich., Ann Arbor, *122:* 68.
Range: Valley of the Río Motagua in southeastern Guatemala, and the valley of the Río Aguan in northern Honduras, at elevations from 150 to 250 meters.

Ctenosaura pectinata (Wiegmann)

1834 *Cyclura pectinata* Wiegmann, Herp. Mex., Saur. Spec., Berlin, 42; Pl. 2. – **Type locality:** not given (**Holotype:** Zool. Mus. Berlin No. 574). – **Restricted type locality** (Bailey 1928): Colima, Colima, Mexico.
1845 *Ctenosaura pectinata* – Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 191.
1886 *Ctenosaura brevirostris* Cope (*syn. fide* Smith 1949), Proc. Am. Philos. Soc., Philadelphia, *23*: 268. – **Type locality:** Colima, in Western Mexico (**Holotype:** U.S. Natn. Mus. No. 24709).
1886 *Ctenosaura teres brachylopha* Cope (*syn. fide* Smith 1949), Proc. Am. Philos. Soc., Philadelphia, **23**: 269. – **Type locality:** Mazatlan, Sinaloa, Mexico (**Syntypes:** U.S. Natn. Mus. No. 7180-7183).
1928 *Ctenosaura brachylopha* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 22; Pl. 6.
1928 *Ctenosaura pectinata* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 24; Pl. 7-11.
1928 *Ctenosaura brevirostris* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *72* 12: 27; Pl. 12, 13, 15.
1928 *Ctenosaura parkeri* Bailey (*syn. fide* Smith 1949), Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 29; Pl. 14, 15. – **Type locality:** Barranca Ibarra, Jalisco, Mexico (**Holotype:** U.S. Natn. Mus. No. 18967).
1949 *Ctenosaura pectinata* – Smith, J. Wash. Acad. Sci., Washington, D.C. *39* 1: 36.
Range: Western México, from just north of Culiacan, Sinaloa, southward at elevations below 1000 meters to the Isthmus of Tehuantepec in southeastern Oaxaca; also the Islas de las Tres Marías in the Pacific Ocean west of Nayarit.

Ctenosaura quinquecarinata (Gray)

1842 *Cyclura quinquecarinata* Gray, Zool. Misc., London, *1842:* 59. – **Type locality:** Demarara? (**Holotype:** Brit. Mus. Nat. Hist. No. 41.3.5.61 [RR 1946.8.30.48]). – **Restricted type locality** (Bailey 1928): Tehuantepec, Oaxaca, Mexico.
1845 *Enyaliosaurus quinquecarinatus* – Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 192.
1869 *Cyclura (Ctenosaura) quinquecarinata* – Cope, Proc. Am. Philos. Soc., Philadelphia, *11:* 161.
1874 *Ctenosaura (Enyaliosaurus) quinquecarinata* – Bocourt *in* Duméril & Bocourt, Miss. Sci. Mex., Paris, *3:* 138.
1928 *Ctenosaura quinquecarinata* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 42; Pl. 24-26.

Range: Isolated populations in arid lowland forests in southern México and northern Central America: in México known from the vicinity of Tehuantepec westward to Puerto Escondido and eastward to Juchitán, Oaxaca; in Honduras from near La Paz and Yaro; in Nicaragua from the states of Chontales, Matagalpa, Jinotega, Boaco, Managua, and Granada; in San Salvador from no specific locality; and in Costa Rica from the state of Guanacaste.

Ctenosaura similis Gray

1831 *Iguana (Ctenosaura) Similis* Gray *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 38. – **Type locality:** not given (**Holotype:** not located). – **Restricted type locality** (Bailey 1928): Tela, Honduras, Central America.
1928 *Ctenosaura similis* – Bailey, Proc. U.S. Natn. Mus., Washington, D.C. *73* 12: 32; Pl. 16-20.
Range: Low to moderate elevations on both Pacific and Atlantic versants from the Isthmus of Tehuantepec, México, southward to Panamá, and the Colombian Caribbean Islands.

Ctenosaura similis similis Gray

1874 *Ctenosaura completa* Bocourt (*syn. fide* Bailey 1928) *in* Duméril & Bocourt Miss. Sci. Mex., Paris, *3:* 145. – **Type locality:** Guatemala. . . .[and] Union (**Syntypes:** Mus. Hist. Nat. Paris No. 2252, 2256, 6499, 6500; Mus. Comp. Zool. No. 22662). – **Restricted type locality** (Smith & Taylor 1950): La Unión.
1934 *Ctenosaura similis similis* – Barbour & Shreve, Occ. Pap. Boston Soc. Nat. Hist., *8:* 197.
1950 *Ctenosaura similis similis* – Smith & Taylor, Bull. U.S. Natn. Mus., Washington, 199: 73.
Range: Southern México from the Isthmus of Tehuantepec southward along both Atlantic and Pacific versants below 800 meters through Central America to the sandy beaches of Panamá at least as far as Colón in the north and Panamá in the south; also Isla Mujeres, Isla del Carmen, and Isla Aguada off the Yucatan Peninsula, Isla de Utilla and Isla de Guanaja off the north coast of Honduras, Isla San Miguel in the eastern Golfo de Panamá, and the Colombian Isla San Andres in the southwestern Caribbean.

Ctenosaura similis multipunctata Barbour & Shreve

1934 *Ctenosaura similis multipunctata* Barbour & Shreve, Occ. Pap. Boston Soc. Nat. Hist., *8:* 197. – **Type locality:** Old Providence Island (**Holotype:** Mus. Comp. Zool. No. 36830).
Range: Colombian Isla Providencia in the Southwestern Caribbean.

Cyclura Harlan

1824 *Cyclura* Harlan, J. Acad. Nat. Sci. Philad., *4*: 250. – **Type species** (subsequent designation by Fitzinger 1843): *Cyclura carinata* Harlan 1824.
1830 *Metapoceros* Wagler, Natür Syst. Amphib., München, 147. – **Type species** (by monotypy): *Iguana cornuta* Bonnaterre 1789.

1837 *Aloponotus* Duméril & Bibron, Erpét. Gén., Paris, *4:* 189. - **Type species** (by monotypy): *Aloponotus ricordii* Duméril & Bibron 1837.
1843 *Hypsilophus (Aloponotus)* - Fitzinger, Syst. Rept., Wien, *1:* 54.
1843 *Hypsilophus (Metapoceros)* – Fitzinger, Syst. Rept., Wien, *1*: 54.
1843 *Cyclura (Cyclura)* – Fitzinger, Syst. Rept., Wien, *1*: 56.
1977 *Cyclura* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 21.
Range: The Bahama Islands, Cuba and nearby islets and archipelagos, the Cayman Islands, Navassa Island, Mona Island, Hispaniola and its satellite islands, Jamaica and its satellite islands, and Anegada Island.

Cyclura carinata Harlan

1824 *Cyclura carinata* Harlan, J. Acad. Nat. Sci. Philad., *4*: 250. – **Type locality:** Turk's Island (**Holotype:** not located).
1831 *Iguana (Cyclura) Carinata* – Gray *in* Cuvier *edit.* Griffith, Anim. Kingd., *9:* 39.
1843 *Cyclura (Cyclura) carinata* – Fitzinger *(partim),* Syst. Rept., Wien, *1:* 48.
1916 *Cyclura carinata* – Barbour & Noble, Bull. Mus. Comp. Zool. Harv. Cambridge, *60* 4: 157; Pl. 8, Fig. 3,4; Pl. 13, Fig. 3,4.
1977 *Cyclura carinata* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 68.
Range: The Caicos Islands, Turk's Islands, and Booby Cay off Mayaguana Island in the eastern Bahama Islands.

Cyclura carinata carinata Harlan

1935 *Cyclura carinata carinata* – Barbour, Zoologica, New York, *19* 3: 118.
1977 *Cyclura carinata carinata* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 69; Fig. 17.
Range: The Caicos Islands (Pine Cay, Ft. George Cay, North Caicos, Big Iguana Cay off East Caicos, Big Ambergris Cay, Little Water Cay, and Fish Cay), and the Turk's Islands (Big Sand Cay, Long Cay) in the eastern Bahama Islands.

Cyclura carinata bartschi Cochran

1931 *Cyclura carinata bartschi* Cochran, J. Wash. Acad. Sci., Washington, D.C. *21* 3: 39. – **Type locality:** Booby Cay, east of Mariguana Island, Bahamas (**Holotype:** U.S. Natn. Mus. No. 81212).
1977 *Cyclura carinata bartschi* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 72.
Range: Booby Cay off Mayaguana Island in the eastern Bahama Islands.

Cyclura collei Gray

1845 *Cyclura Collei* Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 190. – **Type locality:** Jamaica (**Holotype:** Brit. Mus. Nat. Hist. 1936.12.3.108).
1848 *Cyclura lophoma* Gosse (*syn. fide* Grant 1940), Proc. Zool. Soc. London, *1848:* 99. – **Type locality:** Jamaica (**Holotype:** Brit. Mus. Nat. Hist. No. 47.12.27.101).
1916 *Cyclura collei* – Barbour & Noble, Bull. Mus. Comp. Zool. Harv., Cambridge, *60* 4: 158; Pl. 9, Pl. 15, Fig. 5, 6.

1940 *Cyclura collei* – Grant, Bull. Inst. Jamaica, Sci. Ser., Kingston, 1 (2): 97.
1977 *Cyclura collei* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 56; Fig. 14.
Range: Jamaica (close to extinction; may still occur in the Hellshire Hills.), Goat Island and Little Goat Island.

Cyclura cornuta (Bonnaterre)

1789 *Lacerta cornuta* Bonnaterre, Tab. Encycl. Méth. Règ. Nat., Erpét., Paris, 40; Pl. 4, Fig. 4. – **Type locality:** Sainte-Domingue. . . .dans les mornes de l'Hôpital, entre l'Artibonite & les Gonaves (**Holotype:** not located).
1789 *Iguana cornuta* – Lacépède, Hist. Nat. Quad. Ovip. et Serp., Paris, *2*: 493.
1830 *Metapoceros cornutus* – Wagler, Natür. Syst. Amphib., München, 147.
1843 *Hypsilophus (Metapoceros) cornutus* – Fitzinger, Syst. Rept., Wien, *1:* 54.
1886 *Cyclura cornuta* – Cope, Proc. Am. Phil. Soc., Philadelphia, *23* 122: 263.
1977 *Cyclura cornuta* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 47.
Range: Hispaniola, including the islands of Ile Petite Cayemite, Isla Saona, and Isla Cabritos in Lago Enriquillo, and the off-shore islands of Isla Beata, Ile de la Petite Gonave, Ile de la Tortue, and Ile Grand Cayemite, as well as the islands of Mona and Navassa.

Cyclura cornuta cornuta (Bonnaterre)

1937 *Cyclura cornuta cornuta* – Barbour, Bull. Mus. Comp. Zool. Harv., Cambridge, *82* 2: 132.
1941 *Cyclura cornuta cornuta* – Cochran, Bull. U.S. Natn. Mus., Washington, D.C. 177: 195; Fig. 92.
1977 *Cyclura cornuta cornuta* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 48; Fig. 12.
Range: Xeric areas of Hispaniola in Haiti and southwestern República Dominicana, including the islands of Ile Petite Cayemite, Isla Saona and Isla Cabritos in Lago Enriquillo, and the Hispaniolan satellite islands of Isla Beata, Ile de Petite Gonave, Ile de Tortue and Ile Grande Cayemite.

Cyclura cornuta onchiopsis Cope

1885 *C.[yclura] onchiopsis* Cope, Am. Nat., Lancaster, *19* 10: 1006. – **Type locality:** unknown (**Syntypes:** U.S. Natn. Mus. No. 9977, 12239; Mus. Comp. Zool. No. 4717). – **Restricted type locality** (Cope 1886): Navassa Island.
1885 *C.[yclura] nigerrima* Cope (*syn. fide* Schwartz & Thomas 1975), Am. Nat., Lancaster, *19* 10: 1006. – **Type locality:** Navassa (**Holotype:** U.S. Natn. Mus. No. 9974).
1886 *Cyclura onchiopsis* – Cope, Proc. Am. Philos. Soc., Philadelphia, *23:* 264.
1975 *Cyclura cornuta onchiopsis* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 112.
1977 *Cyclura cornuta onchiopsis* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 54.
Range: Navassa Island, probably extinct.

Cyclura cornuta stejnegeri Barbour & Noble

1916 *Cyclura stejnegeri* Barbour & Noble, Bull. Mus. Comp. Zool. Harv., Cambridge, *60* 4: 163; Pl. 12. – **Type locality:** Mona Island (**Holotype:** U.S. Natn. Mus. No. 29367).

1975 *Cyclura cornuta stejnegeri* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 112.

1977 *Cyclura cornuta stejnegeri* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 51.

Range: Isla Mona between Hispaniola and Puerto Rico.

Cyclura cychlura (Cuvier)

1829 *Iguana cychlura* Cuvier, Règ. Anim., Ed. 2, Paris, *2:* 45. – **Type locality:** Carolina (**Holotype:** Mus. Hist. Nat. Paris No. 2367). – **Restricted type locality** (Schwartz & Thomas 1975): Andros Island, Bahama Islands.

1975 *Cyclura cychlura* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 112.

1977 *Cyclura cychlura* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 37.

Range: Andros Island and the Exuma Cays (except White Cay) in the western Bahama Islands.

Cyclura cychlura cychlura (Cuvier)

1862 *Cyclura baelopha* Cope (*syn. fide* Schwartz & Thomas 1975), Proc. Acad. Nat. Sci. Philad., (1861) *13:* 123. – **Type locality:** Andros Island, one of the Bahamas (**Holotype:** Acad. Nat. Sci Philad. No. 8120).

1975 *Cyclura cychlura cychlura* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 112.

1977 *Cyclura cychlura cychlura* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 39; Fig. 10.

Range: Andros Island in the western Bahama Islands.

Cyclura cychlura figginsi Barbour

1923 *Cyclura figginsi* Barbour, Proc. New Engl. Zool. Club, Cambridge, *8:* 108. – **Type locality:** Bitter Guana Cay, near Great Guana Cay, Exuma Group, Bahama Islands (**Holotype:** Mus. Comp. Zool. No. 17745).

1975 *Cyclura cychlura figginsi* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 112.

1977 *Cyclura cychlura figginsi* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 44.

Range: The Exuma Cays, including Guana Cay, Prickly Pear Cay, Allan Cay, Guana Cay off the north end of Norman's Pond Cay, Bitter Guana Cay, Gaulin Cay, and possibly Ozie Cay, all in the western Bahama Islands.

Cyclura cychlura inornata Barbour & Noble

1916 *Cyclura inornata* Barbour & Noble, Bull. Mus. Comp. Zool. Harv., Cambridge, *60* 4: 151; Pl. 14 – **Type locality:** U Cay in Allan's Harbor, near Highborn Cay, Bahamas (**Holotype:** Mus. Comp. Zool. No. 11602).

1975 *Cyclura cychlura inornata* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 112.

1977 *Cyclura cychlura inornata* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 42.

Range: U Cay (= Southwest Allan's Cay) and Leaf Cay in Allan's Cay at the northern extreme of the Exuma Cays in the western Bahama Islands.

Cyclura nubila Gray

1831 *Iguana (Cyclura) Nubila* Gray *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 39. – **Type locality:** South America? (**Holotype:** Brit. Mus. Nat. Hist. No. xxii.18.a [RR 1946.8.29.88]). – **Restricted type locality** (Schwartz & Thomas 1975): Cuba.

1977 *Cyclura nubila* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 23.

Range: Cuba and the Isla de Pinos, and nearby islets and archipelagos, and the Cayman Islands.

Cyclura nubila nubila Gray

1837 *Cyclura Harlani* Duméril & Bibron (*partim; syn. fide* Schwartz & Thomas 1975), Erpét. Gén., Paris, *4:* 218. - **Type locality:** Caroline (**Syntypes:** Mus. Hist. Nat. Paris No. A661, 2367; **Lectotype** (Schwartz & Carey 1977): Mus. Hist. Nat. Paris No. A661).

1845 *Cyclura MacLeayii* Gray (*syn. fide* Schwartz & Thomas 1975), Cat. Spec. Liz. Coll. Brit. Mus., London, 190. – **Type locality:** Cuba (**Holotype:** Brit. Mus. Nat. Hist. No. xx.17.a [RR 1946.8.4.28]).

1916 *Cyclura macleayi* – Barbour & Noble, Bull. Mus. Comp. Zool. Harv., Cambridge, *60* 4: 145; Pl. 1, 2; Pl. 13, Fig. 5, 6.

1975 *Cyclura nubila nubila* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 113.

1977 *Cyclura nubila nubila* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 24; Fig. 7.

Range: Cuba and the Isla de Pinos, and numerous islets of the Archipiélago de los Canarreos, Cayos de San Felipe, Jardin de la Reina, and Archipiélago de Sabana-Camagüey, and presumably other nearby islets and cays; introduced on Isla Magueyes off the southwestern coast of Puerto Rico.

Cyclura nubila caymanensis Barbour & Noble

1916 *Cyclura caymanensis* Barbour & Noble, Bull. Mus. Comp. Zool. Harv., Cambridge, *60* 4: 148; Pl. 3. – **Type locality:** Cayman Islands, probably Cayman Brac (**Holotype:** Mus. Comp. Zool. No. 10534).

1940 *Cyclura macleayi caymanensis* – Grant, Bull. Inst. Jamaica, Sci. Ser., Kingston, *2:* 29; Pl. 1, Fig. 1, 2.

1975 *Cyclura nubila caymanensis* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 113.

1977 *Cyclura nubila caymanensis* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 30.

Range: Cayman Brac and Little Cayman Island; introduced on Grand Cayman Island.

Cyclura nubila lewisi Grant

1940 *Cyclura macleayi lewisi* Grant, Bull. Inst. Jamaica, Sci. Ser., Kingston, *2:* 35, Pl. 2, Fig. 3, 4. – **Type locality:** Battle Hill, east end of Grand Cayman (**Holotype:** Brit. Mus. Nat. Hist. No. 1939.2.3.68 [RR 1946.8.9.32]).
1975 *Cyclura nubila lewisi* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 113.
1977 *Cyclura nubila lewisi* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 33.
Range: Grand Cayman Island.

Cyclura pinguis Barbour

1917 *Cyclura pinguis* Barbour, Proc. Biol. Soc. Wash., Washington, D.C. *30:* 100. – **Type locality:** Anegada, British Virgin Islands (**Holotype:** Mus. Comp. Zool. No. 12082).
1977 *Cyclura pinguis* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 60; Fig. 15.
Range: Anegada Island on the Puerto Rican Bank.

Cyclura ricordii Duméril & Bibron

1837 *Aloponotus Ricordii* Duméril & Bibron, Erpét. Gén., Paris, *4:* 190; Pl. 38. – **Type locality:** Sainte-Domingue (**Holotype:** Mus. Hist. Nat. Paris. No. 8304).
1843 *Hypsilophus (Aloponotus) Ricordii* – Fitzinger, Syst. Rept., Wien, *1:* 54.
1924 *Cyclura ricordii* – Cochran, Proc. U.S. Natn. Mus., Washington, D.C. *66* 6: 5.
1977 *Cyclura ricordi* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 64; Fig. 16.
Range: Hispaniola, from the Valle de Neiba and the Península de Barahona south of the Sierra de Baoruco, and Isla Cabritos in Lago Enriquillo, southwestern República Dominicana; presumably also in the Cul de Sac Plain of Haiti.

Cyclura rileyi Stejneger

1903 *Cyclura rileyi* Stejneger, Proc. Biol. Soc. Wash., Washington, D.C. *16:* 130. – **Type locality:** Watlings Island, Bahamas (**Holotype:** U.S. Natn. Mus. No. 31969).
1977 *Cyclura rileyi* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 74.
Range: Central Bahama Islands, including San Salvador (= Watlings), the Exuma Cays, and islands of the Crooked-Acklins group.

Cyclura rileyi rileyi Stejneger

1975 *Cyclura rileyi rileyi* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 114.
1977 *Cyclura rileyi rileyi* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53* 173: 75; Fig. 18.
Range: San Salvador (= Watlings), Man Head Cay, and Green Cay in the central Bahama Islands.

Cyclura rileyi cristata Schmidt

1920 *Cyclura cristata* Schmidt, Proc. Linn. Soc. New York, *33:* 6. – **Type locality:** White Cay, Bahama Islands (**Holotype:** Amer. Mus. Nat. Hist. No. 7238). – **Corrected type locality** (Schmidt 1936): White Cay, Exuma Cays, Bahamas.
1936 *Cyclura cristata* – Schmidt, Field Mus. Nat. Hist., Zool. Ser., Chicago, *20* 16: 128.
1975 *Cyclura rileyi cristata* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 114.
1977 *Cyclura rileyi cristata* – Schwartz & Carey, Stud. Faun. Curaçao & Carib. Is., Utrecht, *53*, 173: 80.
Range: White Cay, at the southern end of the Exuma Cays, central Bahama Islands.

Cyclura rileyi nuchalis Barbour & Noble

1916 *Cyclura nuchalis* Barbour & Noble, Bull. Mus. Comp. Zool. Harv., Cambridge, *60* 4: 156, Pl. 8, Fig. 1, 2. – **Type locality:** Fortune Island, Bahamas (**Holotype:** Acad. Nat. Sci. Philad. No. 11985).
1975 *Cyclura rileyi nuchalis* – Schwartz & Thomas, Carnegie Mus. Nat. Hist. Spec. Publ., Pittsburgh, 1: 114.
1977 *Cyclura rileyi nuchalis* – Schwartz & Carey, Stud. Fauna Curaçao & Carib. Is., Utrecht, *53* 173: 78.
Range: Fortune Island, Fish Cay and North Cay in the Crooked-Acklin's group, central Bahama Islands.

Dipsosaurus Hallowell

1854 *Dipso-saurus* Hallowell, Proc. Acad. Nat. Sci. Philad., *7:* 92. – **Type species** (by monotypy): *Crotaphytus dorsalis* Baird & Girard 1852.
1855 *Dipsosaurus* – Boulenger, Cat. Liz. Brit. Mus., London, *2:* 201.
Range: Desert regions of southwestern United States in southeastern California, extreme southern Nevada and southwestern Utah and western Arizona, southward in northwestern México through western Sonora and extreme northwestern Sinaloa, and to the southern tip of Baja California, as well as on various islands in the Gulf of California.

Dipsosaurus dorsalis (Baird & Girard)

1852 *Crotaphytus dorsalis* Baird & Girard, Proc. Acad. Nat. Sci. Philad., *6:* 126. – **Type locality:** Desert of Colorado, Cal. (**Holotype:** U.S. Natn. Mus. No. 2699). – **Restricted type locality** (Smith & Taylor 1950): Winterhaven (= Fort Yuma), Imperial County.
1854 *Dipso-saurus dorsalis* – Hallowell, Proc. Acad. Nat. Sci. Philad., *7:* 92.
1950 *Dipsosaurus dorsalis* – Smith & Taylor, Bull. U.S. Natn. Mus., Washington, D.C. 199: 78.
Range: Desert regions of southwestern United States in southeastern California, extreme southern Nevada and southwestern Utah and western Arizona, southward in northwestern México through western Sonora and extreme northwestern Sinaloa, and to the southern tip of Baja California, as well as various islands in the Gulf of California.

Dipsosaurus dorsalis dorsalis (Baird & Girard)

1920 *Dipsosaurus dorsalis dorsalis* – Van Denburgh, Proc. Calif. Acad. Sci., San Francisco, (4) *10* 4: 33.

1922 *Dipsosaurus dorsalis dorsalis* – Van Denburgh, Occ. Pap. Caif. Acad. Sci., *10* 1: 73; Pl. 2.

Range: The lower levels of the Colorado and Mojave Deserts in southern California, extending northward into Owen's, Panamint, Death, Mesquite, and Amargosa valleys, southern Nevada and extreme southwestern Utah, and western Arizona, extending southward in México into extreme northwestern Sonora, and down the peninsula of Baja California, except for the region west of the Sierra de Juarez and the Sierra de San Pedro Martir and north of Punta Santa Rosalia, to at least as far south as Bahía Magdalena; in the Gulf of California on the islands of Encantada Grande, Angel de la Guarda, and San Marcos, and on Magdalena off the Pacific coast.

Dipsosaurus dorsalis catalinensis Van Denburgh

1922 *Dipsosaurus catalinensis* Van Denburgh, Occ. Pap. Calif. Acad. Sci., San Francisco, *10* 1: 83. – **Type locality:** Santa Catalina Island, Gulf of California, Mexico (**Holotype:** Calif. Acad. Sci. No. 50505).

1966 *Dipsosaurus dorsalis catalinensis* - Soulé & Sloan, Trans. San Diego Soc. Nat. Hist., *14* 11: 140.

Range: Isla Santa Catalina in the Gulf of California, México.

Dipsosaurus dorsalis lucasensis Van Denburgh

1920 *Dipsosaurus dorsalis lucasensis* Van Denburgh, Proc. Calif. Acad. Sci., San Francisco, (4) *10* 4: 33. – **Type locality:** San Jose del Cabo, Lower California, Mexico (**Holotype:** Calif. Acad. Sci. No. 46090).

1922 *Dipsosaurus carmenensis* Van Denburgh (*syn. fide* Soulé & Sloan 1966), Occ. Pap. Calif. Acad. Sci., San Francisco, *10* 1: 81. – **Type locality:** Near Puerto Bellandro, Carmen Island, Gulf of California (**Holotype:** Calif. Acad. Sci. No. 50504).

1966 *Dipsosaurus dorsalis lucasensis* – Soulé & Sloan, Trans. San Diego Soc. Nat. Hist., *14* 11: 140.

Range: The southern part of the peninsula of Baja California, and in the Gulf of California on the islands of Carmen, Coronados, Monserrate, San José, and Cerralvo, western México.

Iguana Laurenti

1768 *Iguana* Laurenti, Spec. Med., Synop. Rept., Wien, 47. – **Type species** (by tautonymy): *Lacerta iguana* Linnaeus 1758.

1828 *Prionodus* Wagler, Isis (von Oken), Leipzig, *21* 8/9: 860. – **Type species** (by monotypy): *Lacerta iguana* Linnaeus 1758.

1830 *Hypsilophus* Wagler, Natür Syst. Amphib., München, 147. - **Type species** (by monotypy): *Lacerta iguana* Linnaeus 1758.

1843 *Hypsilophus (Hypsilophus)* – Fitzinger, Syst. Rept., Wien, *1*: 16.

1885 *Iguana* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 189.

1973 *Iguana* – Lazell, Bull. Mus. Comp. Zool. Harv., Cambridge, *145* 1: 1.

Range: On the American mainland from Sinaloa and Veracruz, México, southward at low elevations through Central America and South America to southern Brazil and Paraguay; in the Caribbean northward through the lesser Antilles to the Virgin Islands.

Iguana delicatissima Laurenti

1768 *Iguana delicatissima* Laurenti, Spec. Med., Synop. Rept., Wien, 48. – **Type locality:** Indiis (**Holotype:** Zool. Mus. Torino, not located). – **Restricted type locality** (Lazell 1973): island of Terre de Bas, Les Iles de Saintes, Departement de la Guadeloupe, French West Indies.

1820 *Iguana nudicollis* Merrem (substitute name for *Iguana delicatissima* Laurenti 1768), Tent. Syst. Amphib., Marburg, 48.

1830 *Amblyrhynchus delicatissima* - Wagler, Natür Syst. Amphib., München, 148.

1885 *Iguana delicatissima* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 191.

1973 *Iguana delicatissima* – Lazell, Bull. Mus. Comp. Zool. Harv., Cambridge, *145* 1: 18; Fig. 2.

Range: The lesser Antilles on the islands of Anguilla, St. Martin, Ile Fourchue, Les Iles Frégates, Ile Chevreau, St. Barthélemy, St. Eustatius, Nevis (presence now uncertain), Antigua, the Grande-Terre portion of Guadeloupe, La Desirade, Les Iles de Saintes (Terre-de-Bas and Terre-de-Haut), Dominica, and Martinique.

Iguana iguana (Linnaeus)

1758 *Lacerta iguana* Linnaeus, Syst. Nat., Ed. 10, *1:* 206. – **Type locality:** Indiis (**Syntypes:** Nat. Ricksmus. Stockholm, number unknown; Zool. Inst. Univ. Uppsala, number unknown). – **Restricted type locality** (Lazell 1973): island of Terre de Haut, Les Iles de Saintes, Departement de La Guadeloupe, French West Indies; (Hoogmoed 1973): confluence of the Cottica River and Perica Creek, Surinam.

1768 ? *Iguana minima* Laurenti (*syn. fide* Fitzinger 1843), Spec. Med., Synop. Rept., Wien, 48. – **Type locality:** not given (**Holotype:** Zool. Mus. Torino, not located).

1768 *Iguana tuberculata* Laurenti (*syn. fide* Dunn 1934), Spec. Med., Synop. Rept., Wien, 48. – **Type locality:** not given (**Holotype:** Zool. Mus. Torino, not located).

1802 *Iguana coerulea* Daudin (*syn. fide* Fitzinger 1843), Hist. Nat. Rept., Paris, *3:* 286. – **Type locality:** l'ile Formose (**Holotype:** based upon Seba, 1734, Locupl. v. natur. thesaur., *1:* 44; Fig. 4-5).

1806 *I.[guana] vulgaris* Link (substitute name for *Lacerta iguana* Linnaeus 1758), Beschr. Natural.-Samml. Univ. Rostock., *2*: 58.

1820 *Iguana sapidissima* Merrem (substitute name for *Lacerta iguana* Linnaeus 1758), Tent. Syst. Amphib., Marburg, 47.

1825 *Iguana squamosa* Spix (*syn. fide* Gray 1831), Spec. Nov. Lacert. Brazil, Monachii, *1*: 5; Pl. 5. – **Type locality:** Bahiae, Parae (**Syntypes:** Zool. StSamm. München No. 520/0, 537/0).

1825 *Iguana viridis* Spix (*syn. fide* Gray 1831), Spec. Nov. Lacert. Brazil., Monachii, *1*: 6; Pl. 6. – **Type locality:** supra ripam Rio St. Francisci et Itapicuru (**Holotype:** Zool. StSamm. München No. 540/0).

1825 *Iguana coerulea* Spix (*non* Daudin 1802; *syn. fide* Fitzinger 1843), Spec. Nov. Lacert. Brazil., Monachii, *1*: 7; Pl. 7. – **Type locality:** in locis ripariis vel humidis Rio St. Francisci (**Syntypes:** Zool. StSamm. München No. 71/0 (2), destroyed).
1825 *Iguana emarginata* Spix (*syn. fide* Gray 1831), Spec. Nov. Lacert. Brazil., Monachii, *1*: 7; Pl. 8. – **Type locality:** ad flumen St. Francisci (**Syntypes:** Zool. StSamm. München No. 535/0 (2)).
1825 *Iguana lophyroides* Spix (*syn. fide* Fitzinger 1843), Nov. Spec. Lacert. Brazil., Monachii, *1*: 8; Pl. 9. – **Type locality:** in sylvis Rio de Janeiro, Bahiae (**Syntypes:** Zool. StSamm. München No. 546/0 (2)).
1826 *Iguana tuberculata* – Fitzinger, Neu Class. Rept., Wien, *1:* 48.
1828 *Prionodus iguana* – Wagler, Isis (von Oken), Leipzig, *21*: 860.
1830 *Hypsilophus tuberculatus* - Wagler, Natür. Syst. Amphib., München, 147.
1831 *Iguana (Iguana) tuberculata* – Gray *in* Cuvier *edit.* Griffith, Anim. Kingd., London, *9:* 36.
1834 *Iguana (Hypsilophus) rhinolophus* Wiegmann (*syn. fide* Lazell 1973), Herp. Mex., Saur. Spec., Berlin, 44. – **Type locality:** not given (**Syntypes:** Zool. Mus. Berlin No. 571 (2)). – **Restricted type locality** (Smith & Taylor 1950): Córdoba, Veracruz.
1843 *Hypsilophus (Hypsilophus) Rhinolophus* – Fitzinger, Syst. Rept., Wien, *1:* 55.
1843 *Hypsilophus (Hypsilophus) tuberculatus* – Fitzinger, Syst. Rept., Wien, *1:* 55.
1845 *Iguana tuberculata* – Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 186.
1845 *Iguana rhinolophus* – Gray, Cat. Spec. Liz. Coll. Brit. Mus., London, 186.
1857 ? *Iguana Hernandessi* Jan (*nomen nudum fide* Smith & Taylor 1950), Indice Sistem. Rett. e. Anfib. Medesimo, Milano, 58.
1885 *Iguana tuberculata* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 189.
1885 *Iguana tuberculata* var. *rhinolopha* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 190.
1898 *Iguana iguana rhinolopha* – Van Denburgh, Proc. Acad. Nat. Sci. Philad., (1897) *49:* 461.
1934 *Iguana iguana iguana* – Dunn, Copeia, 1: 1.
1934 *Iguana iguana rhinolopha* – Dunn, Copeia, 1: 1.
1950 *Iguana iguana rhinolopha* – Smith & Taylor, Bull. U.S. Natn. Mus., Washington, D.C. 199: 72.
1973 *Iguana iguana* – Lazell, Bull. Mus. Comp. Zool. Harv., Cambridge, 145 1: 7; Fig. 2, 12.
1973 *Iguana iguana iguana* – Hoogmoed, Biogeographica, The Hague, *4:* 148; Fig. 23; Pl. 16.

Range: On the American mainland from northern México (the town of Costa Rica in Sinaloa on the west, and Laguan de Tamiahua, Veracruz on the east) southward, excluding most of the Yucatan Peninsula, through Central America and South America at least to the Tropic of Capricorn in Paraguay and southeastern Brazil; altitude records include to 800 meters in Michoaćan, México, to 500 meters in Surinam, and to 1000 meters in Colombia. Pacific island records include the Archipiélago de las Perlas in the Golfo de Panamá, and Isla Gorgona off the coast of Colombia. Island records in the western and southern Caribbean include Isla Cozumel off Quintana Roo, México, Las Islas de la Bahía (Isla de Utilla, Isla de Roatán, and Isla de Guanaja), Honduras, the Corn Islands, Providencia and San Andres, and the coastal South American islands of Margarita, Los Testigos, Los Frailes, Los Hermanos, La Blanquilla, La Tortuga, Isla Orchilla, Los Roques, Isla Aves, Bonaire, Klein Bonaire, Curaçao, Aruba, Trinidad, and Tobago. In the Lesser Antilles records include the Virgin Islands (St. Thomas and its satellites Water Island, Patricia Cay, and Hassel Island, St. John, St. Croix, and Tortola and its satellites Peter Island and Guana Island), Saba, Montserrat, the Guadeloupe Bank (the Basse-Terre portion of Guadeloupe and the Iles de Pigeon ou Goyave), Les Iles des Saintes (La Coche, Grand Ilet, Terre-de-Haut, and Ilet à Cabrit), the St. Lucia Bank (southern tip of the larger Maria Island and the northern coast of St. Lucia), the St. Vincent Bank (St. Vincent and all coastal cays that support trees), and the Grenada Bank (Grenada and on most adjacent cays, Bequia Island, Ile Quatre, Battowia Island, Petit Mustique Island, Savan Island, Cannouan Island, the Tobago Cays, Union Island, Frigate Cay, Petite St. Vincent, Mabuya Cay, Carriacou Island, Kick-'em-Jenny, and Ile-a-Caille).

Sauromalus Duméril

1856 *Sauromalus* Duméril, Arch. Mus. Hist. Nat. Paris, *8:* 535 – **Type species** (by monotypy): *Sauromalus ater* Duméril 1856.
1859 *Euphryne* Baird, Proc. Acad. Nat. Sci. Philad., (1858) *10:* 253. – **Type species** (by monotypy): *Euphryne obesus* Baird 1859.
1885 *Sauromalus* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 202.
1945 *Sauromalus* – Shaw, Trans. San Diego Soc. Nat. Hist., *10* 15: 269.

Range: Desert regions of southwestern United States in southern California, extreme southern Utah and Nevada, and western and central Arizona, and western México in western Sonora, various islands in the Gulf of California, and the eastern part of southern Baja California.

Sauromalus ater Duméril

1856 *Sauromalus ater* Duméril, Arch. Mus. Hist. Nat. Paris, *8:* 536, Pl. 23, Fig. 3, 3a – **Type locality:** not given (**Holotype:** Mus. Hist. Nat. Paris No. 813). - **Restricted type locality** (Smith & Taylor 1950): Espíritu Santo Island.
1919 *Sauromalus interbrachialis* Dickerson (*syn. fide* Schmidt 1922), Bull. Am. Mus. Nat. Hist., New York, *41* 10: 463. – **Type locality:** La Paz, Lower California (*en error fide* Schmidt 1922) (**Holotype:** U.S. Natn. Mus. No. 64443).
1922 *Sauromalus ater* – Schmidt, Bull. Am. Mus. Nat. Hist., New York, 46 11: 640 (part).
1945 *Sauromalus ater* – Shaw, Trans. San Diego Soc. Nat. Hist., *10* 15: 284.
1950 *Sauromalus ater* – Smith & Taylor, Bull. U.S. Natn. Mus., Washington, 199: 80.

Range: The islands of Espíritu Santo, Partida, San José, San Francisco, San Diego, Santa Cruz, San Marcos, and Santa Catalina in the Gulf of California, México.

Sauromalus ater ater Duméril

1966 *Sauromalus ater ater* – Soulé & Sloan, Trans. San Diego Soc. Nat. Hist., *14* 11: 141.

Range: The islands of Espíritu Santo, Partida, San José, San Francisco, San Diego, and Santa Cruz in the Gulf of California, México.

Sauromalus ater klauberi Shaw

1941 *Sauromalus klauberi* Shaw, Trans. San Diego Soc. Nat. Hist., *9* 28: 285. – **Type locality:** Santa Catalina Island, Gulf of California, Mexico (**Holotype:** San Diego Soc. Nat. Hist. No. 6859).

1966 *Sauromalus ater klauberi* – Soulé & Sloan, Trans. San Diego Soc. Nat. Hist., *14* 11: 141.

Range: Santa Catalina Island in the Gulf of California, México.

Sauromalus ater shawi Cliff

1958 *Sauromalus shawi* Cliff, Copeia, *1958* 4: 259. – **Type locality:** San Marcos Island (**Holotype:** Stanford Univ. Mus. No. 16120).

1966 *Sauromalus ater shawi* – Soulé & Sloan, Trans. San Diego Soc. Nat. Hist., *14* 11: 141.

Range: San Marcos Island in the Gulf of California, México.

Sauromalus australis Shaw

1945 *Sauromalus australis* Shaw, Trans. San Diego Soc. Nat. Hist., *10* 15: 286. – **Type locality:** San Franciscito Bay, Baja California, Mexico (**Holotype:** San Diego Soc. Nat. Hist. No. 30170).

Range: The eastern part of southern Baja California, from Punta San Gabriel southward to La Paz, México.

Sauromalus hispidus Stejneger

1891 *Sauromalus hispidus* Stejneger, Proc. U.S. Natn. Mus., Washington, D.C. *14* 864: 409. – **Type locality:** Angel de la Guarda Island, Gulf of California (**Holotype:** U.S. Natn. Mus. No. 8563).

1922 *Sauromalus hispidus* – Van Denburgh, Occ. Pap. Calif. Acad. Sci., San Francisco, *10* 1: 99; Pl. 5, 6.

1945 *Sauromalus hispidus* – Shaw, Trans. San Diego Soc. Nat. Hist., *10* 15: 279.

Range: The islands of Angel de la Guarda, Smith, Pond, Granite, Mejía, San Lorenzo Norte, and San Lorenzo Sur in the Gulf of California. México.

Sauromalus obesus (Baird)

1859 *Euphryne obesus* Baird, Proc. Acad. Nat. Sci. Philad. (1858) *10:* 253. – **Type locality:** Fort Yuma (**Holotype:** U.S. Natn. Mus. No. 4172).

1922 *Sauromalus obesus* – Schmidt, Bull. Am. Mus. Nat. Hist., New York, *46* 11: 641 (part).

Range: Southwestern United States in southern California, extreme southern Nevada and Utah, western and central Arizona, and extreme northwestern México in western Sonora.

Sauromalus obesus obesus (Baird)

1945 *Sauromalus obesus obesus* – Shaw, Trans. San Diego Soc. Nat. Hist., *10* 15: 295.

Range: Desert regions of southwestern United States in southern California east of the mountains, extreme southern Nevada and southwestern Utah, and western and central Arizona.

Sauromalus obesus multiforminatus Tanner & Avery

1964 *Sauromalus obesus multiforminatus* Tanner & Avery, Herpetologica, *20* 1: 38. – **Type locality:** North Wash, 11 miles northwest of Hite, Garfield County, Utah (**Holotype:** Brig. Young Univ. No. 11376).

Range: The Colorado River area from Glenn Canyon Dam in northern Arizona, northward and eastward to just north of Hite in southern Utah.

Sauromalus obesus townsendi Dickerson

1919 *Sauromalus townsendi* Dickerson, Bull. Am. Mus. Nat. Hist., New York, *41* 10: 464. – **Type locality:** Tiburon Island, Gulf of California, Mexico (**Holotype:** U.S. Natn. Mus. No. 64442).

1922 *Sauromalus townsendi* – Schmidt, Bull. Am. Mus. Nat. Hist., New York, *46* 11: 643; Fig. 3c, 3d.

1945 *Sauromalus obesus townsendi* – Shaw, Trans. San Diego Soc. Nat. Hist., *10* 15: 290.

Range: Tiburon Island in the Gulf of California, and the adjacent coast of western Sonora southward at least as far as Guaymas, and inland to the vicinity of Hermosillo, northwestern México.

Sauromalus obesus tumidus Shaw

1945 *Sauromalus obesus tumidus* Shaw, Trans. San Diego Soc. Nat. Hist., *10* 15: 292. – **Type locality:** Telegraph Pass, Gila Mountains, Yuma County, Arizona (**Holotype:** San Diego Soc. Nat. Hist. No. 27323).

Range: Southwestern Arizona and adjacent extreme northwestern Sonora, northwestern México.

Sauromalus slevini Van Denburgh

1922 *Sauromalus slevini* Van Denburgh, Occ. Pap. Calif. Acad. Sci., San Francisco, *10* 1: 97. – **Type locality:** South end of Monserrate Island, Gulf of California, Mexico (**Holotype:** Calif. Acad. Sci. No. 50503).

1945 *Sauromalus slevini* – Shaw, Trans. San Diego Soc. Nat. Hist., *10* 15: 280.

Range: The islands of Monserrate, Carmen and Coronados in the Gulf of California, western México.

Sauromalus varius Dickerson

1919 *Sauromalus varius* Dickerson, Bull. Am. Mus. Nat. Hist., New York, *41* 10: 464. – **Type locality:** San Esteban Island, Gulf of California, Mexico (**Holotype:** U.S. Natn. Mus. No. 64441).

1922 *Sauromalus varius* – Schmidt, Bull. Am. Mus. Nat. Hist., New York, *46* 11: 641; Pl. 48.

1945 *Sauromalus varius* – Shaw, Trans. San Diego Soc. Nat. Hist., *10* 15: 288.

Range: The Islands of San Estebán, Lobos, and Pelicano in the Gulf of California, western México.

THE MALAGASY IGUANIDS

Chalarodon Peters

1837 *Tropidogaster* Duméril & Bibron (Official Index [Invalid], Op. 955, 1971). Erpét. gén., Paris, *4:* 329. – **Type species** (by monotypy): *Tropidogaster blainvillii* Duméril & Bibron 1837.
1843 *Ptychosaurus (Tritropis)* Fitzinger (Official Index [Invalid], Op. 955, 1971), Syst. Rept., Wien, *1*: 59. – **Type species** (by original designation): *Tropidogaster blainvillii* Duméril & Bibron 1837.
1854 *Chalarodon* Peters, Mber. K. Akad. Wiss., Berlin, 616. – **Type species** (by monotypy): *Chalarodon madagascariensis* Peters 1854.
1885 *Chalarodon* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 128.
Range: Arid and semiarid regions of southwestern Madagascar, throughout most of Tulear Province, extending into southwestern Fianarantsoa and extreme southwestern Majunga Provinces.

Chalarodon madagascariensis Peters
1837 *Tropidogaster Blainvillii* Duméril & Bibron (Official Index [Invalid], Op. 955, 1971), Erpét. gén., Paris, *4*: 330. – **Type locality:** inconnue (**Holotype:** Mus. Hist. Nat. Paris No. 6869).
1843 *Ptychosaurus (Tritropis) Blainvillii* – Fitzinger (Official Index [Invalid], Op. 955, 1971), Syst. Rept., Wien, *1*: 59.
1854 *Chalarodon madagascariensis* Peters, Mber. K. Akad. Wiss., Berlin, 616. – **Type locality:** Madagascar (St. Augustins Bay) (**Syntypes:** Zool. Mus. Berlin No. 4360 (2), 5617, 9214) (2)).
1885 *Chalarodon madagascariensis* – Boulenger, Cat. Liz. Brit. Mus., London, *2:* 128.
1885 *Tropidurus ? blainvillii* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 178.
1933 *Tropidurus blainvillii* – Burt & Burt, Trans. Acad. Sci. St. Louis, *27* 1: 45.
1942 *Chalarodon madagascariensis* – Angel, Mem. l'Akad. Malag., Tananarive, *36:* 89; Pl. 13, Fig. 3.
1977 *Chalarodon madagascariensis* – Blanc, Faune de Madagascar, Paris, *20* 59; Pl. 7.
Range: Arid and semiarid regions of southwestern Madagascar, throughout most of Tuléar Province, extending into southwestern Fianarantsoa and extreme southwestern Majunga Provinces.

Oplurus Cuvier

1829 *Oplurus* Cuvier, Règ. Anim., Paris, Ed. 2, *2:* 47. – **Type species** (by monotypy): *Oplurus torquatus* Cuvier 1829; subsequent invalid designation by Fitzinger 1843: *Oplurus sebae* Duméril & Bibron 1837.
1843 *Hoplurus* – Fitzinger (invalid emendation of *Oplurus* Cuvier 1829), Syst. Rept., Wien, *1:* 76.
1843 *Doryphorus* Fitzinger (*non* Cuvier 1829), Syst. Rept., Wien, *1:* 77. – **Type species** (by original designation): *Oplurus maximiliani* Duméril & Bibron 1837.
1885 *Hoplurus* – Boulenger, Cat. Liz. Brit. Mus., London, *2*: 129.

1942 *Hoplurus* – Angle, Mem. l'Akad. Malag., Tananarive, *36*: 82.
1952 *Oplurus* – Savage, Copeia, *1952* 3: 182.
Range: Western and central Madagascar and Grand Comore Island.

Oplurus cuvieri (Gray)
1829 *Oplurus torquatus* Cuvier (secondary homonym for *Tropidurus torquatus* Wied 1821), Règ. Anim., Ed. 2, Paris, *2*: 48. – **Type locality:** Brésil (**Holotype:** Mus. Hist. Nat. Paris No. 1433).
1831 *Trop.[idurus] Cuvieri* Gray *in* Cuvier *edit.* Griffith (substitute name for *Oplurus torquatus* Cuvier 1829), Anim. Kingd., London, *9:* 41.
1837 *Oplurus Sebae* Duméril & Bibron (*syn. fide* Savage 1952), Erpét. gén., Paris, *4*: 361. – **Type locality:** Brésil (**Holotype:** Mus. Hist. Nat. Paris No. 1433).
1843 *Hoplurus Sebae* – Fitzinger, Syst. Rept., Wien, *1:* 76.
1845 *Hoplurus Barnardi* Peters (part; *syn. fide* Boulenger 1885), Mber. K. Akad. Wiss., Berlin, 616. – **Type locality:** Madagascar (Bombatuka, St. Augustins-Bay) (**Syntypes:** Zool. Mus. Berlin No. 674 (2), 3951, 5393).
1885 *Hoplurus sebae* – Boulenger, Cat. Liz. Brit. Mus., London, *2:* 129.
1952 *Oplurus cuvieri* – Savage, Copeia, *1952* 3: 182.
1977 *Oplurus cuvieri* – Blanc, Faune de Madagascar, Paris, *45*: 28.
Range: Northwestern Madagascar and Grand Comore Island.

Oplurus cuvieri cuvieri (Gray)
1942 *Hoplurus sebae [sebae]* – Angel, Mem. l'Akad. Malag., Tananarive, *36:* 83; Pl. 3, Fig. 4; Pl. 12, Fig. 1.
1952 *Oplurus cuvieri cuvieri* – Savage, Copeia, *1952* 3: 182.
1977 *Oplurus cuvieri cuvieri* – Blanc, Faune de Madagascar, Paris, *45:* 28; Pl. 1.
Range: Subhumid regions of northwestern Madagascar from western Diego-Suarez Province southward into northern Tuléar Province and inland to the western slopes of the Tananarive Province, with an isolated population in northwestern Fianarantsoa Province.

Oplurus cuvieri comorensis Angel
1942 *[Hoplurus sebae]* var. *comorensis* Angel, Mem. l'Akad. Malag., Tananarive, *36:* 84. – **Type locality:** Grand Comore (**Syntypes:** Mus. Hist. Nat. Paris No. 22-298, 22-299).
1952 *O.[plurus] cuvieri comorensis* – Savage, Copeia, *1952* 3: 182.
Range: Grand Comore Island (westward of northern Madagascar in the northern Mozambique Channel).

Oplurus cyclurus (Merrem)
1820 *Uromastyx cyclurus* Merrem, Tent. Syst. Amphib., Marburg, 56. – **Type locality:** Brasilia (**Holotype:** not located).
1837 *Oplurus Maximiliani* Duméril & Bibron (*syn. fide* Boulenger 1885), Erpét. gén., Paris, *4:* 365. – **Type locality:** Brésil (**Holotype:** Mus. Hist. Nat. Paris No. 1431).
1843 *Dorphorus Maximiliani* – Fitzinger, Syst. Rept., Wien, *1:* 77.
1885 *Hoplurus cyclurus* – Boulenger, Cat. Liz. Brit. Mus., London, *2:* 130.

1942 *Hoplurus cyclurus* – Angel, Mem. l'Akad. Malag., Tananarive, *36:* 84; Pl. 3, Fig. 30; Pl. 11, Fig. 4.
1952 *Oplurus cyclurus* – Savage, Copeia, *1952* 3: 182.
1977 *Oplurus cyclurus* – Blanc, Fanue de Madagascar, Paris, *45:* 20, Pl. 1.
Range: Southwestern Madagascar throughout most of Tuléar Province and extending northward into extreme southwestern Majunga Province.

Oplurus fierinensis Grandidier

1869 *Oplurus Fierinensis* Grandidier, Rev. et. Mag. Zool., Paris, (2) *21*: 341. – **Type locality:** Mafale (**Syntypes:** Mus. Hist. Nat. Paris No. 7638 (4)).
1942 *Hoplurus fierinensis* – Angel, Mem. l'Akad. Malag., Tananarive, *36:* 87; Pl. 13, Fig. 1.
1952 *Oplurus fierinensis* – Savage, Copeia, *1952* 3: 182.
1977 *Oplurus fierinensis* – Blanc, Faune de Madagascar, Paris, *45*: 42.
Range: Arid regions of southwestern Madagascar in the lower reaches of the Fiherenana and Onilahy river valleys, and on the Mahafly Plateau, western Tuléar Province.

Oplurus grandidieri Mocquard

1900 *Hoplurus Grandidieri* Mocquard, Bull. Soc. Philomath., Paris (9) *2* 1: 105; Pl. 2. – **Type locality:** Vananitalo (Forêt d'lkongo) (**Holotype:** Mus. Hist. Nat. Paris. No. 99-359).
1942 *Hoplurus grandidieri* – Angel, Mem. l'Akad. Malag., Tananarive, *36*: 85; Pl. 12, Fig. 2.
1952 *Oplurus grandidieri* – Savage, Copeia, *1952* 3: 182.
1977 *Oplurus grandidieri* – Blanc, Faune de Madagascar, Paris, *45*: 47; Pl. 6.
Range: Semiarid regions of southern central Madagascar in eastern central Tuléar Province and western central Fianarantsoa Province.

Oplurus quadrimaculatus Duméril & Bibron

1851 *Oplurus quadrimaculatus* Duméril & Bibron *in* Duméril & Duméril, Cat. Meth., Paris, 83. – **Type locality:** Madagascar (**Holotype:** Mus. Hist. Nat. Paris No. 1404).
1856 *Centrura quadrimaculatus* – Duméril, Arch. Mus. Hist. Nat., Paris, *8:* 558; Pl. 22, Fig. 4.
1869 *Oplurus montanus* Grandidier (*syn. fide* Boulenger 1885), Rev. et Mag. Zool., Paris, (2) *21*: 340. – **Type locality:** Fiérin (**Syntypes:** Mus. Hist. Nat. Paris No. 95-173, 95-175).
1885 *Hoplurus quadrimaculatus* – Boulenger, Cat. Liz. Brit. Mus., London, *2:* 131.
1942 *Hoplurus quadrimaculatus* – Angel, Mem. l'Akad. Malag., Tananarive, *36:* 88; Pl. 13, Fig. 2.
1952 *Oplurus quadrimaculatus* – Savage, *1952* 3: 182.
1977 *Oplurus quadrimaculatus* – Blanc, Faune de Madagascar, Paris, *45*: 34; Pl. 3.
Range: Arid to humid regions of central and southern Madagascar from the coast of southern Tuléar Province through the higher parts of western Fianarantsoa Province and northern central Tananarive Province.

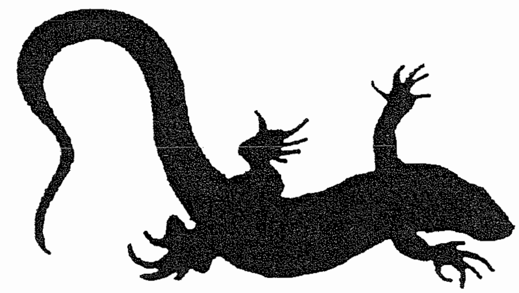
Oplurus saxicola Grandidier

1869 *Oplurus saxicola* Grandidier, Rev. et Mag. Zool., Paris (2) *21:* 340 – **Type locality:** Fiérin [**Syntypes:** Mus. Hist. Nat. Paris No. 7637 (2)].
1942 *Hoplurus saxicola* – Angel, Mem. l'Akad. Malag., Tananarive, *36*: 86; Pl. 12, Fig. 3.
1952 *Oplurus saxicola* – Savage, Copeia, *1952* 3: 182.
1977 *Oplurus saxicola* – Blanc, Faune de Madagascar, Paris, *45:* 53; Pl. 5.
Range: Semiarid regions of southern Madagascar in southern central Tuléar Province.

American Association of Zoos and Aquariums

Lizard Advisory Group

Regional Collection Plan



1994

1. **West Indian rock ground iguanas, Cyclura:**

STATUS: this group of lizards is the single highest conservation priority for the Lizard TAG. A Cyclura regional studbook is in preparation by Bill Christie (Indianapolis Zoo). Five taxa are currently held in N.A. zoos, but space exists for only one or two managed programs.

RECOMMENDATIONS: Cyclura should be designated for SSP status once the studbook is compiled. This will be the first lizard SSP.

A) **Jamaican iguana, C. collei:**

STATUS: most critically endangered of the world's large lizards, this species is the subject of a international conservation and recovery effort, both in- and ex-situ. A captive population in Jamaica and U.S. is necessary as a genetic reservoir to serve as a backup in case of catastrophic loss of the wild population. Eighty 1991-93 hatched juveniles are currently held at the Hope Zoo, Kingston, Jamaica. Twelve will be imported in July 1994 to three U.S institutions: Gladys Porter, Indianapolis and Fort Worth. An iguana headstart facility was constructed at Hope Zoo in May with funds donated largely by AZA Lizard TAG participating zoos. The IMS funded genetics research project will commence in July when blood samples are collected on the captive colony at Hope Zoo.

RECOMMENDATIONS: this taxa should become the primary focus of the Cyclura SSP, with the goal of attaining a captive population of 50.50.100 in North America. An additional 12 progeny should be imported from Hope Zoo in 1995 which will bring the founding nucleus to 24. The new stock should be selected based on the genetic results so as to obtain offspring unrelated to that imported in 1994. The conservation program in Jamaica, both field and captive, will require substantial outside assistance in order to be successful. Continued financial support will be needed from Lizard TAG and Cyclura SSP participating zoos.

B) **Grand Cayman iguana, C. nubila lewisi:**

STATUS: another critically endangered iguana, the wild population exists at dangerously low numbers which are fragmented. A well managed conservation program is operated by the National Trust of Grand Cayman (GCNT). The subspecies hybridization problem has been rectified, both on Grand Cayman and the U.S., and the majority of the zoo captive population (7.7.2 in 5 zoos) now consists of pure lewisi. However the population is descended from only 3.1 wild-caught founders at Life Fellowship, several of which are still alive and breeding. Unless future importation of additional genetic stock from founder breedings at the captive program on Grand Cayman can be arranged, this program is at a dead end in terms of long-term management. The IMS genetic research will commence late in 1994.

RECOMMENDATIONS: work with Fred Burton (GCNT) to obtain new founder lines to improve genetic composition of captive population in U.S. Utilize results of genetic survey to implement a breeding strategy designed to maximize the genetic contribution of all available wild-caught lewisi, both in Grand Cayman and U.S., and then manage the captive population as one. Encourage that a nucleus population be monitored and managed through the studbook if additional stock cannot be obtained. Cyclura SSP participants and those holding this taxa should support the ongoing field and captive conservation program on Grand Cayman.

C) Cuban iguana, C. n. nubila:

STATUS: this taxa is secure in the wild and is in no apparent need of assistance from captive programs in LAG zoos.

RECOMMENDATIONS: a moratorium on breeding is urged, with the goal of substituting target species over time. The LAG stresses the value of maintaining current holdings in order to "hold down" space for target species once specimens become available.

D) Ricord's iguana, C. ricordi:

STATUS: this species is declining in the wild and faces an uncertain future; they are a habitat specialist with a narrow distribution making them much less adaptable than C. cornuta. There are 1.3 at Indianapolis and captive breeding has occurred on two occasions there; however, the program has been hampered by poor hatchability and high juvenile mortality. A captive program also exists at ZOODOM in the Dominican Republic.

RECOMMENDATIONS: the LAG supports the continuation of this program as a joint Indianapolis/ZOODOM endeavor. Due to space limitations, this species should not be included in the Lizard RCP.

E) Rhino iguana, C. cornuta:

STATUS: the most widely held Cyclura (100+) in North American collections, this species has reproduced well in recent years, most notably at Indianapolis, Gladys Porter and Dreher Park. This iguana offers an excellent opportunity for zoos to gain experience with Cyclura; however no immediate need exists for a long-term captive management program for this species. A large amount of captive space is currently being occupied by cornuta that will be needed for target Cyclura programs in the future.

RECOMMENDATIONS: a breeding moratorium should go into effect until a viable outlet for surplus progeny can be identified. The return of captive hatched progeny from Gladys Porter Zoo to

ZOODOM should be monitored. Providing this project moves ahead with favorable results, perhaps breeding could resume with surplus offspring being exported to the D.R.

2. **Lesser Antilles iguana, Iguana delicatissima:**

STATUS: undergoing rapid extirpation in the wild due to hunting pressures, perhaps no other West Indian iguana has undergone such a dramatic population decline in such a short time span (30 years). Six wild-caught specimens are held in two U.S. zoos, Memphis and San Diego; an additional pair is at Jersey (JWPT). Memphis Zoo has developed a good working relationship with the Forestry Department of Dominica from which all captive stock originated. The goal of this pilot project is to develop husbandry guidelines for this poorly known iguana, while promoting and supporting in-situ conservation efforts. Memphis and San Diego Zoo's have funded Mark Day's island surveys to determine the current status and distribution of this increasingly endangered lizard.

RECOMMENDATIONS: increase and continue to support ongoing fieldwork. Once captive breeding has occurred the LAG should support Memphis Zoo's efforts to obtain additional founding stock (up to four new pairs) in order to expand the pilot program. Zoos participating in this program should provide support for the field project in order to bring attention to this species' plight in the wild.

3. **Fiji banded iguana, Brachylophus fasciatus:**

STATUS: a regional studbook is maintained by John Kincaid (San Diego Zoo) which lists 33.21 living specimens held in 11 U.S. collections. Ten founders are represented in the population, of which seven are still living and six are reproducing. There is considerable interest among zoos in this species, and it is obvious that a sizeable population can be accommodated. This is primarily a San Diego Zoo program and outstanding breeding success has been achieved there. Other zoos are beginning to get eggs, but to date no progeny have been produced outside San Diego in recent years. Some specimens are suspected hybrids and genetic work is needed to clarify this problem.

RECOMMENDATIONS: SSP status is not warranted for this species at this time; however, studbook monitoring and management should be initiated as breeding in other institutions becomes more commonplace. The LAG should support genetic research to rectify the potential hybridization issue.

4) **Mexican Beaded lizards, Heloderma horridum:**

STATUS: a regional studbook is being compiled by Craig Ivanyi and Jan Perry-Richardson (Arizona-Sonora Desert Museum). The June 1994 ISIS data lists 140 (52.43.45) specimens in 30+ institutions. Four subspecies are recognized, and two (exasperatum and horridum), are represented in North American collections. Nineteen captive breedings have occurred in nine U.S institutions since 1972; however, only four have had regular success in recent years. Historically, egg infertility and low hatching success have been commonplace. Identification is problematic using presently available keys, and some specimens appear to be intergrades (a natural zone of intergradation occurs between exasperatum and horridum in Sinaloa). The validity of exasperatum is in question and genetic research to elucidate this problem is in progress at Texas A&M. A large group of Beaded lizards confiscated in San Diego in 1992 key out to be "good" exasperatum, and this group, regardless of subspecies, provides a substantial influx of potentially new bloodlines into an aging population.

Taxonomically unique, and one of only two species of venomous lizards in the world, Beaded lizards represent a high-profile and flagship species for Mexico. Many of the captive animals were imported many years ago from Mexico and are considered post-reproductive. No additional stock is expected out of Mexico other than occasional confiscations; however if managed properly, there is an adequate number of wild-caught specimens in captivity to insure a viable population. They are long-lived and can reproduce for many years.

RECOMMENDATIONS: the present captive population should be genetically managed, though not intensively. Attempts should be made to breed previously non-reproductive specimens thus increasing the number of founder bloodlines. Wild-caught specimens that have not contributed to the captive genepool should be assigned priority and placed in situations conducive to breeding. However, until the results of the genetic survey are completed, captive breeding should be suspended on the following:

1) specimens that do not clearly key out to "good" horridum or exasperatum;
2) specimens that are suspected hybrids or intergrades.

The recently confiscated group of "exasperatum" should be maintained separately from other specimens, thus preserving the integrity of this group. Zoos are urged to participate in the genetic survey and collect blood samples on their specimens if requested. The number of institutions holding large breeding groups of beaded lizards needs to be expanded.

5) Solomon Islands Prehensile-tailed skink, Corucia zebrata:

STATUS: a regional studbook was published in 1994 by Frank Slavens (Woodland Park) which lists 170 (50.45.75) specimens held in 45 North American institutions, of which roughly half (80) are wild-born. Since the first captive birth in 1971, 113 babies have been born in captivity, 50% of which still survive.

Corucia is a monotypic genus and as such has a high conservation priority. This species has been heavily exploited for the pet trade since 1986, and was recently placed on CITES II. Loss of habitat from deforestation due to timber harvesting is believed to be causing a decrease in population numbers due to their dependence on old-growth primary forests. These factors, combined with their low reproductive rate (1-2 offspring annually), make Corucia extremely vulnerable. The long-term effects of removing large numbers of adult breeding specimens from the wild is unknown. However, no field data are available, and the status of wild populations is speculative.

RECOMMENDATIONS: this unique lizard should continue to be a focus of the LAG, and efforts made to improve their captive management. Currently there is a 50% juvenile mortality, the causes of which need to be ascertained and corrected such that the captive population become self-sustaining. Non- or under-represented animals should be placed in breeding situations, and new founder stock should be included into the population whenever possible. Genetic analysis of the captive population should be run using the SPARKS database to determine founder representation, etc.

6) Chinese Crocodile Lizard, Shinisaurus crocodilurus:

STATUS: a regional studbook is maintained by Andy Snider (Detroit Zoo) which lists 45.26.41 specimens held in North American zoos. Thirty-eight of these are wild-caught, with the remainder of the population captive born, descended from a minimum of 7.7 founders. Founder representation is difficult to determine since many of the offspring were produced in group situations and are listed as having multiple potential sires or dams. At least five zoos have reproduced Shinisaurus on one occasion, and two (San Diego and Philadelphia) have experienced repeated successes and produced numerous offspring.

Shinisaurus is a monotypic genus and has a high conservation priority. The wild population is reportedly small with an extremely limited distribution is southern China. Collection for the pet trade was a problem until recently; however some smuggling continues. There is considerable interest in this enigmatic lizard, with the potential to serve as flagship species for biodiversity in China.

RECOMMENDATIONS: this species should remain a high priority for LAG attention, and efforts increased to improve their captive husbandry and reproduction. The population should be increased through intensive captive propagation, concentrating especially on unrepresented potential founder stock. High neonatal mortality is hampering efforts to expand the captive population, and the causative factors need to be investigated. A well coordinated husbandry research project should be undertaken to improve the situation in captivity for this problematic lizard.

7) Asian forest monitors

STATUS: this group includes six highly specialized forms which, because of their specific habitat and foraging requirements, are not expected to survive in disturbed areas. None of these taxa have fared particularly well in captivity, and reproduction has been sporadic or non-existent. Captive populations for each are relatively small, and though not self-sustaining, are growing. All of these monitors (except V. olivaceus) are being collected for the pet trade and are commercially available. A regional studbook is being compiled by Winston Card (Dallas Zoo) to assist in monitoring population trends.

RECOMMENDATIONS: all of the following taxa have been targeted for increased captive work and husbandry research/pilot programs. Herp collection managers are urged to evaluate and critically review their captive monitor space and holdings, and to commit additional resources, where feasible, to this group. The LAG believes that a focused effort and intensified approach to this group of lizards will yield markedly improved results. A project/husbandry research coordinator for each taxa is needed.

A) Dumeril's monitor, Varanus dumerili:

STATUS: twenty-three specimens are held in 8 North American zoos, of which 18 (12.6) are wild-caught and potential founders. Has reproduced once in N.A at Buffalo Zoo.

B) Rough-necked monitor, Varanus rudicollis:

STATUS: sixteen in 5 N.A. zoos, most of which are wild-caught. Has reproduced twice in N.A. at Nashville Zoo.

C) New Guinea crocodile monitor, Varanus salvadorii:

STATUS: thirty-eight held in 14 N.A. zoos, 37 of which are wild-caught. Has reproduced once in N.A. at the Gladys Porter Zoo. Good potential founder nucleus.

D) Gray's monitor, Varanus olivaceus:

STATUS: five (3.2) wild-caught adults located in 2 U.S. zoos. Reproduced at Dallas Zoo but specimen did not survive. Though these adults are old, they continue to produce some fertile eggs. Additional breeding stock is needed to improve the prospects for captive reproduction. A zoo consortium approach to import new bloodlines should be initiated. This unique and highly specialized monitor emerged as a high priority for conservation from the 1992 Varanid CAMP workshop. Restricted to two islands in the Philippines, their known range is the second smallest reported for any monitor. Rampant forest destruction and hunting pressures render this species vulnerable.

E) **Green tree monitor, Varanus prasinus:**

STATUS: forty-nine (29.19.1) specimens are located in 15 N.A. zoos; only 3 are captive hatched. Has reproduced at 3 U.S zoos: Dallas, Fort Worth and Riverbanks. Good potential founder nucleus. Most prasinus are currently entering the trade illegally, being imported under the name "kordensis". Therefore zoos may have to rely on USFWS confiscations to increase the captive numbers.

F) **Black tree monitor, Varanus beccari:**

STATUS: twenty-six (11.14.1) in 7 N.A. collections; only 2 are captive hatched. Has reproduced at 3 U.S. zoos: Fort Worth, Dallas and Oklahoma City.

8) **Komodo dragon, Varanus komodoensis:**

STATUS: forty-five young dragons are held in 18 U.S. zoos, the results of 3-4 captive breedings at the National and Cincinnati Zoos in 1992-94. There are 2.1 wild founders represented and another unpaired male at San Diego. An additional 2 specimens have been approved for import, and permits filed to bring in another 2.2 from Indonesia. A regional studbook petition is being filed by the Cincinnati Zoo.

RECOMMENDATIONS: due to low founder representation, SSP management is not indicated at this time; however, this situation is expected to change with the addition of new breeding stock. A regional studbook should be initiated. The LAG supports the acquisition of new founding bloodlines to the N.A. population. It should be stressed that the Komodo dragon population will require careful management in the near future to insure that available space is not monopolized. The LAG stresses the importance of managing the Komodo program such that is does not compete for space for other recommended large lizard programs. This promises to be a difficult task considering the high-profile status that this taxa enjoys.

9) **Madagascar leaf-tail geckos, Uroplatus:**

STATUS: these unique geckos are a potential flagship species for Madagascan lizard diversity. Eight or nine species of Uroplatus are recognized; four are represented in N.A zoos, and three are reproducing with varying degrees of success. There have been no successful second generation breedings. A regional studbook petition is being submitted by Sean Foley (Riverbanks Zoo).

RECOMMENDATIONS: due to widespread interest in this genus, and the prolific nature of several of the species, studbook monitoring and intermediate management is needed.

A) Giant leaf-tail gecko, _Uroplatus fimbriatus_: fifty-two specimens are located in 11 U.S. zoos, and captive breeding has occurred in at least five. Most specimens are wild-caught and potential founders. Reproduction has been sporadic with some zoos noting a cessation of activity following an initial egg-laying period. Husbandry research is needed to correct this problem. Giant leaf-tails can prove to be difficult to maintain.

B) Henkel's leaf-tail gecko, _Uroplatus henkeli_: forty-one specimens are located in 9 N.A. zoos with reproduction having occurred in three. They are potentially highly prolific, e.g. 27 progeny were hatched from one pair in one year. Founder lines are low, and the majority of the captive population is descended from one over-represented pair. Additional lines need to be obtained. Bloodline exchanges need to occur before attempting second generation breedings. They are a hardy captive, and zoos looking to gain experience with leaf-tail geckos should begin with this taxa.

C) Lichenous leaf-tail gecko, _Uroplatus sikorae_: thirty-four specimens are held in six U.S. zoos and reproduction has occurred in one; however breeding has been prolific with four adults producing 55 offspring in a 14 month period. Four founders are represented, but there are potentially more. Wild-caught specimens can be difficult initially, but captive raised animals are hardy.

D) _Uroplatus phantasticus_: six specimens are held in two U.S. zoos and breeding has not occurred. This small gecko is delicate and may prove problematic for captivity.

10) Standing's day gecko, _Phelsuma standingi_:

STATUS: twenty-four U.S. zoos hold 135 (43.40.52) specimens, 73% of which are captive hatched (June 1994 ISIS data). The number of wild-caught founders, both actual and potential, is fairly high. It is now the most numerous and widely held _Phelsuma_ in captivity worldwide with 232 specimens held in Europe and N.A. They are potentially prolific, and surplus animals are already somewhat of a problem. A regional studbook was recommended in 1990 to monitor this growing population. Sue Benson (Denver Zoo) has recently volunteered to accept this task.

RECOMMENDATIONS: the LAG will support the compilation of a regional studbook to monitor the captive population, i.e. founder lines and representation. The wild status of this reportedly "rare" _Phelsuma_ needs to be investigated, and a better understanding will help determine the type of management program needed. Support the Australian Reptile TAG's request to import a founding nucleus.

11) Small _Phelsuma_:

STATUS: the captive management of most of the small taxa of Madagascan day geckos has been problematic, hence generating interest among zoos has proved difficult. _P. serraticauda_ was recommended for a captive program but there was insufficient commitment. Though developing husbandry and management techniques for small _Phelsuma_ is still a priority, the taxa truly in need of captive work still remains a subject of debate.

RECOMMENDATIONS: the LAG encourages zoos to increase their involvement with this group, and those with a special interest should begin to prioritize projects among themselves.

12) New Caledonian giant gecko, _Rhacodactylus leachianus_:

STATUS: twenty-five (13.5.7) are held in five U.S. zoos, ten (6.4) of which are wild-caught. However only 3.3 founders have contributed to the captive population, 3.2 of which are still living. There has been a high incidence of male hatchlings, and research efforts at the Dallas Zoo focuses on reversing this trend with hormone treatment of eggs. Though not highly endangered, this is a high profile lizard with the ability to serve as a flagship species for insular biodiversity.

RECOMMENDATIONS: though there is no immediate need, the LAG supports the development of a regional studbook in the near future to monitor the growing population. Zoos are urged to increase their involvement with members of this interesting genus in order to gain experience that can be applied to more endangered taxa, such as the recently rediscovered _R. ciliatus_.

13) Cuban giant anole, _Anolis smallwoodi_:

STATUS: eighteen (8.9.1) are held in two zoos; 2.5 are wild-caught adults, and 11 are captive hatched. This taxa is the subject of a pilot program to develop husbandry and management techniques for large anolines. The adult breeding stock came from Guantanamo Naval AFB in 1993 where they are relatively common. The program is centered at the Fort Worth Zoo and is being expanded to include other institutions.

RECOMMENDATIONS: since 1990 the LAG has advocated a pilot giant anole program and searched for a "conservation surrogate" species to serve as a model for more threatened forms, e.g. _A. cuvieri_, or _A. roosevelti_, which is feared extinct. The LAG encourages the expansion of this program to prepare for the eventuality of a giant anole recovery program that may involve a captive component.

14) San Esteban chuckwalla, Sauromalus varius:

STATUS: this program is centered at the Arizona-Sonora Desert Museum. Since 1981 204 progeny from 10 maternal lines have been produced. Founder representation is 8.13, 6.8 of which are still alive. Numerous collaborators are involved with this project, including nine zoos in the U.S. and Mexico and two universities; a considerable body of relevant research has been generated from the project, both in the field and in captivity. The species is not particularly endangered, but is vulnerable to several threatening factors. Reintroduction is not warranted at this time.

RECOMMENDATIONS: the LAG urges the continuation of this program and considers it a model by which to structure future ex-situ conservation based captive lizard programs. The LAG considers the maintenance of a genetically viable self-sustaining captive population as important and recommends studbook monitoring. It should be stressed that this program should not compete for space allocated for Cyclura programs.

TARGET ACQUISITION SPECIES

15) Haitian giant galliwasp, Diploglossus warreni:

STATUS: though not threatened the giant galliwasp was recommended for a pilot program by the LAG in 1990, the purpose being to serve as a model for two other endangered Hispaniolan anguids, D. carraui and D. anelpistus. One is known only form the type locality and may be extinct; the other is extremely rare. Once frequently imported, D. warreni has been kept and bred by several zoos over the years, but not recently. Currently only 1.1 exist in one U.S. zoo.

RECOMMENDATIONS: the LAG firms supports the initiation of a pilot program using the more common D. warreni as a conservation surrogate to develop husbandry techniques for the rare taxa should they become available for management. Contacts in the D.R. and ZOODOM (Jose Ottenwalder) should be pursued for the importation of specimens.

16) Sri Lankan agamids, Lyriocephalus and Ceratophora:

STATUS: many of the endemic forest agamids of Sri Lanka are becoming threatened due to forest destruction. Experience with most of these taxa in captivity is extremely limited. Pilot programs for L. scutatus and one or more species of Ceratophora have been proposed to establish husbandry guidelines. Dr. Anslem de Silva has agreed to provide groups of these lizards to zoos in exchange for funds to enable his group (ARROZ) to continue their faunal surveys of endemic herpetofauna. A consortium of zoos including Detroit, Oklahoma City, Sedgwick County, Fort Worth has formed to coordinate this project.

RECOMMENDATIONS: the LAG supports this consortium endeavor and urges others to help support Dr. de Silva's project.

17) **Arboreal alligator lizards, Abronia:**

STATUS: a recent monograph by J. Campbell and D. Frost predicts that of the 23 recognized species of Abronia in Mexico and Central America, at least 13 will become extinct or biologically nonviable within the near future. Some taxa are extremely rare with highly restricted ranges or known only from the type locality. Due to forest destruction, none is expected to survive the 21st century. A few species have been maintained in captivity over the years, and they appear to be hardy captives. Still, little is known regarding their captive biology and reproduction has not occurred in the U.S. This is a potential flagship species for herpetological diversity in Mexico.

RECOMMENDATIONS: the LAG supports the initiation of pilot programs for several species should they become available. This will no doubt prove difficult due to the fact that collecting permits are not being issued by the Mexican government.

18) **Caiman lizard, Dracaena:**

STATUS: these unique mollusc feeders and undergoing heavy exploitation for the skin trade, and thousands are exported annually. Live specimens however, are not imported, and there are no specimens listed in ISIS worldwide. Detroit Zoo is exploring the possibilities of acquiring a group for a pilot program, possibly working through the Brazilian FIG. They are listed as CITES II and their wild status is unknown.

RECOMMENDATIONS: support the importation of either D. guianensis or D. paraguayensis for a trial husbandry and propagation program.

FIVE YEAR ACTION PLAN

In-situ project: Jamaican iguana

Other major focus projects:

1) *Heloderma* and *Brachylophus* genetics (Texas A&M/S.Davis).

2) Field support for *Iguana delicatissima* (Reichling/M.Day).

3) Philippine trip to import new *Varanus olivaceus* founder stock (W. Card).

4) Funding for *Phelsuma standingi* field project.

5) Funding to publish TMA accounts (Hammack).

6) Husbandry research project *Shinisaurus*.

"Conservation strategies for the rapid recovery of depleted populations of large lizards"

Allison C. Alberts and John A. Phillips

Center for Reproduction of Endangered Species
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INTRODUCTION

There is no all-encompassing solution to the problem of decreasing biological diversity. One solution, for species with populations that can be easily manipulated, is captive propagation under semi-natural conditions. The ultimate objective of any captive propagation program for threatened and endangered species is to produce enough individuals to either bolster existing populations or repopulate areas of native habitat where local extinction has occurred. However, successful captive propagation of selected species has only occurred after sufficient behavioral and physiological information has been collected from natural populations. This can only be accomplished by examining populations that have adequate numbers to provide sufficient data, and then applying the findings to areas with depleted populations.

Most large lizards are either varanids or iguanids. The larger iguanids include the Galapagos marine *(Amblyrhynchus)* and land iguanas *(Conolophus)*, spiny-tailed iguanas *(Ctenosaura)*, green iguanas *(Iguana)*, chuckwallas *(Sauromalus)*, and rock iguanas *(Cyclura)*. Although monitor lizards are carnivorous and large iguanas are herbivorous, the behavioral and physiological differences between the two groups may not be as fundamental as currently thought. It is important to compare the social and reproductive behavior of monitors and iguanas because these two groups show substantial variation from typical lizard life history patterns. Additionally, even though these two lizard groups are only distantly related, many management and conservation protocols developed for iguanid lizards will be applicable to varanid lizards (and *vice versa*) because they share the common features of prominent size and a requirement for large tracts of suitable habitat.

Within the Iguanidae is the genus *Cyclura*, the rock iguanas, consisting of eight species. This genus is restricted to the islands in the Greater Antilles and Bahamas. *Cyclura* are the most endangered of all iguanids, probably because they inhabit fragile island ecosystems that are easily destroyed by habitat fragmentation and are highly vulnerable to the negative effects of introduced species, especially cats, dogs, mongooses, goats, and pigs. Several island populations have recently become extinct and others currently number less than a hundred individuals.

Very little information exists concerning the basic biology of *Cyclura* in the wild. Home range size is small relative to body size. Male territorial defense probably guarantees males access to females during the breeding season. Although females breed with more than one male, the largest males accomplish a disproportionate percentage of matings. Similar to other iguanids, females defend nest burrows after oviposition, but are not territorial at other times. Survivorship is positively correlated with body size throughout life. Birds and snakes are the only major native predators of rock iguanas, and then only of juveniles; however, many exotic predators account for the majority of predation in disturbed areas. The biomass in undisturbed areas can exceed 10 kg/ha, whereas populations in disturbed areas often exist at biomass levels less than 0.1 kg/ha, two orders of magnitude below natural density.

Any conservation-oriented study must be designed as an attempt to answer specific questions which can be applied in the broadest sense to other species or ecosystems. The rock iguanas are a group of reptiles with numerous ecological and physiological adaptations which set them apart from the other large lizard groups. Several of their unique features have been clearly defined, yet most of the basic aspects of their natural biology have not been examined. Although the genus is geographically isolated and contains few species, there is evidence that it shares many managerial and conservation-related problems with a diversity of other lizard groups.

PROJECT SUMMARY

Since 1993, we have been studying a population of *Cyclura nubila nubila* on the U.S. naval base at Guantanamo Bay, Cuba. The goal of our research has been to obtain results which will provide guidelines for the practical elements of a conservation strategy that can be applied to most other large lizard groups.

Study 1. What are the annual hormone/behavior correlates of a natural population of Cuban rock iguanas?

Previous field studies with *Cyclura* indicate that territoriality, especially among males, is confined to the breeding season. This suggests distinct seasonality in hormone production; however, hormone/behavior correlates of this group have not been examined in captive or free-ranging populations. Such data from natural populations are important, because the stress involved with captive, high-density situations often leads to reproductive dysfunction, which can be indicated by aberrant hormone cycles.

Accordingly, all adult lizards in a one-hectare study site were captured using hand nets, permanently marked with a unique crest scale clip, and temporarily marked with a painted number on the flank for visual identification from a distance. Behavior and spatial locations of individual lizards were monitored daily for three months during the breeding season and three months during the refractory period. Preliminary results suggest that body length, together with secondary sex characteristics such as head size and femoral pore productivity, may be important in mediating success in aggressive interactions between males, while body mass may be a key determinant of a male's initial willingness to participate in such interactions. Only about a third of adult males were observed to defend territories and guard females. If these dominant males contribute disproportionately to the gene pool, then the observed variability in male social behavior may have significant implications for genetic structuring of local populations.

Once per month, a blood sample was drawn from the caudal vein of each animal for hormonal analysis. These samples will be analyzed for corticosterone, estrogen and testosterone at our laboratory in San Diego. By correlating hormone levels with movements of females relative to males during the breeding season we expect to be able to determine if males are attracted to estrus females or estrus females seek out potential mates.

Study 2. Do the physical characteristics of egg incubation affect hatchability and size of Cuban iguana hatchlings?

One of the more crucial elements in the successful propagation of reptiles requires perfection of artificial incubation techniques for each species in question. Previous studies on reptile eggs have shown that the physical environment inside the nests effects the survival, metabolism and growth of the developing embryos. Embryos often die when they are exposed to extremes of temperature or moisture. Reptile eggs incubated in relatively cool, moist conditions usually consume more of their yolk and hatch at a larger body size than those exposed to relatively warm, dry conditions. Because environmentally induced variation in size and nutrient reserves of hatchlings may affect their ability to acquire food and/or escape predators, the physiological responses of embryonic reptiles to their physical environment may play a key role in the biology of each species.

In 1993, eggs from 20 females were collected and artificially incubated in vermiculite at 28, 29.5 and 31 °C at water potentials of -150, -550, and -1100 kPa. We found that neither temperature or water potential affected survivorship of eggs to hatching, suggesting that the chosen incubation parameters are all within the range of tolerance for this species. However, we did find a negative relationship between female body size and fertility, with larger females producing a higher percentage of infertile eggs. There was also a tendency for the initially viable eggs of larger females not to survive the incubation period as well as those of smaller females. That larger, presumably older, females showed higher levels of infertility and egg mortality suggests that reproductive senescence may occur in this long-live species, in which individuals may survive 50 years or more. Future physiological studies are planned to evaluate how ovarian function and egg viability change with age in female rock iguanas.

Although slightly smaller at hatching, hatchlings from eggs incubated at higher temperatures have grown significantly faster than those incubated at lower temperatures. For reptile conservation programs involving artificial egg incubation, it has been proposed that incubation temperatures be maintained in the lower part of the acceptable range to produce hatchlings of larger size and presumably higher quality. However, results of our studies caution that initially larger size is not necessarily indicative of larger size throughout the neonatal period. As has been suggested for other species, long-term monitoring of hatchling growth may be essential to determining the ultimate influence of incubation conditions on viability of lizard hatchlings.

Study 3. Is alteration of the sex ratio in natural habitats a viable conservation strategy for inducing rapid population recovery? Do females in manipulated populations maintain high fertility/fecundity and still exhibit normal social behavior?

The purpose of this study was to determine if experimental manipulations of the adult sex ratio of a local population could increase population growth and/or genetic diversity by enhancing the probability that sexually mature but genetically-underrepresented males would have the opportunity to mate. This type of manipulation represents a unique approach to lizard conservation, and has the potential to serve as an important management tool for endangered populations. To test this, we removed the most dominant males from our study site for the duration of the 1994 mating season.

Removal of high-ranking males produced dramatic changes in male social structure. Within a few days, several of the largest previously low-ranking males began to win aggressive encounters and could be classified as high-ranking. Resident females did not alter either the size or orientation of their home ranges in response to removal of the dominant males. The only observable change in female behavior was a slight increase in aggressive interactions between females, possibly reflecting increased competition for access to limited high-quality male mates.

At the close of the breeding season, the original dominant males were returned to the study site. They regained their previous territories within two days, although the aggressive interactions required for these males to re-establish themselves were among the longest and most intense observed during the entire study. Behavioral observations and home range mapping for several weeks following the return of the dominant males indicated no long term disruption of local social relationships. Analyses of blood samples collected during this period are currently being carried out to verify that hormonal processes associated with reproduction also were not negatively affected by the manipulation. Results of this study indicate that temporary alteration of local social structure may represent a valuable management tool for small or otherwise genetically-compromised populations by insuring that a greater percentage of males have an opportunity to contribute to the gene pool.

Study 4. How is neonatal survivorship enhanced if hatchlings are released when their size is substantially greater than at hatching?

Studies on reptiles indicate that larger individuals may survive the neonatal period better than smaller ones because they are more successful at avoiding predation and competing for food. This has led to proposals for headstarting programs, in which animals are raised in captivity until they reach a larger and presumably less vulnerable body size, as a conservation strategy for increasing survivorship of reintroduced or translocated individuals. Headstarting programs have not been without criticism, however. In sea turtles, headstarting appears not to address the fundamental causes of population decline and may actually be harmful to the ecosystem by temporarily removing neonatal turtles, an important link in the marine food chain. Even when captive-bred individuals are used in headstarting programs, danger remains that headstarted individuals will lose their fear of humans and other potential predators, as well as have difficulty adapting to natural food sources after a lengthy period in captivity. Although headstarting programs are often recommended to address the problem of low juvenile recruitment, there has never been a rigorous experimental investigation of the potential advantages and disadvantages of this approach.

Raptors, cuckoos, and boid snakes are the only native predators of rock iguanas, and then only of juveniles; however, a variety of introduced predators account for the majority of predation in disturbed areas. Most *Cyclura* populations are depressed due to heavy predation on hatchlings by feral cats and mongooses rather than increased adult mortality or a lack of suitable habitat. This indicates that headstarting, while it may not be successful in all instances, may prove to be a valuable conservation strategy for rock iguanas. Headstarting has the potential to directly address the problem of reduced juvenile recruitment in wild populations, and can probably be accomplished without exceeding the natural carrying capacity of the habitat. Beginning in 1995, we plan to conduct an experimental reintroduction to test whether hatchling Cuban rock iguanas retained in captivity for a headstarting period prior to release fare better in the wild than those released immediately after hatching.

To determine whether headstarting has a beneficial effect on survivorship of reintroduced rock iguanas, two groups of hatchlings, a newly hatched group and a group of headstarted hatchlings currently housed at the San Diego Zoo's Center for Reproduction of Endangered Species, will be simultaneously released at Guantanamo Bay as soon as is logistically feasible. Prior to release, all captive hatchlings will undergo a strict health screening exam which follows procedures specifically developed for reptiles by the AZA Reintroduction and Veterinary Advisory Groups. All hatchlings will receive transponder tags implanted subcutaneously in the left inguinal region for permanent individual identification. Long-distance identification of hatchlings will be facilitated through freeze-branding, a widely-used technique which when properly applied is permanent and does not interfere with shedding. By comparing survival rates among both headstarted and non-headstarted iguanas, it will be possible to critically evaluate the practice of employing a headstarting strategy prior to reintroduction.

During the last week of each visit to the release site, individuals from each of the two groups will be captured, weighed, and measured in order to document growth rates of headstarted and non-headstarted individuals. These data can be compared with comparable measurements on wild iguanas to determine how subsequent maturation is affected by headstarting. Finally, we will note any potential predators encountered during the census surveys, including Cuban boas, raptors, and feral cats. Feral cats are abundant at Guantanamo Bay, and if scat samples can be obtained, they will be examined for any iguana remains that might provide details about the size classes of iguanas most vulnerable to cat predation. This information will be very useful in designing future headstarting programs, especially in determining an appropriate length for the headstarting period.

We are grateful for the assistance of Jeffrey Lemm, Andrew Perry, Kelly Craft, Rick Hudson, Arthur Echternacht, Joan Price, Sandra Perry, Mark Wharton, and Richard Doyle in carrying out these projects.

RECOMMENDATIONS FOR CAPTIVE BREEDING OF MEDIUM TO LARGE-SIZED MONITOR LIZARDS

Andy Phillips, CRES, Zoological Society of San Diego

The following recommendations are based on an 18 month field/laboratory study conducted on *Varanus albigularis* at Etosha National Park, Namibia.

I. Body size measurements and cycles

A. Largest male: 620 mm SVL with a high season mass of 8.1 kg
Largest female: 580 mm SVL with a high season mass of 7.2 kg

B. Weight gain occurs during 5 months, fasting for 7 continuous months each year. Weight loss during the fasting months:

1. Males lose about 35% of their body mass.

2. Females lose over 50% of their body mass during the fasting months because reproduction, including egg production, occurs during the fasting period.

3. During the wet season weight gain for adults is up to 1 kg in three weeks (a 15% in body mass).

RECOMMENDATION: Species of monitor lizards known to have cyclic body weight cycles (all African species, about 75% of the Asian and Australian species) should be maintained on minimal calories for at least 6 months each year. Allow the animal to increase its body fat reserves and then let it fast.

II. Food items and feeding behavior

A. **No** mammals were caught and eaten during the 18 months of this study. The only vertebrate items consumed were either bird eggs, birds, or other reptiles, especially snakes.

B. The major food items were (in order of % calories in the diet):
1. land snails
2. beetles
3. crickets
4. grasshoppers

C. It should be emphasized that during the period of rapid body weight gain in the wet season, 90% of the food items eaten were land snails.

D. In captivity, land snails (purchased as escargot) are inexpensive and readily accepted (cost: $3.75/lb of snail meat).

E. Regardless of size of the individual, each animal normally eats until satiated. For hatchlings this was from 20-30% body mass/day, whereas adults consumed 10-20% per day.

RECOMMENDATION: During the period of the annual cycle when rapid weight gain occurs, lizards should be fed daily until satiated. With the exception of the largest species of varanids, mammals, as a food source, should be avoided. For most species of varanid lizards the sympatric small mammals are nocturnal, therefore it makes perfect sense that few prey items will be mammalian with these exclusively diurnal lizards.

III. Incubation of eggs

A. Over an incubation temperature range of 27-31 C hatchlings increase in size relative to egg size with decreasing temperature. At 31 C, about 120 days are required to pip, whereas eggs require about 160 days to pip at 27 C. Overall, the most vigorous hatchlings were obtained at 27 or 29 C.

B. As with other lizards, hatchlings maintained at high water potentials (-150 kPa) were substantally larger than those hatched at lower water potentials (-550 and -1100 kPa).

C. However, over the 27-31 C temperature range and -150 - -1100 kPa water potential range, fertile eggs had a hatchability of greater than 88% with all combinations of T and WP.

D. The medium of choice is grade #2 vermiculite.

RECOMMENDATION: Analysis of our data and comparisons with other data sets (see Horn and Visser, Int'l Zoo Yearbook) strongly suggest that varanid eggs be incubated on vermiculite at a water potential of -150 kPa at a temperature of about 28-29 C. A water potential of -150 kPa is obtained by mixing 1 kg of #2 vermiculite with 1 liter of water.

IV. Home range size and behavoral interactions

A. Average adult (SVL > 400 mm) male home range was > 15 km^2, whereas adult females exhibited a mean home range of 4-6 km^2.

1. Males utilized their entire home range during the breeding season and wet season, and rarely moved during the fasting months.

2. Females utilized their entire home range during the wet season and remained in one locale during the fasting months. During the breeding season females remained in one locale and males located estrus females.

3. Male-male or male-female interactions occurred only during the breeding season. At all other times males avoided contact with other males, and females avoided males. Up to three females could be found at a particular location, including breeding sites, at all times of the year.

4. Juveniles males form dominant/subordinate relationships at between 9-12 weeks of age. Separation of hatchlings is required at this time to avoid conflict and skewed growth.

5. These lizards are more "intelligent" than other lizards. They are capable of memorizing simple mazes. Investigative behavior is stimulated when the dimensionality of the enclosure is frequently modified.

RECOMMENDATION: Males must be housed separately from other males. Males should be with females only during the breeding season. Clutchmates must be separated at an early age. Each animal must have a large enclosure that is modified frequently to stimulate investigative behavior.

V. Hormone analysis

A. Males during the breeding season exhibit a 30,000% increase in testosterone over baseline.

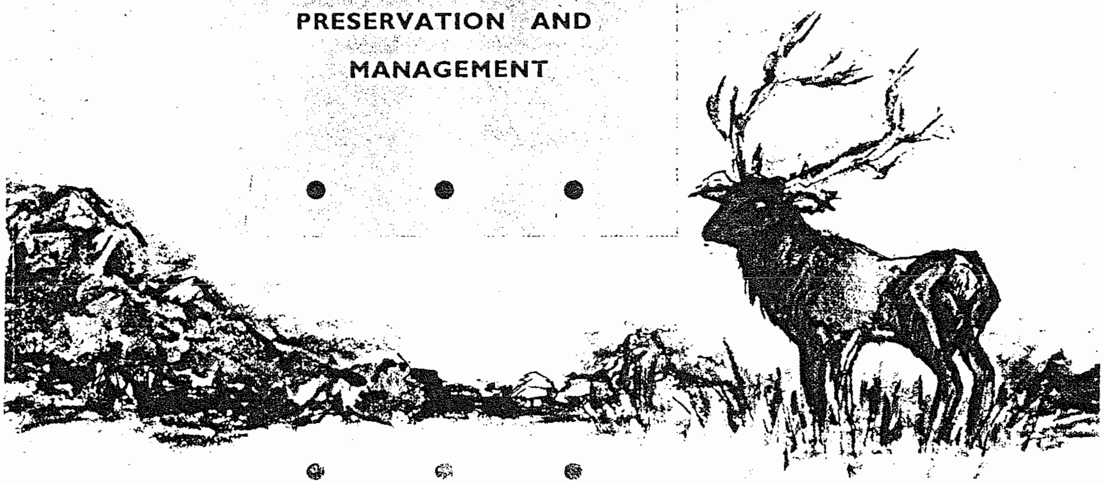
B. Females exhibit a 20,000% increase in estrogen during the breeding season, and also a 25,000% increase in testosterone.

C. The spike in estrogen or testosterone occurs over a three week period, last for two months, and is easily detected.

RECOMMENDATION: Monthly E and T profiles should be determined for each potential breeder in the group. Only 100ul of plasma is required to obtain the hormone profile.

Conservation Biology

THE THEORY AND PRACTICE OF NATURE CONSERVATION PRESERVATION AND MANAGEMENT



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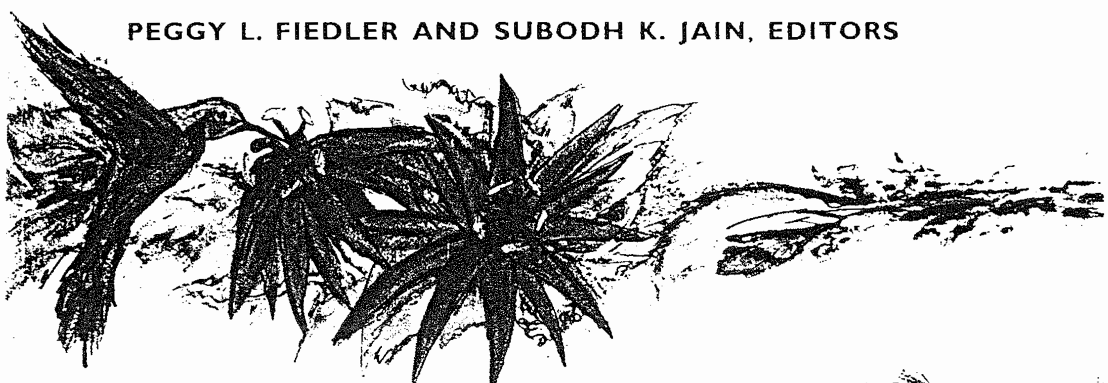

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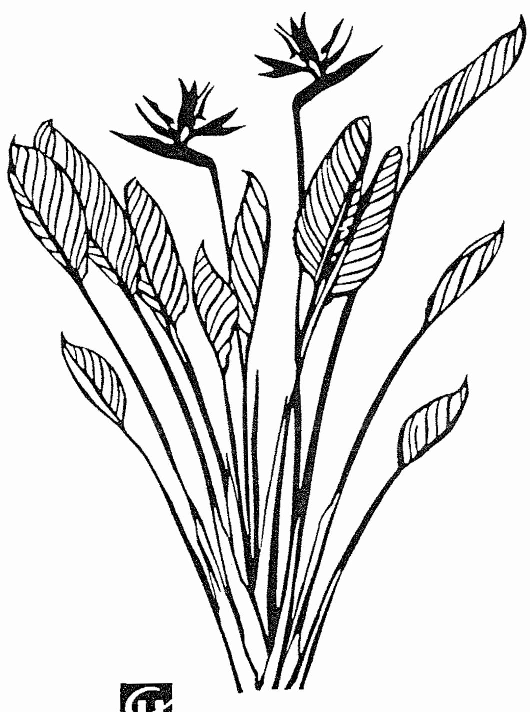

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CHAPTER

5

Reptilian Extinctions: The Last Ten Thousand Years

TED J. CASE

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ABSTRACT

We summarize what is known of reptilian extinctions worldwide over the last 10,000 years. Two patterns are evident: the great majority of these extinctions have occurred on islands, and they are usually due to human-related disturbance. The effects of human-related disturbance are calibrated by measuring the rate of extinction for two sets of Holocene landbridge islands where human impact has been minimal. Extinction rates for islands with a history of human habitation are also determined for comparison. The results of this investigation indicate that human-related disturbance increases extinction rates by roughly an order of magnitude for smaller islands. Interestingly, very large islands and continental areas exhibit lower rates of extinction than predicted from the landbridge island data. More detailed consideration of the cause of species extinction in particular cases strongly implicates introduced predators, chiefly mongoose, rats, cats, and dogs as the agents of many human-related extinctions, whereas competition with introduced reptiles appears to have had little impact on native species.

INTRODUCTION

The fossil record of the earth shows that faunal and floral extinctions increased dramatically during certain periods. These "paleo" upheavals like those at the end of the Permian and Cretaceous have long provided the punctuations that geologists and paleontologists use to divide the geological periods. A challenging question in conservation science is whether the processes affecting extinction rates today are helpful in interpreting extinction in the past, and conversely, whether prehistoric extinctions are useful for understanding recent extinctions.

One overriding pattern affecting historical extinctions that may not be true for prehistoric extinctions is that they are concentrated on islands. Diamond (1984) has recently summarized the modern extinctions of birds and mammals from compilations in IUCN Redbooks. For birds, 171 species and subspecies have gone extinct since about 1600, and over 90 percent of these extinctions have occurred on islands. For mammals, out of 115 documented historical extinctions, 36 percent of these have occurred on islands. The smaller proportion of island extinctions for mammals is in part simply a reflection of their poor representation on islands relative to birds. Many islands (e.g., New Zealand, Hawaii, Fiji, the Mascarenes, and the Seychelles) with large numbers of bird species and many avian extinctions simply have no native mammals except for bats.

Unfortunately, the IUCN Redbook is not yet complete for reptiles (Honegger 1975). Here we attempt to tally many of the historical and Holocene (Recent) prehistorical extinctions and compare the emerging pattern with that for birds and mammals. We find that, as with birds, the proportion of island extinctions compared to continental extinctions is very high. This pattern is in part an unsurprising consequence of island populations. They are small and isolated; thus they cannot recover from local extirpation following environmental perturbations or long-term climatic changes by immigration from other areas (MacArthur and Wilson 1967; Leigh 1981).

A growing body of evidence for birds and mammals suggests that over the last few thousand years, the most important agent of directed change in the environment is not climatic change but human disturbance and alteration of habitats (see Diamond (1984) for recent review). Most extinctions of entire species in recorded history are attributable to some aspect of human intervention. For example, paleontological investigations in the West Indies and Pacific link the extinction of numerous species of vertebrates with human colonization of these islands in recent prehistory (Steadman et al. 1984; Olson and James 1982; Steadman and Olson 1985). For birds and mammals, the major mechanisms are habitat destruction; human hunting; effects of introduced taxa, particularly predators, and trophic cascades (i.e., secondary extinctions caused by previous extinctions; Diamond and Case 1986). Here we look for the generality of these findings by evaluating the evidence for the human impact on Holocene reptilian extinctions.

ISLAND REPTILES AND THE PREHISTORICAL LEGACY

Evidence for extinctions of reptiles in historical time is more fragmentary than for other taxa. For example, while we have a specimen of the dodo from Mauritius residing in a museum, the contemporaneous giant skinks also from Mauritius are known only from subfossils. Careful taxonomy and biogeographic documentation of reptiles lagged somewhat behind that for birds and mammals; consequently, early extinctions of reptiles may have gone without detection. Because reptiles are not as generally conspicuous or noisy as birds, they often pass unnoticed even when they are relatively plentiful. Thus, we must rely more on subfossil evidence for extinctions rather than accurate taxonomic descriptions of extant species. It is not often easy to pin an exact date on a species' extinction, and therefore we are forced to rely on an accumulation of evidence rather than a single survey. For these reasons, choosing the year 1600 as a starting point for historical extinctions, as was done with birds and mammals, is rather arbitrary, and we will review all extinctions dating over the Holocene (or Recent), about the last 10,000 years. In what follows we use the term *prehistoric* to refer to extinctions that occurred prior to the arrival of Europeans to the locality, and so the exact dates delimiting this period vary from place to place.

In the rest of this chapter we will focus more closely on the big questions raised in this introduction. What are the geographic patterns in reptilian extinctions? Are extinctions less common on continents and on large islands than on small islands, as predicted by theory and demonstrated for bird extinctions? We will also explicitly examine the effect of the presence of man on island extinction rates and shed some light on the mechanisms by which humans impact reptile populations. Specifically, we will consider the effect of human-introduced predators and competitors. How much of a role do they play relative to habitat destruction, and is the evolutionary "predator naïveté" of island species important?

A WORLD TOUR OF HOLOCENE REPTILIAN EXTINCTIONS

Continents

The most striking observation about Holocene reptilian extinctions in continental North America is that few occurred. Although the mammalian megafauna was severely depleted, only three reptilian extinctions are known out of perhaps 130 fossil species known for the continental United States since the Pleistocene: a large tortoise (*Geochelone wilsonii*), a horned lizard (*Phrynosoma josecitensis*), and a largish rattlesnake (*Crotalus potterensis*) (Moodie and Van Devender 1979; Gehlbach 1965; Estes 1983). As climates changed and plant communities shifted, reptiles underwent local extirpations, range contractions, or range expansions. These sometimes led to drastic changes in species associations of reptiles (Van Devender 1977, 1987; Van Devender and Mead 1978), but surprisingly only these three extinctions.

The situation is similar for mainland Australia. The largest varanid lizard in the world, *Megalania*, which dwarfed the extant Komodo dragons, went extinct in the Pleistocene, probably sometime after the entry of the Aborigines in Australia 30,000 to 50,000 years ago; exactly how recently is uncertain, but a date of 10,000 B.P. would not be unreasonable (Hecht 1975). The largest boids in Holocene times, the Australian *Wonambi*, became extinct sometime during the same period as did the Australian meiolanid horned tortoises (Molnar 1984a, 1984b). These three extinctions are the only late Pleistocene fossil forms that cannot be assigned unambiguously to living reptile species (Molnar 1984b).

Unfortunately, it is nearly impossible to even begin to make Holocene tallies for South America, Africa, and Eurasia. The extant fauna is not completely known, let alone those species that have failed to survive.

Islands

Islands can be grouped into three categories with respect to human settlement histories and thus to the possible influence of man on extinction.

1. Islands first colonized in prehistory by aboriginal people and then later colonized by Europeans. Many birds and mammals became extinct on these islands during the aboriginal period and are known only as subfossils (Martin and Klein 1984). This pattern also holds for reptiles.

In New Zealand, thirty-eight species of native reptiles are now known from the Holocene period. Three species of lizards are extinct—a species of *Cylodina* larger than any extant form and known only from subfossil deposits in Northland, and *Leiolopisma gracilocorpus* and *Hoplodactylus delcourti* known only from unique museum specimens (Bauer and Russell 1986; Worthy 1987a; Hardy 1977). *Hoplodactylus delcourti* is the largest known gecko, with a snout-vent length of 370 mm. Nine reptiles today are found only on the off-lying islands (five skinks, three geckos, and the tuatara). These include all the relatively large extant species (Hardy and Whitaker 1979). Evidence for a mainland distribution for the tuatara as recently as 1,000 years ago, and for some of the other species as well (Cassels 1984; Crook 1973), suggests that the present distributions are relictual. Only one species, *Leiolopisma fallai* of the Three Kings Islands (which are not landbridge islands but are much older), is regarded as a nonrelictual island endemic (Robb 1986). Since the other islands were connected to New Zealand at the end of the Pleistocene, these unique offshore species probably indicate mainland extinctions. In the case of *Cyclodina macgregori*, *C. alani*, and *Hoplodactulus duvaucelii*, subfossils indeed establish them as formerly occurring on the North Island as recently as 1000 A.D. (Worthy 1987).

The time of disappearance of the tuatara and most of the lizards coincides well with the date for human arrival on New Zealand and the subsequent introduction of the Polynesian rat. On islands where the rat is present, the tuatara is either absent or not breeding (Crook 1973). The three largest of six species of frog (*Leiopelma*) have gone extinct in New Zealand in the Holocene (Worthy 1987b), and the largest surviving frogs (*L. hamiltoni*) occur only on two rat-free islands.

Shifting to the Caribbean region, the pattern is similar. The large herbivorous iguanine *Cyclura* has gone extinct on a number of Caribbean islands in the recent past (Pregill 1981, 1986). The giant *Cyclura pinguis*, which probably became extinct on Puerto Rico in Holocene times, survives on the off-lying small island of Anegada. Two species of iguanids in the genus *Leiocephalus* (the curly-tailed lizards), *L. eremitus* and *L. herminieri*, became extinct in the last 100 years (Pregill 1992). Both occupied small islands in the Caribbean; *L. eremitus* is known only from the type specimen, a female 63 mm snout-vent (SV), which is moderate to large for the genus. *Leiocephalus herminieri* was very large (up to 140 mm SV). Six other relatively large species for the genus (reaching 200 mm SV) are known only from fossil material and probably became extinct during aboriginal occupation on Hispaniola, Jamaica, Puerto Rico, and the Barbuda bank, but other smaller species survive in the Bahamas, on Hispaniola, and Cuba (Pregill 1990).

The extinction of larger endemic forms occurs in other reptile groups in the Caribbean. The giant gecko (*Aristelliger titan*) disappeared from Jamaica sometime before European settlement (Hecht 1951). More recently, the very large legless lizard *Celestus* (*Diploglossus*) *occiduus* vanished from Jamaica. The last specimens were collected around fifty years ago. Greg Pregill (pers. com.) found ample fossil material dating no more than 800 years B.P. when presumably it was much more common. The giant anole, *Anolis roosevelti*, is known only from a few specimens from tiny Culebra Island off the east coast of Puerto Rico and has not been seen since 1932 (Pregill 1981). Finally in the Caribbean, we have Holocene fossils of giant tortoises (*Geochelone*) from the Bahamas, Mono Island, and Curaçao.

The Canary Islands in the East Atlantic are home to the largest lacertid lizards in the world and in the recent past were occupied by even larger species. In 1974, the large *Gallotia* (*Lacerta*) *simonyi*, long thought to be extinct, was rediscovered on Hierro (Böhme and Bings 1975). Hierro is the smallest major island of the Canaries and the most distant from the African mainland. Before the Spanish arrived in the fourteenth century, all the islands were occupied by an aboriginal people, the Guanches, whose ancestors probably arrived around 2,000 to 4,000 years ago (Schwidetzky 1976; Mercer 1980).

In Figure 5.1, we compare the extant lacertids to the fauna that probably existed before the arrival of humans. We restrict our attention to the five relatively mesic western islands where fossil forms have been collected. Four of these islands originally were inhabited by two or three *Gallotia* species in the late Pleistocene and Holocene. There was a small species (*G. galloti*) sympatric with a larger species (*G. simonyi* or *G. stehlini*), and/or a still larger *G. goliath* (Mertens 1942; Bravo 1953; Arnold 1973; Marrero Rodriguez and Garcia Cruz 1978; Hutterer 1985; López-Jurado 1985). The exception is Gran Canaria where no small *G. galloti* exists and none is evident in existing fossil deposits. At least on Tenerife, an even larger species, *G. maxima*, existed from probably the Pliocene to the early Pleistocene, although it is still unclear whether *G. maxima* evolved into *G. goliath* or went extinct. In any event, this very large form seems to have disappeared before the islands were colonized by humans (Bravo 1953).

The other large *Gallotia* species became extinct at the end of the Pleistocene or even more recently and many, if not all, of these extinctions were contemporaneous with human colonization. Fossils of the now extirpated *G. simonyi* on Gomera have been found at one 500 year old, pre-hispanic site (Hutterer 1985). Elsewhere fossil lizards are found in association with abundant human artifacts (Böhme et al. 1981; Bings 1985). There are also a few historical references to the presence of gigantic

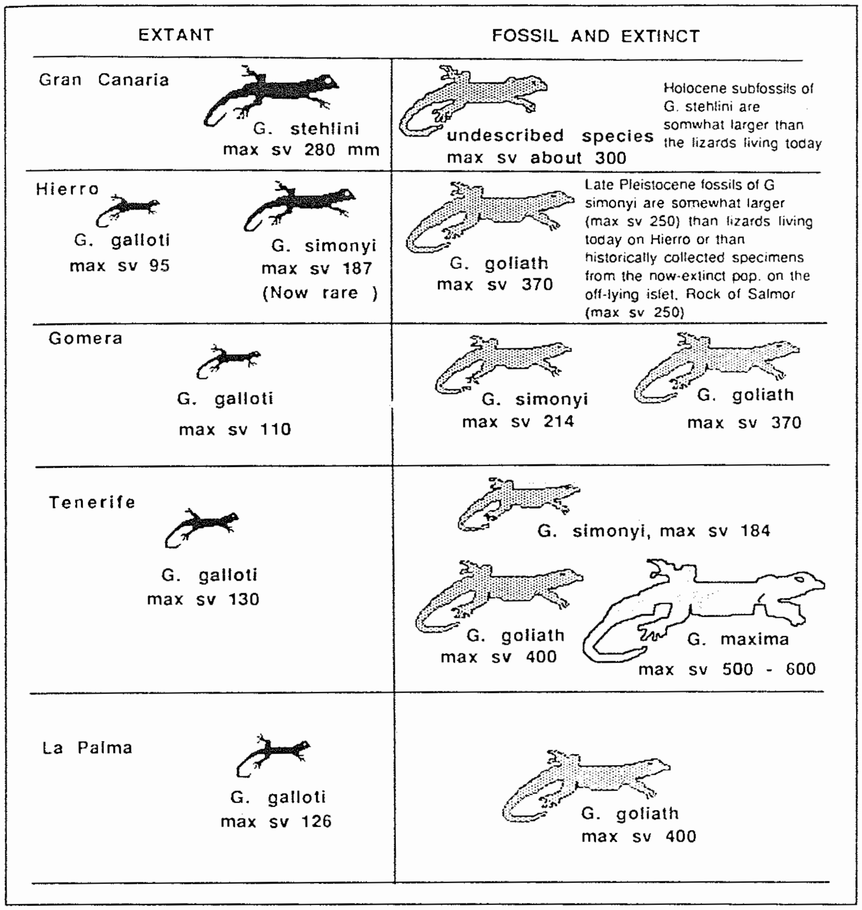

Figure 5.1
Body sizes (maximum snout-vent length, SVL) of extant and extinct lizards of the genus Gallotia *(*Lacerta*) on the Canary Islands. The size data was gathered for extant species during field work by TJC in the Canaries during 1980 and were supplanted by measurements of preserved specimens at the British Museum and records in Machado (1985a) and López-Jurado (1989) for Hierro, and Thorpe (1985) for Lanzarote and Fuerteventura. Extinct species' maximum sizes are based on estimates in Mertens (1942), Bravo (1953), Marrero Rodriguez and Garcia Cruz (1978), Böhme et al. (1981), Hutterer (1985), Izquierdo et al. (1989), and López-Jurado (1985). The length of the lizards is drawn roughly to scale.*

This figure illustrates the preferential extinction of larger forms, probably due to man, and the downward size shifts of surviving large species on Hierro and Gran Canaria. The extinct and extant species were all contemporaneous in the late Pleistocene and Holocene, with the possible exception of G. maxima.

lizards on Hierro, Gomera, and Gran Canaria (see review in Machado 1985b). We know that the early Canary Island aborigines hunted and ate lizards (Hooton 1925; Schwidetsky 1976; Bings 1985), but lizards were not a major portion of their diet. Indirect anthropogenic influences such as the introduction of rats, goats, pigs, and especially dogs by the aborigines may have been more important in the large lizards' eventual demise. Machado (1985b) attributes the exceptional survival of the large *G. stehlini* on Gran Canaria to the absence of any smaller-sized lacertid competitors in the face of introduced predators; he speculates that the tenuous survival of *G simonyi* on Hierro might be due to the apparent absence of Guanche dogs.

Madagascar is the largest nonpolar island in the world and, as with continents, reptilian extinctions are rare. The sole incidents are the giant tortoises (probably two species) that are known only from subfossils and probably became extinct around the same time as the giant elephant birds, after the arrival of humans in about 500 A.D. (Dewar 1984). Some authorities, however, believe the giant tortoises actually went extinct before human contact (Paulian 1984). Three smaller species still survive on Madagascar, and other giant tortoises survived until European settlement in the Seychelles and still survive today on Aldabra (Arnold 1976). The absence of fresh water on Aldabra restricted permanent human settlement, a gratuitous benefit to the tortoises. In the nearby Mascarenes (Mauritius, Reunion, and Rodrigues), at least six species of large tortoises also became extinct shortly after human contact (Cheke 1987; Arnold 1980).

Giant tortoises occurred on Sicily, Malta, and the Balearic islands in the Mediterranean, but their time of extinction is unclear. It may have occurred earlier than the arrival of humans (Reese 1989). The giant lizard *Lacerta siculimelitensis* (220 mm SV) occurred on Malta and Sicily but became extinct sometime toward the end of the Pleistocene (Böhme and Zammit-Maempel 1982). It is not known if it survived to the Holocene or if it was contemporaneous with humans. Recent excavations on nearby Cyprus, however, suggest an earlier date for human influence and a later date for the extinction of that island's megafauna than was previously thought (Reese 1989); here the megafauna and humans are known to have been contemporaneous.

On Tonga in the South Pacific, Pregill and Dye (1988) recently found subfossils of an extinct large iguanine in the genus *Brachylophus* on the island of Lifuka. The length of these lizards is about twice that of the extant *Brachylophus* on nearby Fiji. The fossils are about 2,000 years old. They are directly associated with human artifacts and bear distinctive marks that testify to their use as human food. In New Caledonia, fossils of now-extinct large varanid lizards, giant meiolaniid turtles, and crocodiles occur near or with sediments containing human artifacts (Gaffney, Balouet, and DeBroin 1984; Rich 1982; Gifford and Shutler 1956).

2. Islands with a colonial period but no aboriginal history. Here, unique island species survived to be described as living species, only too often, to meet their demise shortly thereafter. For example, Rodrigues Island in the Indian Ocean experienced a period of intensive European settlement in the late seventeenth century. At that time large numbers of some spectacular endemic geckos were found. *Phelsuma edwardnewtonii* was a large diurnal species, bright green with blue spots. It was described as being so tame that it inhabited houses and would eat fruits from the owners' hands (Leguat 1708). However, the species was devastated by rats and cats on the main island around the mid-nineteenth century. It survived for a short time on small outlying islets but finally disappeared from these too as they became infested with rats. An even larger species, *P. gigas*, reaching nearly a half meter in total length, vanished from the main island prior to the disappearance of *edwardnewtonii*. It too survived on uninhabited off-lying cays only to disappear later when rats were introduced (Vinson and Vinson 1969).

A huge skink, *Leiolopisma mauritiana* (300 mm SV), inhabited nearby Mauritius. This species is known today only as subfossils, and the cause and chronology of its extinction is not known. A likely guess is that they went the way of their contemporary, the dodo, for much the same reasons.

Many of the other endemic reptile species on Mauritius became extinct after conversion of habitat to agriculture and the introduction of rats, cats, and other predators in the seventeenth century. The presence of these "missing species" was only recently confirmed from fossil deposits of quite recent age (Arnold 1980). Some species survived on satellite islands that lie on the same island bank and were connected in times of lowered sea level. Most important in this respect is rat-free Round Island, where four species survive that have gone extinct on Mauritius. This includes the three largest lizards known from Mauritius (*Phelsuma guentheri*, *Leilopisma telfairii*, and *Nactus sepensinsula*) and one snake (*Casarea dussumieri*) in a distinct group of primitive boas, the Bolyerinae. The only other species in the Bolyerinae (*Casarea dussumieri*) also occurs only on Round Island. Yet, since Round was connected to Mauritius less than 12,000 years ago, an extinction is implicated although confirming fossil evidence is so far lacking. The small skink, *Scelotes bojerii*, occurs on Round Island and surrounding islets but was known from Mauritius in the last century and was once thought to be extinct there. It was rediscovered, however, in the Macabé forest (Vinson 1973; Arnold 1980).

The Cape Verde Islands off the west coast of Africa are the home of the second-largest living skink, *Macroscinus coctei* (320 mm SV), the "end product" of a small adaptive radiation of *Mabuya* skinks dating back to the Cretaceous, when these islands were probably formed. The skinks have been described by residents as tame and easy to catch (Greer 1976). Perhaps this is why this giant species is now restricted to two tiny (total area 10 km^2) uninhabited islands in the archipelago, Branco and Razo (Mertens 1956). These islands were severed from the other larger islands on the bank about 10,000 years ago with rising sea levels. Thus, the skink's absence from the larger adjacent islands suggests a recent extirpation. The islands were first colonized in the late fifteenth century by the Portuguese, who left no records of a broader range for this species. Interestingly, the gecko *Tarentola delalandei* is divided into two subspecies on the Cape Verdes. The large form *T. d. gigas* (max 125 mm SV) inhabits the same two islands as *Macroscinus*, whereas the substantially smaller form *T. d. rudis* (max 70 mm SV) occurs on most of the remaining islands in the Cape Verdes (Mertens 1956; Greer 1976).

None of the endemic reptile species of the Galapagos have become extinct, but population densities have declined and local extirpations have occurred in association with introduced cats, rats, dogs, and pigs (Honegger 1975). The land iguana (*Conolophus subcristatus*) is extinct on Baltra and James islands. The cause of extinction on James Island is not known; the species was abundant in Darwin's time but known only as fossils seventy years later in 1905–1906 during the California Academy of Science expedition. Although feral dogs are not now present, they were in the nineteenth century and perhaps drove the local extinction. Land iguanas on Santa Cruz were thought to have been exterminated by feral dogs before 1906, but small populations remained at Conway Bay, Cerro Colorado, and East Tortuga Bay. These populations persisted until they were heavily attacked by feral dogs in the 1970s. Today, only captive individuals remain. Giant tortoises (*Geochelone elephantopus*) have become extinct on Barrington and Floreana and are rare on all the other major islands except Isabela, Duncan, and Santa Cruz (Steadman 1986; Kramer 1984; Thorton 1971).

3. Islands with no permanent human settlement to date. Usually these islands are too small or too bleak and isolated to support human settlement (e.g., tiny islets in the Caribbean and Pacific, Malpelo Island off South America, most of the desert islands in the Sea of Cortez or off arid Australia, and many polar islands). Many of these islands are not well studied for obvious reasons, and the high-latitude islands are too cold to support any reptiles. Moreover, such islands usually support few endemics, so local extirpations do not result in the extinction of a species.

Yet these islands are extremely important for calibrating the magnitude of natural extinctions apart from the effects of human disturbance.

Richman, Case, and Schwaner (1988) used some relatively undisturbed arid landbridge islands to estimate the local extinction rate in the absence of human disturbance. Landbridge islands were formed as a consequence of rising sea levels at the end of the Pleistocene. They are convenient in this regard because one may estimate the rate of extinction for a particular taxon using (a) information on the number of species in the taxon of interest on the island today; (b) an estimate of the number of species on the island at its time of isolation, as determined by counting the average number of species on the mainland today in a similar-sized area; and (c) an estimate of the time elapsed since island isolation. These data are then fit to an a priori model that describes the dynamics or "relaxation" of species loss over time (Diamond 1972).

Richman et al. (1988) estimated the relaxation rate for reptilian faunas of two landbridge island groups, one off Baja California and the other near South Australia. If relaxation rates on landbridge islands are to provide a valid estimate of a natural background rate of extinction, it is essential to evaluate the importance of human-related effects on these islands. The islands of Baja California are arid, extreme environments, and the establishment of human settlements or introduced animals have been severely limited as a result (Bahr 1983). Most of the islands of South Australia are similarly uninhabited, though a few of the largest islands have been settled for some time. However, in these instances initial surveys of the resident faunas began quite early. Thus, species lists for the islands used in this analysis have not been impoverished by anthropogenic extinctions.

Compared to other vertebrate taxa, reptiles present particular advantages for partialling out the contribution of extinction to observed relaxation rates. They are poor overwater dispersers and thus rarely recolonize these islands subsequent to their isolation from the mainland. In addition, they are relatively resistant to extinction compared to warm-blooded vertebrates (Wilcox 1980; Case and Cody 1987), presumably because of their lower metabolic requirements and often higher densities. Thus, the observed disparity between current island censuses and estimates of species number at the time of island isolation may be attributed largely to extinctions occurring in the absence of confounding immigration events.

Conclusions from these relaxation studies are as follows:

1. Even in the absence of much habitat disturbance or climatic change, a substantial number of extinctions may occur, and the rate of extinction declines with increasing area. Figure 5.2 shows a significant

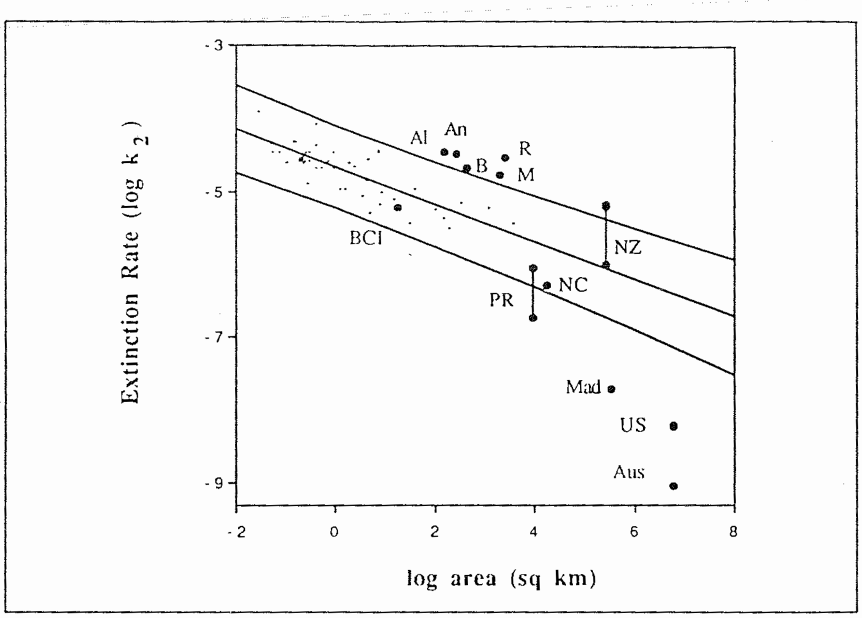

Figure 5.2

The extinction rate for recent reptile faunas (log of the relaxation parameter k^2) is plotted against the log of area for selected areas discussed in the text: Al (Aldabra), An (Antigua), B (Barbuda), M (Mauritius), R (Reunion), PR (Puerto Rico), US (continental United States). The small, unlabeled points represent landbridge islands off Baja California and Australia. The regression line and its 95 percent prediction intervals are calculated for all landbridge islands. Data are from major reference sources in Richman et al. (1988) with additions and changes as follows:

Place	Reference	Spp now	Spp extinct	Time (yr)
New Zealand (NZ) (two main islands)	Robb 1986; Bauer and Russel 1986	30	13 7	10,000 1,000
Madagascar (Mad)	Blanc 1972, 1984	247	2	2,000
New Caledonia (NC)	Gaffney et al. 1984; Sadlier 1986; 1988; A. Bauer, pers. comm.	42	3	300
Mauritius (M)	Cheke 1987	4	9	10,000
Reunion (R)	Cheke 1987	2	3	10,000
Aldabra (Al)	Gardner 1986; Arnold 1976	2	8	10,000
Australia (Aus)	Molnar 1984b	628	3	10,000
Barro Colorado (BCI)	Myers and Rand 1969	66	2	77

The two extinction rates for New Zealand are both based solely on the main two islands (not including their satellites). The first is based on

(continued)

Figure 5.2 *(continued)*
the roughly thousand-year period since the islands were first occupied by Maoris and includes known historical extinctions plus identified and dated subfossil extinctions. The second calculation makes the assumption that the endemic satellite landbridge island species were also present on the two main islands 10,000 years ago when these islands would have been connected to the main islands. In all cases, species whose incidence on an island is probably man-aided are excluded from the species count. This excludes the following species for all these sites: Hemidactylus frenatus, Hemidactylus mercatorius, Lepidodactylus lugubris, Gehyra mutilata, Cryptoblepharus boutonii, *and* Typhlops braminus *(see Case and Bolger 1991 and Darlington 1957). The point for the USA is based on only the contiguous 48 states.*

negative correlation between extinction risk as measured by the extinction rate parameter k_2 and increasing island area. (The rate of species loss is empirically unlike radioactive decay, where there is a constant half-life independent of initial abundance. Instead, species loss is better described by nonlinear models of faunal relaxation. The constant k_2 is the rate parameter from an equation describing faunal relaxation, $dS/dt = -k_2S^2$. Greater extinction rates correspond to higher levels of k_2.) This pattern is a general one. Case and Cody (1987) calculated extinction rates based on Baja island mammals and found the regression line of k_2 with an island area to have the same slope (but higher overall magnitude) as that for reptiles.

In addition, experimental support for declining rates with increasing island area comes from the study of Schoener and Schoener (1983) who introduced *Anolis sagrei* or *Leiocephalus* spp. onto 30 very small islands in the Bahamas having no lizards naturally. Small island populations quickly became extinct while larger island populations still survive today (Schoener, pers. com.).

2. In spite of widely different faunas with little taxonomic overlap even at the family level, the two island groups (Australia and Baja California) display the same pattern and magnitude of extinction rate as a function of island area; the two regressions are not significantly different (test for coincidence of regression lines, $p > 0.5$). Similarly, Figure 5.2 plots the known reptilian extinctions for Barro Colorado Island (BCI). Since its inception about 80 years ago as a reserve in the Panama Canal, BCI has lost two reptile species (Myers and Rand 1969). This translates to about 3 percent of the initial fauna and compares to 23 percent for bird species (Willis 1974). When plotted in Figure 5.2, the point for BCI falls roughly on the regression line for the undisturbed arid islands. Since these islands all have minimal

human impact and little climatic change over the interval measured, we believe that these extinctions primarily represent "background" extinction rates in the absence of significant human intervention.

Worldwide, a few islands have both a reasonable historical record documenting environmental changes and abundant fossil records documenting past extinctions. Here we are not inferring extinctions but actually have the "smoking gun" in subfossil form. Richman et al. (1988) calculated the extinction rates for these islands assuming that the original species number is the present species number (minus all species introduced by humans) plus the number of extinct species (or forms) as determined by subfossil evidence. If anything, this will give a conservative estimate of extinction because undiscovered fossils may include new extinct forms. Of course, there are many islands with no known extinctions simply because geological conditions are not favorable for their deposition or discovery or researchers have not yet looked.

The results are superimposed as points on Figure 5.2. It is apparent that the effects of disturbance are most telling on the smallest islands; the per-species extinction rate for Antigua, Barbuda, Mauritius, and Reunion is approximately ten times that on islands of similar size in Australia or Baja California. It is impossible from these data alone to entangle the causative role of introduced predators, competitors, and the like from simple habitat destruction.

Significantly, the now-familiar trend of decreasing extinction risk with increasing area is preserved even for these disturbed areas where extinction rates are calculated on the basis of known fossils. The observed elevation of the extinction parameter decreases with area, with no elevation in risk for the very large "islands" of Australia, the continental United States, and Madagascar. Indeed, these points lie far below the predicted extinction rate based on relatively undisturbed landbridge islands. The low number of extinct reptiles recorded in the continental U.S. contrasts with the large numbers of Holocene extinctions of reptiles in the nearby West Indies (Etheridge 1964; Pregill 1981). Although data for Madagascar are probably much less complete because of its larger area, fewer fossil digs, and a reptilian fauna that is still incompletely documented, the calculated extinction rate (two species in 2,000 years or about 0.4% of the fauna) yields an extinction rate roughly similar to that of the continental U.S. and substantially lower than that for the next smaller islands of New Zealand and New Caledonia. This low extinction rate for reptiles is all the more surprising given the tremendous amount of habitat destruction on Madagascar; about 80 to 90 percent of the original vegetation has been cleared (Jolly, Oberlé, and Albignac 1984) and along with other human impacts has resulted in an extinction of at least 13 of the 75 native mammal species (approximately 17%; Jolly et al. 1984).

For completeness, it would be nice to compare extinctions on the continents of Africa, Eurasia, and South America with those from North America and Australia, but unfortunately the fossil record for these areas is not well known for the Holocene and late Pleistocene. Based on present knowledge, the record for South America is like that of North America in that practically all fossils known for the past 10,000 years are referable to extant taxa (Baez and Gasparini 1979).

It probably is the case that many undocumented large-island and continental extinctions simply await discovery, but we see no reason that there should be any particular bias against fossil discovery on mainlands compared to islands. Moreover, abundant evidence for mammalian extinctions on continents occurs worldwide over this same time frame and from the same deposits. The greater number of mammalian species is probably at least partly due to overhunting by Pleistocene humans (Martin and Klein 1984). Certainly it is often difficult to distinguish taxa at the level of species from fossil material alone but this problem befalls islands as well as mainlands.

Conventional explanations for island extinctions emphasize the extreme vulnerability of native island species to introduced predators, and this effect cannot be denied (see Predation section). Mainlands and large islands have endemic predators with which the fauna has presumably coevolved. The prey have probably evolved better defenses and the predators' populations are in turn kept in check by higher-order predators and parasites. Perhaps equally important, low extinction rates are expected given large area and thus increased opportunity for immigration after local extirpation.

3. Reptiles have lower rates of extinction than birds or mammals. Case and Cody (1987) showed that on the same islands in the Sea of Cortez, mammals have extinction rates about an order of magnitude higher than those for reptiles. Additionally, Schoener (1983), based on a wide review of the literature, finds that species turnover rates for reptiles generally fall below those of birds and mammals and most arthropod systems. Lizard populations should be expected to be more resistent to extinction because their lower metabolic rate should allow higher densities than either birds or mammals and thus larger population sizes.

   We have made a tally of reptile extinctions over the last 10,000 years, both historic and prehistoric. This count is only an approximation because of the previously mentioned lack of fossils from Asia and South America and also because of the difficulty in deciding whether fossil finds in certain taxa such as turtles and tortoises represent one or several extinct species. This minimum estimate is likely to be revised upward in the future but presently there is evidence for 60 Holocene species extinctions, eight (or 13 percent) of which involve continental species. When we compare this to 115 mammalian (64% continental) and 171 bird extinctions (10% continental) just since 1600 (Diamond 1984), we must conclude (cautiously, given the caveats above) that Recent reptile extinctions are primarily on islands and that reptiles are less extinction-prone than the endothermic vertebrates.

Terrestrial mollusks are one of the few invertebrate taxa for which some compilation of extinctions has been attempted, although not comprehensively. In Hawaii alone, over twenty terrestrial snail species have gone extinct (Hadfield, Miller, and Carwile 1989). This vulnerability is probably caused by the limited geographical range of many of the endemic species and again the introduction of exotic species.

PREDATION

One of the most important factors influencing lizard abundance on islands is the variety and density of predators. On predator-free islands, lizards can achieve extremely high densities. For example, on small rat-free islands off New Zealand densities reach 1,390 lizards per acre, or nearly one lizard every 3 m^2 (Crook 1973; Whitaker 1968, 1973). In other parts of the world, one finds this pattern repeated. Up to 2,074 diurnal lizards per acre have been reported for rat-free Cousin Island in the Seychelles (Brooke and Houston 1983) and 1,214 per acre for San Pedro Martir in the Sea of Cortez, Mexico (Wilcox 1981; Case unpublished data).

That predation can have a large impact on lizard densities is tested by the introduction of lizard predators to some islands and not to others. Although strictly illegal in most places today, this "experiment" was conducted historically many times with rats, cats, dogs, and mongooses. The mongoose is one of the most potent predators on diurnal ground-foraging lizards. Mongooses have been introduced to various islands around the world with the hope of controlling rats and other vertebrate pests. Although their success in this regard has been mixed, their impact on native reptile (as well as bird populations), particularly ground-foraging forms, like skinks, teiids, lacertids, and snakes, has been devastating. In Puerto Rico, reptiles and insects, not rats, form the bulk of the mongoose diet (Pimentel 1955).

One of us (TJC) attempted to quantify the impact of the mongoose on diurnal lizard abundance on islands in the South Pacific by censusing lizards on islands with and without the mongoose (Case and Bolger 1991). Lizards were counted along 2–3 transects of about 1 km meter. There is nearly a 100–fold increase in diurnal lizard abundance on islands without mongooses compared to islands with mongooses (Figure 5.3).

The same qualitative pattern is evident in the West Indies. Nearly fifty years after the introduction of the mongoose to Jamaica, Barbour

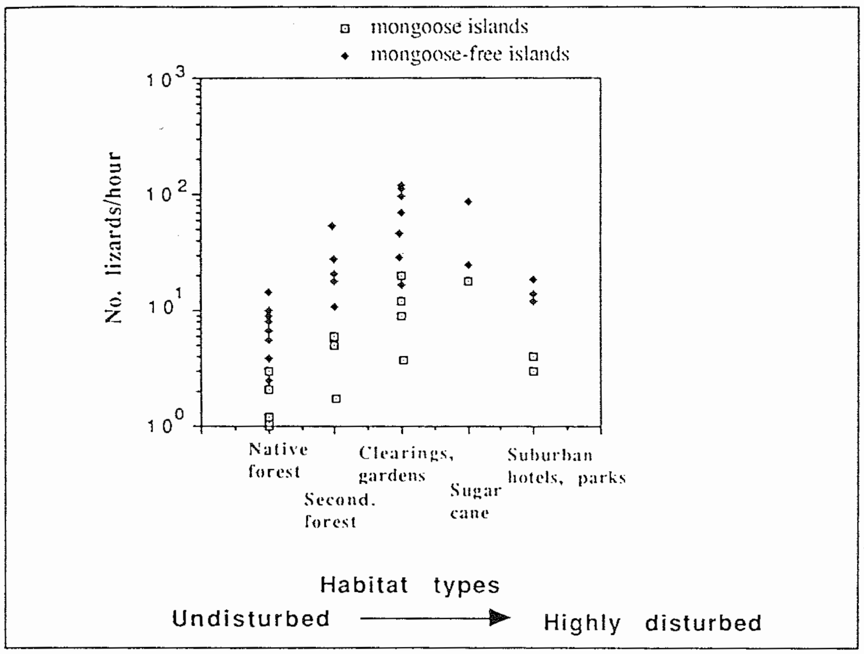

Figure 5.3
Crude lizard censuses (expressed as the average number of diurnal lizards seen per hour; also see Case 1975) in natural and human-modified habitats on mongoose-inhabited and mongoose-free islands in the tropical Pacific. All censuses were conducted during sunny days from 1984 to 1988 by TJC. No attempt was made to capture any of the lizards so that a constant search speed could be maintained. Nearly all lizards seen were skinks and included both native and introduced species. Each point represents the average of two to four censuses. The islands and the number of habitats censused are mongoose-inhabited islands in Hawaii (2), Oahu (2), Molokai (2), and Maui (1); in Fiji, Vite Levu (5), Rabi (2), and Vanua Levu (1). Mongoose-free islands are New Caledonia (3), Kauai (3), Efaté (2), Espiritu Santo (2), Tahiti (3), Moorea (1), Roratonga (1), and Atiu (2); in Fiji, Kadavu (4), Taveuni (3), and Ovalau (1).

(1910, 273) noticed the "almost complete extinction of many species which were once abundant . . . true ground inhabiting forms have, of course, suffered most . . . snakes have perhaps suffered more than lizards." This effect on lizard abundance is also seen today on small cays off Jamaica and elsewhere in the West Indies. Where the mongoose is absent, terrestrial lizards and snakes are much more common (Barbour 1930; Schmidt 1928; Pregill 1986; Mittermaier 1972).

On St. Lucia island in the Lesser Antilles, for example, three reptile species have been extirpated in historical time coincident with the introduction of mongoose: one skink (*Mabuya mabuya*) and two colubrid snakes (*Clelia clelia* and *Liophis ornatus*; Corke 1987). *Liophis ornatus* survives only on the tiny offshore island of Maria Major along with the ground-foraging lizard, *Cnemidophorus vanzoi*, which is curiously absent from St. Lucia itself. It seems unlikely that this lizard was not once present on St. Lucia in that the islands are so close inshore, yet no specimens were ever deposited in museum collections. Similarly, the colubrid snake, *Alsophis antillensis*, once occupied Barbuda and Antigua but today can be found only on mongoose-free offshore cays (Pregill et al. 1988).

The last major experiment with rat control by mongoose introduction took place in Mauritius but not until about 1900, after most of the large endemic species had already become extinct (see earlier). Today, the only surviving ground-dwelling species on Mauritius, the skink *Scelotes bojerii*, is extremely rare and until recently, was thought to be extinct. The other surviving species are relatively common but are arboreal (the endemic *Phelsuma* day geckos) or are widely-distributed non-endemic species (the skink *Cryptoblepharus boutonii* and the house gecko *Hemidactylus frenatus*) of continental origin whose introductions here and elsewhere have been man-aided (Cheke 1984, 1987).

Domestic cats and dogs have also had devastating effects on island species. We have already mentioned the role of dogs in the local extinction of land iguanas in the Galapagos. Dogs have also reduced populations of marine iguanas as well, but to date no extirpations are known. Because they are more arboreal than dogs or mongooses, cats and tree rats (*Rattus rattus*) affect prey species that the mongooses and dogs are less likely to capture. Gibbons and Watkins (1982) suggest that cats may have been even more damaging than mongooses to highly arboreal Fijian lizards and in particular to the now rare endemic Fijian iguanas. Today, substantial populations can be found only on small islands lacking both mongooses and cats. The combination of cats and mongooses on the two largest islands of Fiji, Viti Levu and Vanua Levu, has resulted in the local extinction of the ground-foraging skinks *Emoia nigra* and *E. trossula*. These are the two largest skinks in Fiji, and they have not been seen in over 100 years (Gibbons pers. com.; Zug 1992), although they survive quite well on mongoose-free islands in the archipelago (e.g., Ovalau, Rotuma, and Taveuni). Interestingly, nearly all these islands have rats (*Rattus rattus* and *R. exulans*). The ground-nesting banded rails (*Rallus phillippensis*) and ground doves are also absent from the mongoose-inhabited islands and are presumed to be extinct (Gibbons 1984).

The large herbivorous iguanine *Cyclura carinata*, was nearly extirpated on Pine Cay in the Caicos islands (West Indies) during the three years following construction of a hotel and tourist facility (Iverson 1978). Predation by cats and dogs introduced during the hotel construction resulted in the decline from about 5,500 adults to only around five. Iverson also presents evidence suggesting that population declines of *Cyclura* elsewhere in the Turks and Caicos Banks stem directly from cat and dog predation.

Thomson (1922) noted that New Zealand lizards became much less common after the mid-nineteenth century, and he attributed this decline to loss of cover and predation by cats. Today reptile density and species numbers are almost invariably higher on predator-free islands than on mainland New Zealand or islands with introduced mammalian predators (Whitaker 1982). Off-lying islands with *Rattus exulans*, the Polynesian rat, support small populations of lizards and tuataras than do islands without rats (Crook 1973; Whitaker 1973). The only exceptions occur in predator-proof habitat at some mainland sites, such as deep boulder banks where local lizard densities may exceed one per m^2 (Whitaker 1982; Towns 1972).

If introduced predators reduce reptile densities low enough, extinction follows, particularly on smaller islands. The role of predators in causing many of the extinctions documented here is circumstantial but voluminous. The tuatara is the last remaining representative of a widespread Mesozoic order of reptiles known as the Ryncocephalia. Today it is found on uninhabited landbridge islands off New Zealand, but subfossils, less than a thousand years old, are found on both of the main islands (Cassels 1984). In all, ten species of lizards (about 1/3 of the New Zealand lizard fauna), in addition to the tuatara, are restricted to small off-lying islands formerly connected to the main islands (Robb 1986; Newman 1982; Cassels 1984). Predation by introduced animals, predominantly rats, is thought to be responsible for this pattern of extinctions. Whitaker (1973) found that small islands off New Zealand with the introduced Polynesian rat have fewer lizard species (all natives) for their size than islands without rats. McCallum (1986) documents the changes to the herpetofauna following the colonization of Lizard Island by the Polynesian rat in 1977. Two lizard species appeared to go locally extinct, and overall lizard densities dropped by at least one order of magnitude. Norway rats colonized Whenuakura Island in 1983–84, and by 1985 the previously thriving tuatara population had disappeared as had nearly all the lizards (Newman 1986).

This pattern of endemic lizards being restricted or at least much more common on smaller rat-free islands off-lying larger rat-infested islands is repeated in the Mascarenes (Vinson and Vinson 1969), the Seychelles (Gardner 1986), the Canary Islands (Klemmer 1976), the Cape Verdes (Greer 1976), Norfolk (Cogger, Sadlier, and Cameron 1983) and Lord Howe Islands (Cogger 1971). On most of these islands, rats arrived so early historically that we do not have adequate pre-rat reptile records or census data. In the case of Lord Howe Island, however, the numerical decline of the only two native lizards, *Phyllodactylus guentheri* and *Leiolopisma lichenigerum*, on the main island seems to have occurred after the arrival of rats in 1918 (Cogger 1971).

In the Seychelles, all the populations of the largest extant skink, *Mabuya wrightii,* are on rat-free islands that usually also have nesting seabirds (Cheke 1984; Gardner 1986). When Lanz visited Marianne in 1877 both seabird colonies and *M. wrightii* were present and rats were not found (Cheke 1984). Subsequently rats were introduced and today neither *M. wrightii* nor breeding seabirds are present.

Mammals are not the only taxa implicated in causing reptile extinctions or extirpations. The introduced brown tree snake, *Boiga irregularis,* which has become infamous for decimating populations of endemic birds on Guam (Savidge 1987), has also severely impacted the lizard fauna there (Engbring and Fritts 1988). Juvenile snakes prey predominantly on lizards and are suspected of being a major factor in the possible extirpation of three species of skinks and two geckos (T.H. Fritts, pers. com.). They have also apparently reduced the numbers of forest populations of some other geckos (*Gehyra oceanica*, *G. mutilata*, and *Lepidodactylus lugubris*), species that are usually abundant in these habitats in the absence of the tree snake (pers. obs.). This snake originates from New Guinea, the Solomons, northern Australia, and Indonesia, where it is not particularly common (e.g., McCoy 1980 describes it as uncommon in the Solomons) and where it coexists with a rich landbird and reptilian fauna. The havoc that it is causing on Guam could stem from its high densities due to release from its own predators or prey naïveté or both.

Most human-introduced predators are brought to islands shortly after they are colonized, either by aborigines or Europeans. Pregill (1986) has correlated the settlement time of islands with the extinction times of a number of insular reptiles. The overall picture is quite convincing; the arrival of humans to an island is closely associated with increased reptile extinction rates, especially of large endemic species. The inference is that habitat destruction and predation by humans and/or their entourage of introduced animals is responsible for these extinctions.

Another feature of these extinctions and extirpations is that they seem to occur most often within the endemic component of the fauna and on islands with high levels of endemism. The fossil species going extinct on the islands in Figure 5.2 are typically forms that are endemic at the species or genus level on the island or archipelago. This trend is explored further in a subset of islands in Table 5.1 that have both endemic and nonendemic species as well as good fossil evidence for extinction. For each island the proportion of species becoming locally extinct on the island is broken down into three categories: (1) species endemic to the island (or its immediate satellites); (2) species that are nonendemic; and, (3) species that are endemic to the island group (e.g., a species endemic to Aldabra and the Comoros would be counted in category 3 but not category 1 or 2). Endemic species have significantly higher extinction rates than nonendemics ($p < 0.034$; Mann-Whitney U test).

Table 5.1

Terrestrial Reptile Extinctions on Selected Islands for Endemic and Nonendemic Species over Roughly the Last 10,000 Years

The table's entries give the number of species in each category becoming locally extinct on the island divided by the number of species in that category that were initially present on the island. Human-introduced species are excluded. Species are grouped into three categories: endemic to the island or its satellites, endemic to the region, or nonendemic to the island or region. Species that are "endemic to the island" occur only on the island in question. Species that are "endemic to the island or region" include species confined to the island plus species endemic to the island and nearby islands or archipelagoes. The total number of species in each category on the island appears in parentheses. For example, Aldabra had a total of five species that were not endemic to the island or nearby islands. Forty percent, or two, of these species have become extinct. Overall, extinction rates are significantly higher in the endemic species component of the fauna compared to the nonendemic.

	Extinction Probabilities		
Island	**Nonendemic**	**Endemic**	**Endemic to Island or Region**
Aldabra	0.40 (5)	1.00 (4)	0.83 (6)
Tenerife, Canary Is.	0.00 (1)	1.00 (1)*	0.33 (6)*
Mauritius	0.00 (4)	0.89 (9)	0.75 (12)
Reunion	0.00 (3)	1.00 (1)	0.50 (4)
Rodriques	— (0)	1.00 (4)	1.00 (4)
Puerto Rico	0.00 (4)	0.13 (30)	0.13 (30)
Means	0.08	0.84	0.59

*This includes *Gallotia maxima*, so far only known from Tenerife, although it is not clear whether it survived into the Holocene. We follow the taxonomy of Machado, López-Jurado, and Martin 1985.

Endemic species have been isolated on islands lacking mammalian predators for long periods and have presumably become relatively defenseless to introduced predators. Few attempts have been made, however, to quantify this supposition, although Shallenberger (1970) measured the flushing distance of insular and mainland iguanid lizards and found that a human can get up to ten times closer to the insular varieties.

A similar predator naïveté, this time in birds, is apparent when one compares the effects of introduced predators on islands that previously had no similar predators to those that did. On Hawaii, Midway, Lord Howe, New Zealand, and others, introduced rats have led to the extinction of many native bird species. Yet on others, like Fiji, Tonga, Samoa, Marquesas, Rennell, the Solomons, Aldabra, Christmas (Indian Ocean), and the Galapagos, the introduction of rats was not accompanied by a wave of avian extinctions. Atkinson (1985) points out that the extinction-resistant islands all have native rats or land crabs. Atkinson argues that land crabs fill an ecological niche very similar to that of the rat. Birds on predator-free islands are easy prey for the rats, whereas on the other islands the birds have presumably acquired a more effective predator-avoidance behavior.

Rats are similarly implicated in reptile extinctions or extirpations on many of the same islands as for birds (except, of course, those where no native reptiles occur). Rats have had the greatest effect (in terms of lizard densities and numbers of extinctions) in the Mascarenes, Seychelles, Lord Howe, Norfolk, and New Zealand but interestingly seem to have had little effect in most of the Central Pacific, for example, Fiji, New Caledonia, Tonga, Samoa, the Solomons, the Galapagos, and Australia.

Why should the reptile fauna in these different places exhibit such varying susceptibilities to rat introductions? This question needs further study. Invading rats freed from their continental predators and parasites can reach high densities on islands and often invade forest habitats; whereas in more continental faunas they are nearly restricted to man-modified habitats. This factor however does not readily explain the apparent differences between islands lacking rat predators. One likely factor is the high frequency of introduced reptile species on islands where rats have not had a big impact. Introduced reptiles generally come from mainland areas where they have had a long coevolutionary history with predators. In Fiji, for example, 46 percent (11/24) of its reptile fauna is introduced, and rats have had little apparent effect. Contrast this with New Zealand, with no introduced reptiles, and a reptile fauna severely impacted by rat introduction. Introduced mongoose has played a large role in the Central Pacific in affecting overall lizard densities but it has not greatly affected the number of *introduced* reptile species on islands. After partialling out differences between islands in their area and maximum elevation, islands in the mid-Pacific with mongooses do not have significantly fewer species of introduced reptiles than do mongoose-free islands (Case and Bolger 1991). (A similar analysis cannot be done for the native species because about half the islands have none at all.)

In the Seychelles and the Comoros, rat-free islands have approximately equal numbers of introduced lizard species as do rat-infested islands, although densities may be very different (Cheke 1984; Evans and Evans 1980; Brooke and Houston 1983). Because nearly all introduced species come originally from predator-rich continental areas, they may be less susceptible to introduced predators than the sympatric endemic predator-naive species.

Another contributing factor to the apparent vulnerability of island endemics could be the lack of recolonization sources. When a population of nonendemics or regional endemics becomes locally extinct on an island, the island can potentially be recolonized from individuals still surviving on other nearby islands. For a single-island endemic, however, extirpation and extinction are synonymous.

COMPETITION FROM AND AMONG INTRODUCED SPECIES

Unlike birds, lizards have not been able to colonize on their own the remotest islands of the world, such as those in the mid-Pacific (e.g., Hawaii and the Marquesas). For the most part, reptiles reached these islands when the Polynesians and Melanesians inadvertently began spreading a set of geckos and skinks throughout much of the Pacific about 4,000 years ago. Additions to this set of aboriginal introductions have occurred more recently during European settlement. The reptilian faunas of somewhat less-isolated islands (e.g., Guam, Fiji, Vanuatu) today are a mixture of native and introduced species. These introductions, although unconscious, poorly documented, and not as well controlled as a manipulative experiment, can be used to sort out competitive relationships among species because of the huge sample sizes involved (i.e., literally hundreds of island and mainland locations).

Case and Bolger (1991) reviewed this literature for reptiles and found no documented case in which a native reptile species was reduced to extinction by the introduction of a reptilian competitor. We are aware of only one example where an introduced species seemed to numerically supplant a native species. South Florida has only two native anoles (*A. carolinensis* and *A. distichus*). In recent years it has been a beachhead for at least six introduced anoles from the more anole-rich Greater Antilles. Most of these introductions are still highly localized in urban areas, but

Anolis sagrei is successfully displacing the native *A. carolinensis* as the most common anole in urban areas, penetrating agricultural and even native habitats (Wilson and Porras 1983; Salzburg 1984).

Case and Bolger (1991) also found evidence that (1) native species-rich faunas seem to resist invasion by exotics, and (2) the densities of resident introduced species may decline after the introduction of new competing species, but the mechanisms behind both these effects are not well understood.

A striking example apparent competitive displacement occurs among introduced species in Hawaii. Until about 1940 one of the most common skink was *Emoia cyanura*, a Polynesian introduction, that is still the most common skink in Fiji, Samoa, the Marquesas, and nearly everywhere else in the eastern Pacific where it occurs (Oliver and Shaw 1953; McKeown 1978; Jones 1979). It is also common in subfossil deposits on Hawaii from the Polynesian period (G.K. Pregill pers. com.). This pattern changed when *Lampropholis delicata* was accidentally introduced to Hawaii from southeast Australia (McKeown 1978; Case pers. obs.). Today *E. cyanura* is rare, whereas *Lampropholis* is the most frequently seen ground-dwelling skink on the islands. Since *L. delicata* was not introduced elsewhere in the Pacific, we have no replicates, but on the many "control" islands in the Pacific *E. cyanura* is still very common. Moreover, in lizard-rich southeast Australia and Tazmania where *L. delicata* originated, it is neither particularly common nor widespread (Case pers. obs.; Cogger 1983).

Another example of apparent competitive exclusion has also occurred in Hawaii. After World War II, a new gecko appeared in Hawaii: the common house gecko, *Hemidactylus frenatus*, native to Asia and the Indo-Pacific. It subsequently increased in numbers in urban/suburban habitats, while three other Polynesian-introduced geckos, the fox or Polynesian gecko (*Hemidactylus garnotii*), the mourning gecko (*Lepidodactylus lugubris*), and the stump-toed gecko (*Gehyra mutilata*), formerly occupying this niche, became scarce in these habitats (Oliver and Shaw 1953). Today, the most common association on lighted building walls is the house gecko, alone or sometimes in association with the smaller and typically less abundant mourning gecko (Table 5.2). The pattern is complicated by two additional factors. The house gecko has spread beyond Oahu to other Hawaiian islands but this spread has been recent and the situation is not at equilibrium. Secondly, based on our studies in progress in Hawaii and Fiji, it is apparent that climatic factors also impinge on the competitive interaction between house geckos and mourning geckos. The competitive displacement goes slower in the more mesic habitats on the windward sides of islands. Today one can still find good numbers of mourning geckos on building walls in Hilo (on Hawaii) for example,

Table 5.2
Gecko introductions and faunal affects in the guild of gecko species occupying human structures. (a), (b)

Archipelago	Island	Historical house geckos	Recent invaders (a)	House geckos today (b)
Fiji	w. Viti Levu	(GO) (LL) (c)	HF in 1960 (d)	HF:LL 30:1 (n=90)
	e. Viti Levu	GO, LL (c)	HF in 1982 (e)	HF:LL:GO 30:20:1 (n=several hundred)
	Other islands	GO, LL (c)	none	LL:GO 7:3 (n=several hundred)
Western Samoa	Upolu	GO, LL, (GM) (f)	HF to Upolu in 1960's (g)	Upolu—HF dominant. Other islands—LL and GO (g)
	Savai'i	GO, GM, LL (f)	None (except local invasion of HF at Saleloga Wharf)	LL:GO:GM 10:10:1 (n=41)
American Samoa		GO, LL (f)	HF to Tuitilla in mid-1960's (h)	Tuitilla—HF dominant. Other islands—LL, GO, GM (h)
Vanuatu	Espiritu Santo	GO, LL (i)	HF post 1971	HF:LL 17:3 (n=99)
	Efaté (Port Vila)	GO, LL (i)	HF post 1971	HF:LL:GO 85:15:1 (n=99)
	north. Efaté	GO, LL	none	LL:GO 2:1 (n=32)
	Emao	GO, LL	none	LL:GO 1:1 (n=33)
Hawaii	Oahu	GM, LL, (HG) (j)	HF 1951 (k)	HF:LL:GM:HG 30:1:0:0 (n=31)
	e. Hawaii	GM, LL, HG (j)	HF post 1965 (l)	HF:LL:GM:HG 10:1:0:0 (n=37)
	w. Hawaii	GM, LL, HG (j)	HF post 1965 (l)	HF:LL:GM:HG 2:1:0:0 (n=72)

(continued)

Table 5.2 *(continued)*

Archipelago	Island	Historical house geckos	Recent invaders (a)	House geckos today (b)
Society Islands	Tahiti, Papeete port area	GO, GM, HG, LL (m)	mid 1980's	HF:LL:GO 30:1:2 (n=36)
	Tahiti, elsewhere	GO, GM, HG, LL (m)		LL:GO:GM 27:12:1 (n=40)
	Moorea	GO, GM, HG, LL (m)		LL:GO:GM 12:9:1 (n=22)
Mainland Mexico (San Blas and Mazatlan)		GM (n)	HF post 1963 (n)	HF dominant (n)

(a) In most cases the exact date of the invasion is unknown, the date given is the date of the last survey that did not find the invader.
(b) Except where noted these are personal observations by the authors. GO = *Gehyra mutilata;* GO = *Gehyra oceanica;* LL = *Lepidodactylus lugubris;* HF = *Hemidactylus frenatus;* HG = *Hemidactylus garnotii*
References: (c) Pernetta and Watling 1978; (d) Watling pers. com.; (e) Gibbons pers. com.; (f) Burt and Burt 1932; (g) Zug pers. comm.; (h) Amerson et al. 1982; (i) Medway and Marshall 1975; (j) Stejneger 1899; (k) Hunsaker and Breese 1967; (l) Jones 1979; (m) I. Ineich pers. com.; (n) N. Scott pers. com.

although they are typically far outnumbered by house geckos. This same leeward/windward difference is also evident on islands in Fiji.

Frogner (1967) found that the house gecko could displace the mourning gecko from favored shelter sites in laboratory experiments and that it would eat juvenile *Lepidodactylus*. The reverse is not true, however, in that hatchling house geckos are larger than the largest prey taken by *Lepidodactylus* in the field. Laboratory experiments have shown that *H. frenatus* is behaviorally dominant to both the smaller *L. lugubris* and the equivalently sized *H. garnotii* (Bolger and Case in press).

Elsewhere in the Pacific where the house gecko has yet to invade, for example, most of the Societies, Tuamotus, and Marquesas, most of the Cooks, and most of Fiji, *G. mutilata* or *G. oceanica* with *Lepidodactylus lugubris*, and/or *Hemidactylus garnotii* have remained dominant in the "human building" niche (Table 5.2). This appears to be changing, however, on the main Fijian island, Viti Levu. Although unrecorded until recently, the house gecko has been in the Nadi area on the west for at least twenty years (Pernetta and Watling 1979; D. Watling pers. com.) and now is the only gecko common in towns along the west. It appeared in the major port city of Suva on the southeast windward side in about

1983 and already has become the most frequent gecko on walls at the University of the Pacific in Suva with the concomitant decline of the previous resident geckos on the same walls (Bolger 1991; J. Gibbons pers. com.; D. Watling pers. com.). Today the area around Suva is a mosaic, with *H. frenatus* already dominant in some areas but absent in others, and instead the other geckos are found in high numbers. In areas where *H. frenatus* is present but not common, its numbers have been increasing over the last two years (Bolger 1991). Transplantation experiments are under way to determine whether these enclaves have simply not yet been reached by *H. frenatus* and to uncover the mechanism behind the competitive interaction.

The house gecko fauna also changed rapidly in Vanuatu (New Hebrides). In 1971, the Royal Society did not find a single *H. frenatus* in Vanuatu (Medway and Marshall 1975). Today it is virtually the only urban gecko seen in the major city of Port Vila on Efate (although it is still restricted to the Port Vila area on Efate) and is by far the most common gecko in the town of Santo on Espiritu Santo (Table 5.2). Despite much recent work on the geckos of the Society Islands, Ineich (1987) and Ineich and Blanc (1988) did not find any *Hemidactylus frenatus*. In 1989 we recorded the presence of this species on Tahiti for the first time; it presently is restricted to the wharf area of Papeete where it is already the most common gecko on buildings. A second census of Papeete was performed in 1991; *H. frenatus* had now spread about 10 km beyond where we found it localized in 1989 (Bolger and Case, pers. obs.).

Bermuda has no native lizards other than a single endemic skink. Wingate (1965) documents the introduction of *Anolis grahami* from Jamaica in 1905. After about 35 years the lizard had spread throughout the main island. Sometime around the early 1940s a second anole (*Anolis leachi*) was introduced from the Barbuda Bank in the Lesser Antilles; the exact circumstances are unknown. The rate of spread of this second species was considerably slower than that of *A. grahami* and today the range of *A. leachi* is encompassed within that of *A. grahami*. *Anolis leachii* is much larger and is behaviorally and numerically dominant, consequently the two species are allotopic on a fine scale. Finally, a third anole, *A. roquet*, from Barbados, was introduced sometime prior to 1945. *Anolis roquet* has not spread yet into the range of *A. leachii* but is sympatric with *A. grahami*, which it resembles in body size and habits. In spite of this ecological similarity, Wingate (1965) found no obvious displacement as for the previous size-dissimilar species pair, suggesting that competition among these anoles might have more to do with overt interference interactions between size-dissimilar lizards than competition for limited food resources.

CONCLUSIONS AND SUMMARY

A worldwide survey of Holocene (Recent) reptile extinctions yielded several conclusions: (1) Humans are implicated either directly or indirectly in many extinctions, extirpations, and population declines. (2) In the absence of much environmental change, either climatically or due to humans, a background extinction rate still exists, and the magnitude of local extinction decreases with increasing island area. (3) In the presence of humans, this background rate is exaggerated—sometimes by an order of magnitude for small islands, but the effect of island area is, if anything, accentuated because very large islands and mainlands have lower extinction rates than predicted from landbridge island extrapolations. (4) Island extinctions are more common than mainland extinctions. This resilience of continental faunas may in part be an artifact of the difficulties in finding fossils spread throughout larger areas. Yet, native island species seem more vulnerable to introduced predators. Perhaps equally important, low extinction rates are expected given large area and thus increased opportunity for immigration after local extirpation. (5) Species becoming extinct are usually those with relatively large body size and a long history of island isolation resulting in endemic status. (6) Predators, chiefly mongooses, rats, cats, and dogs, are often implicated in the extinction of reptiles. (7) Introduced reptiles do not usually competitively affect native reptiles, although they have sometimes had dramatic impacts on the densities of other introduced species. (8) Reptile extinction rates are often lower than those calculated for mammals and birds.

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