KOMODO MONITOR

Varanus komodoensis

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

4-7 December 1995

Taman Safari Indonesia
Cisuara, Indonesia

REPORT

Ulysses S. Seal, Jansen Manansang, Dwiatmo Siswomartono,
Tony Suhartono, and Jito Sugarjito (Editors)

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14 August 1996

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RINGKASAN KOMODO

Komodo Monitor (Varanus komodoensis) merupakan reptil terbesar di dunia, dapat mencapai panjang 3 meter dan berat 50 Kg. Komodo merupakan satwa endemik di bagian Tenggara Indonesia yaitu kepulauan Sunda kecil.

Pulau Komodo, Rinca dan Gili Motang dan Flores adalah bagian dari Taman Nasional Komodo. Kemungkinan punahnya komodo akibat berbagai macam ancaman seperti kurang atau hilangnya mangsa, kehilangan/kerusakan habitat, persaingan dengan satwa exotic, dan akibat bencana alam.

Upaya pengelolaan dan pelestarian adalah untuk memelihara secara genetik sehingga populasi komodo di alam bebas dapat bertahan. Untuk mencapai keberhasilan upaya tersebut, perlu diketahui faktor-faktor penganggu (bahaya) yang dapat mempengaruhi keberadaan komodo. Evaluasi tentang resiko bahaya merupakan kepedulian yang utama dalam mengelola satwa yang terancam punah tujuannya adalah untuk mengurangi resiko kepunahan pada tingkat yang dapat diterima. Perangkat lunak untuk membantu simulasi dan evaluasi kuantitative terhadap resiko kepunahan disediakan dan merupakan bagian yang dipergunakan dalam workshop PHVA. Tehnik tersebut dapat meningkatkan identifikasi dan tingkat bahaya, serta membantu analisa mengenai alternatif yang terdapat dalam pengelolaan.

Menurut perkiraan, total populasi komodo di TN Komodo kurang dari 3000 ekor, sekitar 1600 ekor diperkirakan terdapat di pulau Komodo (33,937 Ha), 1100 di Rinca (19,825 Ha) dan 70 ekor di Gili Motang (3.328 Ha), sekitar 100 ekor di Wae Wual. Daerah yang dilindungi di luar TN Komodo terdapat di Barat Flores dan Utara Flores.

Di luar daerah yang dilindungi, Komodo dapat ditemukan disekitar bagian pantai Barat arah Selatan sampai teluk Nangalili dan bagian Timur sampai Maumere. Di daerah tersebut di luar batas kawasan konservasi dan sampai saat ini belum ada pengelolaan atau kekuasaan hukum yang resmi untuk memonitor atau melindungi Komodo. Pulau Padar merupakan bagian dari TN Komodo yang ditempati Komodo sampai tahun 1970, setelah itu tidak ada laporan keterangan tentang keberadaan Komodo. Kurangnya mangsa (terutama rusa), diakibatkan karena perburuan yang intensive merupakan penyebab utama punahnya komodo di pulau Padar.

TN. Komodo dikukuhkan pada thaun 1980, dan pengelolaanya pertama kali dilaksanakan pada tahun 1984. Lunas TN Komodo sekitar 173.300 ha yang meliputi 2 pulau di bagian utara TN sedang diajukan. Di pulau Rinca terdapat 2 kampung sedangkan di pulau Komodo terdapat 1 kampung, dimana tingkat pertumbuhan penduduknya lebih dari 5% per tahun (Subiyanto, 1995). Pemindahan pemukiman dari TN Komodo sedang diajukan.

Komodo yang terdapat di pulau Komodo merupakan populasi terbesar di dunia. Hal ini mendasari alasan utama sehingga daerah tersebut dijadikan kawasan konservasi.

3 alasan utama dinyatakannya sebagai Taman Nasional adalah :

1. Melindungi proses ekologi sistem penunjang kehidupan dan pengawetan keanekaragaman hayati, terutama komodo.
2. Mengembangkan kawasan sebagai tempat untuk penelitian dan pendidikan untuk meningkatkan kualitas sumber daya manusia.
3. Memperkuat penggunaan secara lestari Taman Nasional dan sekitar taman seperti ekosistem, penggunaan secara lestari sumber daya alam secara tradisional di TN dan sekitarnya.

Untuk mencapai tujuan tersebut beberapa kegiatan telah dilaksanakan meliputi pengembangan rencana utama, sistem zonasi, sistim penjagaan, pengelolaan habitat dan populasi, sistim monitoring, rumusan penelitian, rumusan tentang wisata, program pemasyarakatan dan koordinasi di semua aktivitas tersebut.

Workshop PHVA Komodo yang dilaksanakan pada tanggal 4 - 7 Desember 1995 diselenggarakan oleh Ditjen PHPA bekerjasama dengan TSI/PKBSI dan Captive Breeding Specialist Group (CBSG) SSC/IUCN diikuti oleh 44 peserta ahli biologi, pengelola dan pembuat kebijakan. Dalam workshop dibahas mengenai penerapan prosedur yang baru dikembangkan untuk menganalisa tentang resiko dan menformulasikan dan mencoba rencana pengelolaan Komodo yang bertujuan untuk menilai kembali data populasi dari alam dan penangkaran sebagai dasar untuk menganalisa resiko kepunahan, menganalisa skenario pengelolaan yang berbeda-beda, mengevaluasi pengaruh pemindahan populasi, menguji strategi yang memungkinkan untuk reintroduksi di Padar dan mengembangkan model simulasi populasi secara acak. Dengan menggunakan model tersebut akan mengurangi resiko kepunahan dan laju hilangnya sumber gentis dari interaksi demographi, genetik dan faktor lingkungan sebagai alat untuk pengelolaan yang sedang dilakukan terhadap sub species. Tujuan lain meliputi penentuan kapasitas dan kebutuhan habitat, peranan dari kegiatan penangkaran, dan prioritas perlunya penelitian.

Workshop hari pertama terdiri dari ringkasan presentasi populasi data di habitat aslinya dan di penangkaran. Setelah presentasi proses PHVA, peserta dibagi 3 kelompok kerja (populasi di alam, populasi di penangkaran, biologi populasi dan modeling). Untuk menilai berbagai informasi secara lengkap, mendengarkan ide-ide dan mengembangkan skenario pengelolaan dan rekomendasi . Model simulais populasi secara acak dikembangkan dan berawal dengan nilai kisaran sebagai kunci variabel untuk meramalkan keberadaan populasi di alam dengan menggunakan modeling perangkat lunak VORTEX, menggunakan data yang dikumpulkan dari berbagai literatur dan dikonsultasikan dengan para peserta workshop, nilai populasi dasar yang disepakati untuk parameter yang diinginkan dikembangkan oleh program VORTEX. Kemudian digunakan sebagai model populasi di tiga pulau, Gili Motang, Rinca dan Komodo.
Flores mempunyai proses ancaman tersendiri yang unik, terutama karena populasi di Flores tidak dilindungi di TN atau kawasan konservasi, sehingga model harus dipisahkan.

Laporan workshop ini meliputi rekomendasi untuk penelitian-penelitian pengelolaan populasi di alam dan populasi di penangkaran, sebagai bagian dari sejarah populasi, pengelolaan di TN Komodo dan biologi populasi dan model simulasi dari populasi.

REKOMENDASI

Populasi di alam dan modelling.
Model ini menunjukan bahwa populasi di pulau Komodo dan pulau Rinca dianggap aman, namun demikian populasi selama beberapa generasi dianggap stabil. Laju yang rendah dari perubahan populasi akan sulit diketahui/di deteksi, dan kemungkinannya timbul. Sensus data populasi yang sistematik dan konsisten akan penting untuk dapat mendeteksi beberapa perubahan. Metodelogi untuk sensus secara akurat akurat harus diperbaharui, dengan menggunakan pengalaman yang ada dalam tehnik sensus kuantitative di lapangan
.

1. Menganalisa metode yang ada saat ini dan penerapan dari penelitian mengenai: a) analisa populasi komodo, (b). analisa populasi dari jenis-jenis mangsa dan (c). analisa scat untuk evaluasi dar mangsa yang disukai.

2. Menyelidiki daya tahan secara spesifik umur di habitat aslinya, khususnya betina dewasa dan anakan menyelidiki laju perkembangbiakan.

3. CBSG sebaliknya menyediakan perangkat keras, perangkat lunak dan kursus untuk penggunaan secara rutin dari model VORTEX terhadap populasi dan aktivitas pengelolaan komodo.

4. Menggunakan populasi di penangkaran untuk menentukan sex ratio pada saat penetasan (mengorbankan satu kelompok untuk menganalisa metode sex ratio) dan umur saat pertama kali dapat bereproduksi.

5. Studi lapangan perlu segera dilaksanakan untuk menilai jumlah penyebaran dan tingkat fragmentasi populasi Komodo di Flores. Ancaman terhadap populasi dan habitatnya juga diharapkan diselidiki.

6. Tingkat migrasi diantara semua pulau (terutama dari dan ke Gili Motang) perlu segera diperkirakan (studi genetik di gunakan dalam penelitian ini).

7. Meningkatkan populasi species-species mangsa komodo, yang bertujuan menganalisa kebutuhannya terhadap jumlah populasi.

8. Jika reintroduksi ke pulau Padar dapat dipertimbangkan, maka translokasi dari populasi di alam dapat mewakili sumber komodo yang efisien dan aman.

9. Repopulasi komodo di P. Padar sangat penting untuk meningkatkan jumlah populasi dan sebagai bagian kisaran sejarah. Namun demikian, evaluasi dari kapasitas populasi mangsa secara detail, analisa habitat, dan kapasitas dari komodo perlu direncanakan untuk kembangkan.

10. Pemeriksaan hama dan species exotic (anjing, tikus, dll) harus dilanjutkan.

TAMAN NASIONAL KOMODO

11. Melaksanakan latihan untuk TNK dalam keahlian pengelolaan, ekologi dan komunikasi dengan turis.

12. Meningkatkan pendidikan kepariwisataan dan fasilitas di TNK.

13. Menunjuk koordinator (contohnya Kepala TN) untuk mengepalai sebagai panitia pengelola, mengevaluasi dan memberikan saran dan ide-ide , serta merekomendasi dalam pengelolaan TN.

14. Koordinasi antar kegiatan PHPA dengan Pemerintah daerah setempat untuk bekerjasama untuk merekomendasi dari PHVA komodo menjadi Rencana Utama (Master Plan), sedang dalam pengembangan untuk TNK dan sekitarnya.

15. Meningkatkan kepedulian terhadap lingkungan, termasuk memasukannya dalam kurikulum di sekolah-sekolah di seluruh Indonesia.

16. Meneruskan dan mengembangkan keberadaan kelompok kerja Komodo .

17. Meningkatkan peranserta masyarakat setempat diluar dan dialam TN dan sekitarnya.

18. Melanjutkan monitoring populasi masyarakat di TN Komodo untuk menjamin kerusakan habitat sekecil-kecilnya. Demografi populasi manusia di TN harus dievaluasi untuk membantu gambaran jangka panjang terhadap pengaruh di TNK.

19. Mengembangkan integrasi rencana pengelolaan berdasarkan rencana pengembangan tata ruang secara regional.

POPULASI DI PENANGKARAN.

20. Mengumpulkan dan menerbitkan Rencana pengelolaan dan petunjuk pemeliharaan, untuk disebarkan di Indonesia dan semua kebun binatang yang mempunyai komodo.

21. Meningkatkan dasar keterwakilan dari populasi yang ada di alam untuk yang menggunakan specimen liar yang telah ditangkarkan.

22. Program pengelolaan penangkaran komodo di Indonesia memerlukan koordinator, Pengelola studbook dan komite pengelolaan penangkaran untuk merancang dan menerapkan rencana utama penangkaran populasi tersebut.

23. Dibutuhkan koordinasi global populasi yang ditangkarkan untuk sepenuhnya menggunakan jenis yang ditangkap di alam dan menyediakan populasi yang tersedia yang ditangkarkan sebagai perlindungan dalam jangka waktu yang lama untuk menghindari bencana di alam.

EXECUTIVE SUMMARY

The Komodo monitor *Varanus komodoensis* is the world's largest extant lizard. It reaches a length of 3 m and a weight of 80 kg. It is endemic to four south eastern Indonesian islands in the Lesser Sunda region: Komodo, Rinca, Gilli Motang, and Flores. Three of these islands (Komodo, Rinca, and Gilli Motang) are part of the Komodo National Park (KNP). This species is vulnerable due to its restricted range and the possibility of extinction from a number of threats such as decline or loss of prey, habitat loss, competition with exotic species, and natural catastrophes. The management and conservation objective is to maintain a genetically viable, self-sustaining, free-living Komodo dragon population. In order to achieve this goal, it is necessary to understand the risk factors that affect survival of the Komodo dragon. Risk evaluation is a major concern in endangered species management and a goal is to reduce the risk of extinction to an acceptable level. A set of software tools to assist simulation and quantitative evaluation of risk of extinction is available and was used as part of Population and Habitat Viability Assessment Workshop. This technique can improve identification and ranking of risks and can assist assessment of management options.

Recent estimates place the total population of the Komodo monitor at less than 3000 individuals within the KNP. About 1600 individuals have been estimated to live on Komodo (33,937 ha), 1100 on Rinca (19,825 ha) and 70 on Gilli Motang (3,328 ha). About 100 individuals have been estimated to live in Wae Woul, a protected area outside of the Park located in W. Flores. In the north part of the island the Komodo monitor is also protected around Riung. Outside the protected area *V. komodoensis* is present mainly along the west coast southward as far as Nangalili bay, and eastward as far as Maumere. No management or official jurisdiction exist in these areas to monitor or protect beyond the park boundary. The island of Padar, which is part of the KNP, harbored the Komodo monitor till 1970. After this date, no evidence of the presence of this species has been reported. A depletion of prey (mainly deer), because of intensive poaching, is considered to be the main cause of the disappearance of the Komodo monitor from Padar s island.

The Komodo National Park (KNP) was established in 1980, and the first management unit was put in place in 1984. The Park has a total area of about 173,300 hectares. An extension of the existing Park boundaries, which will include two further islands to the North of the Park, has been proposed. There are two villages on the island of Rinca and one on Komodo, all of them with a population increase of more than 5% a year (Subijanto, 1995). A restriction on further settlements on Komodo has been proposed. Komodo NP embodies the area which carries the largest population of Komodo dragon in the world. That was the main reason for appointing the area as a conservation area. Three main objectives for the establishment of the park are: 1) protection of ecological processes as a life support system and preservation of its biodiversity, especially the Komodo dragon; 2) development of the area as a place to facilitate research and education for the betterment of the quality of human life; 3) enhancement of sustainable uses of the park and surrounding areas such as ecotourism, sustainable traditional uses of the park resources and surrounding areas. To achieve such objectives several measures are being

implemented including development of a master plan, zoning system, guarding system, habitat and population management, monitoring system, research scheme, tourism scheme, a community program and coordination of all of these activities.

Forty-four biologists, managers, and decision makers attended a Population and Habitat Viability Assessment (PHVA) Workshop in Cisuara, Indonesia at the Safari Garden Hotel on December 4-7, 1995 to apply the recently developed procedures for risk assessment and formulation and testing of management scenarios to the Komodo dragon. The workshop was proposed by the PHPA and was a collaborative effort of the PHPA, TSI/PKBSI, and the Conservation Breeding Specialist Group (CBSG) of the Species Survival Commission/World Conservation Union (SSC/IUCN). The purpose was to review data from the wild and captive populations as a basis for assessing extinction risks, assessing different management scenarios, evaluating the effects of removals from the populations, examining possible strategies for reintroduction to Padang, and developing stochastic population simulation models. These models estimate risk of extinction and rates of genetic loss from the interactions of demographic, genetic, and environmental factors as a tool for ongoing management of the subspecies. Other goals included determination of habitat and capacity requirements, role of captive propagation, and prioritized research needs.

The first day consisted of a series of presentations summarizing data from the wild and captive populations. After a presentation on the PHVA process the participants formed three working groups (wild population, captive population, and population biology and modeling) to review in detail current information, to hear all ideas, and to develop management scenarios and recommendations. Stochastic population simulation models were developed and initialized with ranges of values for the key variables to estimate the viability of the wild population using the VORTEX software modeling package. Using data compiled from the literature and by consultation with workshop participants, a series of agreed baseline population values for the parameters required by the Vortex program were developed. These were then used to model the populations on three islands, Gilli Motang, Rinca and Komodo. Flores has its own unique set of threatening processes, mainly because the population there is not protected in a park or wildlife area, therefore we felt that it should be modeled separately.

This workshop report includes a set of recommendations for research and management of the wild and captive populations as well as sections on the history of the population, management in the Komodo National Park, and the population biology and simulation modeling of the population.

RECOMMENDATIONS

Wild Populations and Modeling

The models indicate that populations on Komodo and Rinca Islands are reasonably secure, however, all scenarios assume that populations have been stable over a number of generations. Slow rates of change in these populations will be difficult to detect, and may be occurring. Consistent and systematic population census data will be crucial for detection of such changes. Methodologies for accurate and sensitive censuses need to be refined, using the best available expertise in quantitative field census techniques.

1. Assess and refine current methodology and implementation of research on: a) population levels of the Komodo monitor, b) population levels of prey species, c) habitat assessment and distribution, d) scat analysis for evaluation of prey preference.

2. Investigate age-specific survivorship in wild populations, in particular of adult females and of yearlings. Investigate age-specific breeding participation rates of adult females in wild populations.

3. The funds offered by North American zoos to support conservation measures for Komodo dragons should be directed to making available the hardware, software and training necessary to allow the routine use and refinement of VORTEX models of the Komodo dragon populations.

4. Use captive populations to determine sex ratio at hatching (sacrificing surplus clutches is likely to be required to verify sexing methods currently under development), and age at first reproduction.

5. Field studies are urgently needed to determine the size, distribution and degree of fragmentation of Komodo Dragon populations on Flores. The extent of any additional threats to these populations and their habitat also requires investigation.

6. Levels of migration between all islands (in particular to & from Gilli Motang) need to be estimated (the results of the current genetic studies are likely to be useful here).

7. Develop population models for prey species of the Komodo Dragon, aiming specifically to assess required population sizes.

8. Should re-introduction to Padar Island be considered, translocation of young animals from wild populations may represent the most efficient and safe source of animals.

9. Repopulation of Padar island with Komodo dragons is important however, more detailed evaluation of prey population capacity, habitat assessment, and Komodo

dragon carrying capacity is needed to develop a plan.

10. Control of pests and exotic species (e.g. feral dogs, rats) should continue.

Komodo National Park

11. Provide training for KNP staff in park management skills, ecology, and tourist communications.

12. Improve tourist education resources and facilities at the KNP.

13. Appoint a coordinator (e.g., the National Park Director) to head a small management committee, to evaluate and advise on the ideas and recommendations received for management of the Park.

14. Coordinate PHPA activities with Local and National Governments to incorporate useful recommendations from the Komodo PHVA into the Master Plan (already being developed) for the KNP and the entire Komodo monitor range.

15. Develop an environmental awareness curriculum to be included in formal education throughout the country.

16. Continue and expand the existing "Komodo Working Group".

17. Increase the local communities participation in land management planning inside and outside the National Park within the Komodo monitor range.

18. Continue monitoring of the local human population within KNP to insure a minimum of damage to the habitat. The demography of the human population within the park needs to be evaluated to assist projections of long term impacts on the KNP.

19. Develop an integrated management plan based on the Regional Spatial Development Plan (RTRWP).

Captive Populations

20. A management plan and husbandry manual should be compiled, published in Indonesian and distributed to all zoos working with Komodo dragons.

21. Improve founder representation of the existing population that fully utilizes all wild-caught specimens in captivity.

22. A captive management program in Indonesia for the Komodo dragon will require a Species Coordinator, a Studbook Keeper and a Captive Management Committee to draft and implement a captive population master plan.

23. There needs to be global coordination of the captive populations (Komodo dragon CBSG Global Animal Survival Plan or GASP) to fully utilize all of the wild caught founders and provide a viable captive population as a long term protection against unexpected catastrophe in the wild.

KOMODO MONITOR

Varanus komodoensis

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

December 4-7, 1995

Taman Safari Indonesia
Cisuara, Indonesia

Invitation, Opening Addresses, Overview

DEPARTEMEN KEHUTANAN
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Nomor : 335 / DJ-VI / Binprog /95 Jakarta, 24 April 1995

Dr. Ron Tilson
CBSG Southeast Asia Programs
Minnesota Zoo
13000 Zoo Blvd
Fax 612 423 7261

Dear Dr. Tilson,

I am writing to invite the CBSG is assist PHPA to coordinate a Population and Habitat Viability Analysis Workshop on Komodo monitors. We would like you to coordinate the workshop with staff from the National Zoo of Washington DC. They plan to visit zoos in Indonesia with Komodo monitors and will develop improved management guide lines.
This ex-situ program should be integrated with in-situ conservation strategies.

Drs. Jansen Manansang at Taman Safari Indonesia will be the coordinator from Indonesia and will also host the workshop at TSI. We would the workshop to be held sometime in November this year.

Please contact Mr. Jansen when you have any question,

Sincerely,

DEPARTEMEN KEHUTANAN
DIREKTUR JENDERAL PERLINDUNGAN HUTAN DAN PELESTARIAN ALAM

Ir. Soemarsono
Director General of PHPA

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.

DEPARTEMEN KEHUTANAN
DIREKTORAT JENDERAL PERLINDUNGAN HUTAN DAN PELESTARIAN ALAM

Alamat : Gedung Pusat Kehutanan Jl. Jend. Gatot Subroto Telp. 583033 - 583037 JAKARTA
Jl. Ir. H. Juanda No. 15 Telp. (0251) 324013 Bogor

SAMBUTAN PENGARAHAN
DIREKTUR JENDERAL PHPA
PADA LOKAKARYA KONSERVASI KOMODO
Cisarua 4-7 Desember 1995

Assalamualaikum Wr Wb
Salam sejahtera dan selamat pagi.

Saudara-saudara para peserta lokakarya, para undangan dan hadirin sekalian yang saya hormati.

Puji syukur patut kita panjatkan kepada Tuhan Yang Maha Esa atas rachmat dan karuniaNya yang dilimpahkan kepada kita semua sehingga pada hari ini kita dapat berkumpul bersama di tempat ini dalam keadaan sehat wal'afiat dalam rangka menghadiri Lokakarya Konservasi Komodo yang diselenggarakan atas kerjasama Departemen Kehutanan, Direktorat Jenderal Perlindungan Hutan dan Pelestarian Alam, IUCN , National Zoo, Minnesota Zoo, The Miami Metro Zoo dan Taman Safari Indonesia yang telah banyak membantu Departemen Kehutanan , Direktorat Jenderal Perlindungan Hutan dan Pelestarian Alam dalam upaya konservasi in-situ maupun eks-situ di Indonesia.

Pada kesempatan ini saya ingin mengemukakan rasa kegembiraan saya, karena saudara-saudara dapat menghadiri Lokakarya ini yang merupakan rangkaian dari kegiatan Konservasi Flora dan Fauna Nasional dalam rangka memperingati "Hari cinta Puspa dan Satwa Nasional (HPCSN) dimana satwa Komodo telah ditetapkan menjadi Satwa Nasional.

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Saya juga bersyukur kepada Tuhan Yang Maha Esa, karena Saudara-saudara dapat menghadiri Lokakarya ini untuk memberikan sumbang saran dalam konservasi Komodo. Tentunya sumbangan saran Saudara ini akan sangat berarti bagi upaya meningkatkan pembangunan berwawasan lingkungan yang berkelanjutan.

Para hadirin yang saya hormati.

Direktorat Jenderal Perlindungan Hutan dan Pelestarian alam mempunyai tugas pokok dibidang perlindungan hutan dan pelestarian alam dan mempunyai fungsi antara lain merumuskan kebijaksanaan teknis, bimbingan dan pembinaan serta pengamanan pelaksanaan di bidang perlindungan hutan dan pelestarian alam.

Arah dan strategi upaya konservasi sumberdaya alam hayati dan ekosistemnya telah dibuat dan diundangkan dalam Undang-Undang No 5 tahun 1990, pelaksanaannya yang merupakan tugas dan kewajiban kita bersama.

Strategi konservasi dan upaya pelestarian dan pemanfaatan yang lestari mempunyai 3 embanan yaitu :

a. Perlindungan sistem penyangga kehidupan
b. Pengawetan keanekaragaman plasma nutfah
c. Pemanfaatan secara lestari

Ketiga embanan tersebut merupakan suatu kesatuan filosofis yang menyatu, dan sebagai upaya dalam pelaksanaannya ditempuh antara lain dengan cara konservasi in-situ dan konservasi ex-situ.

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Para hadirin yang saya hormati.

Dalam penjelasan Undang-undang No 5 tahun 1990 tentang Konservasi Sumber Daya Alam Hayati dan Ekosistemnya telah ditegaskan bahwa satwa liar adalah semua binatang yang hidup di darat dan di air dan atau di udara yang masih mempunyai sifat-sifat liar, baik yang hidup bebas maupun yang dipelihara oleh manusia .
Komodo sebagai 'Heritage Species" yang merupakan salah satu binatang purba yang masih hidup hingga saat ini ,telah mengalami penurunan populasi yang cukup drastis . Jenis satwa liar ini adalah merupakan sumber daya alam hayati yang menempati ekosistem tertentu yang dapat diusahakan kelestarian dan keseimbangan ekosistemnya yang merupakan tanggung jawab dan kewajiban pemerintah serta masyarakat untuk melestarikannya.

Kondisi populasi yang ada saat ini perlu ditingkatkan, karena kondisi populasi ini pulalah yang akan berdampak positif terhadap pemanfaatannya . Upaya penangkaran oleh beberapa Kebun Binatang telah menunjukkan keberhasilan , namun demikian teknologi tepat guna masih perlu dikembangkan.

Para hadirin yang saya hormati

Telah ditegaskan dalam Undang-undang No 5 tahun 1990 tentang Konservasi Sumber Daya alam Hayati dan Ekosistemnya bahwa peran serta masyarakat dalam konservasi sumber daya alam hayati dan ekosistemnya diarahkan dan digerakkan oleh Pemerintah melalui berbagai kegiatan yang berdaya guna dan berhasil guna. Sehingga informasi-informasi terbaru yang ilmiah populer dapat dikembangkan dan dimasyarakatkan, baik oleh Lembaga Swadaya Masyarakat maupun Perguruan - perguruan Tinggi.

Taman Nasional Komodo, SBKSDA NTT, BKSDA VII Kupang serta TAman-Taman MArgasatwa pemelihara/penangkar KOmodo diharapkan dapat menangani secara profesional. Sebagai Lembaga Konservasi in-situ maupun ex-situ diharapkan profesional dalam pengelolaan jenis-jenis satwa, profesional dalam kemampuan upaya penangkaran jenis, profesional dalam mengembangkan pendidikan konservasi dan penyuluhan, profesional dalam mengembangkan sumberdaya manusia.

Upaya pemanfaatan secara lestari sebagai salah satu aspek konservasi sumber daya alam hayati dan ekosistemnya, belum sepenuhnya dikembangkan sesuai dengan kebutuhan, seperti untuk keperluan penangkaran, tukar menukar , bahkan apabila kondisi populasi di alam meningkat dan hasil penangkaran telah menunjukkan hal-hal yang positif ada kemungkinan untuk dimanfaatkan.

Para hadirin yang saya hormati.

Besar harapan saya agar dalam Lokakarya ini Saudara-saudara dapat merumuskan hal-hal yang sangat mendasar untuk dapat mengimplementasikan kegiatan konservasi satwa komodo ini yang telah dilindungi agar dapat bermanfaat bagi kesejahteraan masyarakat dan kehidupan manusia.

Saya berharap bahwa rumusan hasil-hasil Lokakarya ini merupakan petunjuk-petunjuk pelaksanaan yang akan dihasilkan oleh para pakar komodo dapat segera dioperasionalkan di lapangan secara teknis, sederhana dan mudah dilaksanakan.

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Para hadirin yang saya hormati.

Sekali lagi saya sampaikan terima kasih kepada panitia penyelenggara dan Saudara-saudara peserta yang berperan serta dalam lokakarya ini. Semoga sumbangan pemikiran saudara-saudara dapat bermanfaat bagi pengembangan konservasi Komodo, dan satwa liar lain pada umumnya di Indonesia.

Akhirnya dengan mengucapkan Bismillahhirrohmanirohim, dengan ini saya buka Lokakarya Konservasi Komodo.

Kami atas nama Departemen Kehutanan mengucapkan selamat Berlokakarya, semoga Tuhan memberkahi kita sekalian.

Wassalamu'allaikum Wr.Wb

Jakarta, Desember 1995

Direktur Jenderal

Soemarsono

OBYEK WISATA NASIONAL & LEMBAGA KEGIATAN KONSERVASI EX - SITU

Taman Safari Indonesia

Jl Raya Puncak No 601 Cisarua
Bogor, 16750
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Fax. 0251 - 253225

WELCOME ADDRESS

By. Drs. Jansen Manansang

Taman Safari Indonesia 4-7 Desember 1995

I would like to welcome everyone to the Komodo PHVA Workshop, a special welcome to the Director General of PHPA, Mr. Ir. Soemarsono, the Chairman of PKBSI - Mr. D. Ashari, the Chairman of CBSG - DR. Ulysses Seal, our colleagues from Amerika, Europe, Australia, Asia and also all the institutions which participation to this workshop.

The object of a PHVA workshop is to assess the viability to sustain a population species with in a given area. The aims of this workshop are to gather and discuss information which will enable us to :

1. To assess the populations of Komodo Dragons in the wild, and also the probability for their survival without intervention.

2. To assess the possibilities of an increase or decline in numbers due to environmental changes, changes in habitat and conflicting management plans.

3. To conclude a possible role for repopulation or translocation of Komodo Dragons to maintain viable populations within their historical territories.

4. To define field methods to assess populations status and quality of habitat.

5. To assess what role captive breeding can play as an option in repopulation or translocation.

6. Above all else to produce an Indonesian conservation strategy using recommendations obtained from this PHVA workshop and results from recommended studies.

This workshop is possible thanks to the collaboration of PHPA, PKBSI, and CBSG/IUCN.

Hopely this workshop will have a successful, thus insuring the continuance of further workshops for other species.

Thank you.

Jansen Manansang

KOMODO : Kadal Purba Raksasa

Ini mungkin satu-satunya reptil raksasa purba yang masih tersisa hingga saat ini yang hanya hidup di Pulau Komodo dan sekitarnya. Prilaku primitif masih dipunyai, seperti kanibal, memakan telur dan anak-anaknya. Karena semakin terjepit dengan manusia, perlu perlindungan dan pengembangan baik in-situ maupun ex-situ.

Sejak dunia ilmu pengetahuan mengenal Komodo (*Varanus komodoensis*) pada tahun 1912, sifat biologinya satwa ini banyak menarik perhatian dunia, baik dalam maupun luar negeri. Hal ini dikarenakan, sifat bangsa reptil ini, tidak dipunyai pada oleh satwa sejenisnya. Misalnya dari ukuran tubuh yang terbesar dan terpanjang diantara bangsa biawak yang saat ini masih bertahan hidup. Selain itu Komodo satu-satunya satwa purba yang masih dapat bertahan hidup dan beradaptasi pada daerah yang panas dan kering.

Komodo, merupakan salah satu jenis Biawak yang primitif, bila dilihat dari bentuk luar. Banyak para pakar, mengatakan keberhasilan Komodo bertahan hidup hingga saat ini, dikarenakan proses evolusi "kadal Purba" ini agak terlambat, walaupun fosil yang diketemukan menunjukkan bangsa ini mempunyai proses evolusi yang panjang. Ada beberapa pendapat, keberhasilan Komodo dapat bertahan hidup hingga saat ini, dikarenakan proses geology Dataran Sunda adalah baru.

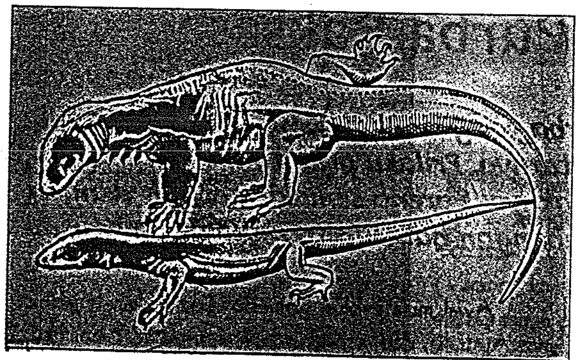
Awal mula evolusi Komodo diperkirakan terjadi di Benua Australia, dan menyebar ke arah utara ke Timor Laut, Sumba, Flores, Sabu, Timor Roti dan Komodo, dan hal tersebut diperkirakan terjadi pada masa Pliocene. Namun ada pendapat lain, bahwa pusat penyebaran Komodo ada di Kepulau Indo-Australian, tak hanya di Australia. Kejadian ini ketika Australia masih bersatu dengan pulau-pulau yang ada dalam Wilayah Indonesia.

HABITAT

Indonesia yang terletak antara 2 zona, yaitu zona oriental yang berpusat di Asia Selatan dan Tenggara serta zona Australia, sehingga daerah ini mempunyai jenis flora dan fauna yang sangat menguntungkan bagi bangsa Varanus.

Bebera bangsa Biawak hidupnya sangat tergantung dari lingkungannya. Sebagai contoh *Varanus salvator*, hidupnya cocok pada daerah yang banyak airnya, jenis ini banyak ditemui di tepian sungai, kolam, rawa dan lubang-lubang pohon. *Varanus timorensis*, lebih menyukai lubang-lubang batu karang, *Varanus gouldii* banyak ditemui pada hutan-hutan semak belukar, sedangkan bagi *Varanus nebulotus* lebih menyukai hutan-hutan tepian sungai. Dan pada umumnya suku Varanus, lebih suka pada daerah yang tak jauh dengan air.

Tidak demikian halnya *Varanus komodoensis*, yang lebih menyukai daerah-daerah kering, dan telah beradaptasi dengan daerah yang panas dengan musim kemarau rata-rata 4 bulan lebih setiap tahunnya. Kurang lebih 80 % dari habitat alamnya berupa padang rumput yang diselingi pohon pohon lontar atau pohon gebang. Tanahnya berbukit, hutan mason yang tumbuh di sekitar lembah.



Perubahan Komodo muda yang baru menetas dan dewasa, tak ada perubahan yang menyolok khususnya bentuk tubuh dan ekor.

PENYEBARAN.

Penyebarannya sangat terbatas dan bersifat endemik, hanya dijumpa di Pulau Komodo dan sekitarnya, seperti di P. Rinca, P. Padar dan Flores Barat yaitu di daerah Pegunungan Mbura.

Keluarga Biawak, mempunyai penyebaran yang sangat luas, dan dapat dikatakan kosmopolitan, ada di mana mana, mulai dari daerah tropis hingga sub-tropis, seperti di Asia, Afrika dan dan Indo-Australia. Di Australia, diketahui ada 17 jenis Varanus, akan tetapi separuhnya dapat dikatakan sudah punah, dan di Afrika ada 2 jenis. Sedangkan di Indonesia sendiri ada beberap jenis, diantaranya adalah :

1. *Varanus heteropolis*, tersebar di Kalimantan.
2. *Varanus dumerilii*, tersebar di Jawa, Sumatera, Bangka, Belitung dan Kalimantan.
3. *Varanus rudicollis*, ada di Irian.
4. *Varanus nebulotus*, hampir sebagian besar pulau-pulau di Indonesia.
5. *Varanus togianus*, di Sulawesi,P. Togian & P. Selayar.
6. *Varanus salvadorii*, terbatas di Irian Jaya.
7. *Varanus salvator*, hampir tersebar di Pulau-pulau di Indonesia.
8. *Varanus timorensis*, di P. Timor, P. Roti, P. Sayu, P. Sepak dan P. Bacan.
9. *Varanus kordensis*, terbatas di P Rinca, P. Komodo dan P. Padar.

POPUPASI

Populasi Komodo yang ada di habitat aslinya, belum tahu pasti berapa jumlah yang sebenarnya. Di Pulau Komodo sendiri, sebarannya juga tidak merata, hanya di daerah Utara, Barat laut dan Timur Laut Gunung Komodo saja yang banyak populasinya.

Di pulau-pulau lain, seperti Pulau Rinca, yang kondisinya mirip dengan P. Komodo, populasinyapun tidak merata. Sedangkan P. Flores yang dihuni oleh Biawak Komodo, adalah Flores Barat, daerah ini kondisinya mirip dengan P. Komodo. Jumlahnya cukup besar bila dibandingkan dengan daerah lain, walaupun tidak sebanyak di P. Komodo. Pulau Padar, bila dibandingkan dengan pulau lain, merupakan pulau yang terkecil, luas hanya 2500 Ha terletak di sebelah timut P. Komodo. Jumlah faunanya sedikit, termasuk Biawak Komodo.

Beberapa expedisi yang memonitor kehidupan Komodo, sulit menentukan berapa jumlah yang ada. Kendalanya adalah kunjungan singkat dan tak tahu persis jumlah Komodo muda yang masih berada pada sarang/liang. Namun Tahun 1981, Auffenberg menganssumsikan bahwa dengan anggapan densitas di pulau-pulau lain tidak lebih dari pada di P. Komodo yang rata-rata 17 individu/Km persegi dan perkiraan minimum 6,4 individu perkilometer persegi. Di Pulau Padan dan Flores diperkirakan ada 5000-an ekor lebih.

Perkiraan para peneliti tentang jumlah populasi Komodo.

Sumber	Komodo	Padar	Rinca	Flores	Jumlah
Van Heurn (1932)					ribuan
Lallemant (1929					1000
Hoogerweif (1954)					1000
Pfeffer (1959)	400-500	100	400-500	500	1500-2000
Piazzini (1960)	1500		1000		2500
Auffenberg (1981)	2348	60	792	2448	5713 *

* + 1500 Komodo muda yang baru menetas.

GAYA HIDUP BIAWAK KOMODO

Komodo, masih satu keluarga dengan jenis-jenis kadal atau biawak yang sering 'keluyuran' di sekitar kita, di semak-semak atau pun dipinggir-pinggir kolam, dengan ukuran yang bervariasi dan mikrohabitatnya yang berbeda-beda.

Berbeda dengan Biawak Komo do, yang lebih senang tinggal di daerang yang kering dan gersang, berbukit dan berumput,seperti halnya di daerah Nusa Tenggara Timur yang mempunyai daerah semacam itu. Kehidupan di daerah yang keras seperti ini, tentulah sifat mahluk hidup yang ada juga keras, dan penuh perjuangan di dalam mempertahankan hidup.

KANIBAL

Mungkinkah sifat ini dimiliki oleh satwa purba atau primitif pada masa silam ?. Mungki ya, mungkin tidak. Tidak semua satwa purba mempunyai sifat kanibal, memangsa jenisnya sendiri atau keluarganya. Namun Komodo di dalam hidupnya sifat kanibalisme masih dimiliki. Induk Jantan masing sering 'melahap' telur-telur yang ada di dalam sarang, dan juga induk betina. Rupanya tak hanya telur yang dimakan, akan tetapi kadang-kadang mereka memakan anak-anak komodo.

Kehidupan mereka saling membunuh dan memakan satu sama lain, merupakan gaya hidup Komodo yang ada di alam aslinya. Sifat tersebut, ada beberapa pendapat, dikarenakan kondisi lingkungan yang membuat demikian. Daerah yang kering, dan sulit untuk mendapatkan makanan atau saling berkompetisi satu sama lain di dalam merebutkan makanan, terutama pada musim kemarau yang panjang, di mana mereka sulit untuk mendapatkan mangsa.

KEGAGALAN HIDUP.

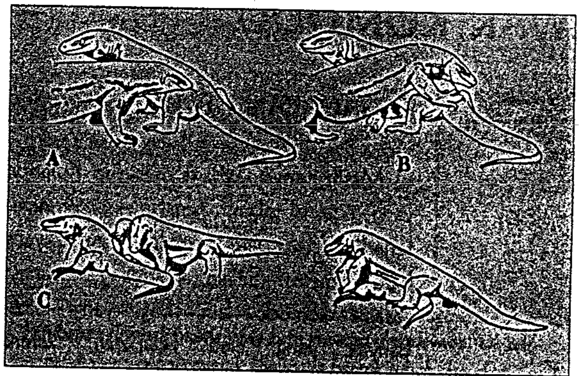
Masih banyak kegagalan hidup Komodo yang ada di alam. Kegalan ini, terutama terjadi pada Komodo-komodo muda yang baru menetas. Selain ada yang dimangsa sesama komodo lain, bagi yang lolos, banyak yang mati kelaparan, karena kegagalan mendapatkan makanan hingga beberapa minggu, semenjak menetas. Atau kematian anak-anak komodo karena faktor lingkungan. Sering terjadi mereka tertimbun, karena runtuhnya liang yang digunakan untuk bersarang induknya.

Walaupun sebagai kanibal, ternyata komodo juga banyak musuhnya di alam. Mulai dari binatang yang kecil, seperti tikus, anjing liar, kucing hutan dan beberapa jenis ular sering memangsa anak komodo atau telurnya, terutama komodo yang panjangnya kurang dari 1 meter. Selain itu, komodo juga tidak tahan terhadap gigitan ular berbisa. Ada beberapa penyakit yang dapat menyerang anak-anak komodo seperti Amoebiasis. Amoeba ini, bersama-sama dengan bakteri lain sering menjadi infeksi yang serius yang menyerang hati dan cloaca.

GAYA HIDUP SEHARI-HARI

Biawak Komodo, merupakan salah satu bangsa reptil yang digolongkan ke dalam bangsa karnivora tingkat tinggi. Dalam mencari makan mereka aktif pada siang hari (**diurnal**), sedangkan pada malam hari, umumnya dihabiskan untuk istirahat pada lubang-lubang yang digalinya.

Saat masih muda, mereka sering memanjat pohon, baik sendiri ataupun bersama saudara-saudaranya. Komodo-komodo muda ini saat di pohon, berburu binatang kecil ataupun telur burung atau anakan burung. Sedangkan setelah menginjak dewasa, karena tubuhnya semakin tambun, tak mampu lagi untuk berkeliaran di pohon. Namun mampu



Perilaku kawin Komodo, umumnya Jantan yang agresip.

berdiri tegak dengan bertumpu pada kedua kaki belakang dan ekornya, dan kadang-kadang dapat meloncat kedua kaki belakangnya dan hanya bertumpu dengan ekor untuk beberapa saat.

Untuk mendapatkan mangsa, mereka berburu satwa satwa yang ada di sekitarnya. Untuk mendapatkannya, Komodo sering menunjukan sifat yang seolah-olah mati, tidak bergerak dan kadang-kadang berkamuflse dengan kondisi lingkungan. Setelah satwanya mendekat dengan kecepatan tinggi menyambar mangsanya. Hewan-hewan yang dimangsa, antara lain Rusa (*Cervus timorensis*), Babi Hutan (*Sus vittatus)* kadang-kadang mamalia yang lebih besar seperti Kerbau liar *(Bos bubalus)* ataupun Kuda Liar *(Equss sp)*. Selain itu Komodo juga senang memakan binatang-binatang laut yang ada di tepi pantai seperti kerang, kepiting, telur penyu, ikan dsb.

ORGAN DETEKTOR

Seperti bangsa bangsa reptil lainnya, di dalam berburu mangsanya, mereka mengandalkan organ tambahan untuk mendeteksi keberadaan mangsa. Organ ini disebut "Orga Jacobson", yang terletak pada rongga antara hidung dan mulut. Organ ini sangat penting artinya, khususnya bangsa reptil yang daya penglihatannya perkembangannya kurang baik.

Demikian halnya Komodo, walaupun pada malam hari, yang kadang-kadang juga melakukan aktifitas, mereka dapat berburu mangsa dengan mengandalkan ketajaman Orga Jacobson bersama-sama dengan indera penciumannya.

Dalam percobaan di lapangan, Komodo dapat menemukan mangsanya yang diumpankan dalam waktu kurang dari setengah jam. Sedangkan pemasangan umpan yang luasnya 50 Ha dengan arah angin yang tak menentu, Komodo memerlukan waktu kurang lebih 24 jam.

PERILAKU KAWIN

Setiap binatang, mempunyai gaya tersendiri saat saat musim kawin tiba. Pada Komodo, umumnya jantan lebih dahulu mendekati betina pada saat-saat musim kawin, dengan mencoba manaikinya. Jantan lebih agresif mendekati betina. Perilaku ini dilakukan berkali-kali, karena umumnya hewan betina berusaha menghindar.

Percumbuan, umumnya dilakukan berhari-hari dan tidak semua diakhiri dengan kopulasi. Apabila betina telah siap, biasanya jantan menempelkan kepalanya ke seluruh bagian tubuh hewan betina. Musim kawin pada komodo, baik di alam habitatnya, maupun dalam penangkaran, terjadi antara bulan Juni - Agustus. Sedangkan bagi hewan betina siap kawin /dewasa secara sexual umurnya berkisar 6-7 tahun, atau panjangnya minimal 160-an Cm.

Setelah lebih kurang 35 hari dari saat perkawinan terlihat betina mulai menggali tanah untuk membuat lubang sebagai tempat bertelur. Jumlah telur yang dikeluarkan berkisar antara 3 - 27 butir. Musim bertelur biasanya hingga 7 hari dan terjadi setiap saat pagi hingga malam hari. Masa inkubasi/penetasan cukup lama dan berlangsung antara 8-8,5 bulan.

Telur Komodo merupakan telur yang terbesar diantara bangsa biawak, bentuknya elips, kulitnya putih agak gelap beratnya berkisar 109-205 gram, panjang antara 90-100 mm dan garis tengah 50-65 mm. Telur tidak dierami, hanya disimpan dan ditimbun dengan pasir/tanah pada lubang yang dibuat. Di kebun-kebun binatang, anak Komodo yang baru menetas mempunyai berat tubuh lebih dari 100 gram dengan panjang tubuh lebih dari 190 mm.

(Eds-disarikan dari berbagai sumber)

KOMODO MONITOR

(*Varanus komodoensis*)

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

December 4-7, 1995

Cisuara, Indonesia

Komodo National Park Management

The Management of Komodo Population in Komodo National Park
J. Subijanto, Chief of Komodo National Park

Background

Komodo NP embodies the area which carries the largest population of Komodo dragon (*Varanus komodoensis*) in the world. That is the main purpose in appointing the area as a conservation area. Three main objectives for the establishment of the park are:

1. protection of ecological processes as live support system and preservation of its biodiversity, especially Komodo dragon;

2. development of the area as a place to facilitate research and education for the betterment of the quality of human life;

3. enhancement of sustainable uses of the park and surrounding areas such as ecotourism, sustainable traditional uses of the park resources and surrounding areas.

To achieve these objectives several measures are being implemented including development of a master plan, zoning system, guarding system, habitat and population management, monitoring system, research scheme, tourism scheme, community program and coordination of these activities.

Many of those activities still have to be refined including the development of a master plan (25 year plan) which is still underway. The Park itself consists of 3 major islands and several surrounding islets and their waters. The area of 173,300 hectares size is managed under a management unit manned by 90 personnel since 1984. The Komodo dragon population is confined to three islands i.e. Komodo, Rinca, and Gilli Motang Islands. There was a population of Komodo in Padar Island, but since early 1970 no evidence is reported. In addition to Komodo dragons, are at least 190 other species of terrestrial animals are reported on the islands. While the Komodo dragon is still the main species of the Park, a concern for the importance and aesthetical values of the Park marine resources is growing. The most recent surveys find that more than 700 species of coral fish and 200 species of corals inhabit the Park's waters. This makes the Park one of the most biologically diverse areas in the world. This paper does not emphasize the wildlife management practices in the park in details. Rather it overviews the overall park management in brief including what has been done in the areas of wildlife habitat and population management, research and problems. My main intention is to derive feedback from the experts and other interested parties for the improvement of the park management.

Komodo population

The park now conducts regular censuses (since 1992) and monitoring of the Komodo dragon population and of other major wildlife species (especially it's prey species and competitors) in order to obtain data on the status of these species. The census and monitoring activities are integrated into various park activities. Komodo censuses which were conducted since 1984 were carried out mainly using the direct bait-count method introduced by W. Auffenberg (1970). The results are the figures for the Komodo population which concentrated at the set permanent bait sites scattered throughout the Park. There are 300 to 350 animals of various size and age group sighted each year at those sites (22 sites). A rough population size deduced from the various surveys estimates about 2000 - 3000 animals in the Park. In cooperation with JICA and Universitas Udayana these days the park management is conducting a total count survey on Komodo population in Rinca. It is expected that a more reliable population figure for Rinca could be presented sometime early next year. It will enable the management to get a better understanding on the population status of the park and to define the necessary habitat and population management measures.

Research

Research activities in the Park have been conducted since the early 1900s on various aspects of the area. At least 20 researches and studies carried out during the last 5 year by various agencies and universities ranged from tourism to genetic variability of the dragon . Though, the Park has made itself a facility for research activities, a scheme on research priorities needs to be developed in order to make the activities supportive to the Park management and goals. An ongoing cooperation between JICA - Universitas Udayana and the Park management is intended to develop such scheme which will be incorporated in the master plan. Another shortcoming of the park management is that although various surveys have been carried out on park resources, many of those data, findings, and their publications are still somewhere outside the Park library. It is the intention of the Park management that someday in the near future a library on Komodo NP resources can be established in the park compounds. We are also in the very early stage of developing a geographic-referenced data management system (GIS). We solicit your assistance and participation to make it happen.

Termination of feeding practices

Since the early 1970s, goat feeding to attract Komodo dragons for visitor purposes had been practiced, especially at the Poreng and Banu Nggulung feeding sites. The steady increase of visitation produced by this practice led to significant behavioral change in some populations of dragon in those areas. They (20 - 25 individuals) showed many signs of becoming adapted to humans, very dependent on feeding rituals and losing their ability to catch their natural prey (deer, wild boar, bird, monkey, buffalo, etc.) and lazy. The feeding which originally designed to gather dragons for visitation switched more and more into a kind of goat killing arena. Beside complaints which were more and more frequently raised by various individuals such practices were also becoming more and more unbearable burdens to the park wardens (such as goat fees, dragon responses to feeding). Starting in early 1994 these feeding practices were gradually discontinued. Artificial feeding was decreased from twice a week to once a week to once per two week and by August 1994 the feeding for visitation exhibition was terminated. Longer interval feedings were still carried out until June 1995. To keep the gathering of dragons at the Banu Nggulung viewing site visible, an artificial watering hole was constructed in the area by pulling pipe from the adjacent spring (2 km) to attract the gathering of wildlife prey such as deer and wild pigs. In such a dry area, the scheme appears to work quite well. Gathering of many deer and pigs around the said water hole is very visible. The dragons tend to mingle around the hole and stalking for the right moment to catch the prey. Reports on deer or pig slaughtering by dragons in the area are very common. Not all of the former dragon inhabitants adapted well to the new procedure and setting. Some of them just went away, some less easily adapted animals became very thin in the early months of the new treatment period, especially the old ones, which needed a longer temporary supplemental feeding before adapting. One animal found dead which was suspected to be caused by a combination of starvation, disease, and age. Now there are about 12 animals which seem well adapted to the new environment and they keep showing up in the area. A new killing field is being established. A more natural wildlife viewing area is now there. The Park management is still closely watching the process.

Repopulation of Padar Island

Before 1970, the report on the encounters of Komodo dragon in Padar Island was common. The drastic decline of the deer population by poaching activities is considered as the main cause of that disappearance. The dragon is recognized to be able to swim and they were suspected to cross the Lintah straits which divide Komodo, Padar and Rinca Islands to a better environment. The poaching activity has become much less in the last 10 years. There are also signs of recovery in the deer population in Padar with more than 200 animals sighted during the 1994 census. A study carried out by LIPI in 1994 recommends a further study of habitat requirements if a repopulation program is to be pursued. The Park management is considering to incorporate the development of repopulation program in the research scheme.

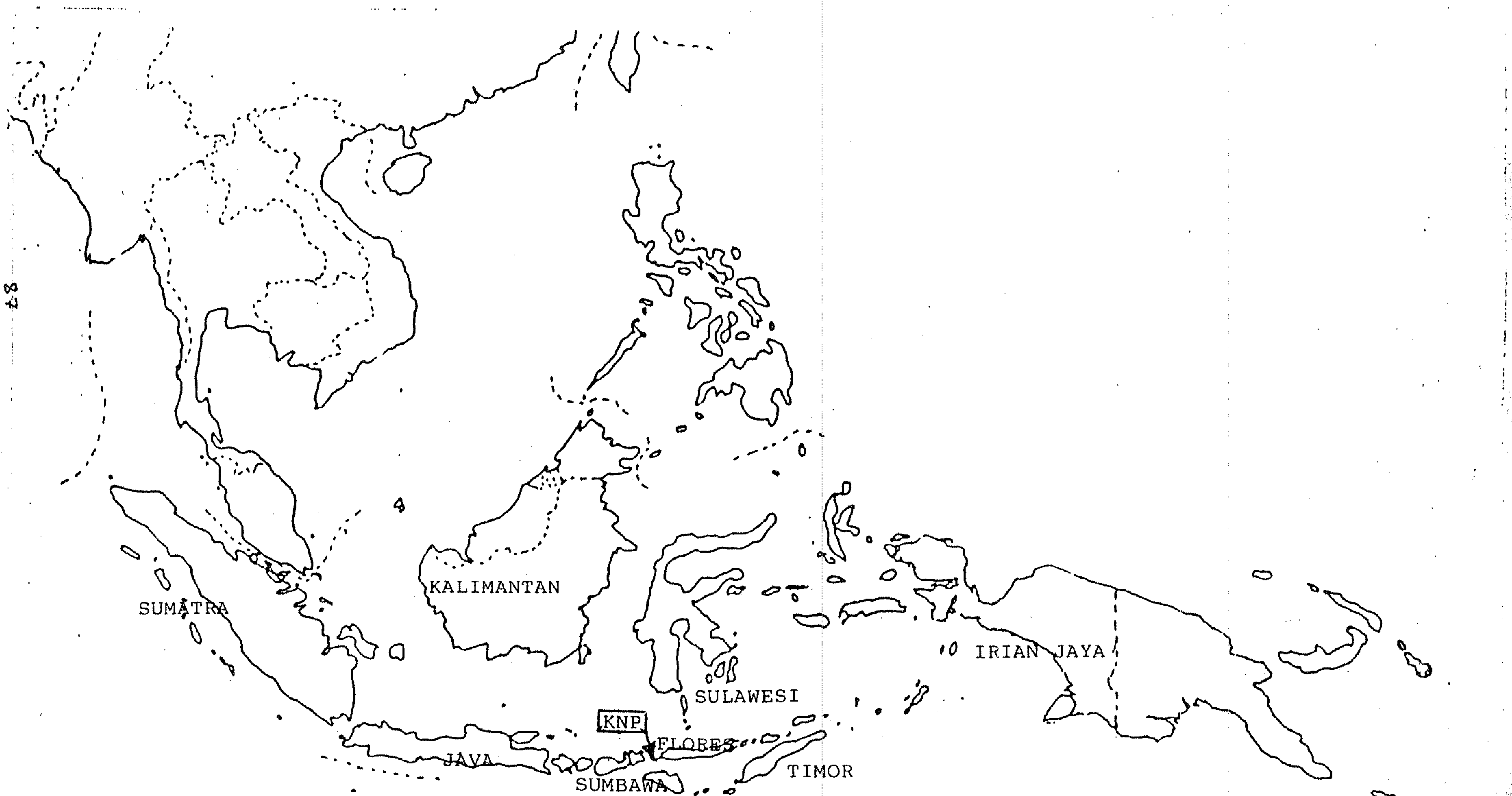
Disturbances

The main problems for terrestrial wildlife management in Komodo NP are poaching, forest fire, and habitat encroachment. As mentioned above, poaching activities on prey species diminished the dragon population in Padar. Though such activities are much less these days, it still occurs with a serious degree of life threatening to Park wardens. There are 10 guard posts scattered in the park area manned by about 54 personnel. But since they are not armed, while the poachers used to carry firearms, the wardens are hardly able to counter them sufficiently. Several shooting accidents have been reported. Cooperation with police is occasionally arranged to sustain special cases, but a capacity to promptly and timely respond in the field is urgently needed. Improvement in skills and supporting facilities is underway and the management expects those law enforcement exercises combined with an awareness program will resolve the poaching problem in the near future.

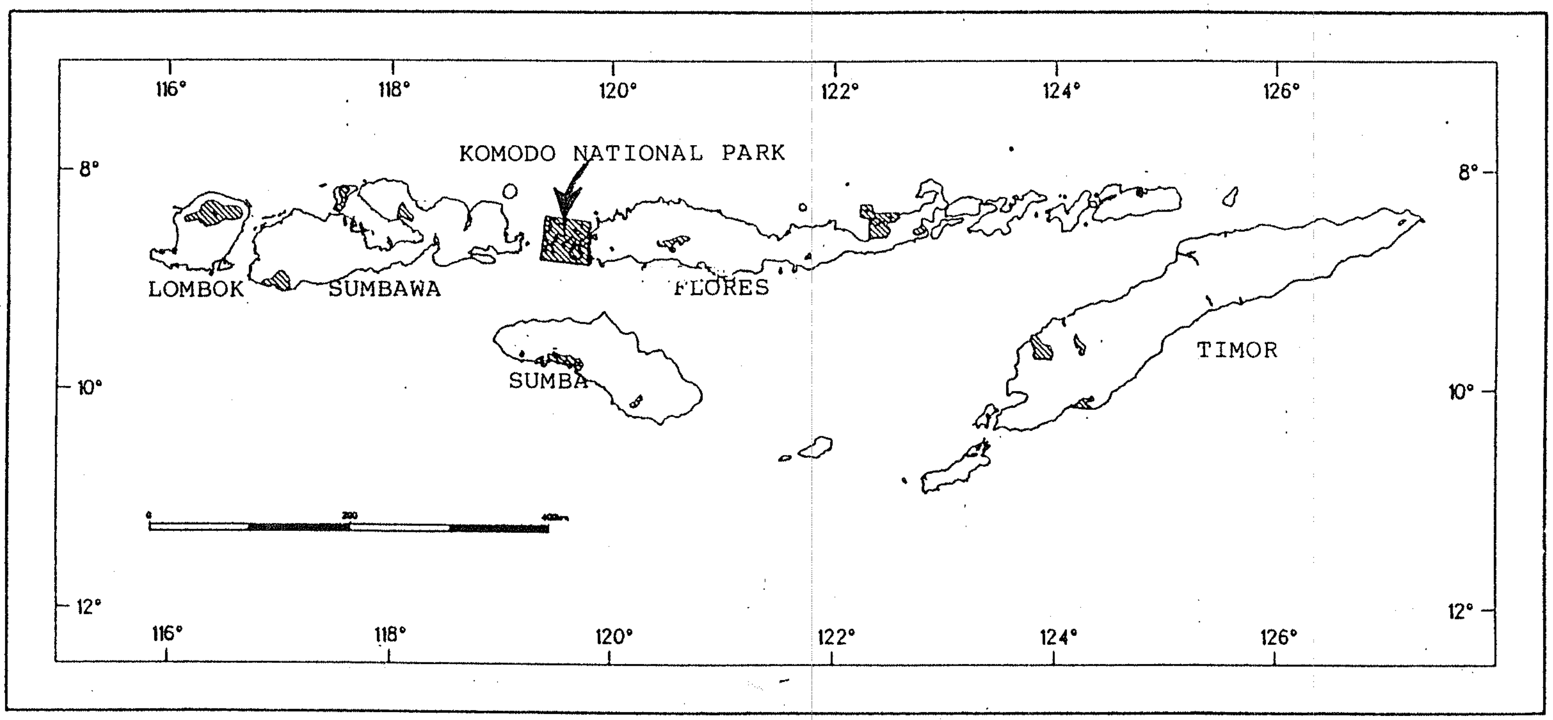
Forest fires in the park are mostly induced by human activities such as neglectful cooking or fish drying activities by fishermen harbored in the park beaches. The savannah types of vegetation are very susceptible to fire during the long dry season. Each year there are 2 to 4 fires which on average consume 200 to 300 hectares. This year, due to early rainfall and prohibition for harboring in the Park beaches, fires have been suppressed to one fire which burned about 4 hectares.

Consortium

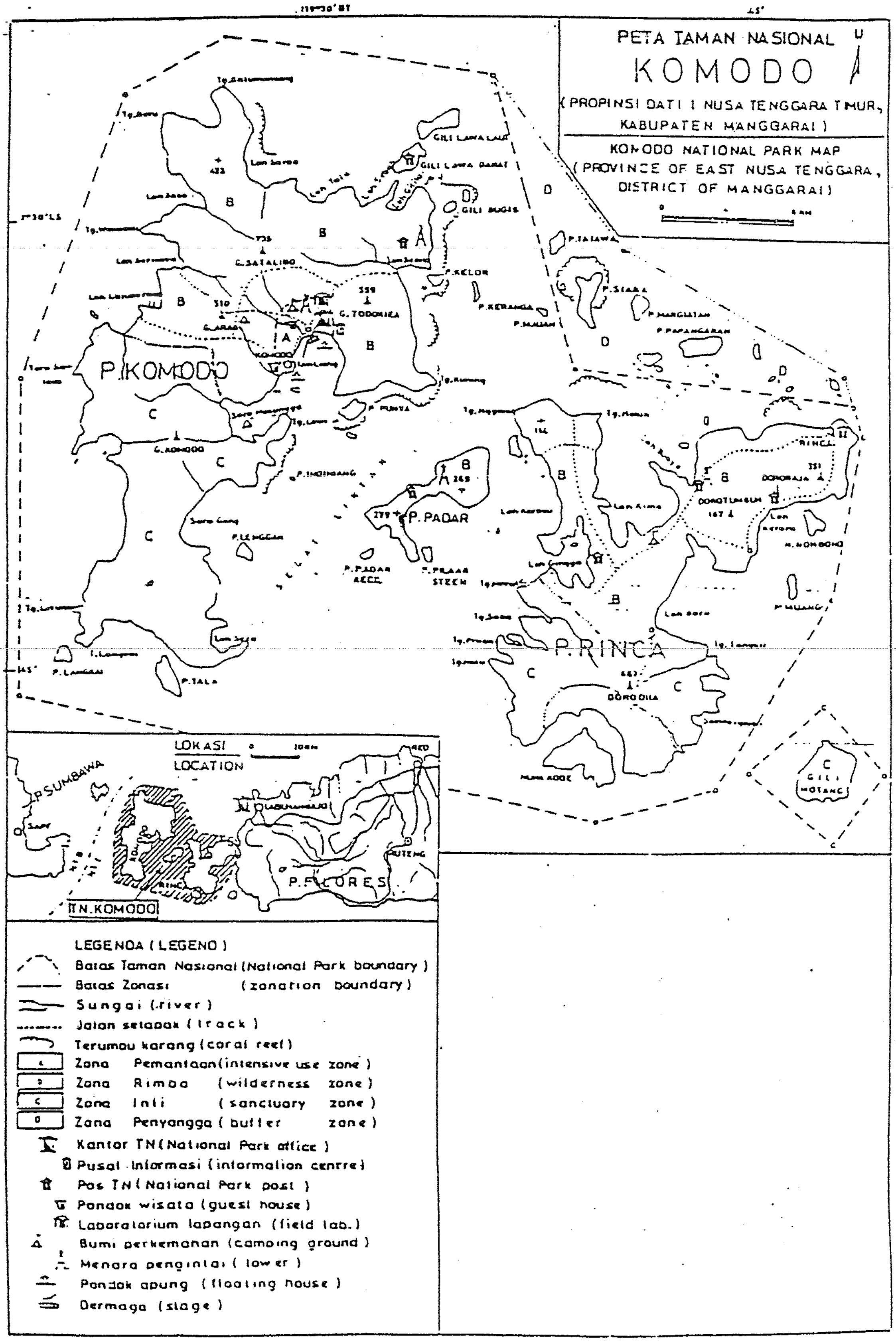
The support of communities in the broad sense to support the management and development of the park is overseen as becoming more and more crucial now and in the future. The Park is regarded as resources for and by the surrounding communities. The Park is also a resource to global communities. Global conservation awareness urges a more active participation of local communities in various processes of conservation areas management. Komodo NP is in the process of appealing for the active participation of various parties in its management. In the area of wildlife management such participation is becoming more and more mandatory, including the obvious shortcomings possessed by the management for the area. From the beginning, the scientific community already (sporadically) contributed to the management of the park. A consortium for development of Komodo NP is in the proposal stage, in which concerned parties are facilitated to discuss, to exchange ideas in various aspects of the park management, to support the park development and to involve themselves in the park issues. Who will be eligible to be parties? Those are concerned individuals, researchers, scientists, tour operators/agencies, local governments, local leaders, NGOs, universities etc. It will be a kind of active advisory board which may develop programs and funds and together with the park management execute them. This is still a proposal and inputs are mostly welcome.



APP. 2. MAP 1. Location of Komodo National Park in Indonesia.



MAP 2. Location of Komodo National Park in Nusa Tenggara (Lesser Sunda Islands) (adapted from ref.IUCN 1991)



MAP 3. Zonation map of Komodo National Park, showing location of Padar island.

KOMODO MONITOR

Varanus komodoensis

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

December 4-7, 1996

Taman Safari Indonesia
Cisuara, Indonesia

Population Biology and Modeling

LIFE HISTORY AND POPULATION MODELING

Introduction

Wild populations of *Varanus komodoensis* have a restricted geographic distribution and (depending upon degree of isolation) some populations may be comprised of relatively few individuals. The viability of such populations can be sensitive to the effects of a number of factors - for example, fluctuations in environmental conditions, disease epidemics, genetic drift, inbreeding - any of which could increase their chances of extinction.

The VORTEX software program can model population viability under a range of conditions and using a range of population parameters. The effect of varying basic deterministic parameters, or the frequency and intensity of stochastic events can be simulated and the probability of a population persisting over a period of time estimated. Results from VORTEX simulations can therefore be used to indicate:

1. which management strategies would be likely to have most effect on population viability, and

2. which additional data are most crucial to obtain in order to increase the accuracy of population projections.

Baseline Population Parameters

Data Sources

There appear to be few published data on the dynamics and parameters of *V. komodoensis* populations. Therefore, in order to establish baseline population values for population simulations, the group relied heavily on Auffenberg's published studies (1978, 1981), unpublished data from the Komodo National Park annual censuses (Subijanto unpub.), and 'best guesses' of field researchers, national park rangers and captive managers. Informal opinions were those of the participants of both the Wild Population and Captive Population Working Groups, with input primarily from P. Sastrawan (Udayana University), J. Subijanto (Chief of Komodo National Park), T. Walsh (National Zoo, USA), V. Gepak (Surabaya Zoo) and D. Boyer (San Diego Zoo).

Opinions on some of the basic parameters for *V. komodoensis* differed amongst workshop participants (evidence of the lack of good quality data generally available for this species). In an attempt to ensure that the risks of extinction are not under-estimated, a relatively conservative, precautionary approach has been taken when establishing baseline characteristics to be used in the VORTEX simulations.

For example, the probability of migration between populations was suggested by the Wild Population Working Group and some preliminary genetic evidence appears to support this (C. Ciofi, unpub.). It is likely that any such migration would increase meta- population viability and particularly the viability of the smaller populations. However, no estimates of rates of migration were possible. To support a precautionary analysis, we assumed migration does not occur. Hence populations on the various islands have been modeled separately.

Apart from size and carrying capacity, populations on Komodo, Rinca, and Gilli Motang islands were assumed to all have the same characteristics.

Modeling the populations currently on Flores Islands presented some problems. Estimates of the possible size, circumstances or existence of some of the populations in unprotected areas were suggested by Subijanto (pers comm.). However, these estimates were extremely vague and Subijanto expressed little confidence in them. Further, given their unprotected status, and proximity to human development, the assumption of similar population parameters as those within the managed National Park is not considered reasonable, and would likely underestimate risk of extinction. For example, Subijanto reports much lower densities for populations along the north coast of Flores, indicating the influence of additional or different factors than those operating on the Komodo National Park populations. It is reasonable to assume a greater risk of local extinction for these populations than for similarly sized populations within the managed National Park.

As estimates of immigration have not been included, modeling during the workshop was not adequate to assess the overall impact on meta-population viability of any local extinctions of the Flores Island populations.

However, some indication of population status was available for Wae Woul Reserve on Flores. In the past, this populations has been the source of animals removed from the wild to establish or enhance captive populations. The effect of harvesting on populations of this size (approximately 100 individuals) was modeled.

Parameter Values

The following are the parameters required by the VORTEX population simulation modeling program and the values selected to establish a baseline model.

<u>Population size</u>

Four base populations were modeled to simulate populations on Komodo, Rinca, Gilli Motang islands and the population in Wae Woul Reserve on Flores Island. Starting population sizes were constructed as described below.

1. Komodo: An initial estimate of 2,250 individuals was used. This figure represents an extrapolated population size based upon data from population density studies (Sastrawan, pers comm.). However, the Wild Population Working Group subsequently concluded that this initial estimate may be too high and a revised estimate of approximately 1,600 individuals for Komodo Island was proposed. As there was little detectable difference between results of simulations of the Komodo and the smaller Rinca populations projected over 100 years, the revised Komodo estimate was not expected to detectably affect the output results. Therefore simulations were not re-run using the revised figure.

2. Rinca: 800 individuals were estimated. A variety of estimates were available for this population. Auffenberg's (1981) original estimate of 800 individuals was supported by estimates from more recent field surveys (Sastrawan pers comm.). The Wild Population Working Group subsequently concluded that a slightly higher estimate of 1,100 individuals may be realistic, however the lower estimate was retained for use in the models as a conservative approach.

3. Gilli Motang: 70 individuals were estimated. A recent survey of this island produced total census figures of 70-80 individuals (Subijanto pers comm.).

4. Flores: The population in Wae Waul Reserve was estimated to be approximately 100 individuals (Subijanto pers comm.). This was assumed to be an isolated population and was used in models to investigate the effect of harvesting on a small wild population.

   Flores: The total population of *V. komodoensis* on Flores was estimated by Subijanto to be in the region of 2,200 individuals. These included:

   South-western coast an isolated population of 200-250 individuals.

   A population around Ruing over a large area (size of Komodo Island) but at much lower densities and no means to estimate population size.

   Some individuals around the town of Maumere.

   A population of low density along a narrow band of the north coast of the island.

   No means to estimate possible levels of migration or exchange among these populations are available.

<u>Carrying Capacity</u>

In the absence of any evidence to suggest otherwise, all populations were considered to have been stable over the long term. Therefore carrying capacities only slightly above estimates of current population sizes were assumed, with small standard deviations.

Values used:	Komodo	2,500
	Rinca	900
	Gilli Motang	90
	Wae Waul	110

No significant trends in increase or decline of carrying capacity were included (although improved success with anti-poaching activities aimed at protecting *V. komodoensis* prey species may result in a small increase in carrying capacity over time).

Variance in carrying capacities over time was assumed to be small, with a standard deviation of 5% of the mean over 100 years set for all values.

Mating System

Auffenberg (1978) suspected monogamy. However participants of both the Wild & Captive Population Working Groups suggested that evidence for this is not apparent and that polygyny (probably polyandry) is a more reasonable assumption.

Auffenberg (1981) reported an adult sex ratio of 3.3 males : 1 female which was derived from examination of 65 museum specimens. Additional field observations support this value (Sastrawan pers comm.). However, live animal sexing techniques remain unverified and were widely questioned by participants of both the Wild & Captive Population Working Groups. Such skewed adult sex ratios may represent a bias in sex ratios at birth or be the result of subsequent differences in the rate of sex-specific mortality. As long as any differential mortality predominantly occurs before first reproduction in females, the effect on the overall population will be largely similar to that of sex ratios skewed to the same extent at birth.

Suggestions that sex ratios are determined by incubation temperature have not been verified in experiments with other varanid lizards (Mackness pers comm.).

A sex ratio of 0.773 at birth, reflecting Auffenberg's data, has been used as a basis for most of the simulations. However, as sex ratio could have an important effect on the viability of the smaller populations (limiting the number of breeding females in a population) and as both Wild and Captive Population Working Groups considered the data to be inadequate, simulations were also run using a range of sex ratio values from 0.773 to 0.50 to determine the relative importance of an accurate determination of this characteristic.

Age of First Reproduction

These values refer to the age of the parents when first offspring are successfully hatched, rather than the age at which animals first reach sexual maturity.

Auffenberg (1981) suggested that both males and females become sexually mature between the age of 5-7 years. Data from the captive population, however, suggest first reproduction in both sexes may occur some years latter. It was estimated that females produce the first viable clutch between 7-10 years old (Walsh, Boyer, Gepak pers comm.); eggs are incubated for a further 7-8 months. High levels of mate competition have been assumed to further delay age of first reproduction in males. The more skewed the population towards males, the greater this effect can be expected to be.

Baseline values of 9 years for first reproduction in females and 10 years for males were used in all of the simulations.

Clutch Size

A value of 18.7 for mean clutch size, Auffenberg 1981, was used in all scenarios.

Maximum clutch sizes have been assumed to be 26 eggs; a conservative estimate based on observations of a number of clutches in the wild (Subijanto pers comm.). Auffenberg (1981) suggests maximum clutch sizes are likely to be in the order of 30. Reports of an observation of a clutch of 66 eggs (Hisada cited in Auffenberg 1981) could not be properly assessed, as the possibility of multiple nests could not be discounted.

Breeding females were assumed to produce only on clutch per year.

No information was available to construct a model of density dependence in reproductive rates.

Age of Senescence

Auffenberg (1982) suggested a mean longevity of approximately 50 years. Captive records of longevities greater than 30 years exist (Gepak pers comm.). However, both Wild and Captive Working Groups report evidence of reproductive capability ceasing in females a number of years prior to death. General observations on varanids support this decline in reproductive capability (Mackness pers comm.). Captive females have ceased breeding at an age known to be greater than 20 years (Gepak pers comm.).

For all scenarios, females have been assumed to cease breeding at approximately 30 years.

Breeding Participation

Auffenberg (1981) states that most females breed annually. However, there was general agreement that fertility in captive females probably begins declining around 20 years (Walsh, Boyer, Gepak pers comm.), with lower participation rates in older animals. An initially low estimate for the proportion of non- breeding females each year was increased to include possible reduced participation rates from 20-30 years of age. An average of 75% of females per year are assumed to breed successfully throughout with a standard deviation of 12.5% of mean.

23% of males were assumed to be unavailable for mating each year to reflect the estimated surplus of males in the adult population.

Age-Specific Mortality Rates

In the absence of evidence to suggest otherwise, age-specific mortality rates were presumed to be similar for both sexes. Three functional age classes, based upon age-specific body size (a crude measure of vulnerability) were included in the model. These age classes were: 0-1 year (yearlings), 1-6 years (juveniles), and 7+ years (adults).

A high first year mortality rate was assumed with predation and cannibalism as factors. This is consistent with the dynamics of a fecund, long-lived species with a population at or close to carrying capacity. This is also supported by field observations indicating very low recruitment of yearlings, with possibly no recruitment in some years (Sastrawan pers comm.). Both mortality and variance in mortality rates were assumed to decline with age to adulthood. The baseline values used for each age class were:

Mortality rates:

Yearlings	90% (± 10% sd)
Juveniles	3% (± 3% sd)
Adults	1% (± 1% sd)

Mortality rates were checked using raw data from the Komodo National Park annual censuses (Subijanto unpub.) to determine the relative proportions of juveniles to adults for the years 1989 to 1994. Data for yearlings from these counts were not used. The raw data represent counts at bait stations. The dietary preferences of yearlings are markedly different from those of the older Komodo Dragons (Auffenberg 1981; Sastrawan, Subijanto pers comm.) therefore bait stations are likely to underestimate the abundance of animals in this age class.

The mean ratio of juveniles to adults from these data were compared to those generated by the baseline model (mean age structure of surviving projected populations at 100 years which excludes population that become extinct). In both cases the age structure was close to 50% juveniles and 50% adults, providing some confidence that the mortality rates used in the baseline model are reasonable.

The proportion of juveniles to adults from the raw data for the Komodo National Park census showed high variability; the standard deviation from the mean of these data was 18.3%. Much of this variation is due to the difference in proportions in counts in 1989 and in 1992-1994 (when the 1989 data are removed, the sd = 8.76%). This reduced standard deviation may indicate either age-specific mortality varies substantially between years or it may reflect methodological differences in data collection between the years.

To assess the impact of high variability in age specific survivorship, a number of simulations were run in which variance in mortality rates were increased separately for each of the age classes with increases up to double the population estimates modeled.

Age Distribution

A stable age distribution was assumed for starting populations in all scenarios.

Inbreeding

The potential effect of inbreeding depression was modeled on the smallest population (Gilli Motang). The 'Heterosis Model' of inbreeding depression was used to incorporate the effect of mildly deleterious alleles. A value of 3.14 lethal equivalents per genome was assumed (i.e.: as estimated for outbred mammal populations, Ralls et al., 1988). This may represent an over-estimate of the expected deleterious effects of inbreeding on a small, closed and presumably stable population, as some purging of deleterious alleles may have occurred over time.

Correlation between EV of Reproduction and Survivorship

It was assumed that there is little correlation between the impact of environmental variation on reproduction and survivorship. Auffenberg (1982) suggested a relationship between egg production and food availability, however, Sastrawan reported that when food availability was reduced over the short term, there had been no evidence of any large increases in adult mortality.

Catastrophic Threats

Possible catastrophic threats to *V. komodoensis* populations include the following factors.

1. Disease: No evidence of prior catastrophic disease epidemics exists, either among wild or captive populations. However, small closed populations are predicted to have low levels of genetic variability and increased diseased susceptibility (Frankham 1995) and the potential threat from infrequent but substantial disease outbreaks can not be ignored.

2. Volcanic activity: In recent times one incident of nearby volcanic activity has been reported (Subijanto and Sastrawan pers comm.). Islands within the Komodo National Park experienced a substantial deposition of volcanic ash which destroyed much of the vegetational cover in some areas. The impact on prey species can be assumed to have been harsh with subsequent impact on *V. komodoensis* survivorship and reproduction. A frequency of 1-2 nearby eruptions per 100 years was suggested.

3. Fire: Subijanto reports some evidence of decline in prey species after fire presumably reducing reproductive capability for *V. komodoensis*. However, information from Komodo Island suggests that fires are frequent (2 or 3 per year) but small in impact (maximum of 600 ha burnt per fire on 33,000 ha island (Subijanto pers comm.). Small and frequent fires are likely to reduce the probability of catastrophic fires by reducing the accumulation of fuel. As long as the current fire management regime is maintained fire was considered unlikely to represent a significant catastrophic threat.

Where the impact of catastrophic threats was modeled, simulations included a 2% probability of the occurrence in any one year of events that result in a 50% increase in mortality with no effect on reproduction. All scenarios were run with and without the inclusion of catastrophic events.

Harvest

A number of scenarios were included which involved several levels of intensity of harvesting on the Wae Woul population on Flores. This population has been used in the past to supply animals to establish or enhance captive populations. Two harvesting scenarios were modeled with the removal of a total of 10 males and 10 females over 100 years.

Short term harvest: Removal of 5 males and 5 females twice during the first 4 years.

Long term harvest: Removal of 1 male and 1 female every 10 years for 100 years.

The effect of each strategy was modeled in several ways by varying the age classes of the animals removed. The short term harvest strategy was modeled in three ways by removing animals from each of the three age classes. The long term strategy was modeled in two ways with animals removed from either the yearling or adult age classes.

RESULTS

Simulations were run using VORTEX 7.0. Model *V. komodoensis* population simulations were projected for 100 years with results summarized at 10 year intervals. Each scenario was run 200 times and probability estimates represent means of these iterations.

Komodo and Rinca populations

The populations on Komodo and Rinca showed no detectable probability of extinction over the next 100 years. Further, the probability of extinction did not appreciably increase for these populations when any of the following key variables were modified:

- Increasing the annual variation in age-specific mortality (doubling the SD) across all age classes.

- Decreasing the proportion of females breeding during any one year to 50%.

- Including inbreeding depression at a level consistent with that observed in mammal populations (performed only for the (smaller) Rinca population using the Lethal Allele model - computer memory a limiting factor)

Assuming that each population represents a single functional unit, it seems reasonable to conclude that the Komodo dragon populations on Komodo and Rinca Islands are under no apparent risk of extinction as long as current management and protection practices for the dragons and their prey are continued. Further, considerable surplus reproduction occurs, as evidenced by high levels of mortality among 0 -1 year old animals.

Gilli Motang

Using the base population parameters, VORTEX modeling suggests that the population on Gilli faces a low probability of extinction over the next 100 years. However, the population is sensitive to variation of some of the key parameters as follows:

- Decreasing the female participation rate to 50% (i.e.: on average 50% of adult females breeding each year until age 25 yrs) increased the probability of extinction by about 1% over the ensuing 100 years. However, it reduced the intrinsic growth rate (r) by about 50% which resulted in lower mean final population sizes.

- Increasing the mortality rate of yearlings to 95% substantially increased the probability of extinction to 35.5% and halved the mean final population size of surviving populations.

- Increasing the yearly variation in age-specific mortalities to double that assumed in the original model increased the probability of extinction to 16.5%. This increase was almost entirely accounted for by the effect of increased variance in mortality among the 0 -1 age class (this alone increased the probability of extinction to 16%).

- Inbreeding depression did not substantially increase the susceptibility of the Gilli Motang population, increasing the probability of extinction by only 1%. The genetic loading was assumed to be equivalent to the average calculated for outbred mammal species; it is not known how appropriate this level is for Komodo Dragons.

- Applying an equal adult sex ratio doubled the intrinsic rate of population growth (r), thereby greatly increasing the resilience of the population to perturbation.

- Including the catastrophes in the model had little impact on any of the measures of population decline.

Flores population(s)

Because of the similar population size of the Wae Woul population to that on Gilli Motang we have assumed that the Gilli Motang results are equally applicable to Wae Woul. The only different scenario relates to harvesting of the population to add to captive colonies.

The short-term harvesting regime had little impact over the 100 year time frame for any age group, not even on intrinsic growth rates. Regular harvesting of yearlings for the entire 100 years also had no significant impact. However, regular removal of adults increased the probability of extinction to 35% over the 100 year period and more than halved the growth rate of the population.

Doubling the rate of harvest of both adults and yearlings for the short-term scenario simply increased the likelihood that harvesting targets were not reached, it did not affect probability of extinction.

RECOMMENDATIONS

The models indicate that Komodo dragon populations on Komodo and Rinca Islands are reasonably secure, however, all scenarios assume that populations have been stable over a number of generations. Slow rates of change in these populations will be difficult to detect, and may be occurring. Consistent and systematic population census data will be crucial for detection of such changes. Methodologies for accurate and sensitive censuses need to be developed and tested, using the best available expertise in quantitative field census techniques.

Recommendation:

1. Further investigate census methodologies and then establish agreed census protocols.

A number of key unknown population variables compromise the ability of the models to accurately predict the long term viability of the Komodo Dragon population on Gila Motang Island. Research on both wild and captive populations should be directed to this end.

Recommendations:

2. Investigate age-specific survivorship in wild populations, in particular of yearlings from the smaller islands.

3. Investigate breeding participation rates of females in wild populations.

4. Use captive populations to determine sex ratio at hatching (sacrificing surplus clutches is likely to be required to verify sexing methods currently under development), and age at first reproduction.

5. Use captive populations to study the impact of inbreeding depression on Komodo dragons (in particular the impact on clutch size, egg fertilities, and yearling survival).

6. Use the captive population to determine the frequency distribution of body mass for both sexes.

7. Use the captive population to trial techniques for attaching radio-transmitters for use under field conditions. Dr Brian Weavers, Australian Heritage Commission, Sydney, has considerable experience in radio-tracking *Varanus varius* and should be consulted about methodologies, including techniques for transmitter attachment.

Interaction between current Komodo dragon populations could not be included in these models due to lack of information about possible migration rates. This may have a significant effect on the viability of the Gilli Motang population.

Recommendation:

8. Levels of migration between all islands (in particular to & from Gilli Motang) need to be estimated (the results of the current genetic studies are likely to be useful here).

The Flores population(s) may face additional threats as a result of population fragmentation, and the (possible) greater impact of human development. These were not able to be properly assessed by the current population models, as the impacts on population parameters are not known.

Recommendation:

9. Field studies are urgently needed to determine the size, distribution and degree of fragmentation of Komodo dragon populations on Flores. The impacts of any additional threats to these populations and their habitat also requires investigation.

Reintroduction and Translocations: The results of our modeling reveal no apparent need for re-stocking to enhance the viability of existing populations. However the controlled re-establishment of a Komodo Dragon population on Padar Island could provide unique opportunities to develop release methods in case they are needed in the future, and to study Komodo dragon population dynamics. To properly assess the feasibility of this, the population dynamics of prey species need to be considered in light of food requirements of wild Komodo dragons.

Recommendations:

10. Develop additional population models for prey species of the Komodo dragon, aiming specifically to assess required population sizes.

11. Should re-introduction to Padar Island be considered, translocation from wild populations represents the most efficient and safe source of animals. The considerable annual surplus of yearlings should allow for harvesting of hatchlings with negligible effect on the source population. There appears no need to consider captive populations as a potential source for re-stocking wild populations.

To obtain maximum value from the modeling undertaken at this PHVA Workshop the wildlife managers and Park managers responsible for Komodo dragon conservation should be able to use Vortex routinely as a management tool.

Recommendation:

12. The funds offered by North American zoos to support conservation measures for Komodo Dragons need to be directed to making available the hardware, software and training necessary to allow the routine use and refinement of VORTEX models of Komodo Dragon populations.

Removal of animals from the wild: Simulations of the effect of the removal of animals from the small wild populations such as that at the Wae Woul reserve suggest that regular removal of adults substantially increases the chance of local extinction. Removal of yearlings at a rate of two per year had no detectable impact on the model population.

Recommendation:

13. Should further removal of animals from wild populations be considered, only hatchling animals less than 1 year of age should be removed.

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Participants

Jito Sugarjito - convener (Indonesian Institute of Sciences)
Jonathan Wilcken (Australasian Regional Association of Zoological Parks and Aquaria)
Peter Menkhorst (Department of Conservation and Natural Resources, Victoria, Australia).

Table 1. Summary statistics for the Gilli Motang Island population simulations.

File name	Prob. extinction	N - Mean Pop Size	r (growth rate)
gilli.01	0.005	81	0.047
gilli.02	0	78	0.052
gilli.05	0.165	56	0.03
gilli.06	0.15	59	0.03
gilli.11	0.16	58	0.03
gilli.12	0.12	59	0.03
gilli.15	0.005	68	0.02
gilli.16	0.01	68	0.03
gilli.19	0.355	40	-0.009
gilli.20	0.28	44	-0.0008
gili2.11	0.10	62	0.035
gili2.12	0.03	72	0.04

Table 2. Summary statistics for the Rinca Island population simulations.

File name	Prob. Extinction	N - Mean Pop. Size	r (growth rate)
Rinca.01	0	830	0.05
Rinca.02	0		
Rinca.05	0.09	606	0.04
Rinca.06	0.06	607	0.04
Rinca.11	0.095	658	0.04
Rinca.12	0.065	650	0.04
Rinca.19	0.05	420	-0.002
rinca2.11	0	754	0.045
rinca2.12	0	757	0.05

Table 3. Summary statistics for simulated effects of harvesting on population size 100.

File name	Prob. Extinction	N - Mean Pop. Size	r (growth rate)
harvest.01	0	98	0.05
harvest.02	0	98.6	0.05
harvest.03	0	97.7	0.04
harvest.04	0	95.3	0.05
harvest.05	0.01	99	0.04
harvest.06	0	96.8	0.05
harvest.07	0.005	98	0.05
harvest.08	0.005	97.2	0.05
harvest.09	0.355	76	0.02
harvest.10	0.26	78.5	0.03

Table 4. Key to VORTEX output files for the scenarios presented.

Scenario	File Name	File Name
	with catastrophe	without catastrophe
Base	Gilli.02	Gilli.01
Sex ratio 1:1	Gilli.04	Gilli.03
SD mortality all ages X2	Gilli.06	Gilli.05
As above, adults only	Gilli.08	Gilli.07
Juveniles	Gilli.10	Gilli.09
Yearlings	Gilli.12	Gilli.11
Sd mortality yearlings X 1.5	Gili2.12	Gili2.11
Female participation rate = 90%	Gilli.14	Gilli.13
= 50%	Gilli.16	Gilli.15
Yearling mortality = 85%	Gilli.18	Gilli.17
= 95%	Gilli.20	Gilli.19
Longevity = 30 years	Gilli.22	Gilli.21
= 35 years	Gilli.24	Gilli.23

NB Rinca series uses same file naming system but population size is 800 and carrying capacity is 900.

Scenario	with catastrophe	no catastrophe
short harvest of yearlings	harvest.02	harvest.01
Juveniles	harvest.04	harvest.03
Adults	harvest.06	harvest.05
Prolonged harvest yearlings	harvest.08	harvest.07
Adults	harvest.10	harvest.09

KOMODO MONITOR

Varanus komodoensis

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

December 4-7, 1995

Taman safari Indonesia
Cisuara, Indonesia

WILD POPULATION MANAGEMENT

WILD POPULATION MANAGEMENT

Synopsis

The Komodo monitor *Varanus komodoensis* is the world's largest extant lizard. It reaches a length of 3 m and a weight of 80 kg. It is endemic to four south eastern Indonesian islands in the Lesser Sunda region: Komodo, Rinca, Gilli Motang, and Flores. Three of these islands (Komodo, Rinca, and Gilli Motang) are part of the Komodo National Park (KNP). This species is vulnerable due to its restricted range and the possibility of extinction from a number of threats such as poaching of prey, habitat loss, competition with exotic species, and possible natural catastrophes.

In order to maintain a viable wild population in the whole range of the Komodo monitor, the following points should be considered:

1. Understanding of the habitat, distribution, population dynamics and genetics of the species;
2. Development of an adequate population management system;
3. Strong commitment in a long term management plan by all parties;
4. Maintenance of strong links to ex-situ population management groups, in order to insure against possible catastrophes affecting the wild population and to provide sources for repopulation.

General Considerations on the Species

A long term study by Walter Auffenberg offers the most complete picture of this species to date. Some aspects of this study, together with other short term research are included in the briefing book (sections 5,6).

The Komodo monitor occurs principally from the coastline to 450 m above sea level. Tropical deciduous monsoon forest, tropical savanna forest, steppe and mangrove forest constitute the main habitats of *V. komodoensis*. This species is a carnivorous lizard which both actively searches for prey and eats dead animals. It feeds primarily on wild boar, deer, eggs of both sea turtles and the megapode bird *Megapodius freycineti*, other species of birds, monkeys, lizards, snakes, and insects.

The activity range, thus far described only by Auffenberg (1981), is divided into scavenging and foraging areas, of which the former is much larger. The latter includes a core area, where most of the activity takes place. While there is a direct correlation between animal size and foraging area (up to about 500 ha in adult specimens), which is related to prey density, the size of the scavenging area is determined mainly by the location of dead animals. The core area is that part of the activity range which least overlaps the activity area of other individuals, and is apparently most related to shelters and thermoregulatory sites. Unlike other species of monitor lizards, the Komodo monitor is active throughout the year; during the dry season, its activity has also been recorded until long after sunset.

In the wild, courtship and mating generally occur from May to July. Most of the eggs are laid from July to September in nests generally located on the slope of a hill or in the nest of the Megapode bird. Incubation lasts 200-250 days, and eggs hatch in April and May with an estimated sex ratio biased towards males of 3.3:1.

Distribution and Status

Recent estimates place the total population of the Komodo monitor at less than 3000 individuals within the KNP. About 1600 individuals have been estimated to live on Komodo Island (33,937 ha), 1100 on Rinca Island (19,825 ha) and 70 on Gilli Motang Island (3,328 ha). About 100 individuals have been estimated to live in Wae Woul, a protected area outside of the Park located in W. Flores. In the north part of the island the Komodo monitor is also protected around Riung. Outside the protected area *V. komodoensis* is present mainly along the west coast southward as far as Nangalili bay, and eastward as far as Maumere; no management or official jurisdiction exist in these areas to monitor or protect beyond the park boundary. The island of Padar, which is part of the park, harbored the Komodo monitor till 1970; after this date, no evidence of the presence of this species has been reported. A depletion of prey (mainly deer), because of intensive poaching, is considered to be the main cause of the disappearance of the Komodo monitor from this island.

Management of Wild Populations

The population size of the Komodo monitor has been assessed since 1929. Different methodologies have reported numbers ranging from 1000 to 5,500 individuals. In 1992 the Park started a regular yearly estimate using a direct bait-count method following the work of Auffenberg in 1970. This method uses simultaneous counts of animals attracted by bait at an average of 20 sites per island. In 1995 the Park, in collaboration with the Japan International Cooperation Agency and Udayana University, estimated the population size by means of regular transects in the island of Rinca. Estimates have also been made for deer populations. These methodologies need to be reviewed and possibly updated. The existing populations of both Komodo monitor and deer on Flores are becoming increasingly fragmented due to human encroachment on their habitat. More over, there is much less protection for animals outside of KNP on Flores where poaching of deer is not monitored.

Komodo National Park

General information

The Komodo National Park (KNP) was established in 1980, and the first management unit was put in place in 1984. The Park has a total area of about 173,300 hectares. An extension of the existing Park boundaries, which will include two further islands to the North of the Park, has been proposed. There are two villages on the island of Rinca and one on Komodo, all of them with a population increase of more than 5% a year (Subijanto, 1995). A restriction on further settlements on Komodo has been proposed.

The Park receives its funds entirely from the central government office in Jakarta, although there are occasionally donations of equipment and materials from outside agencies. The remoteness of KNP has made effective management of this park difficult until recent times. The KNP is currently managed by PHPA, whose main office is at Labuan Bajo on the west coast of Flores. Out of a total number of 90 KNP total staff, 54 work as rangers at 10 guard posts located on the islands of Komodo and Rinca.

Visitor facilities and tourism

Tourism has been increasing at KNP yearly. The number of tourists (mainly foreigners) in 1990-91 was 13,792. This number increased to 25,760 in 1994-95 (Subijanto, 1995). At present, the Park admission fee is 2,000 Rp. (US$ 0.90), but an increase to 10,000 Rp. has been proposed to the Ministry of Forestry.

Information centers exist in Sape (Sumbawa) and Labuan Bajo (western Flores). The latter holds limited educational material for visitors, while the PHPA office has a small library. Offices with basic visitor facilities exist on the islands of Komodo (with restaurant facilities) and Rinca. Komodo also has a small laboratory and museum which are no longer in use due to lack of funds for maintenance. Interpretation materials were also donated by the US Department of Agriculture to be used to provide awareness and education to visitors, specifically to create trails and signs. However it has not been implemented as yet due to the lack of funding and human resources.

Since 1970, two areas (Poreng and Banu Nggulung) in Komodo island were used as feeding sites for the Komodo monitor, mainly to provide an attraction for visitors. Following this practice, significant behavioral changes were observed in the individuals resident in those areas. Visitors started to complain about the slaughter of animals for feeding the dragons, while park wardens became overloaded with guiding visitors to the feeding sites. Starting August of 1994 the frequency of the feeding practice has been gradually reduced and eventually stopped at the end of 1995.

Current status

The PHPA has initiated a conservation awareness program for young people within the region. Some of these people have already been sent for tour guide training in Kupang, while others have been encouraged to take part in censuses within the park. Many potential educational videos, photos, and reports have been produced by outsiders in the park but little has been returned for use in education.

Facilities and equipment are still very basic and restrict management efficiency. Given the lack of fuel and boat resources, sea patrols are infrequent. Land patrols are done on foot, with a simple radio system as the only means of communication between posts and the Headquarters outside the park at Labuan Bajo. There is no middle management infrastructure between the rangers and the Head Office. The rangers patrol unarmed whereas the poachers usually carry weapons. More over, a National Zero Growth Policy imposed on the civil service prevents further recruitment of staff. Opportunities for staff development and training are limited due to the lack of funds, and English language limitations of the staff are a barrier with visitors and researchers.

Threats

Some major threats have been identified as affecting both directly and indirectly the efficient management of the Komodo monitor within the National Park. These include the increasing human population, illegal fishing, coral blasting and poisoning, fires, poaching, tourists, pollution, and the introduction of exotic species.

Illegal fishing/coral blasting and poisoning have had a serious effect on the Park's marine resources and are increasing drastically. Dynamite and cyanide poisoning and other unsustainable fishing techniques are used to collect fish for food. Since 1993 there have been 422 instances of dynamiting within Park boundaries. This is an increase of over 400% of the 1990-92 figure of 93 (Subijanto 1995). Fishermen are coming from areas outside of KNP after their own local resources have been depleted.

Poachers enter KNP to hunt deer. They use guns to kill the prey and fires or dogs to find or drive the prey. Dogs left within the park by the poachers directly compete with the monitors for food. Fire has been implicated in the extirpation of Komodo monitors from Padar island. Fires were started by poachers to drive deer and by careless fishermen drying fish on beaches. There are approximately 4 fires per year, affecting from 200 to 600 ha (Subijanto 1995). Boats carrying the tourists to KNP bring a large quantity of trash, pollute the waters of the park, and damage the coral reefs through anchoring.

Recommendations for Priority Actions

Research Priorities

1. Assess methodology for and implementation of research of: a) population assessment of the Komodo monitor, b) population assessment of prey species, c) habitat assessment and mapping, d) scat analysis for indication of prey preference,

2. The lack of management outside the park but within the range of Komodo monitors is an issue that needs to be incorporated into a the Master Plan being developed at this time. These Flores monitor populations are important to the management of the species, and research should include animals and habitats outside the park boundaries.

3. A comparison between the genetic structure of the wild populations and the captive population is a crucial issue for reintroduction programs. If captive animals are to be used for release programs, then it is important to know the amount of genetic variation existing in the captive animals and the amount of the genetic representation of the wild population retained by the captive populations in order to generate a viable population for relocation.

Management Priorities

4. Continue monitoring of the local human population within the park to insure a minimum of damage to the habitat which may occur by cutting of the mangroves for firewood, limiting brush fires, and protection of existing fresh water resources.

5. Increase sea patrols to limit illegal fishing activities.

6. A recommendation has been made by PHPA to restructure the park management to create mid-level managers who will facilitate some of the responsibilities of personnel such as patrols, anti-poaching, habitat and population management, and visitor services.

7. Secure alternative sources of funding, by means of: a) donations from special interest groups, b) direct involvement of parks in tourism so that financial benefits are received by the park instead of outside private tour companies, c) raising of the entrance fee to a minimum of 10,000 Rp., d) promotion of marine dive trips run by park staff with the financial benefits channeled back into the park.

8. Regulate the number and frequency of visitors.

9. Develop a waste disposal system which removes the waste to outside the Park boundaries.

10. Continue the ongoing control of pests and exotic species (e.g. feral dogs, rats).

11. Develop a contingency plan to anticipate the possible catastrophic occurrence of diseases, earthquakes, and volcanic eruptions.

12. The repopulation of Padar island is considered important, however prior to this more information on the variables: population, prey and habitat assessment and carrying capacity is needed before a plan can be developed.

Education, Extension, and Professional Development

13. Training for park staff
   a) AMDAL (Indonesian Environmental Impact Analysis) training for PHPA staff
   b) English language training (identify source: VSO, Peace Corps, etc.)
   c) Transportation operation and maintenance
   d) Principles of ecology
   e) Use of communications media, computer software, and its maintenance
   f) Visitor management skills
   g) To promote professional development by introducing a merit scheme
   h) GIS and Vortex training
   I) Fire fighting training
   j) Training on marine resource management

14. Development of an environmental awareness curriculum to be included in formal education throughout the country.

15. Develop a program for general education and awareness about the impacts of human presence on the environment with emphasis on the most serious threats to the park e.g., illegal fishing, poaching, etc. to encourage the sustainable use of park resources.

16. Improvement of tourist education in the form of:
   a) Upgrading of visitor services.
   b) To provide organized nature tours and develop nature trails within the park.
   c) To produce comprehensive educational materials.
   d) The ongoing utilization of existing US Department of Agriculture Forestry Service visitor interpretation materials.

16. Continue the existing "Komodo Working Group" and expansion in the following ways:
   a) Establish a coordinator to act as official project/forum committee member
   b) Develop guidelines for the organization
   c) Develop relationships with the PKBSI and other scientific institutions
   d) Sponsorship and fund raising

17. Use media techniques to implement the extension and education plans:
a) Newsletters, b) Radio/TV, c) Publicity

Policy

18. Project/Forum coordination: Appoint a coordinator (e.g. the National Park Director) to head a small management committee, to: a) implement recommendations drawn from advisory groups and other interest groups; b) coordinate the development of partnerships with interest groups; c) implement recommendations from these groups as considered fit by the coordinator and his management committee.

19. Coordination with government: Coordination of PHPA activities with Local and National Governments to incorporate useful recommendations from the Komodo PHVA into the Master Plan (already being developed) for the KNP and the entire Komodo monitor range. This will then form part of the regional and national development plan. Special considerations should be given to the areas where Komodo monitors exist outside of protected areas, including the proposed extension of KNP boundaries.

20. Law enforcement:
a) strengthen the capacity of the policing in the park by increased coordination with other law enforcement agencies;
b) seek legislation that would enforce punishments for breaking the law.
c) arm the park rangers.
d) seek stronger punishment for poachers/fishermen found carrying dynamite, firearms, or cyanide.
e) provide materials to rangers to increase their capacity to effectively carry out their work; fast patrol boats, bullet proof vests, night vision goggles, relay antenna, radio communications system, firearms, continuous fuel supply, four X Four patrol vehicles for Flores, and motorcycles/horses.

21. Involve local communities: Increase the local communities participation inside and outside the National Park within the Komodo monitor range. Involve them in park activities and encourage a more direct role in tourism whereby they gain financial benefit. This will form part of community based development within the whole Nusa Tenggara region;

22. Review, update, and produce regulations for the protection of Komodo monitors in unprotected areas, specifically by the local government.

27. Develop an integrated management plan based on the Regional Spatial Development Plan (RTRWP). Set up a series of meetings to coordinate this between PHPA, local government, and concerned agencies.

Participants In Wildlife Population Management Group.

Facilitator: Tony Suhartono, PHPA, Head Office

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Putra Sastrawan	Udayana University
Koestoto	Indonesian Institute of Sciences
J. Subijanto	Komodo National Park
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David Ware	Taman Safari
Ron Lilley	WWF, Indonesia
Brian Mackness	Australia
Claudio Ciofi	Zoological Society of London, U.K.
Roger Rosscoe	National Zoo, USA

KOMODO MONITOR

Varanus komodoensis

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

December 4-7, 1995

Taman Safari Indonesia
Cisuara, Indonesia

CAPTIVE POPULATION

CAPTIVE POPULATIONS

Introduction

The Komodo Dragon is endemic to several small islands within the Indonesian archipelago, (western Flores, Komodo, Rinca and Padar). This species is vulnerable due to its small range and the possibility of extinction from a number of threats. These include poaching of Komodo dragon prey, habitat loss, and possible catastrophic events.

The goals of maintaining of a global captive population are to:

1. Increase the existing population to meet goals of viability.
2. Maintain protected groups as a genetic reservoir to safeguard against extinction.
3. Provide public exhibition and display to increase public awareness of an Indonesian national treasure.
4. Conduct research designed to enhance captive management and reproduction and knowledge of the basic biology of the species that might be used for management of the wild populations.
5. Assist development of conservation resources and funding opportunities.

Captive Population

Zoo Inventory

The total global captive population is 191 (31.21.139) located in three primary geographic regions: Indonesia, United States and Europe/Australia/Asia. This contains approximately 36 (19.14) wild-caught adults of which roughly 13 have reproduced and are founders. This population is located in the following geographic regions:

Indonesia: 103 (19.14.74); 10.8 wild-caught with roughly 10 founders represented.
United States: 63 (5.3.55); 5.3 wild-caught with 3 (2.1) founders represented.
Europe/Asia/Australia: 21 (7.4.10) with 7.3 potential founders (no breeding yet).

A total of 13 founders (out of a potential 36) are currently represented in this population, and efforts should be directed at improving this founder base through selective breeding.

Preliminary attempts to determine the carrying capacity for zoos worldwide have been made, and crude estimates are forthcoming. Indonesia has estimated they have a carrying capacity of 130 dragons.

Successes and failures

The following zoos have experienced breeding success with Komodo monitors in captivity:

1. Ragunan
2. Surabaya
3. Yogyakarta
4. National, DC
5. Cincinnati

Expressed concerns primarily involve the need to improve sexing, incubation techniques and rearing young to maturity.

Studbooks

Johnny Arnett (Cincinnati Zoo) is the International studbook keeper and is currently compiling information; surveys will be distributed soon. Preliminary data will be distributed to all participants in January 1996.

Indonesia will designate a regional studbook keeper (tentatively an individual from TSI), and will later determine whether to assume the international studbook responsibilities. TSI currently is familiar with these programs, and currently holds a regional studbook

In April of 1996 the Singapore Zoo will conduct training which will be available to Indonesian Zoos on the use of SPARKS and ARKS computer analysis. The tentative date is April 1996.

Identification

The Trovan transponder system is recognized as the international standard for microchip identification of zoo animals. This system is currently in use at TSI but should be expanded to include the other Indonesian zoos. Import/export specimens should receive transponders prior to shipping. The standardized implantation site is on the left side of the animal in the shoulder region. The injection site should be cleaned with alcohol or betadine prior to implantation.
Protocols will be made available for the proper use of this system.

Interest was expressed in having a quick visual ID system for in-house management; possibilities include paint marking such as in use a Yogyakarta Zoo. Each zoo will be responsible for developing their own such system if needed.

Master plan

Indonesian Zoos are in the process of developing a collaborative management plan for Komodo monitors in captivity. Considerations should include improving the genetic composition of the captive population by insuring that all wild-caught animals reproduce, i.e. become founders. To facilitate this, an ongoing program of exchanges between Indonesian zoos should occur. Providing the optimal opportunity for each potential founder to reproduce and contribute to the population is a high priority. A master plan session to decide how to best accomplish this should be conducted in conjunction with a husbandry and captive management workshop. The date and location of this workshop has yet to be determined.

Husbandry

Handling, restraint and transportation

Several methods of restraint are currently being used with adult Komodo monitors ranging from manual to chemical immobilization. It should be stressed that manually handling adults can result in severe injury. Cargo nets and ropes have been employed; however luring into crates appears to be the safest for a variety of manipulations and transportation.

Behavior

Social interactions among adult and juveniles is an area that needs clarification and further investigation. It was noted that in some Indonesia zoos larger mixed groups were maintained; thus far US zoos have maintained juvenile animals separately and few introductions have been attempted. Experimentation with juvenile introductions have resulted in aggression and wounds. Experience in two Indonesian zoo have shown that young dragons raised together from the beginning (hatching) will coexist well. However during the breeding season, and during feeding episodes, aggression can occur and should be closely monitored. Gravid females should be separated from males prior to egg-laying.

Health, quarantine, nursery

Though generally disease tolerant, Komodo monitors are nevertheless susceptible to a variety of medical problems. Bacterial, fungal, parasitic and viral causes have been identified as possible causes. Improved sanitation may help alleviate some of these conditions. Dr. W.A. Rapley (Metro Toronto Zoo) has offered to compile veterinary treatment records from zoos worldwide and provide this information to Indonesian authorities.

A minimum of 30 days quarantine period is recommended, during which time fecal and blood samples can be examined. Unusual behaviors can be observed and a normal feeding schedule established. Sick animals should be isolated and treated. Medical reports on animals shipped out of Indonesia should be returned to the sending institution.

The possibility of zoonotic disease transmission from Komodo dragons will be investigated and references on this topic will be provided.

A separate rearing facility for juvenile monitors is recommended to insure proper growth and survival. Considerations such as light, temperature and diet should be evaluated in the nursery design.

Reproduction

Currently zoos are not experiencing difficulty in reproducing sexual pairs of animals. Further development of sexing techniques including x-ray, ultrasound, analysis of blood, tissue and albumin are under investigation. Interest was expressed in artificial incubation techniques utilized at the National Zoo. Information on the incubation parameters is included in the PHVA briefing book (Section 7 under captive management and husbandry).

Nutrition and growth

Proper nutrition and exposure to ultraviolet is essential for successful rearing. Juvenile lizards should be fed whole prey items such as mice when available. Feeding should begin at 1 week of age offering half grown mice. Exposing the rodents viscera (slit belly open) may encourage reluctant feeders. It was discussed that the establishment of rodent colonies at participating zoos would insure a constant supply of food for young specimens. Ultraviolet light whether natural or artificial is essential for proper growth and calcium metabolism. A special diet composed of beef, eggs, vitamins A and D3, calcium, minerals, crude fiber (chicken feathers) that is mixed and finely chopped is being used successfully in 3 Indonesian zoos: Ragunan, Surabaya, and Yogyakarta.

Growth data is available in the PHVA briefing book from Indonesian and data will be provided with this report from US zoos. Extensive growth data is also presented in a lengthy report compiled by the Gembira Loka Zoo in Yogyakarta.

Exhibit, Holding and Environmental Conditions

In warmer tropical climates zoos maintain dragons outdoors while US zoos are usually forced by climate to keep them inside. At all holding institutions animals are currently utilizing dirt substrate which encourages natural digging and nesting behaviors. Access to thermal gradients and ultraviolet light should be provided by either natural (sunlight)or artificial means. Currently there are several sources of UV light that are commercially available, and Repti-Sun is widely considered the best source.

As discussed earlier some Indonesian zoos have reported sanitation problems associated with a lack of available resources. In some cases, such as communal housing of young, overcrowding may induce stress and add to sanitation problems. Interest was shown by some Indonesian zoos on the ease of practical and inexpensive individual holding systems for young. This might further insure the survival of weaker animals as well as aid in the identification of specific individuals and bloodlines. It was mentioned that a dilute solution bleach (Sodium hypochlorite) is an effective and inexpensive disinfectant.

Research, Training, Education and Information

Research and population management committee.

It was discussed that an Indonesian research committee should be developed to help decide priority issues for management of captive Komodo dragons. Previously little transfer of information occurred between Indonesian zoos on all levels. An SEAZA Zoo Newsletter and a PKBSI Newsletter are currently available for the distribution of information relating to Komodo dragon as well as other Indonesian wildlife management issues. Additionally a new CBSG Indonesia Newsletter to be published by TSI and PKBSI will soon be available for this purpose as well.

Training of keeper and technology transfer.

SEAZA to conduct formal training of SPARKS, ARKS, ISIS and captive husbandry and management workshops.

Mr. Trooper Walsh will conduct informal training at Indonesian zoos following PHVA workshop. He will be available to assist in evaluating husbandry procedures and learning Indonesian techniques. Once the specific needs of each individual zoo have been assessed, this information will be conveyed to the American Zoo Association Lizard Advisory Group which can then serve as a vehicle to assist that those needs are met as animal exchanges occur.

Indonesian zoo staff identified a variety of equipment needs which include: transponder systems, computers, sexing equipment, incubators and library/reference material. US zoos have expressed an interest in assisting with the acquisition of equipment and transfer of technology.

Research priorities

Sexing techniques
Egg incubation guidelines
ID systems
Broadening knowledge of rearing techniques, health and management concerns
Genetic analysis of both the captive and the wild population

Other Topics

Ownership

If a need is demonstrated to supplement the wild population, to be determined by PHPA, then 10% of all captive-hatched offspring, both within Indonesia and outside, will be returned for the release program.

Conservation fund raising

National Zoo has established a fund to support Komodo monitor conservation in Indonesia. It was suggested that future exchanges of Komodo dragons from Indonesian zoos should involve equipment and technology transfer that improves the breeding and management of Komodo Dragon at these zoos.

Summary

The Indonesian people have already initiated procedures and implementation of all the concerns listed above by requesting the Komodo dragon PHVA workshop and the general sharing of information and animals. The Komodo dragon is considered a high profile endangered species which has recently enjoyed good reproductive success in zoos, both inside and outside of Indonesia. Foreign zoos holding or desiring Komodo dragons should likewise consider how they may assist Komodo dragons in their country of origin.

Recommendations from Captive Management Group

1. A management plan and husbandry manual should be compiled, published and distributed to all zoos working with Komodo dragons. The following topics should be included: Housing, Identification, Sexing, Egg incubation, Pregnancy detection, Medical management, Rearing techniques, and Specific equipment needs relating to Komodo dragon management for each Indonesian zoo.

2. Analysis at the PHVA workshop indicates the need to improve founder representation of existing population that fully utilizes all wild-caught specimens in captivity. Unpaired wild-caught animals (potential founders) in zoos are a high priority for breeding. This should be implemented by the International Species Coordinator.

3. There is a need to identify primary contacts (PHPA, SEAZA) to facilitate coordination of the activities of both foreign and Indonesian zoos with captive Komodo dragons.

4. A captive management plan in Indonesia will require a Species Coordinator, a Studbook Keeper and a captive management committed to draft and implement a captive population Master plan. The coordinator and management committee will serve to coordinate the management of the national and international program.

5. A second workshop will be necessary to further develop husbandry guidelines as well comprehensive captive management strategy, and to assist with the implementation of this Strategy within Indonesia. International experts are available to assist conducting this workshop.

List of Participants in Group 3

Facilitator:	Dwiatmo Siswomartono	PHPA Indonesia
	Jansen Manansang	Taman Safari
	Edy Hendrar	Taman Safari
	Faustina Ida	PHPA Indonesia
	Soeparmi Surahya	Fac. Biology UGM
	Wardani Endang Setiawati	Ragunan Zoo Jakarta
	Erna Suzanna	Forestry Faculty , IPB
	Vincent Harwono Gepak	Surabaya Zoological Garden
	KMT Tirtodiprojo	Zoological & Botanical Garden Gembiraloka, Jogya
	Machmud Asvan	Zoological & Botanical Garden Gembiraloka, Jogya
	Hendrykus Parus Matur	Surabaya Zoological Garden
	Sjamsuddin Joeda	Balai Karantina
	Hewan Soekarno	Hatta Pusat Karantina Pertanian
	Francis Lim	Singapore Zoological Gardens
	Jiri Holba	Taman Safari
	Sharmy Prastiti	Taman Safari
	Rick Hudson	Fort Worth Zoo Texas, USA
	Donal Boyer	San Diego Zoo California, USA
	Trooper Walsh	National Zoo Washington DC, USA
	Johnny Arnett	Cincinnati Zoo Ohio, USA
	William A. Rapley	Metro Toronto Zoo Canada

THE CINCINNATI ZOO AND BOTANICAL GARDEN

MEMORANDUM

TO: All Concerned
FROM: Johnny Arnett, International Studbook Keeper
RE: Information about *Varanus komodoensis*

Dear Esteemed Colleagues,

I am in the process of compiling information about Komodo Dragons (*Varanus komodoensis*) for a future publication of an International Studbook. All current as well as historical information about your specimens is needed. The more historical information submitted will allow for a more complete world-wide view of the keeping of this species.

I have enclosed an information fact sheet which can be used for the submitting of all data that you may have for this long term project. This sheet can be used for ease in data collection, and processing. Please use one sheet for each of your specimens, and feel free to photo-copy it if you have more animals than sheets provided.

Please return this information to me at the address listed below. Any questions and/or concerns can also be directed to me at the following address:

Johnny R. Arnett
Cincinnati Zoo & Botanical Gardens
3400 Vine Street
Cincinnati, Ohio 45237 USA

I would like to thank you in advance for your help with this important project, and will keep you updated as to it's progress.

Sincerely,

Johnny R. Arnett
Area Supervisor, Cincinnati Zoo

3400 Vine Street, Cincinnati, Ohio 45220-1399, phone (513) 281-4701

INTERNATIONAL STUDBOOK INFORMATION SHEET

Varanus komodoensis

Please complete all information as it pertains to each one of your animals. Use a separate sheet for each specimen.

VITAL STATISTICS

House Name (if any): ____________________ House ID# (if any): ____________________

Date of Birth: ______________________________ Sex: ______________

Type of Birth: ☐ WILD, If yes Date Caught: ____________________

Area Caught: ____________________

☐ CAPTIVE HATCH If yes, Sire ____________________

Dam ____________________

Type of Rearing (hand, parent, etc.) ______________

Date of Death: ______________ Cause of Death (if known): ____________________

Autopsy performed: ☐ YES ☐ NO

Specimen Preserved: ☐ YES ☐ NO if yes how?: ________

____

Transponder ID #: ____________________ Date Implanted: ______________

Site of Implantation: ______________________________

ANIMAL MOVES / TRANSFERS / CHANGE IN OWNERSHIP / ETC.:

(First entry should be when animal first came to your institution)

DATE	TYPE OF TRANSACTION (breeding loan, transfer, gift, etc.)	RECEIVING INSTITUTION / INDIVIDUAL	NEW HOUSE ID (name, number if known)

Submitting Institution / Individual : ______________________________ Date: ______________

Varanus griseus koniecznyi/**GREY MONITOR/**

LOSANGELE 1. 0. 0(0) Region (1.0.0(0))

Total held: 1.0.0 =1 Number of institutions: 1 Captive Born:100% Wild Born: 0% Captive births last 12 months: 0 Deaths first 30 days: 0

Varanus indicus (no subsp)/**MANGROVE MONITOR/**

ARNHEM 1. 1. 0(0)
MONROE 1. 1. 0(0)
SYDNEY 1. 0. 0(0)
DRESDEN 0. 1. 1(0)
REDWOOD 1. 0. 0(0)
Region (1.0.0(0))
Region (1.2.1(0))
ST LOUIS 3. 1. 0(0)
BALTIMORE 3. 2. 0(0)
Region (11.6.0(0))
CLEVELAND 0. 2. 0(0)
TOKYOUENO 0. 1. 0(0)
HONOLULU 3. 0. 0(0)
Region (0.1.0(0))

Total held: 13.9.1 =23 Number of institutions: 10 Captive Born: 13% Wild Born: 52% Captive births last 12 months: 0 Deaths first 30 days: 0

Varanus indicus kalabeck/**MONITOR/**

BALTIMORE 0. 0. 2(0)
CHICAGOLP 1. 0. 0(0)
Region (1.0.2(0))

Total held: 1.0.2 =3 Number of institutions: 2 Captive Born: 0% Wild Born: 67% Captive births last 12 months: 0 Deaths first 30 days: 0

22 *Varanus komodoensis*/**KOMODO DRAGON/** IUCN Red List: Rare in wild

ROTTERDAM 1. 0. 0(0)
CLEVELAND 0. 0. 2(0)
LOUISVILL 0. 0. 2(0)
YULEE 1. 1. 0(0)
SYDNEY 1. 0. 0(0)
Region (1.0.0(0))
COLUMBUS 0. 0. 2(0)
METROZOO 1. 1. 0(0)
Region (6.5.35(10))
Region (1.0.0(0))
ATLANTA 0. 0. 2(0)
DALLAS 0. 0. 1(0)
MINNESOTA 1. 1. 0(0)
SAIGON 1. 1. 0(0)
AUDUB SSC 1. 1. 0(0)
DREHER PA 0. 0. 1(0)
NZP-WASH 1. 1. 14(10)
SINGAPORE 3. 0. 0(0)
BROWNSVIL 0. 0. 4(0)
FORTWORTH 0. 0. 1(0)
SEDGWICK 0. 0. 2(0)
TOKYOUENO 0. 1. 0(0)
CINCINNAT 1. 0. 2(0)
FT WAYNE 0. 0. 1(0)
ST LOUIS 0. 0. 1(0)
Region (4.2.0(0))

Total held: 12.7.35 =54 Number of institutions: 22 Captive Born: 72% Wild Born: 26% Captive births last 12 months: 10 Deaths first 30 days: 0

Varanus mertensi/**MERTEN'S WATER MONITOR/**

FRANKFURT 0. 1. 0(0)
KREFELD 0. 0. 2(0)
Region (0.1.2(0))
NY BRONX 1. 1. 2(0)
Region (1.1.2(0))

Total held: 1.2.4 =7 Number of institutions: 3 Captive Born: 86% Wild Born: 0% Captive births last 12 months: 0 Deaths first 30 days: 0

Varanus mitchelli/**MITCHELL'S MONITOR/**

MELBOURNE 0. 0. 1(0) Region (0.0.1(0))

Total held: 0.0.1 =1 Number of institutions: 1 Captive Born: 0% Wild Born: 0% Captive births last 12 months: 0 Deaths first 30 days: 0

Varanus niloticus/**NILE MONITOR/**

ANTWERP 0. 0. 1(0)
Region (3.1.11(0))
CHEHAW 0. 0. 1(0)
NZP-WASH 0. 0. 1(0)
Region (1.0.0(0))
BARCELONA 1. 0. 8(0)
JOHANSBRG 0. 0. 1(0)
FORTWORTH 0. 0. 1(0)
SCOTTSBLU 0. 0. 1(0)
COLCHESTR 0. 1. 0(0)
KRAAIFONT 0. 0. 1(0)
FRANKLINP 0. 0. 1(0)
WACO 0. 0. 1(0)
DUBLIN 1. 0. 1(0)
PORT ELIZ 2. 0. 0(0)
HONOLULU 0. 0. 3(0)
WILD WRLD 0. 0. 2(0)
LISBON 0. 0. 1(0)
Region (2.0.2(0))
LUFKIN 1. 0. 0(0)
Region (1.1.13(0))
PARIS JP 1. 0. 0(0)
CHATTANOO 0. 0. 2(0)
METROZOO 0. 1. 0(0)
RAMAT GAN 1. 0. 0(0)

Total held: 7.2.26 =35 Number of institutions: 21 Captive Born: 9% Wild Born: 46% Captive births last 12 months: 0 Deaths first 30 days: 0

See report introduction for a description of values

Age Pyramid Report

```
Restricted to:                KOMODO DRAGON Studbook                     Page     1
 Status: Living by  5 Dec 1995
===============================================================================
Taxon Name: VARANUS KOMODOENSIS
===============================================================================

Age                                    Males|Females
---               N =  40          ---------------               N =  35
 13-                                       X|
 12-                                   XXXXX|
 11-                                       X|
 10-                                        | X
  9-                                       X|
  8-                                       X| XXX
  7-                                        |
  6-                                        |
  5-                                        |
  4-                                        |
  3-                                  X?????| ?????XX
  2-                               X????????| ????????
  1-                        ????????????????| ????????????????
  0-
- - - - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - - -
        32  28  24  20  16  12  8   4           4   8   12  16  20  24  28  32
                                   Number of Animals

 X >>> Specimens of known sex...
 ? >>> Specimens of unknown sex...
     1 Male Specimens of unknown age...
```

Census Report

Restricted to: KOMODO DRAGON Studbook

Dates: As of End of date <= 31/12/1993

Year as of 31 Dec	Specimen Counts		Observed Lambda Annual	Observed Lambda Geometric Mean
1993	10.4.23	(37)	1.61	
1992	9.4.10	(23)	2.56	2.03 (last 2 yrs)
1991	7.2.0	(9)	1.13	1.67 (last 3 yrs)
1990	6.2.0	(8)	1.33	1.58 (last 4 yrs)
1989	4.2.0	(6)	1.50	1.56 (last 5 yrs)
1988	3.1.0	(4)	2.00	1.63 (last 6 yrs)
1987	2.0.0	(2)	1.00	1.52 (last 7 yrs)
1986	2.0.0	(2)	2.00	1.57 (last 8 yrs)
1982	1.0.0	(1)	1.00	1.49 (last 9 yrs)

Note: Lambda values include Imports and Exports...

Growth Chart Captions

1994 Egg Weight During Incubation shows the changes in egg mass throughout the period of incubation.

Weight vs Age Growth in Captive *Varanus komodoensis* shows the changes in weight for all of juvenile dragons for which we have data. The diamonds mark the actual data points.

Weight vs Age Growth in Captive *Varanus komodoensis*/Mean and Standard Deviation illustrates in red one measure of variability in the data, in this case the extent to which individual data deviate from the "average" (in this case the mean). In other words this chart helps identify those animals that are not "typical" (like Odoe) compared to the group as a whole. The standard deviation value increases as the animals' age because the growth rates of the animals' are deviating more and more from the mean. This can be due to differing feeding and care regimens at the various institutions, error introduced in measuring technique, individual characteristics (for example, a picky eater), and whether the animal was weighed with a meal in its belly. The mean and standard deviation values really get wacky for animals greater than 24 months, because we have only 13 animals from which we can get data. Even assuming that we had data on all 13, this is not enough data for meaningful interpretation; as the younger animals age in the next year we will be able do better.

SVL vs Age Growth in Captive *Varanus komodoensis* shows the changes in snout-vent length for all of the juvenile dragons for which we have data. The diamonds mark the actual data points.

SVL vs Age Growth in Captive *Varanus komodoensis*/Mean and Standard Deviation illustrates the variability in the snout-vent length data. There seems to be less variability in how juvenile dragons grow in snout-vent length compared to how they grow weightwise.

Tail Length vs Body Length Growth in Captive *Varanus komodoensis* illustrates the gradual change from juvenile body proportions (tail nearly 2/3 of the total length) to adult proportions (tail only 1/2 of the total length). On this chart the gray line represents the halfway point between 2/3 and 1/2 tail (otherwise known as 7/12 tail) and bisects the wedge-shaped area of interest. In general the data points for very young juveniles are clustered on the 7/12 line or on the 2/3 tail side of of it. The tail:body ratio starts to gravitate towards the 1/2 tail side of the wedge as the animals age.

Weight vs Total Length Growth in Wild and Captive *Varanus komodoensis* compares data from a number of sources: the 3 years worth of data on the 55 captive born dragons produced by the NZP female, Sobat; 20 months worth of data on 8 dragons born at the Surabaya Zoo, and a set of measurements taken of 29 individual wild dragons by Dr. Auffenberg and published in Figure 2-2 in *The Behavioral Ecology of the Komodo Monitor*, 1981.

Average Egg Mass vs incubation time (Vivarium slide)...
- shows average Komodo dragon egg mass by incubation time in three different water to soil concentrations:

① ▲= 1 to 1 water to soil.
② X= 1 to 2
③ ■= 1 to 4

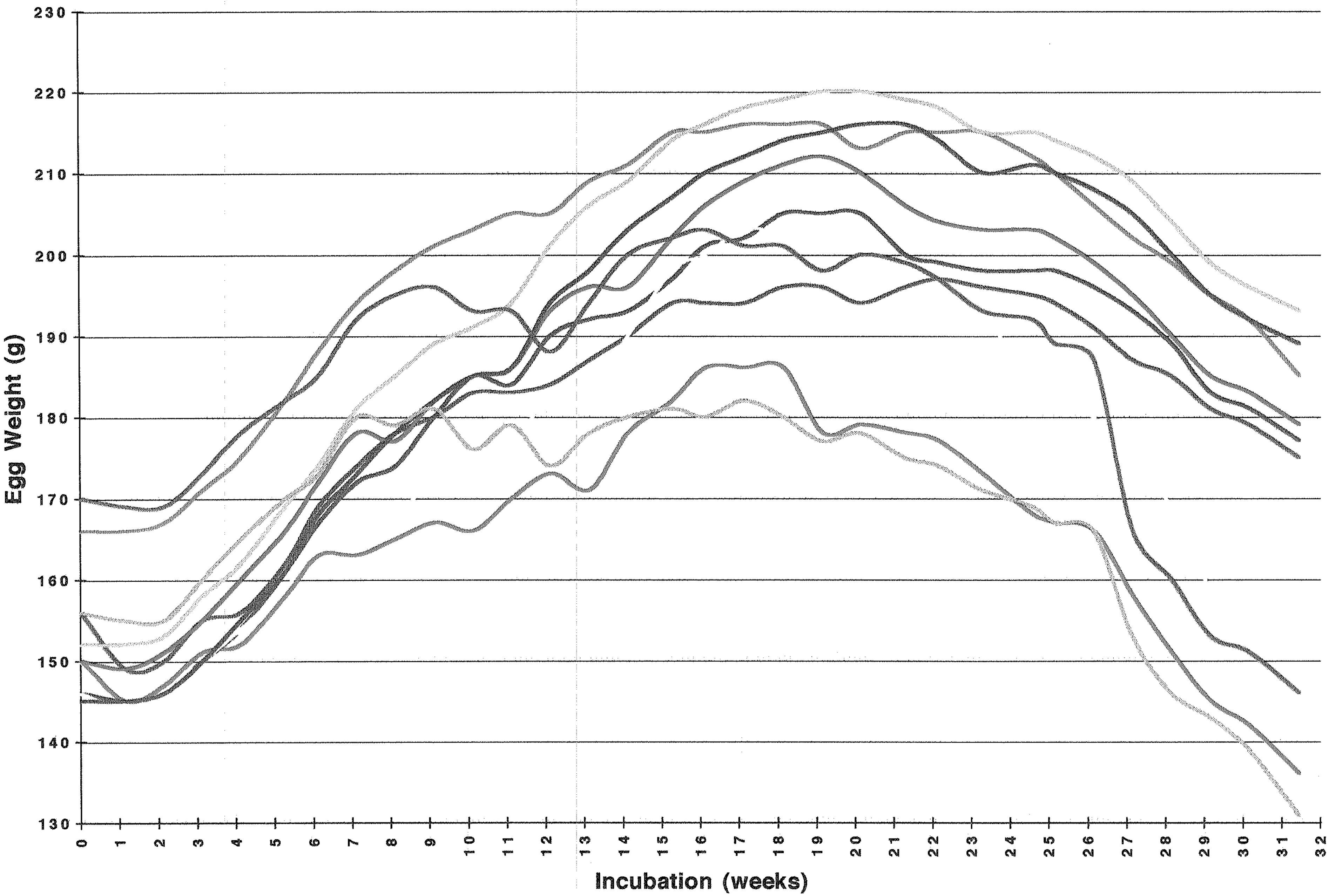
---

mean: Is different than average and is the value exactly midway positionally in a series of sorted data. 6 is the mean for the 5 data values: 1, 2, 6, 100, 1000 - it's the one in the middle.

standard deviation: In a normal distribution (also called a "bell curve"), ± 1 standard deviation from the mean would encompass 68% of the animals.

Note ↑

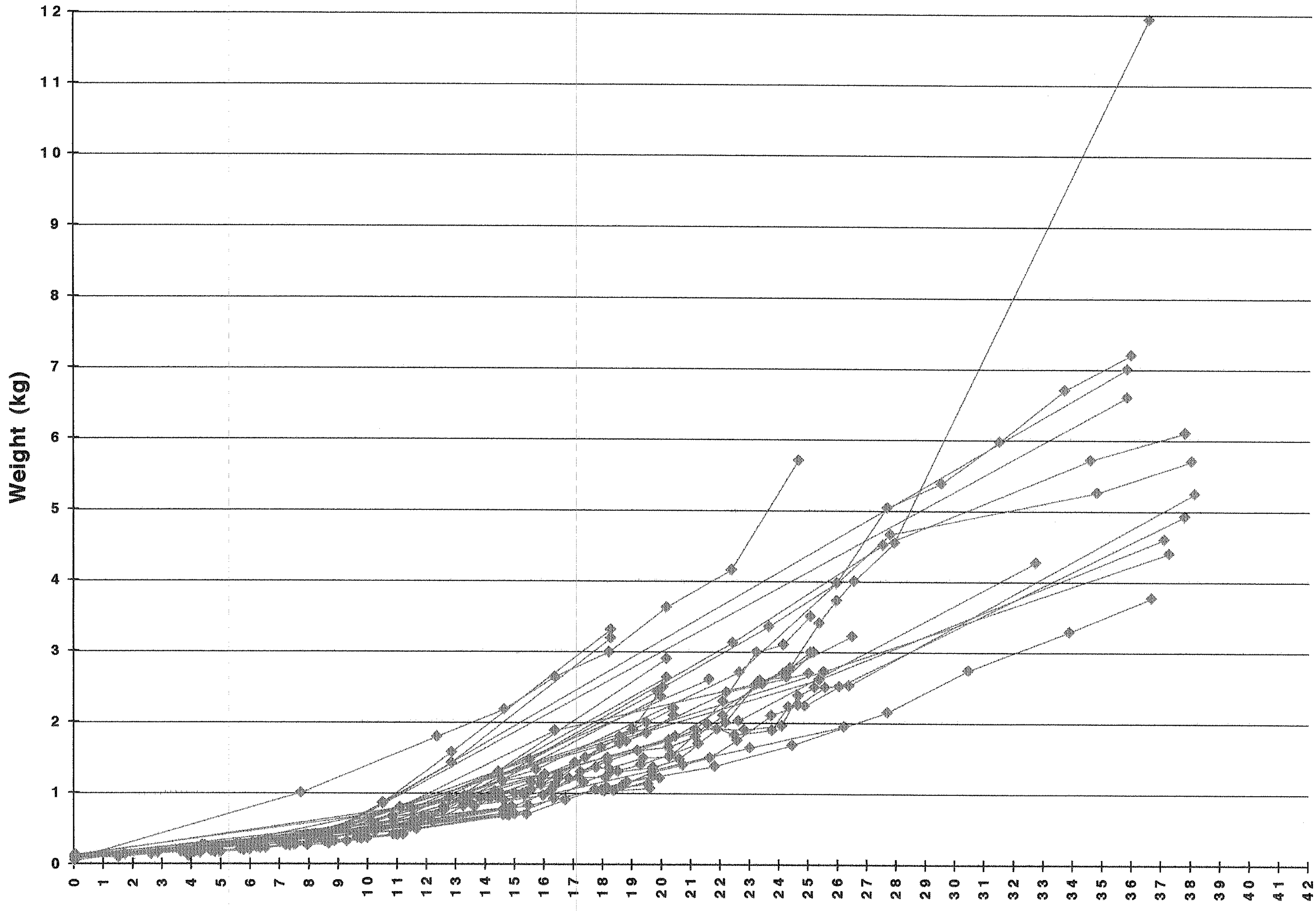
Egg Weight during Incubation
1994 Clutch



National Zoo/Department of Herpetology

11/20/95

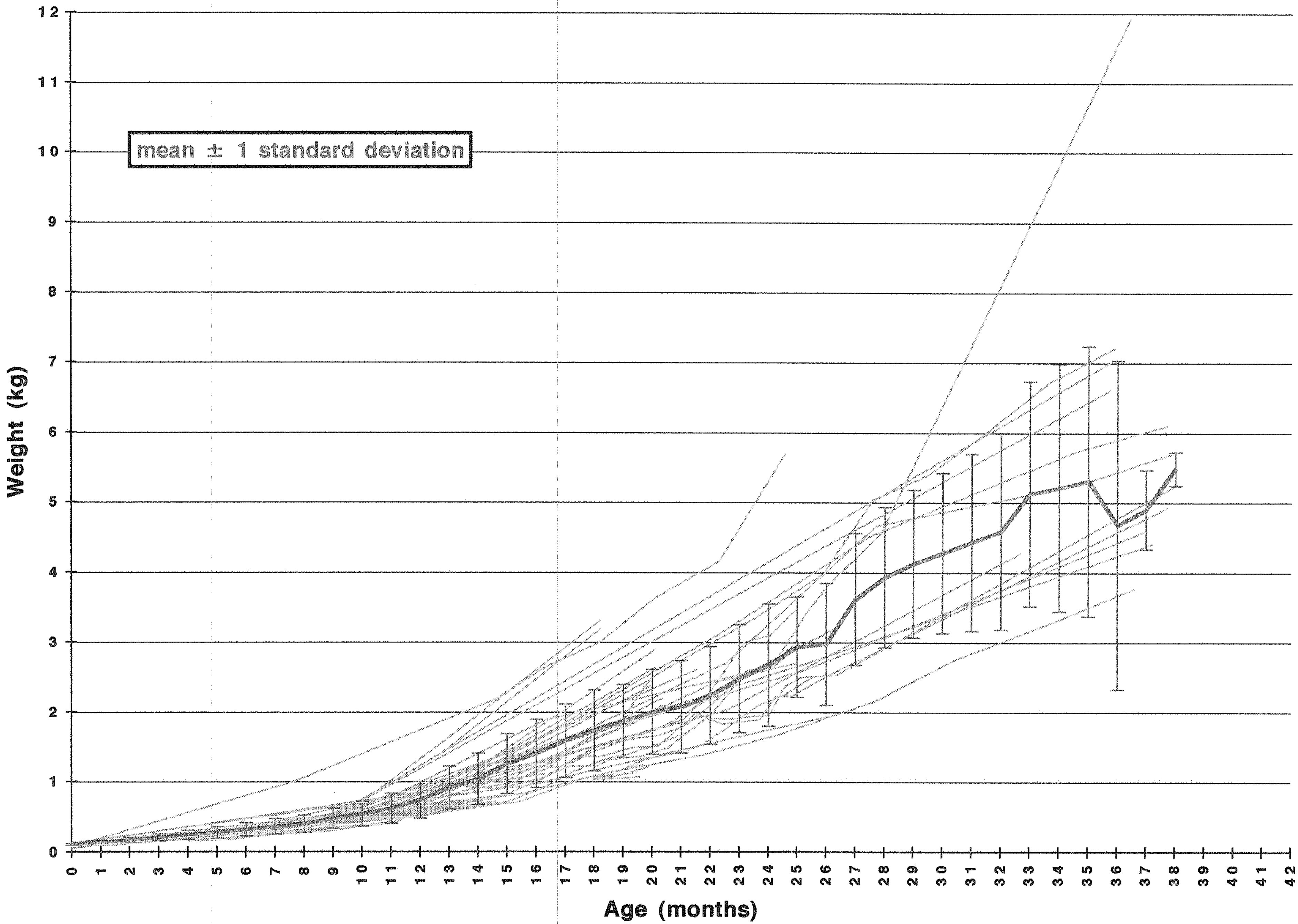
Growth in Captive *Varanus komodoensis*
Weight vs Age



National Zoo/Department of Herpetology

11/20/95

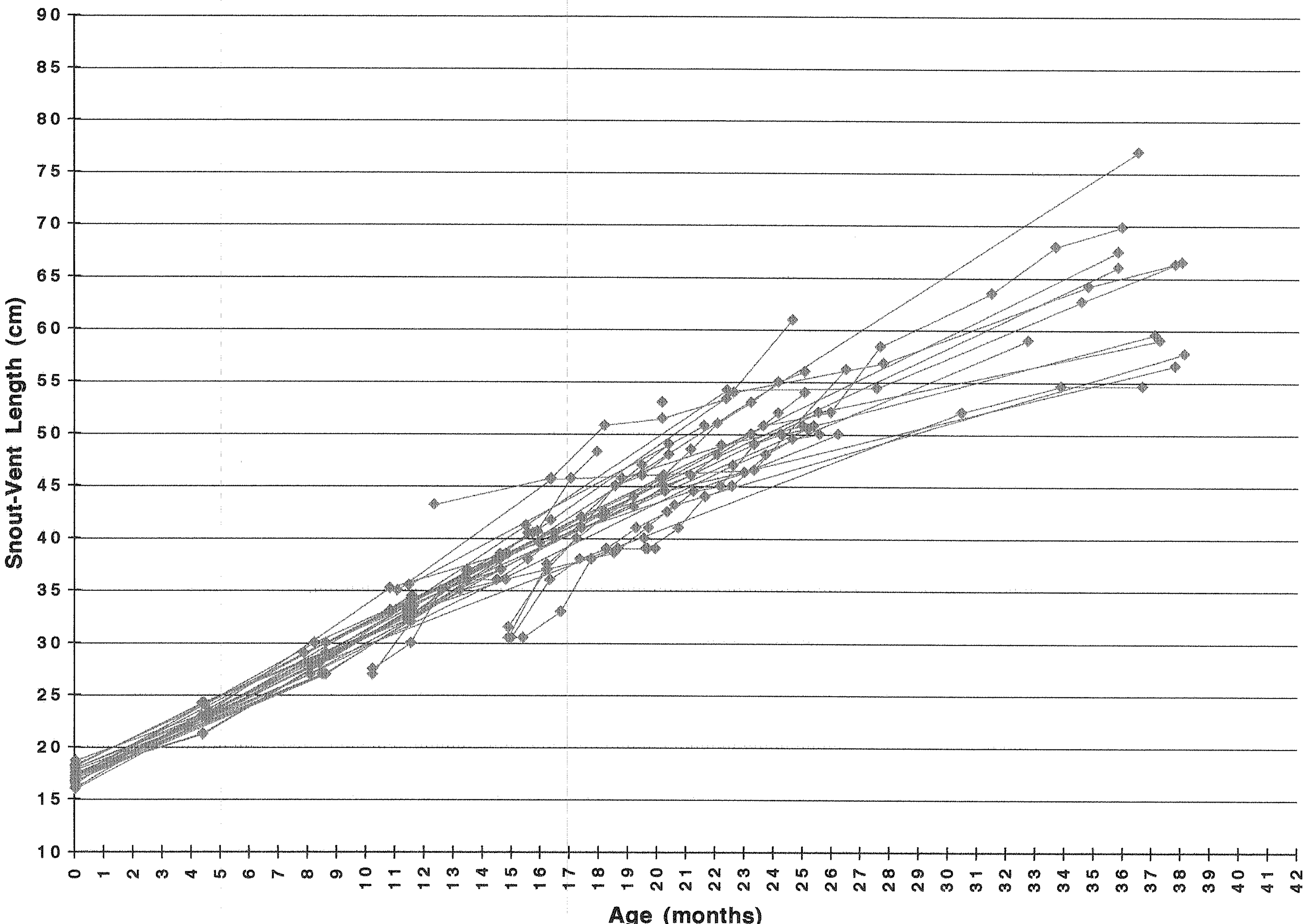
Growth in Captive *Varanus komodoensis*
Weight vs Age



National Zoo/Department of Herpetology

11/20/95

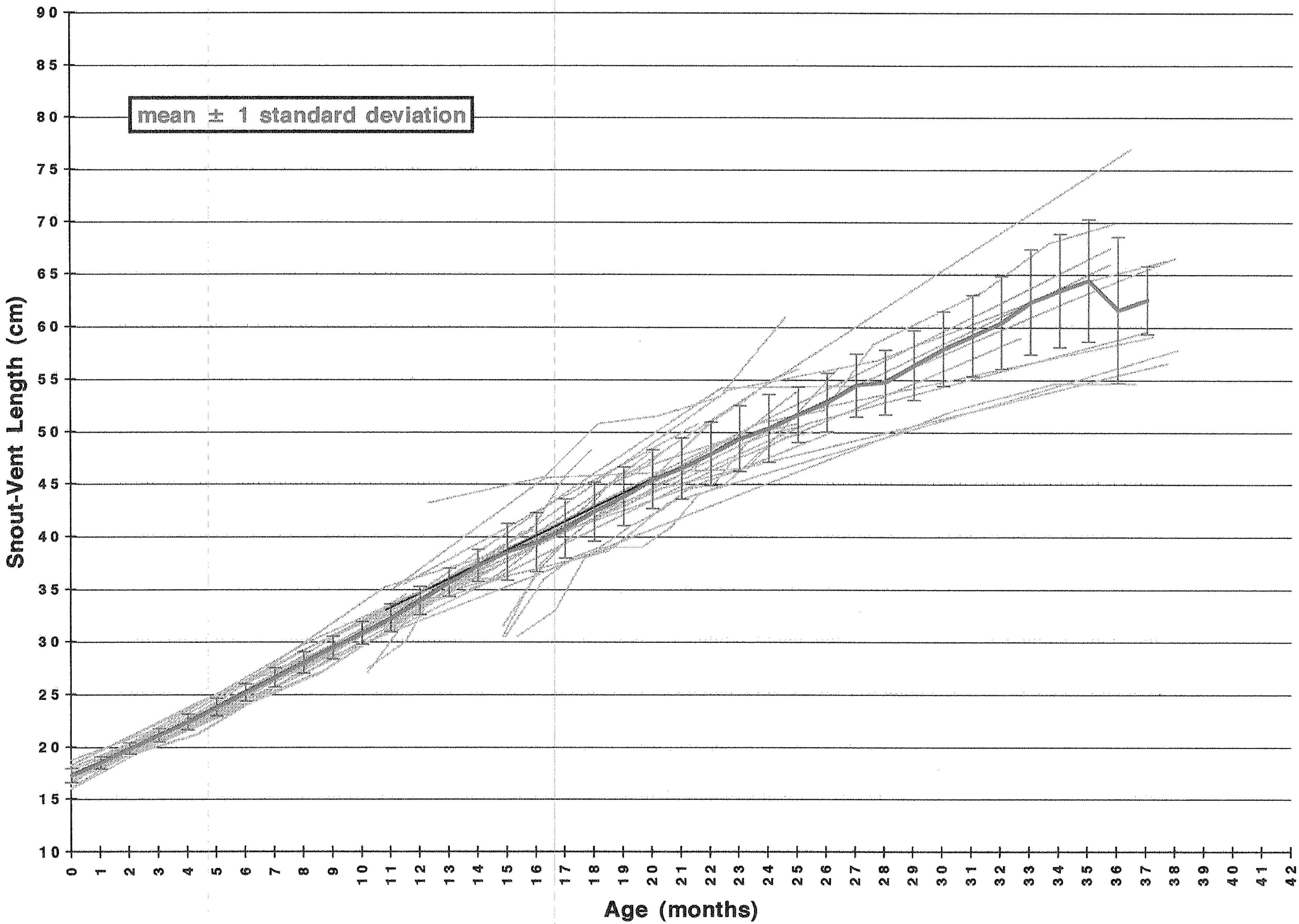
Growth in Captive *Varanus komodoensis*
Snout-Vent Length vs Age



National Zoo/Department of Herpetology

11/20/95

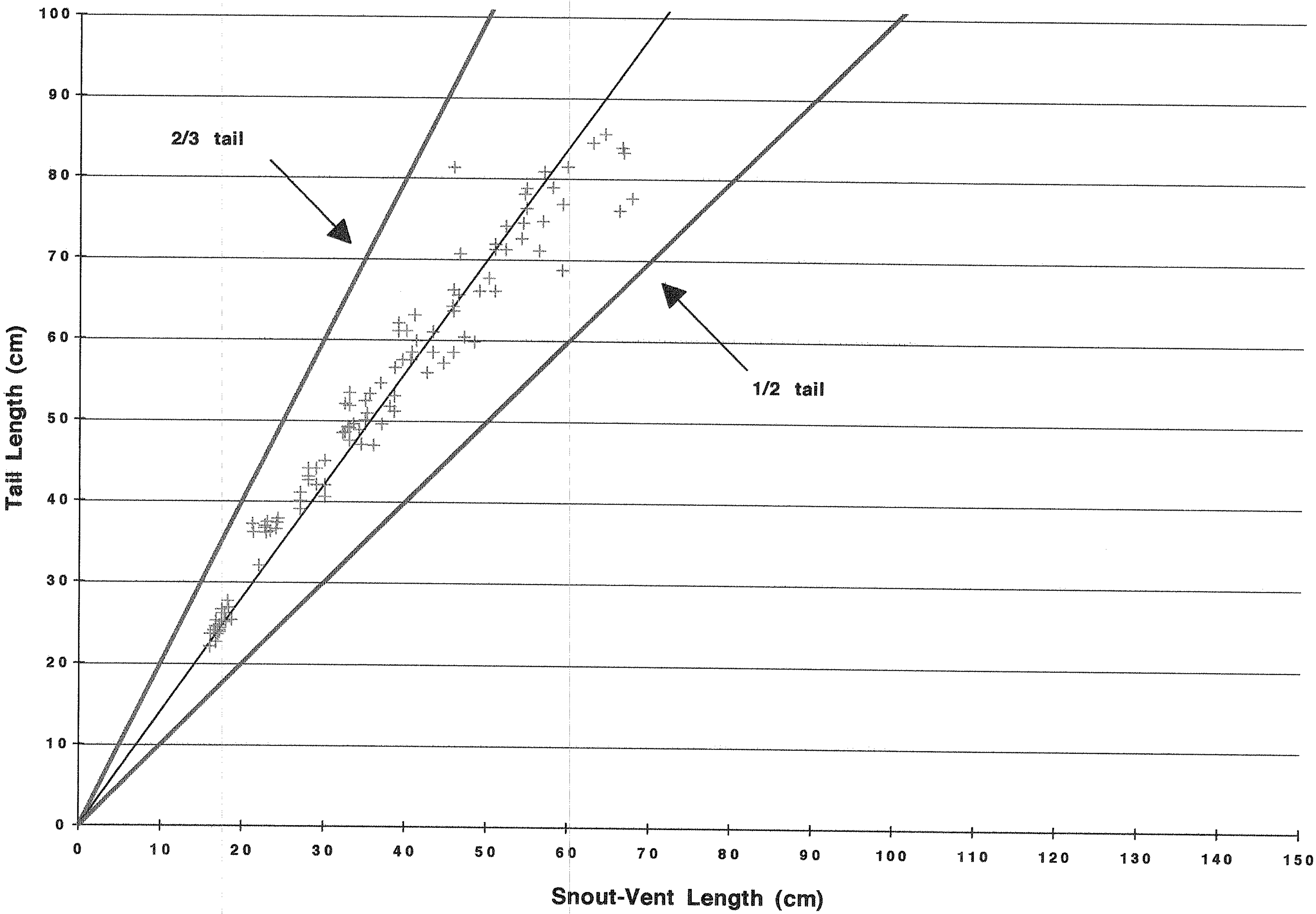
Growth in Captive *Varanus komodoensis*
Snout-Vent Length vs Age



National Zoo/Department of Herpetology

11/20/95

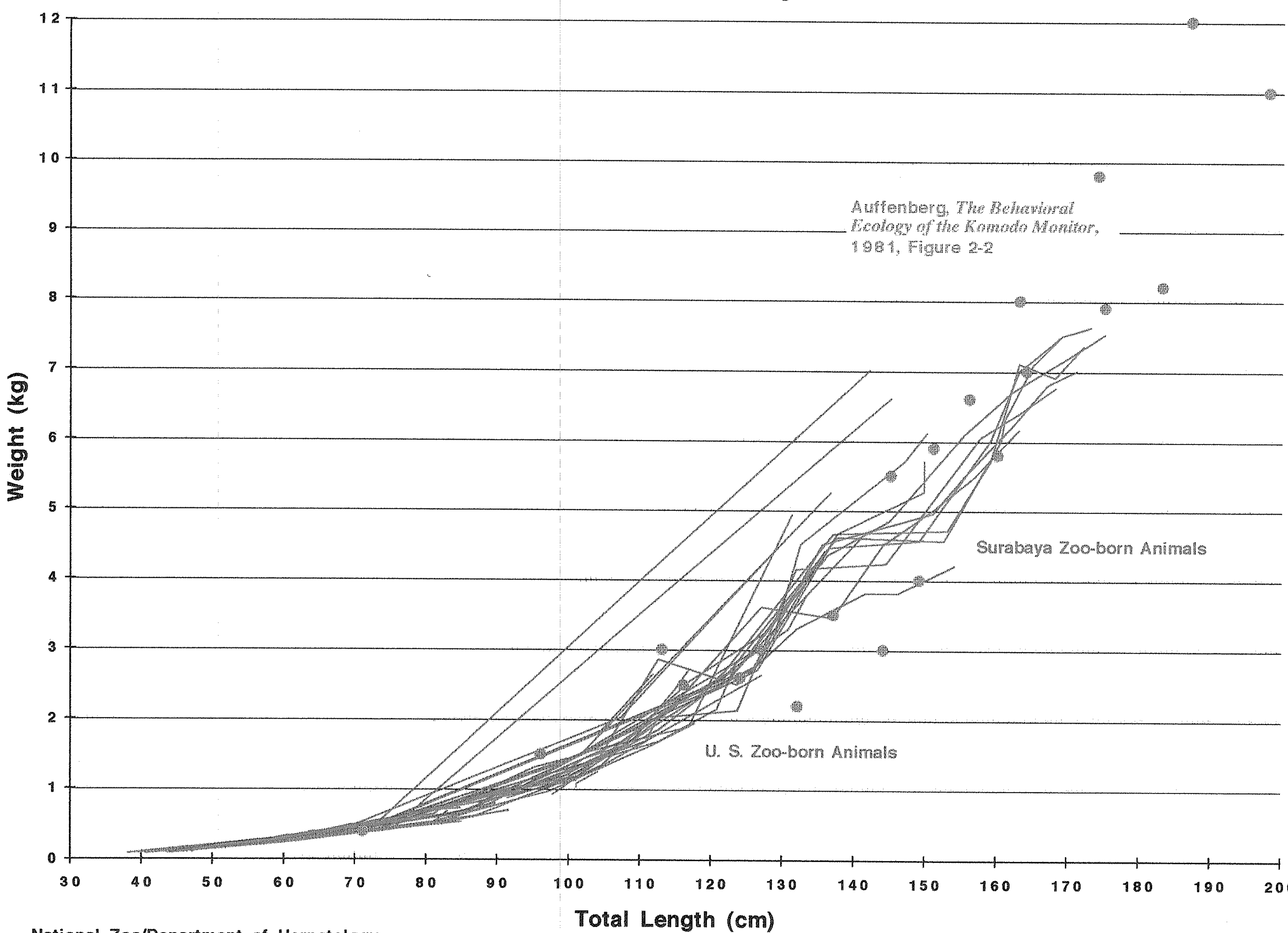
Growth in Captive *Varanus komodoensis*
Tail Length vs Snout-Vent Length



National Zoo/Department of Herpetology

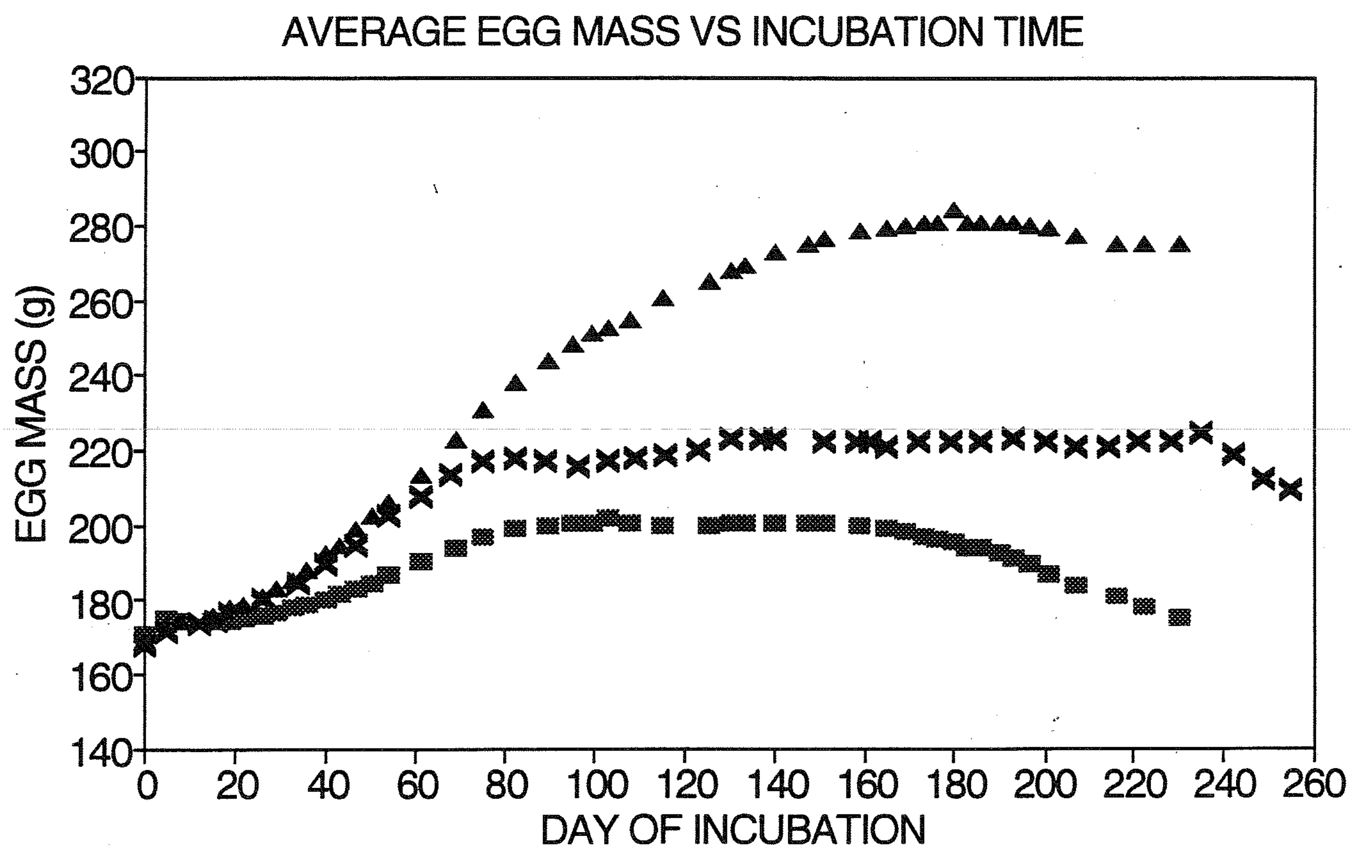
11/20/95

Growth in Captive and Wild *Varanus komodoensis*
Weight vs Total Length



National Zoo/Department of Herpetology

11/20/95


AVERAGE EGG MASS VS INCUBATION TIME
EGG MASS (g)
320
300
280
260
240
220
200
180
160
140
0
20
40
60
80
100
120
140
160
180
200
220
240
260
DAY OF INCUBATION

KOMODO MONITOR

Varanus komodoensis

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

December 4-7, 1995

Taman Safari Indonesia
Cisuara, Indonesia

APPENDIX I

TAXON MANAGEMENT ACCOUNT

Compiled by: Trooper Walsh, National Zoo, U.S.A.
Compilation date: 2 May 1996

KOMODO DRAGON

Sauria
Varanidae
Varanus komodoensis

Introduction and Natural History

Description: Adult male Komodo dragons generally grow larger than females and may be 3 m total length and 90 kg. Females are usually under 2 m and weigh about 70 kg. The body mass of large Komodo monitors is proportionately more bulky than that of smaller specimens. Color undergoes an ontogenetic change. Juveniles to about age four are multi-hued (yellow, green, brown, gray) speckled and banded. Ground color in mature animals is rather uniform but varies in different populations. Adult dragons from Flores are an earthen red whereas specimens from other islands range from slate gray to black. Age of sexual maturity is estimated to be about six years. Longevity is known from captive specimens to be over 20 years (3, 5, 14).

Distribution and Habitat: The distribution of Komodo dragons is restricted to a few Indonesian islands of the Lesser Sunda chain including Komodo, Rintja, and the western coast of Flores. Reports of dragons on smaller nearby islets, including Padar and Gila Motang, are probably based on records of transient animals. These latter populations are somewhat ephemeral with the species occasionally being totally absent. This has been attributed to periodic fires and the lack of suitable prey. The depopulation and repopulation of Padar and Gila Motang is proof that these lizards can swim and survive for relatively long periods in the water. The total land area occupied by Komodo dragons is less than 1000 sq km, making it the smallest range of a top carnivore anywhere in the world (3).

The volcanic islands on which the Komodo monitors live are arid uplifts with steep angular slopes and alluvial fans. The stream beds and valley floors are rocky with shallow soils. The vegetation communities are simple; the low rainfall and its seasonal occurrence produce open, semiarid types such as monsoon forest, savanna, and steppe, dominated by the savanna. The dragons are most abundant in the lowland monsoon forests and savanna communities up to 700 m.

The range of the Komodo dragon includes the driest areas of Indonesia and receives less than 75 cm of rain a year, falling almost entirely during the months of December to March. Average annual air temperature at sea level on Komodo is 26.7 C (43 C annual maximum and 17 C annual minimum). November is the warmest month and February the coolest (3).

Ecology and Life History: Adult dragons have large activity ranges, moving an average of 2 km a day. This range includes a core area, where most of the animals' activities take place, and a larger foraging area. Although the animals avoid each other's core areas, their foraging areas overlap. The core areas contain the animal's burrow and favorite thermoregulatory sites. Core areas are defended by the resident dragon. Adult Komodo dragons dig their own burrows or utilize natural shelters between rocks or cavities in river banks. Juvenile dragons live an arboreal lifestyle which enables them to avoid the larger, cannibalistic adults (3).

Komodo dragons are opportunistic carnivores and are at the top of their food chain. They feed on both live prey and carrion and are capable of taking down deer, wild boar, and water buffalo (all introduced species). Approximately 10 percent of an adult dragon's diet consists of smaller, weaker Komodo dragons. Their keen sense of smell enables them to locate food from as far away as five miles if the wind conditions are right and the scent strong. Their teeth are curved and serrated for tearing off large chunks of flesh and their claws are strong and sharp for ripping open carcasses. The saliva of wild Komodo dragons is known to harbor a variety of virulent bacteria, probably the result of feeding on carrion. Even an incidental bite from a dragon may lead to blood poisoning and death in a short period of time. Dragons have been observed eating up to 80% of their own body weight in one meal. When necessary they may not feed for months at a time. Young dragons, living in a different niche, feed on insects, small birds and mammals, and other reptiles which may be more readily available throughout the year. Carrion of any type is acceptable to dragons of all ages (3).

Courtship and breeding usually occur May through June, often in foraging areas near carrion and frequently in the presence of other lizards. Females dig nesting burrows in their core areas which they backfill after egg laying. The nest mounds of the brush turkey, *Megapodius freycineti*, are sometimes used by dragons for egg laying. Egg laying usually takes place July through August. Laying females may defend nest sites for a period of time after oviposition. After approximately nine months the eggs hatch and the young are on their own (3).

Conservation Status

Varanus komodoensis is CITES Appendix 1 and is listed as endangered by the International Union for the Conservation of Nature and Natural Resources (IUCN) and the United States Department of the Interior. Indonesia accords the Komodo dragon its highest level of protection and considers it a national treasure.

The range of the Komodo dragon, with the exception of Flores, was declared Komodo National Park (KNP) in 1980. In 1991 the park was classified as a World Heritage Site.

In late 1995 the IUCN sponsored a Komodo dragon Population and Habitat Viability Assessment (PHVA) workshop in Bogor, Indonesia. The PHVA resulted in recommendations for management of both captive and wild populations of dragons. Priority actions for *in situ* management included: a) updated census of Komodo monitors in the KNP; b) habitat assessment and census of prey species; c) study and protection of dragons on Flores; d) development of simple and reliable sexing techniques; e) determination of the genetic structure of Komodo dragons throughout their range and on individual islands; and f) study of the effects and impact of ecotourism (17).

In 1996 the Director of the KNP instituted a consortium for the park, open to internationals, in an effort to better study and protect the Komodo monitor and its habitat (20).

The wild population of several thousand animals is currently relatively stable except possibly on the island of Flores where dragons compete with local farmers for resources. Major threats include habitat alteration, poaching of prey species, and perhaps tourism (17).

Captive Management

Captive Population: As of December 1995 there was a total global captive population of 191 (31.21.139) Komodo dragons known to ISIS. Of these, 36 are founders of which 13 are represented in the population. Their locations are as follows:

* Indonesia: 103 (19.14 74); 10.8 wild-caught with roughly 10 founders represented.
* United States: 63 (5.3.55); 5.3 wild-caught with 3 (2.1) founders represented.
* Europe/Asia/Australia: 21 (7.4.10) with 7.3 potential founders (no breeding yet).

Less than a dozen successful breedings have been recorded worldwide. The first documented captive breeding of Komodo dragons took place at the Gembira Loka Zoo in 1968 (6). The most recent hatching also occurred at Gembira Loka in May of 1995. The following institutions have had breeding successes with Komodo dragons:

1. Ragunan Zoo, Indonesia
2. Surabaya Zoo, Indonesia
3. Gembira Loka Zoo, Indonesia
4. National Zoo, United States
5. Cincinnati Zoo, United States

The captive working group of the PHVA suggested that efforts be made to selectively breed unrepresented founder animals to increase the genetic diversity of the captive population. There was also a consensus that founder stock should be increased and dispersed into capable institutions worldwide (17).

The zoo carrying capacity for dragons has yet to be established, although Indonesian zoos estimated that 130 adult animals could be maintained in their institutions.

Johnny Arnett of the Cincinnati Zoo is compiling data for both the United States regional and the international studbooks. Plans are for an Indonesian counterpart to assume the role of international studbook keeper in the near future.

The majority of the Komodo dragons in the U. S. population are permanently tagged for identification with implanted microchip transponders (InfoPET/Trovan Electronic Animal Identification System, manufactured by AEG/Daimler-Benz, Germany). The standardized implantation site is on the left side of the animal in the shoulder or hip region. Ultimately the entire captive dragon population should be given Trovan transponders as this system has been accepted internationally as the standard for microchip identification of zoo animals (17).

Husbandry Parameters

Housing: As large predators dragons seem to benefit from some of the same caging parameters that big cats have come to enjoy in zoos, such as quality and quantity of space.

Indonesian zoos have had success maintaining groups of Komodo dragons and have bred them in large outdoor facilities (200 to 400 sq m) under natural conditions (6, 15, 16, 17, 21). Environmental factors in Indonesia which seem key to long term maintenance and the display of natural behaviors in dragons include: adequate space and visual barriers, earthen substrate for denning and nesting, natural sunlight, the opportunity to bask at high temperatures, and seasonal climatic change.

Through the mid 1980s Komodo dragons rarely thrived and did not breed in zoos outside of Indonesia. There are a number of possible reasons for this. Dragons that were exported for zoos were generally larger, older animals which were easily stressed by capture and shipment. Also, European and American zoos typically kept dragons in small, sterile, concrete cages with limited heat sources.

In the late 1980s American zoos, starting with the NZP, began to incorporate some of the environmental ingredients that worked well in Indonesian exhibits. The National Zoo developed a 68 sq m L-shaped duplex for a pair of adult dragons imported in 1988. This exhibit is a dirt floored greenhouse incorporating multiple retreat and basking areas, a nesting area, and a variety of visual barriers. The exhibit can be sectioned off into two fully complimented enclosures so that animals can be kept separately (15, 17, 23). Currently eight U. S. institutions have adequate modern facilities for adult dragons. The zoos are Audubon, Cincinnati, Ft. Worth, Miami Metro, Minnesota, NZP, San Diego, and the White Oak Plantation.

Environmental concerns: This xeric adapted varanid should be kept in dry quarters with a thermal gradient of 25 - 45 C. Animals should not be allowed to come into direct contact with heating elements. It is not known if Komodo dragons need ultraviolet (UV) light for processing vitamin D-3 and proper bone mineralization, but these lizards do seek out natural sunlight. Current studies at NZP suggest that young dragons and reproducing females may benefit to some degree from UV light in the B spectrum (1). Where climate allows, it is suggested that outdoor enclosures be incorporated into exhibits. In temperate climates greenhouse facilities with UV-transmitting panels are desirable. Komodo monitors kept indoors should have access to UV-B producing fluorescent lights situated 20 - 50 cm above basking areas.

Juvenile and young adult dragons are excellent climbers, so this should be taken into consideration when choosing cage furnishings and restraints. Care should be taken to avoid abrasive materials like rough concrete block with exposed corners or wire mesh which allow escapes and foot injuries. Enclosures surrounded by smooth, solid walls and glass viewing areas at least 1.8 m high are recommended for outdoor dragon exhibits. Footers need to be buried at least 50 cm to discourage animals from digging out. Secondary hot wire restraints have been used with success at several institutions including the Cincinnati and Singapore Zoos.

Natural and man made burrows are readily used by dragons as sleeping dens at night and as retreats from the heat of the day. Soil, sand, hardwood mulch, or a combination thereof, are acceptable exhibit substrates as they allow natural digging behaviors and are non-abrasive to feet and tails. Substrate integrity should be considered when animals are digging to avoid collapsed burrows and suffocation. Dragons will utilize partially buried logs as burrow entrances for structural integrity. If large rocks or detached cement pools are used in the exhibit the lizards may burrow underneath making it difficult to access the animals. Komodo dragons rarely dig vertically beyond 50 cm but may tunnel horizontally for several meters.

Communal exhibits should be as spacious as possible with a recommendation of 30 sq m per adult dragon and should incorporate visual barriers between multiple basking, denning, and nest areas. Nest areas should be sectioned off to allow isolation of gravid females and should have 60 - 100 cm of top soil. At an ambient air temperature of 28 C it is recommended that the nest site have an overhead heat source warming the surface of the soil to 40 C. In addition to isolated nest sites, individual holding areas should be available in group enclosures to sequester injured or subordinate specimens. Several zoos have developed specialized shift boxes for dragons to facilitate manipulations, examinations, x-rays, and medical procedures. Fresh drinking water should be available at all times. Specimens will utilize pools both as retreats and to thermoregulate. Pools, shift doors, and keeper entrance ways should be elevated from the floor to avoid interference from substrate when it is shifted by inhabitants.

Nutritional requirements: Indonesian and American zoos feed dragons differently. The Gembira Loka Zoo on Java feeds hatchling dragons daily for the first eight months and then every three days through the next year. This frequency of feeding is necessary to avoid cannibalism among young dragons being raised communally (22). These lizards are provided a diet of 20% whole mice and 80% chopped beef or lamb with vitamin/mineral supplements. It is not yet known what possible long term effects may result from such frequent feedings in young dragons which may be growing at an accelerated rate. Subadult and adult animals are fed less frequently on lamb and beef with organ meats included. All of the Komodo dragons at Gembira Loka, including hatchlings, are given daily access to hot spots and direct sunlight to aid digestion and bone mineralization.

Most North American zoos have been raising young dragons based upon a protocol established by the NZP. Hatchlings at the NZP are started on whole 15 gm mice offered every five days until approximately 10 months of age when they are fed proportionately larger meals once a week. Reluctant feeders are stimulated to eat by splitting open the head or stomach of mice, exposing blood and organs. At one year of age they are introduced to small rats. Adult dragons eat 1.5 - 3 kg of rats each per week depending upon the size of the lizard and the time of year. The National Zoo philosophy is to feed small meals to dragons on a regular basis rather than allowing them to gorge and fast for extended periods. Komodo dragons at NZP are not given any vitamin/mineral supplements. It is felt that a diet of whole animals combined with access to hot spots of 40 C and natural or artificial UV-B light are enough to promote healthy growth and development. Since 1992 the NZP has been tracking the growth of about 40 of the 55 dragons produced from the NZP female in an effort to comprehend growth patterns in this species (17).

Komodo dragons are easily conditioned to audio or visual cues by food. This can be used to advantage in management.

Health: Komodo dragons are generally disease tolerant but are known to be susceptible to amoebic and bacterial infections as well as internal and external parasites (11, 12). Most health problems in captive dragons seem to be the result of environmental factors. Animals kept too cool may regurgitate or refuse food (9). The lack of suitable heat may also lower a dragon's resistance to infections. Dragons commonly suffer tail and foot injuries in zoos due to suboptimal caging situations. Cagemate aggression is also a serious consideration (5).

In 1992 several neonate dragons at the NZP were discovered to have femoral fractures soon after hatching. Radiographs revealed that all of the young had poorly mineralized bones. Treatment consisted of incorporating UV-B producing light and reduced handling. X-rays at four months of age showed greater bone densities and healing of old fractures. Subsequent groups of young have also shown poorly mineralized skeletons right out of the egg, but have not experienced fractures when raised under the revised husbandry procedures. Research at NZP using *Varanus exanthematicus* showed that these lizards also have poorly mineralized bones as hatchlings (1). It is possible that this may be a naturally occurring phenomenon in hatchling monitor lizards which is of little consequence if proper husbandry is applied.

Chemical restraint of Komodo dragons for physical examination and treatment is being developed. At the National Zoo subadult dragons up to three years of age and 7 kg are successfully anesthetized using manual restraint and masking with 1 - 3% isoflurane (Aerrane, Ohmeda PPD Inc., Liberty Corner, New Jersey 07938 USA). Larger animals up to 55 kg are initially knocked down with dart or pole and then put on isoflurane. The current cocktail of choice for injection is a mix of ketamine (Ketaset, Aveco Co., Fort Dodge, Iowa 50501, USA) at 10-12 mg/kg and midazolam (5 mg/ml, Versed, Hoffman-LaRoche, Nutley, New Jersey 07110, USA) at 0.2-0.4 mg/kg (19).

Social management: In nature Komodo monitors live solitary lives but in captivity they may be kept in groups. In Indonesian zoos adults of mixed sex but similar size are often collected simultaneously from the wild and caged together. Juveniles are raised together from the time of hatching with siblings. Alternatively North American zoos generally keep adults singly or in pairs, and neonates are caged individually.

It is unclear if the groups of adult animals in Indonesian zoos always establish hierarchy or if there are casualties. It has been suggested that newly introduced specimens may experience aggression from established captives (5, 10). Inherent to the Indonesian group exhibit strategy is a lack of control over individuals and a difficulty in tracking breedings.

The Indonesian method of raising young dragons together has many advantages and is reminiscent of crocodile farming. Advantages include maximum use of available space and socialization which may prove useful in establishing communal exhibits for older animals. At the Gembira Loka Zoo groups of 10-15 siblings were being reared together without incident. Aggression was reported when attempts were made to introduce individuals from different clutches and with same clutches when animals were introduced to groups of established siblings (22). The disadvantages of communal rearing include the difficulty of monitoring individual's condition and behavior and the need to feed these normally solitary lizards frequent meals in order to prevent cannibalism.

Some captive Komodo dragons show individual recognition of people and may bond to regular keepers (9, 23). The sense of smell appears to be very important to dragons and olfactory familiarization with keepers and potential cagemates may help with management. Staff at the National Zoo have left articles of clothing in dragon exhibits with this intention. The presentation of scat from prospective mates was employed prior to the introduction of animals at the National and Cincinnati Zoos.

Reproduction

Sexing techniques: Komodo dragons are difficult to sex visually with the exception of very large animals (3 m and 90 kg) which are likely to be old males. Auffenberg (3) suggests that males possess two sets of rosettes formed by scales anterior to the cloaca but this characteristic does not appear consistent in all individuals. Likewise the use of manual sexing probes and hemipenal eversion are methods which are unreliable. There are a variety of promising techniques being developed for sexing dragons including blood, albumin, and fecal hormone assay, x-ray, laparoscopy, and ultrasound(7, 8, 13, 18). Of these methods transintestinal sonography may turn out to be the quickest and most reliable way to sex dragons of all sizes (13).

Reproductive groupings: To trace parentage single compatible pairs should be kept together with access to separate quarters for nesting and other management concerns. Gravid females should be separated from other dragons several days prior to oviposition. Laying females may defend egg sites from all intruders. In communal situations males may combat for territory or females and females may fight over nesting areas. Combat and courtship behaviors may appear similar and can be stimulated by feeding sessions. These behaviors can include rapid tongue flicking to the neck and cloacal areas, jerky chin rubbing, neck arching, racking with claws, biting, pinning, and mounting. Male to male copulation has been observed and is thought to be a display of dominance (2).

Seasonal reproductive patterns: Komodo dragons in the wild and in Indonesian zoos have been noted to breed June through August. This is the dry season and the time of shortest day lengths in the Southern Hemisphere. Egg laying likely occurs after a six to eight week gestation period. In the wild most dragon eggs are thought to hatch in April-May just after the short wet season at a time when the density of potential prey (insects, fledgling birds) is the highest (3).

Thus far the Cincinnati Zoo and National Zoo have been the only institutions outside of Indonesia that have reproduced Komodo dragons. In the United States dragons have typically bred in December and January which coincides with the shortest photo period and coolest temperatures in the Northern Hemisphere. Egg laying has normally taken place in January and February. An NZP dragon has laid two clutches in one year on two occasions, but this activity is not considered a normal occurrence nor a recommended procedure. Oviposition occurs 40-50 days from conception. Clutches have varied from 20 to 30 eggs. Egg mass can be as much as 20% of the female's normal weight. Incubation periods have ranged from 205-256 days with an average of about 220 days. Staggered hatchings ranging from eight to 40 days in a clutch have been observed (17).

Incubation techniques: In Indonesian zoos egg clutches have normally been left in the outdoor exhibits for natural incubation. In some instances protective wire caging was placed over nest sites to protect them from predators and to confine hatchlings (10). In other cases the laying females have successfully guarded the nests throughout incubation and keepers were positioned in the exhibit to collect hatchlings as they as they emerged (22).

Four clutches of eggs have been hatched artificially in North American zoos using Model #I-35-L Percival environmental chambers (Percival Manufacturing Co., Boone, Iowa 50036) as dry box incubators (4, 17). Sealed plastic sweater boxes were utilized to hold the eggs and medium. The egg medium was vermiculite (Terr-Lite, grade 3, W.R. Grace, Cambridge, Mass.) which was initially baked dry and then mixed with water by weight. Eggs have hatched out at water to soil ratios kept at 1:1 (very wet) to 1:4 (very dry). Set moisture potentials were maintained in the soil by adding water weekly. Incubation temperatures ranging from 28-29.5 C have been used (4). The best hatch results were from eggs initially set up at a 1:3 water potential and 29 C. After one week the temperature was increased to 29.5 C. These conditions were sustained for the next 180 days after which the temperature was dropped to 28.5 C and no more water was added to the soil. By day 230 all of the eggs hatched yielding vigorous, healthy young (17).

Neonate husbandry: At hatching Komodo dragons were approximately 40 cm total length and weighed about 100 gm. Current protocol at NZP has involved setting up hatchlings inside the incubator for up to two weeks in an effort to reduce stress and to allow their bones to further mineralize. The hatchlings were placed individually in plastic shoe boxes (32 x 17 x 8 cm) on dry paper towels and hydrated every three days by soaking them for several hours. First meals were offered to the neonates while they were still in the incubator. After two weeks the young dragons were housed in plastic tubs (38 x 58 x 36 cm) containing a hide area, a basking platform, and a water bowl. Astroturf was used as substrate for ease of cleaning. Heat was provided by 75 watt spot bulbs which produced temperatures up to 40 C at the basking area. Ultraviolet-B emitting fluorescent tubes were used in conjunction with the spot bulbs and were situated six inches over the basking area for maximum benefit. Both light systems were put on a 12 hour photo/heat cycle.

Introductions of individually raised, captive hatched Komodo dragons in American zoos have met only with aggression to date.

This behavior is in contrast to the seemingly compatible nature of young dragons raised communally in Indonesia.

Comments and Discussion

The Komodo dragon is a high profile endangered species which has recently enjoyed some reproductive success in zoos both inside and outside of Indonesia. The recent Komodo dragon PHVA in Indonesia highlighted some of the pressing issues about dragons *in situ* and *ex situ*.

Further laboratory and field studies will help us to better understand the population dynamics and reproductive biology of wild dragon populations. It is important to increase awareness/appreciation of Komodo dragons among the Indonesian people because this animal is a unique national treasure with resource potential. Indonesian government agencies, zoos, and researchers are currently meeting these challenges in conjunction with international counterparts.

Unrepresented founder stock needs to be incorporated into the global captive gene pool. There is need for commitment to developing additional holding and breeding facilities for dragons as more animals become available to zoos. Current zoo-research interests with dragons include metabolic and calcium absorption studies in eggs, and investigations of thermal preferences and social behaviors in young and adult animals. Work also continues on developing practical sexing methods for dragons. Verification of sex determination methods with a quantitative sample of captive animals is yet several years away.

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MAR 07 1996

(Varanus komodoensis)

Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
Royal Zool Society of Antwerp, B-2018 Antwerpen, , BELGIUM											
8	F	????	UNK	UNK	SURABAIA	????	UNK	Hatch			
					ANTWERP	19 Sep 1973	R2253	Transfer	BELGIUM		
						28 Dec 1986		Death		28 Dec 1986	
9	M	????	UNK	UNK	ANTWERP	17 Apr 1977	R2539	Transfer	BELGIUM		
						7 Mar 1982		Death		7 Mar 1982	
Totals: 1.1.0 (2)											
Rotterdam Zoo, 3000 Am Rotterdam, , THE NETHERLANDS											
16	M	~ 1983	UNK	UNK	FLORES	~ 1983	UNK	Capture	URUGUAY		KOMO
					SURABAYA	????	UKN	Transfer	INDONESIA		
					SINGAPORE	27 Jul 1986	KOMO	Transfer	SINGAPORR		
					ROTTERDAM	22 Aug 1992	KOMO	Loan to	NETHERLND		
19	M	~ 1983	WILD	WILD	WEST FLOR	~ 1983	UNK	Capture			KOMO
					SINGAPORE	????	UNK	Transfer	SINGAPORR		
					ROTTERDAM	22 Aug 1992	702635	Loan to	NETHERLND		
96	?	20 Aug 1994	20	21	NZP-WASH	20 Aug 1994	306480	Hatch	U.S.A.		
					ROTTERDAM	12 Oct 1995	UNK	Transfer	NETHERLND		
98	?	22 Aug 1994	20	21	NZP-WASH	22 Aug 1994	306481	Hatch	U.S.A.		
					ROTTERDAM	12 Oct 1995	UNK	Transfer	NETHERLND		
99	?	23 Aug 1994	20	21	NZP-WASH	23 Aug 1994	306484	Hatch	U.S.A.		
					ROTTERDAM	12 Oct 1995	UNK	Transfer	NETHERLND		
Totals: 2.0.3 (5)											
Madrid - Zoo De La Casa De Campo, Casa De Campo S/N, 28011 Madrid, SPAIN											
12	F	????	WILD	WILD	INDONESIA	????	UNK	Capture	INDONESIA		
					JAKARTA	????	UNK	Transfer	INDONESIA		
					DE CAMPO	8 Oct 1982	DK1	Transfer	SPAIN		
						22 Oct 1992		Death		22 Oct 1992	
13	M	????	WILD	WILD	DE CAMPO	8 Oct 1982	DK2	Transfer	SPAIN		
						26 Jun 1983		Death		26 Jun 1983	
Totals: 1.1.0 (2)											
San Diego Zoological Garden, San Diego, CA, USA											

Restricted to: (Varanus komodoensis)
Status: Living by 26 Feb 1996
Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name

Rotterdam Zoo, 3000 Am Rotterdam, , THE NETHERLANDS

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
16	M	~ 1983	UNK	UNK	FLORES	~ 1983	UNK	Capture	URUGUAY		KOMO
					SURABAYA	????	UKN	Transfer	INDONESIA		
					SINGAPORE	27 Jul 1986	KOMO	Transfer	SINGAPORR		
					ROTTERDAM	22 Aug 1992	KOMO	Loan to	NETHERLND		
19	M	~ 1983	WILD	WILD	WEST FLOR	~ 1983	UNK	Capture			KOMO
					SINGAPORE	????	UNK	Transfer	SINGAPORR		
					ROTTERDAM	22 Aug 1992	702635	Loan to	NETHERLND		
96	?	20 Aug 1994	20	21	NZP-WASH	20 Aug 1994	306480	Hatch	U.S.A.		
					ROTTERDAM	12 Oct 1995	UNK	Transfer	NETHERLND		
98	?	22 Aug 1994	20	21	NZP-WASH	22 Aug 1994	306481	Hatch	U.S.A.		
					ROTTERDAM	12 Oct 1995	UNK	Transfer	NETHERLND		
99	?	23 Aug 1994	20	21	NZP-WASH	23 Aug 1994	306484	Hatch	U.S.A.		
					ROTTERDAM	12 Oct 1995	UNK	Transfer	NETHERLND		

Totals: 2.0.3 (5)

San Diego Zoological Garden, San Diego, CA, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
18	M	~ 1983	WILD	WILD	FLORES IS	~ 1983	UNK	Capture			WANITA
					INDONESIA	????	UNK	Transfer	INDONESIA		
					CINCINNAT	30 Apr 1990	390002	Transfer	U.S.A.		
					SANDIEGOZ	21 Oct 1992	192470	Loan to	U.S.A.		
46	?	24 Aug 1993	17	21	NZP-WASH	????	306432	Transfer	U.S.A.		DIAMOND
					CINCINNAT	14 Oct 1993	393033	Transfer	U.S.A.		
					SANDIEGOZ	29 Nov 1994	UNK	Loan to	U.S.A.		
49	?	27 Aug 1993	17	21	NZP-WASH	27 Aug 1993	306423	Hatch	U.S.A.		ED
						27 Aug 1993	306423	Loan to			
					CINCINNAT	14 Oct 1993	393037	Transfer	U.S.A.		
					SANDIEGOZ	29 Nov 1994	UNK	Loan to	U.S.A.		
61	?	11 Sep 1993	17	21	NZP-WASH	11 Sep 1993	306434	Hatch	U.S.A.		RUBY
						????	306434	Transfer			
					CINCINNAT	14 Oct 1993	393125	Transfer	U.S.A.		
					SANDIEGOZ	28 Nov 1994	UNK	Loan to	U.S.A.		
62	?	11 Sep 1993	17	21	NZP-WASH	11 Sep 1993	306435	Hatch	U.S.A.		OPAL
						????	306435	Transfer			
					CINCINNAT	14 Oct 1993	393036	Transfer	U.S.A.		

KOMODO DRAGON Studbook
(Varanus komodoensis)

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
1	F	????	WILD	WILD	INDONESIA	????	UNK	Capture	INDONESIA		JL KEBUN #
					TAMAN	24 Oct 1985	JL#6	Transfer	INDONESIA		
2	?	????	WILD	WILD	INDONESIA	????	UNK	Hatch	INDONESIA		
					YAYASAN	19 Sep 1990	UNK	Loan to	OFF ISIS		
3	?	~ 1934	WILD	WILD	INDONESIA	~ 1934	UNK	Capture	INDONESIA		
					GRISWOLD	~ 1934	UNK	Transfer			
					NZP-WASH	21 Jun 1934	14842	Transfer	U.S.A.		
						11 Jul 1936		Death		11 Jul 1936	
4	?	~ 1937	WILD	WILD	INDONESIA	~ 1937	UNK	Capture	INDONESIA		
					NZP-WASH	28 Sep 1937	16256	Transfer	U.S.A.		
						13 Oct 1949		Death		13 Oct 1949	
5	F	????	WILD	WILD	INDONESIA	~ 1964	UNK	Capture	INDONESIA		RINI
					NZP-WASH	4 Mar 1964	29711B	Transfer	U.S.A.		
						13 May 1973		Death		13 May 1973	
6	M	~ 1964	WILD	WILD	KOMODO	~ 1964	UNK	Capture			ORA
					NZP-WASH	4 Mar 1964	29711A	Transfer	U.S.A.		
						2 Jun 1964		Death		2 Jun 1964	
7	M	????	WILD	WILD	KOMODO	????	UNK	Capture			KELANA
					INDONESIA	????	UNK	Transfer	INDONESIA		
					NZP-WASH	28 May 1970	35507	Transfer	U.S.A.		
						26 Apr 1975		Death		26 Apr 1975	
8	F	????	UNK	UNK	SURABAIA	????	UNK	Hatch			
					ANTWERP	19 Sep 1973	R2253	Transfer	BELGIUM		
						28 Dec 1986		Death		28 Dec 1986	
9	M	????	UNK	UNK	ANTWERP	17 Apr 1977	R2539	Transfer	BELGIUM		
						7 Mar 1982		Death		7 Mar 1982	
10	F	????	WILD	WILD	TOKYOUENO	14 Oct 1977	921443	Transfer	JAPAN		E3TU011-00
					NZP-WASH	6 Dec 1995	UNK	Loan to	U.S.A.		
11	F	~ 1978	WILD	WILD	KOMODO IS	~ 1978	UNK	Capture			DINA
					RAGUNAN	????	UNK	Transfer			
					SYDNEY	16 Mar 1981	810075	Transfer	AUSTRALIA		
					OFF ISIS	26 Oct 1989	UNK	Transfer	OFF ISIS		
12	F	????	WILD	WILD	INDONESIA	????	UNK	Capture	INDONESIA		
					JAKARTA	????	UNK	Transfer	INDONESIA		
					DE CAMPO	8 Oct 1982	DK1	Transfer	SPAIN		
						22 Oct 1992		Death		22 Oct 1992	

Restricted to:
Status: Living by 26 Feb 1996
Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
					SANDIEGOZ	28 Nov 1994	UNK	Loan to	U.S.A.		
78	?	4 Feb 1994	17	21	CINCINNAT	4 Feb 1994	394013	Hatch	U.S.A.		LUCIFER
					SANDIEGOZ	28 Nov 1994	UNK	Loan to	U.S.A.		
88	?	9 Feb 1994	17	21	CINCINNAT	9 Feb 1994	394020	Hatch	U.S.A.		JADE
					SANDIEGOZ	28 Nov 1994	UNK	Loan to	U.S.A.		

Totals: 1.0.6 (7)

Denver Zoological Gardens, Denver, CO, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
30	?	13 Sep 1992	20	21	NZP-WASH	13 Sep 1992	306270	Hatch	U.S.A.		ODO
					DENVER	14 May 1994	UNK	Transfer	U.S.A.		
71	?	30 Jan 1994	17	21	CINCINNAT	30 Jan 1994	394006	Hatch	U.S.A.		BRUTUS
					DENVER	8 Jun 1994	UNK	Loan to	U.S.A.		
82	?	5 Feb 1994	17	21	CINCINNAT	5 Feb 1994	394014	Hatch	U.S.A.		CASTOR
					NZP-WASH	5 Feb 1994	306445	Ownership	U.S.A.		
					DENVER	8 Jun 1994	UNK	Transfer	U.S.A.		
90	?	10 Feb 1994	17	21	CINCINNAT	10 Feb 1994	394024	Hatch	U.S.A.		HECTOR
					DENVER	8 Jun 1994	UNK	Loan to	U.S.A.		

Totals: 0.0.4 (4)

National Zoological Park, Washington, DC, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
10	F	????	WILD	WILD	TOKYOUENO	14 Oct 1977	921443	Transfer	JAPAN		E3TU011-00
					NZP-WASH	6 Dec 1995	UNK	Loan to	U.S.A.		
20	M	~ 1984	WILD	WILD	FLORES	~ 1984	UNK	Capture	URUGUAY		FRIENDTY
					INDONESIA	????	UNK	Transfer	INDONESIA		
					NZP-WASH	12 May 1988	305409	Transfer	U.S.A.		
21	F	13 May 1985	WILD	WILD	FLORES	~ 1985	UNK	Capture	URUGUAY		SOBAT
					INDONESIA	????	UNK	Transfer	INDONESIA		
					NZP-WASH	12 May 1988	305408	Transfer	U.S.A.		
					CINCINNAT	30 Oct 1992	392001	Loan to	U.S.A.		
					NZP-WASH	????	305408	Transfer	U.S.A.		
					CINCINNAT	1 Nov 1992	392001	Loan to	U.S.A.		
					NZP-WASH	13 Oct 1993	305408	Transfer	U.S.A.		
28	?	13 Sep 1992	20	21	NZP-WASH	13 Sep 1992	306268	Hatch	U.S.A.		KRAKEN
35	?	20 Sep 1992	20	21	NZP-WASH	20 Sep 1992	306282	Hatch	U.S.A.		PRECIOUS

KOMODO DRAGON Studbook
(Varanus komodoensis)

Restricted to:
Status: Living by 26 Feb 1996
Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
51	?	30 Aug 1993	17	21	NZP-WASH	30 Aug 1993	306426	Hatch	U.S.A.		NO-NAME
55	?	7 Sep 1993	17	21	NZP-WASH	7 Sep 1993	306430	Hatch	U.S.A.		
95	?	18 Aug 1994	20	21	NZP-WASH	18 Aug 1994	306478	Hatch	U.S.A.		
97	?	20 Aug 1994	20	21	NZP-WASH	20 Aug 1994	306479	Hatch	U.S.A.		
100	?	24 Aug 1994	20	21	NZP-WASH	24 Aug 1994	306485	Hatch	U.S.A.		
101	?	25 Aug 1994	20	21	NZP-WASH	25 Aug 1994	306486	Hatch	U.S.A.		
102	?	25 Aug 1994	20	21	NZP-WASH	25 Aug 1994	306487	Hatch	U.S.A.		
103	?	26 Aug 1994	20	21	NZP-WASH	26 Aug 1994	306488	Hatch	U.S.A.		
104	?	26 Aug 1994	20	21	NZP-WASH	26 Aug 1994	306489	Hatch	U.S.A.		

Totals: 1.2.11 (14)

Dreher Park Zoo, West Palm Beach, FL, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
87	?	9 Feb 1994	17	21	CINCINNAT	9 Feb 1994	394019	Hatch	U.S.A.		ZEPHER
					NZP-WASH	9 May 1994	306453	Ownership	U.S.A.		
					DREHER PA	7 Mar 1995	UNK	Transfer	U.S.A.		

Totals: 0.0.1 (1)

Miami Metrozoo, Miami, FL, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
25	M	~ 1987	WILD	WILD	INDONESIA	~ 1987	U	Capture	INDONESIA		
					TAMAN	????	U	Transfer	INDONESIA		
					METROZOO	15 Jun 1995	H00957	Transfer	U.S.A.		
26	F	~ 1987	WILD	WILD	INDONESIA	~ 1987	UNK	Capture	INDONESIA		
					TAMAN	????	UNK	Transfer	INDONESIA		
					METROZOO	15 Jun 1995	H00958	Transfer	U.S.A.		

Totals: 1.1.0 (2)

White Oak Plantation, Yulee, FL, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
41	F	30 Sep 1992	20	21	NZP-WASH	30 Sep 1992	306290	Hatch	U.S.A.		
					YULEE	6 Apr 1994	940308	Transfer	U.S.A.		
58	M	9 Sep 1993	17	21	NZP-WASH	9 Sep 1993	306433	Hatch	U.S.A.		

Restricted to:
Status: Living by 26 Feb 1996
Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
					YULEE	6 Apr 1994	940307	Transfer	U.S.A.		

Totals: 1.1.0 (2)

Zoo Atlanta, Atlanta, GA, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
42	?	1 Oct 1992	20	21	NZP-WASH	1 Oct 1992	306291	Hatch	U.S.A.		GASHER
					ATLANTA	1 Jul 1993	936300	Loan to	U.S.A.		
					NZP-WASH	????	306291	Transfer	U.S.A.		
					ATLANTA	18 Mar 1994	936300	Transfer	U.S.A.		
43	?	6 Oct 1992	20	21	NZP-WASH	6 Oct 1992	306302	Hatch	U.S.A.		SLASHER
					ATLANTA	1 Jul 1993	936301	Loan to	U.S.A.		
					NZP-WASH	????	306302	Transfer	U.S.A.		
					ATLANTA	18 Mar 1994	936301	Transfer	U.S.A.		

Totals: 0.0.2 (2)

Honolulu Zoo, Honolulu, HI, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
33	?	15 Sep 1992	20	21	NZP-WASH	15 Sep 1992	306272	Hatch	U.S.A.		TW
					HONOLULU	18 Sep 1993	930249	Transfer	U.S.A.		
39	?	25 Sep 1992	20	21	NZP-WASH	25 Sep 1992	306287	Hatch	U.S.A.		DOC
					HONOLULU	18 Sep 1993	930250	Transfer	U.S.A.		

Totals: 0.0.2 (2)

Fort Wayne Children's Zool Garden, Fort Wayne, IN, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
83	?	5 Feb 1994	17	21	CINCINNAT	5 Feb 1994	394015	Hatch	U.S.A.		GORGON
					NZP-WASH	5 Feb 1994	306452	Ownership	U.S.A.		
					FT WAYNE	10 Jun 1994	UNK	Transfer	U.S.A.		

Totals: 0.0.1 (1)

Sedgwick County Zoo, Wichita, KS, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
93	?	????	UNK	UNK	CINCINNAT	????	394009	Hatch	U.S.A.		SULTAN
					SEDGWICK	8 Jun 1994	6669	Transfer	U.S.A.		
94	?	????	UNK	UNK	CINCINNAT	????	394018	Hatch	U.S.A.		GAIA
					SEDGWICK	8 Jun 1994	6668	Transfer	U.S.A.		

Totals: 0.0.2 (2)

Restricted to:
Status: Living by 26 Feb 1996
Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
Louisville Zoological Garden, Louisville, KY, USA											
45	?	23 Aug 1993	17	21	NZP-WASH	23 Aug 1993	306422	Hatch	U.S.A.		NAOMI
					CINCINNAT	14 Oct 1993	393035	Transfer	U.S.A.		
					LOUISVILL	22 Mar 1994	_____	Loan to	U.S.A.		
47	?	24 Aug 1993	17	21	NZP-WASH	24 Aug 1993	306431	Hatch	U.S.A.		MARIAH
					CINCINNAT	14 Oct 1993	393034	Transfer	U.S.A.		
					LOUISVILL	21 Mar 1994	301056	Loan to	U.S.A.		
Totals: 0.0.2 (2)											
Audubon Park Zoological Garden, New Orleans, LA, USA											
29	F	13 Sep 1992	20	21	NZP-WASH	13 Sep 1992	306269	Hatch	U.S.A.		
					AUDUBON	7 Aug 1993	R1115	Loan to	U.S.A.		
31	M	13 Sep 1992	20	21	NZP-WASH	13 Sep 1992	306271	Hatch	U.S.A.		
					AUDUBON	7 Aug 1993	R1116	Loan to	U.S.A.		
Totals: 1.1.0 (2)											
Minnesota Zoological Garden, Apple Valley, MN, USA											
22	M	????	WILD	WILD	INDONESIA	~ 1987	U	Capture	INDONESIA		
					PUBLIC	????	U	Transfer	OFF ISIS		
					MINNESOTA	15 Jun 1995	8527	Transfer	U.S.A.		
24	F	~ 1987	WILD	WILD	INDONESIA	~ 1987	U	Capture	INDONESIA		
					PUBLIC	????	U	Transfer	OFF ISIS		
					MINNESOTA	15 Jun 1995	8529	Transfer	U.S.A.		
Totals: 1.1.0 (2)											
St Louis Zoological Park, St Louis, MO, USA											
34	?	17 Sep 1992	20	21	NZP-WASH	17 Sep 1992	306279	Hatch	U.S.A.		
					ST LOUIS	31 Aug 1993	930845	Loan to	U.S.A.		
59	?	10 Sep 1993	17	21	NZP-WASH	10 Sep 1993	306437	Hatch	U.S.A.		
					ST LOUIS	1 Jun 1994	UNK	Transfer	U.S.A.		
Totals: 0.0.2 (2)											
Rio Grande Zoological Park, Albuquerque, NM, USA											
36	?	20 Sep 1992	20	21	NZP-WASH	20 Sep 1992	306283	Hatch	U.S.A.		

KOMODO DRAGON Studbook

(Varanus komodoensis)

Restricted to:
Status: Living by 26 Feb 1996
Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
					RIO GRAND	31 Jul 1993	R93053	Loan to	U.S.A.		
						18 Mar 1994	UNK	Transfer			
60	?	10 Sep 1993	17	21	NZP-WASH	10 Sep 1993	306438	Hatch	U.S.A.		
					RIO GRAND	5 Nov 1993	R93054	Loan to	U.S.A.		
						18 Mar 1994	UNK	Transfer			

Totals: 0.0.2 (2)

Cincinnati Zoo & Botanical Garden, Cincinnati, OH, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
17	M	~ 1983	WILD	WILD	FLORES IS	~ 1983	UNK	Capture			NAGA
					INDONESIA	????	UNK	Transfer	INDONESIA		
					CINCINNAT	24 Apr 1990	390001	Transfer	U.S.A.		
					FORTWORTH	31 Jul 1995	UNK	Loan to	U.S.A.		
					CINCINNAT	15 Sep 1995	390001	Transfer	U.S.A.		
50	?	28 Aug 1993	17	21	NZP-WASH	23 Aug 1993	306424	Loan to	U.S.A.		SAPHIRE
						28 Aug 1993	306424	Hatch			
					CINCINNAT	14 Oct 1993	393038	Transfer	U.S.A.		
56	?	7 Sep 1993	17	21	NZP-WASH	7 Sep 1993	306431	Hatch	U.S.A.		
					CINCINNAT	14 Oct 1993	UNK	Transfer	U.S.A.		
57	?	8 Sep 1993	17	21	NZP-WASH	8 Sep 1993	306432	Hatch	U.S.A.		
					CINCINNAT	14 Oct 1993	UNK	Transfer	U.S.A.		
68	?	28 Jan 1994	17	21	CINCINNAT	28 Jan 1994	UNK	Loan to	U.S.A.		
69	?	28 Jan 1994	17	21	CINCINNAT	28 Jan 1994	UNK	Loan to	U.S.A.		
74	?	31 Jan 1994	17	21	CINCINNAT	31 Jan 1994	UNK	Loan to	U.S.A.		
75	?	1 Feb 1994	17	21	CINCINNAT	1 Feb 1994	394010	Hatch	U.S.A.		LUTHER
76	?	1 Feb 1994	17	21	CINCINNAT	1 Feb 1994	UNK	Loan to	U.S.A.		
80	?	4 Feb 1994	17	21	CINCINNAT	4 Feb 1994	UNK	Loan to	U.S.A.		
81	?	4 Feb 1994	17	21	CINCINNAT	4 Feb 1994	UNK	Loan to	U.S.A.		

Totals: 1.0.10 (11)

Cleveland Metroparks Zoological Park, Cleveland, OH, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
73	?	30 Jan 1994	17	21	CINCINNAT	30 Jan 1994	394008	Hatch	U.S.A.		REX
						30 Jan 1994	UNK	Loan to			

Restricted to:
Status: Living by 26 Feb 1996
Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
					NZP-WASH	????	306447	Transfer	U.S.A.		
					CLEVELAND	12 May 1994	940508	Transfer	U.S.A.		
86	?	7 Feb 1994	17	21	CINCINNAT	7 Feb 1994	394017	Hatch	U.S.A.		LOKI
					NZP-WASH	7 Feb 1994	306451	Ownership	U.S.A.		
					CLEVELAND	13 May 1994	940509	Loan to	U.S.A.		
						1 Dec 1994	940509	Ownership			

Totals: 0.0.2 (2)

Columbus Zoological Gardens, Powell, OH, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
65	?	28 Jan 1994	17	21	CINCINNAT	28 Jan 1994	394003	Hatch	U.S.A.		REGIS
					COLUMBUS	8 Sep 1994	UNK	Loan to	U.S.A.		
77	?	4 Feb 1994	17	21	CINCINNAT	4 Feb 1994	394011	Hatch	U.S.A.		NAGAMET
					COLUMBUS	8 Sep 1994	UNK	Loan to	U.S.A.		

Totals: 0.0.2 (2)

Gladys Porter Zoo, Brownsville, TX, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
66	?	28 Jan 1994	17	21	CINCINNAT	28 Jan 1994	394004	Hatch	U.S.A.		JASMINE
					BROWNSVIL	15 May 1994	L00270	Loan to	U.S.A.		
79	?	4 Feb 1994	17	21	CINCINNAT	4 Feb 1994	394012	Hatch	U.S.A.		PANDORA
					BROWNSVIL	15 May 1994	L00271	Loan to	U.S.A.		
85	?	7 Feb 1994	17	21	CINCINNAT	7 Feb 1994	394016	Hatch	U.S.A.		JASPER
					BROWNSVIL	15 May 1994	L00272	Loan to	U.S.A.		
89	?	9 Feb 1994	17	21	CINCINNAT	9 Feb 1994	394021	Hatch	U.S.A.		IVAN
					BROWNSVIL	15 May 1994	L00273	Loan to	U.S.A.		

Totals: 0.0.4 (4)

Dallas Zoo, Dallas, TX, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
63	?	15 Sep 1993	17	21	NZP-WASH	15 Sep 1993	306436	Hatch	U.S.A.		
					DALLAS	20 May 1994	948904	Transfer	U.S.A.		

Totals: 0.0.1 (1)

Fort Worth Zoological Park, Ft Worth, TX, USA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
40	?	29 Sep 1992	20	21	NZP-WASH	29 Sep 1992	306289	Hatch	U.S.A.		DANTE
					FORTWORTH	16 Aug 1993	936306	Loan to	U.S.A.		

Restricted to:
Status: Living by 26 Feb 1996
Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
						18 Mar 1994	UNK	Transfer			
54	?	2 Sep 1993	17	21	NZP-WASH	2 Sep 1993	306429	Hatch	U.S.A.		FAUST
					FORTWORTH	20 May 1994	946303	Transfer	U.S.A.		

Totals: 0.0.2 (2)

Taman Margasatwa Bundo Kandung Bukitti, Bukittinggi, S -Barat, INDONESIA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
1	F	????	WILD	WILD	INDONESIA	????	UNK	Capture	INDONESIA		JL KEBUN #
					TAMAN	24 Oct 1985	JL#6	Transfer	INDONESIA		

Totals: 0.1.0 (1)

Singapore Zoological Gardens, Singapore, , SINGAPORE

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
15	M	~ 1983	UNK	UNK	FLORES	~ 1983	UNK	Capture	URUGUAY		RINCA
					SURABAYA	????	UKN	Transfer	INDONESIA		
					SINGAPORE	27 Jul 1986	RINCA	Transfer	SINGAPORR		
23	M	~ 1986	WILD	WILD	FLORES	~ 1986	UNK	Capture	URUGUAY		JOKO
					JOGJAKART	????	JOKO	Transfer	INDONESIA		
					SINGAPORE	26 Oct 1989	G99	Transfer	SINGAPORR		
27	F	~ Oct 1987	WILD	WILD	FLORES	~ Oct 1987	UNK	Capture	URUGUAY		RINJA
					JOGJAKART	????	RINJA	Transfer	INDONESIA		
					SINGAPORE	26 Oct 1989	G100	Transfer	SINGAPORR		

Totals: 2.1.0 (3)

Sydney's Taronga Zoo, Mosman, New South Wales, AUSTRALIA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
14	M	~ 1982	WILD	WILD	W.FLORES	~ 1982	UNK	Capture			
					RAGUNAN	????	UNK	Transfer			
					SYDNEY	3 Dec 1991	910382	Transfer	AUSTRALIA		

Totals: 1.0.0 (1)

Unknown Specimen Removal, , ,

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
11	F	~ 1978	WILD	WILD	KOMODO IS	~ 1978	UNK	Capture			DINA
					RAGUNAN	????	UNK	Transfer			
					SYDNEY	16 Mar 1981	810075	Transfer	AUSTRALIA		
					OFF ISIS	26 Oct 1989	UNK	Transfer	OFF ISIS		

Totals: 0.1.0 (1)

KOMODO DRAGON Studbook
(Varanus komodoensis)

Restricted to:
Status: Living by 26 Feb 1996
Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
Unknown Location, , ,											
2	?	????	WILD	WILD	INDONESIA	????	UNK	Hatch	INDONESIA		
					YAYASAN	19 Sep 1990	UNK	Loan to	OFF ISIS		

Totals: 0.0.1 (1)

TOTALS: 12.9.60 (81)
27 Institutions

KOMODO DRAGON Studbook
(Varanus komodoensis)

Report ordered by: current (last) location...

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
					JOGJAKART	????	JOKO	Transfer	INDONESIA		
					SINGAPORE	26 Oct 1989	G99	Transfer	SINGAPORR		
27	F	~ Oct 1987	WILD	WILD	FLORES	~ Oct 1987	UNK	Capture	URUGUAY		RINJA
					JOGJAKART	????	RINJA	Transfer	INDONESIA		
					SINGAPORE	26 Oct 1989	G100	Transfer	SINGAPORR		

Totals: 2.1.0 (3)

Sydney's Taronga Zoo, Mosman, New South Wales, AUSTRALIA

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
14	M	~ 1982	WILD	WILD	W.FLORES	~ 1982	UNK	Capture			
					RAGUNAN	????	UNK	Transfer			
					SYDNEY	3 Dec 1991	910382	Transfer	AUSTRALIA		

Totals: 1.0.0 (1)

Unknown Specimen Removal, , ,

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
11	F	~ 1978	WILD	WILD	KOMODO IS	~ 1978	UNK	Capture			DINA
					RAGUNAN	????	UNK	Transfer			
					SYDNEY	16 Mar 1981	810075	Transfer	AUSTRALIA		
					OFF ISIS	26 Oct 1989	UNK	Transfer	OFF ISIS		

Totals: 0.1.0 (1)

Unknown Location, , ,

Stud #	Sex	Hatch Date	Sire	Dam	Location	Date	Local ID	Event	Country	Death-Date	Name
2	?	????	WILD	WILD	INDONESIA	????	UNK	Hatch	INDONESIA		
					YAYASAN	19 Sep 1990	UNK	Loan to	OFF ISIS		

Totals: 0.0.1 (1)

TOTALS: 19.12.73 (104)
29 Institutions

ANTWERP Royal Zool. Society of Antwerp
Koningin Astridplein 26, B-2018 Antwerpen, Belgium, 32 3 231 1640.

ATLANTA Zoo Atlanta
800 Cherokee Ave. SE, Atlanta, GA, USA, 30315-1440, (404)624-5600.

AUDUBON Audubon Park Zoological Garden
P.O. Box 4327, New Orleans, LA, USA, 70178-4327, (504)861-2537.

BROWNSVIL Gladys Porter Zoo
500 Ringgold St., Brownsville, TX, USA, 78520, (210)546-7187.

CINCINNAT Cincinnati Zoo & Botanical Garden
3400 Vine St., Cincinnati, OH, USA, 45220, (513)559-7712.

CLEVELAND Cleveland Metroparks Zoological Park
3900 Brookside Park Dr., Cleveland, OH, USA, 44109, (216)661-6500x261.

COLUMBUS Columbus Zoological Gardens
P.O. Box 400, Powell, OH, USA, 43065-0400, (614)645-3429.

DALLAS Dallas Zoo
621 E Clarendon Dr., Dallas, TX, USA, 75203-2996, (214)670-6825.

DE CAMPO Madrid - Zoo de la Casa de Campo
Zoo de la Casa De Campo, Casa De Campo S/N, 28011 Madrid, Spain, 34 1 711 9950.

DENVER Denver Zoological Gardens
2900 E 23rd Ave., Denver, CO, USA, 80205, (303)331-4102.

DREHER PA Dreher Park Zoo
1301 Summit Blvd., West Palm Beach, FL, USA, 33405-3098, (407)533-0887.

FLORES FLORES
URUGUAY, South America, AMERICAN REGION.

FLORES IS ____________________

FORTWORTH Fort Worth Zoological Park
1989 Colonial Pkwy., Ft Worth, TX, USA, 76110, (817)871-7000.

FT WAYNE Fort Wayne Children's Zool Garden
3411 Sherman Blvd., Fort Wayne, IN, USA, 46808-1594, (219)482-4610.

GRISWOLD ____________________

HONOLULU Honolulu Zoo
151 Kapahulu Ave., Honolulu, HI, USA, 96815, (808)971-7174.

INDONESIA INDONESIA
MALAY ARCHIPELAGO, Asian Region.

JAKARTA Kebun Binatang Ragunan Zoo
Zoological Gardens, Jarkarta, Indonesia, 62 21 781280/782975.

JOGJAKART Kebun Binatang Gembira Loka
Jogjakarta, Java-Jogjakarta, Indonesia.

KOMODO ____________________

KOMODO IS ______________________________

LOUISVILL Louisville Zoological Garden
P.O. Box 37250, Louisville, KY, USA, 40233-7250, (502)459-2181.

METROZOO Miami Metrozoo
12400 SW 152nd St., Miami, FL, USA, 33177-1499, (305)251-0401.

MINNESOTA Minnesota Zoological Garden
13000 Zoo Blvd., Apple Valley, MN, USA, 55124-8199, (612)431-9294.

NZP-WASH National Zoological Park
3000 Blk of Connecticut Ave. NW, Washington, DC, USA, 20008, (202)673-4821.

OFF ISIS Unknown Specimen Removal
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PUBLIC General Public
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RAGUNAN ______________________________

RIO GRAND Rio Grande Zoological Park
903 Tenth St. SW, Albuquerque, NM, USA, 87102, (505)843-7413.

ROTTERDAM Rotterdam Zoo
P.O. Box 532, 3000 Am Rotterdam, The Netherlands, 31 10 443 1431.

SANDIEGOZ San Diego Zoological Garden
P.O. Box 551, San Diego, CA, USA, 92112-0551, (619)231-1515.

SEDGWICK Sedgwick County Zoo
5555 Zoo Blvd., Wichita, KS, USA, 67212, (316)942-2213.

SINGAPORE Singapore Zoological Gardens
80 Mandai Lake Rd., Singapore, Singapore, 2572, 65 269 3411.

ST LOUIS St. Louis Zoological Park
Forest Park, St. Louis, MO, USA, 63110, (314)781-0900.

SURABAIA ______________________________

SURABAYA Kebun Binatang Surabaya
Jalan Setail 1, Wonokromo, Surabaya, Indonesia, 62 31 68703.

SYDNEY Sydney's Taronga Zoo
P.O. Box 20, Mosman, NEW SOUTH WALES, Australia, 2088, 61 2 969 2777.

TAMAN Taman Margasatwa Bundo Kandung Bukitti
Bukittinggi, S -Barat, Indonesia.

TOKYOUENO Ueno Zoological Gardens
Ueno Park 9-83, Taito-Ku, Tokyo, Japan, 110, 81 3 3828 5171.

W.FLORES ______________________________

WEST FLOR ______________________________

YAYASAN ____________________

YULEE White Oak Plantation
726 Owens Rd., Yulee, FL, USA, 32097, (904)225-3396.

'STEMATIC OF KOMODO DRAGON

BY SOEPARMI

GADJAH MADA UNIVERSITY

YOGYAKARTA INDONESIA

SUMMARY

The land crocodile, Ora, Komodo, the Giant Lizard, the Komodo Dragon, the Indonesian Dragon, the Indonesian Dinosaur "Biawak Raksasa", "the Wonder of Nature", the "rare" animal, the " Dragon", the "Modern Dragon", the "dragon fossil that comes to life again", "Dragon lizard of Komodo", the "endemic giant monitor", and *Varanus komodoensis* (Ouwens, 1912), these are the names given to the animal that lives on the Island of Komodo and the surrounding islands in the province of Nusa Tenggara Timur, Indonesia. The characteristics of this animal are as follows: it has an oval head, an arc-shaped snout, polyphyodont teeth, cylindrical trunk and legs, and the cauda is of the same length as the trunk. Its scales are made up of ossified. Several movements of the komodo are movements that cannot be found in the progressive reptile. In general, the komodo's movements are clumsy and slow. The caput can only move in ventroflexio and dorsoflexio, and the back can hardly move in lateroflexio either to the left or to the right. The position of the brachium when the komodo stands is horizontal. The antebrachium at the maximum extension forms an obtuse angle with the brachium facing the body. The crus at the maximum extension forms an obtuse angle with the femur facing the body. Between the crus and pes there is an extremely restricted movement. The movements of the brachium against the cingulum membri cranialis liberi in a horizontal line are limited.

The movements of the femur against the cingulum membri caudalis liberi towards the craniocaudal are limited while ventrodorsally movements are larger. The claws of the membrum craniale liberum and membrum caudale liberum are long, curving towards the palm and planta, with black and pointed distal tips.

As far as I am concerned, the description above poses a problem which needs to be answered because this animal resembles a fossil reconstruction of a reviviscent primitive reptile.

The outward characteristics of this animal, which will henceforth be called "komodo", are very different from those of the animals that belong to genus *Varanus*.

This study on the komodo covers both anatomical and systematic fields, the first of which is descriptive comprising: osteologia, arthrologia, myologia, systema nervosum, splanchnologia, and angiologia. Certain organs such as the skin, hepar, pancreas, ovarium, and testis, are studied microscopically. The study of the nervous system does not include one organ, i.e., the encephalon. This is caused by a failure in fixation work. On an injection of 10% formalin into the cavity of the encephalon, the needle cannot penetrate the cranial bone. It cannot even penetrate the skin on the caput area because the scales are calcified so that the formalin cannot reach the encephalon, and as a result the encephalon is damaged. Therefore the nervous system that is successfully studied is the nervous system on the region of memberi cranialis and the nervous system on the region of membri caudalis.

In order to test the place of the komodo in animal systematic, which Ouwens classifies as belonging to genus *Varanus*, the anatomic elements of the komodo are compared to the anatomic elements of the subgenus of genus *Varanus*, which in this particular case is those of *Varanus salvator*. The findings have shown some outstanding features in the komodo that distinguish it from *Varanus salvator*. These outstanding features are as follows.

In the komodo's cranium and mandible, the connection between one element and another element is sufficiently loose as to cause: prokinesis, mesokinesis, metakinesis, and streptognathia. This loose connection is found between: os supraoccipitale and os exoccipitale and

os epioticum, os exoccipitale and os opisthoticum and os basioccipitale, os basisphenoidale and os parasphenoidale, os epioticum and os opisthoticum and os exoccipitale, os prooticum and os basisphenoidale, os frontale and os nasale and os parietale, os premaxillare and os maxillare, os squamosum and os postorbitale, os supratemporale and os parietale, os prefrontale and os lacrimale, vomer and os premaxillare, os entopterygoideum and os dermopalatinum, os ectopterygoideum and os maxillare, the distal tips of os dentale and os spleniale and the mesial ends of os surangulare and os angulare.

The komodo's teeth consist of marginal and lingual teeth and are polyphyodont.

The komodo has 72 vertebras: 9 cervical vertebras, 18 thoracic vertebras 2 lumbar vertebras, 3 sacral vertebras, and 40 caudal vertebras. Each thoracic vertebra has 2 joints with a costal bone in the form of diapophysis dorsally and parapophysis ventrally. Vertebra lumbalis II contains zygospheneum and zygantrum. Facies articularis caudalis corporis vertebrae thoracicae XIV grow and stick together with facies articularis cranialis corporis vertebrae thoracicae XV. Facies articularis caudalis corporis vertebrae thoracicae XVIII and facies articularis cranialis corporis vertebrae lumbalis I also stick together.

Ossa thoracis of komodo have the shape of a costal bone which joints at vertebra cervicalis VI up to IX and at vertebra thoracica I up to XVIII, each costal bone having 2 heads, tuberculum and capitulum, which joint at diapophysis and parapophysis. Interclavicula is shaped like the letter T. The sternum is thick and consists of a cartilago.

Ossa membri cranialis; coracoscapula, clavicula, humerus, radius, ulna, articulatio humeri, articulatio humeroradialis and articulatio humeroulnaris, ossa carpalia, ossa metacarpalia, phalanges.

Ossa membri caudalis; os ilium and articulatio sacroiliaca, acetabulum, os pubis, os ischii, os femoris, articulatio coxae, patella, 4 os articulare genus and articulatio genus, tibia, fibula, ossa tarsalia, ossa metatarsalia, phalanges, articulatio between facies articularis distalis tibiae and astragalocalcaneus, articulatio between facies articularis distalis fibulae and astragalocalcaneus, articulatio between astragalocalcaneus and os tarsale distale IV.

The komodo's exoskeleton is made up of boned scales.

The komodo's muscles generally have more parts.

Musculi dorsi; musculus trapezius, musculus iliocostalis, musculus longissimus dorsi, musculus transversospinalis.

Musculi thoracis; musculi pectoralis, musculus serratus lateralis.

Musculi abdominis; musculus rectus abdominis medialis, musculus rectus abdominis lateralis, musculus obliquus externus abdominis, musculus obliquus internus abdominis, musculus transversus abdominis.

Musculi membri cranialis; musculus deltoideus, musculus scapulohumeralis, musculus biceps brachii, musculus brachialis, musculus triceps brachii, musculus coracobrachialis, musculus coracoulnaris, musculus flexor carpi radialis, musculus flexor carpi ulnaris, musculi flexores breves superficiales, musculi flexores breves profundi, musculi extensor digitorum communis, musculus extensor carpi radialis, musculus extensor carpi ulnaris, musculus abductor pollicis longus, musculi extensores breves digitorum superficiales, musculi extensores breves digitorum profundi, musculus extensor indicis proprius.

Musculi membri caudalis; musculus obturatorius, musculus caudofemoralis, musculus flexor tibialis primarius, musculus flexor tibialis primarius posterior, musculus flexor tibialis internus anterior, musculus flexor tibialis internus posterior, musculus hypoischiadicus, musculus flexor tibialis externus, musculus arcualis, musculus gastrocnemius, musculus flexor digitorum longus, musculi flexores breves superficiales, musculi flexores breves profundi, musculus extensor tibiae, musculus extensor femoris, musculus extensor iliotibialis, musculus extensor iliofibularis, musculus abductor femoris, musculus femorotibialis, musculus addcutor femoris, musculus extensor digitorum communis, musculus extensor tarsi tibialis, musculus extensor tarsi fibularis, musculus abductor et extensor hallucis, musculi extensores breves digitorum superficiales, musculi interossei dorsales.

Musculi colli; musculus sphincter colli, musculus costomandibularis, musculus sternohyoideus superficialis, musculus sternohyoideus profundus, musculus mylohyoideus, musculus (arcus) visceromandibularis, musculus (arcus) viscerohyoideus, musculus costoclavicularis, aponeurosis dari musculus pterygomandibularis, musculus pterygomandibularis superficialis, musculus pterygomandibularis profundus, musculus pterygomandibularis tertius, musculus pterygoparietalis, musculus depressor palpebrae inferior.

The komodo's articulatio humeri is in the form of facies articularis humeri which joints with cavitas glenoidalis coracoscapula. The komodo's facies articularis humeri are in the form of an arc of 180°. The form of facies articularis humeri as a whole is elliptical, on the medial and lateral sides there is a pair of large curves. The wall of the cavitas glenoidalis coracoscapula is cylindrical a semicircle. The position of the komodo's humerus in a standing attitude lies. This is caused by the curves which lie on the side of facies articularis humeri are held by the dorsal edge of cavitas glenoidalis. The humerus also cannot stand vertically against the ground because the curve in the middle of the facies articularis humeri is held by the ventral edge of the cavitas glenoidalis. Furthermore the humerus cannot be rotated against the coracoscapula, because the facies articularis humeri are elliptical. From the point of view of form, articulatio humeri is called articulatio ellipsoidea in which towards one craniocaudal axis there occurs a dorsal ventral movement, and towards one dorsoventral axis there occurs a cranial caudal movement. The curve in the horizontal area along the arc of 60° causes the cranial caudal movements to be limited. The komodo's articulatio cubiti consists of two articulations: articulatio humeroradialis in the form of articulatio ellipsoidea with two axes, and articulatio humeroulnaris in the form of articulatio trochlearis with one axis. The radius and ulna grow stickingly together so that the movements go towards one axis only, i.e., flexio and extensio. When the antebrachium is at the maximum extension, an angle between the brachium and antebrachium is 135°. The komodo's ulna has a large and irreducible olecranon. At the position of 135° the olecranon is held back by the edge of the facies articularis at condylus humeri which is situated at the end of the distal extremity, i.e., the extremitas distalis humeri. When the komodo's antebrachium is at the maximum flexion, the angle between the brachium and the antebrachium is 70°. The proximal point of the medial radius of the komodo is large and irreducible; at this position of 70° this increase in size hinders flexion. The komodo's articulatio genus is in the form of articulatio trochlearis consisting of: articulatio femoropatellaris, the condylus lateralis and condylus medialis joints with four os articulare genus the caput fibulae joints with os articulare genus I, and the caput tibiae joints with three other os articulare genus. Facies articularis ossa articularia are bumpy, so that the movements of the ossa articularia are limited, and even when the ossa articularia is at the maximum extension ossa articularia are held back by the patella. The patella is large and irreducible. Facies articularis os articulare genus I is bumpy, so that the movements of the fibula are limited. Three os articulare genus where the caput tibiae lie are also bumpy and os articulare genus III sticks closely with caput tibiae so that the movements of the tibia are limited. When the crus extends at a maximum, the femur forms an angle of 135° with the crus open towards the body.

The komodo's plexus nervosus is formed by more ramus ventralis nervus spinalis.

Plexus nervosus in the area of membrum craniale; nervus scapulo-humeralis, nervus deltoideus, pars scapularis, nervus triceps brachii, nervus carpi radialis, nervus brachialis, nervus biceps brachii, nervus coracobrachialis, nervus coracoulnaris, nervus triceps brachii, nervus latissimus dorsi, nervus carpi ulnaris, 4 nervus flexor carpi radialis, nervus interosseus, nervus coracobrachialis, 5 nervi cutanei brachii medialis, nervus cutaneus antebrachii medialis.

Plexus nervosus in the area of membrum caudale; nervus ischiadicus, nervus peroneus, nervus extensor iliofibularis, nervus gastrocnemius, nervus interosseus, nervus medianus.

The komodo's hepar has the shape of a beam of wood, consisting of 3 irreducible lobes.

The komodo's pancreas coils and sticks fast to the end of the ventriculus.

The cavity of the sinus venosus is large, and there no signs of it being reducible. The komodo's septum interventriculare is perforated.

The systematic research on komodo is based on the evolutionary approach. In order to find out the characteristics of phyletica used in the evolutionary approach, a comparative anatomy is adopted to obtain the characteristics of differentiative komodo as opposed to other reptiles.

The high - weighted phyletic characteristics in this study lie in the cranium and craniokinesis which are made up of:

a. the os parietale group (unit I) consisting of:
   1. a single os parietale
   2. a pair of os supratemporale
   3. a pair of os squamosum
   4. a pair of os postorbitale
   5. a pair of os frontale
   6. a single of processus ascendens tecti synotici
   7. a pair of processus paroccipitalis
b. the axes for movement in unit I consisting of:
   1. axis mesokinesis
   2. axis metakinesis
c. the os quadratum group (unit II) consisting of:
   a pair of os quadratum
d. the axis for movement in unit II is:
   axis streptostylia
e. the basal bones group (unit III) consisting of:
   1. a pair of os entopterygoideum
   2. a pair of os ectopterygoideum
   3. a pair of os jugale
   4. a pair of os palatinum at the posterior
   5. a single os basisphenoidale
   6. a pair of processus basipterygoideus
f. the axis for movement in unit III between one element and the other elements
g. the group of the segmentum maxillare bones (unit IV) consisting of:
   1. a single os maxillare
   2. a single os nasale
   3. a pair of os frontale at the anterior
   4. a pair of os prefrontale
   5. a pair of os lacrimale
   6. a pair of os palatinum at the anterior
   7. a pair of os supraorbitale
h. the movements in unit IV:
   1. between os palatinum and os entopterygoideum
   2. between os palatinum and os maxillare
   3. between os nasale and os frontale

i. the os epipterygoideum group (unit V) consisting of:
   1. a pair of os epipterygoideum
   2. a pair of os entopterygoideum
   3. a pair of os parietale
j. the axes for movement in unit V:
   1. between the ventral point of os epipterygoideum and the dorsal edge of os entopterygoideum
   2. between the os epipterygoideum and os parietale
k. the mandibular bones group (unit VI) consisting of:
   1. os dentale
   2. os coronoideum
   3. os surangulare
   4. os angulare
l. the axis for movement in unit VI:
   the streptognathia axis
m. the types of craniokinesis:
   1. prokinesis
   2. mesokinesis
   3. metakinesis
   4. amphikinesis
   5. streptostylia
   6. streptognathia

A systematic study of the komodo by way of comparing between the description of the komodo by Ouwens and the description put forward in this research will show the difference between Ouwens' version and my version with regard to the place of the komodo in animal systematic.

A comparison between the craniokinesis of the komodo and that of *Varanus salvator* shows that the craniokinesis of the komodo has 5 kinds: prokinesis, mesokinesis, metakinesis, streptognathia, and streptostylia. *Varanus salvator* has 2 kinds of craniokinesis, i.e., mesokinesis and metakinesis, while prokinesis, streptognathia, and streptostylia, do not occur because os frontale, os nasale, os prefrontale, and os maxillare, are mutually connected; os surangulare, os dentale, os angulare, and os spleniale, are mutually connected; and so are the dorsal edge of os quadratum, processus paroccipitalis, os squamosum, and os supratemporale, are mutually connected. In the komodo there is prokinesis, because the connection between the front points of os frontale and os prefrontale and the occipital points of os nasale and os maxillare, are sufficiently loose as to function as axis prokinesis. In the komodo there is streptognathia because the connection between the distal points of os dentale and os spleniale and the mesial points of os surangulare and os angulare, are extremely loose, so that there is an almost vertical axis which functions as axis streptognathia. Os quadratum is irreducible so that os quadratum towards os pterygoideum is at vertical position. Because of this mechanical construction of such craniokinesis, any slight movements of os quadratum to the front will result in a considerable craniokinesis. The mesial points of the right half and the left half are separate. There is streptognathia. With such a mandibular construction, each left and right half of the mandible can be moved laterally.

Connectio cranii *Varanus salvator* has only 2 axes. i.e., metakinesis and mesokinesis. The connection of the bones at these axes are very tight, and there is even a phenomenon that the bones grow stickingly together, so metakinesis and mesokinesis are limited. Os quadratum is reducible so that the position of os quadratum against os pterygoideum slants towards the front. With such a mechanical construction of the connectio cranii of *Varanus salvator*, craniokinesis is highly limited.

From the comparison between the phyletic characteristics of the komodo and *Varanus salvator* a conclusion can be made that between the komodo and *Varanus salvator* in 291 elements of the organs, there are 271 elements whose patterns are different and 20 elements that have the same pattern. From this fact, it is reasonable to say that there is a great difference in characteristics between *Varanus salvator* and the komodo. It should be further mentioned that of the 271 elements of the komodo that differ from *Varanus salvator* there are 269 elements in the komodo which are more primitive than those of *Varanus salvator* and there are 2 elements in the komodo that are more progressive than those of *Varanus salvator*. These two elements are vertebra thoracica XIV which sticks together with vertebra thoracica XV and vertebra thoracica XVIII sticks together with vertebra lumbalis I. This is caused by the fact that the

komodo has a big and heavy abdomen, so that to raise the abdomen, it needs stronger vertebrae. Furthermore, the weight of the komodo's phyletic characteristics is much lower than that of *Varanus salvator*; likewise, the compared organs do not have the same weight, which shows that the komodo is not closely related to *Varanus salvator*.

From a comparison between the phyletic characteristics of the komodo and those of the primitive reptile, a conclusion can be drawn that from the 210 phyletic characteristics of the primitive organs of the primitive reptile which are compared to those of the komodo, there are 210 phyletic characteristics which have the same weight, an evidence which justifies a classification of the komodo into the primitive reptile.

From a comparison between the weight of the phyletic characteristics of the komodo and those of the animals in other subgenera genus *Varanus*, i.e., *Psammosaurus*, *Polydaedalus*, *Empagusia*, *Indovaranus*, *Varanus*, *Dendrovaranus*, *Tectovaranus* and *Odatria* a conclusion can be made that the phyletic characteristics of each taxon of the subgenus of genus *Varanus* have the same weight, except for certain phyletic characteristics, for instance: the scale structure, the length and shape of the trunk, the shape of the caput, the shape of the snout, the length and shape of the cauda. Each phyletic characteristic of the organs in 8 taxons has different weights, but since this difference is not significant for the purpose of systematic, the 8 subgenus taxon of genus *Varanus* can be grouped under one taxon. i.e., genus *Varanus*. The weight of the komodo's phyletic characteristics is lower than that of *Psammosaurus*, *Polydaedalus*, *Empagusia*, *Indovaranus*, *Varanus*, *Dendrovaranus*, *Tectovaranus* and *Odatria*, and none of the same so that it is not possible to classify the komodo as a member of the following taxons: *Psammosaurus*, *Polydaedalus*, *Empagusia*, *Indovaranus*, *Varanus*, *Dendrovaranus*, *Tectovaranus*, and *Odatria*.

From a comparison between the phyletic characteristics of the komodo and those of genus *Varanus* a conclusion can be made that the phyletic characteristics of the komodo and those of genus *Varanus* are all of different weights: the komodo is more primitive while genus *Varanus* is more progressive; in fact, the komodo cannot be considered to belong to genus *Varanus*.

A comparative study of the high-weighted phyletic characteristics between the komodo and the *Varanus* and the primitive Diapsida which belongs to the genus *Mosasaurus* has shown that the komodo belongs to *Mosasaurus* instead of Varanidae.

Paleontological study is mainly concerned with phylogeny of Mosasauridae, Varanidae, and the komodo; paleogeography is concerned with the distribution of fossils phylogenetically based on time-scale; paleoecology is concerned with the food of the sea Mosasauridae and the komodo; paleoclimatology is mainly concerned with the earth temperature; all these studies reveal that the komodo's linea descensus is as follows: The komodo does not belong to linea descensus Varanidae, because according to the high-weighted phyletic characteristics, all the animals in Varanidae are the results of speciatio antecessor monitor and its descendants. The komodo is not an antecessor of antecessor monitor, because there is no evidence that the komodo lived in the period before the existence of antecessor monitor. The komodo is not a descendant of antecessor monitor. This is based on the irreversibility of evolution. On the basis of these three facts, the komodo is outside linea descensus Varanidae.

The high-weighted phyletic characteristics of the komodo and *Mosasaurus* are the same as those of antecessor mosasaur, so that the only possibility that one can think of is that the komodo is a result of speciatio antecessor mosasaur that survives on land. Therefore it is necessary to reclassify the komodo in animal systematic and designate it as *Mosasaurus komodoensis*; this means that are can describe four kinds of phylogram *Mosasaurus komodoensis*: phylogram that describes *Mosasaurus komodoensis* in the family of Mosasauridae, dendrogram that describes the relation and the origin of *Mosasaurus komodoensis* in the Squamata order, phylogram that describes *Mosasaurus komodoensis* and the Varanidae family based on the divergence theory, and phylogram that describes *Mosasaurus komodoensis* based on the divergence theory and the parallelism theory.

Ron Lilley 11/95

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KOMODO MONITOR

Varanus komodoensis

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

December 4-7, 1995

Taman Safari Indonesia
Cisuara, Indonesia

APPENDIX II

CBSG PROCESSES
GLOSSARY
IUCN REINTRODUCTION GUIDELINES
IUCN RED LIST CATEGORIES

CBSG Population and Habitat Viability Assessment (PHVA) Processes

Information on Capabilities of Conservation Breeding Specialist Group (CBSG/SSC/IUCN)

Introduction

There is a lack of generally accepted tools to evaluate and integrate the interaction of biological, physical, and social factors on the population dynamics of the broad range of threatened species, on the characterization of their risk of extinction, on the effects of management interventions, and the possible effects of future events.

The Conservation Breeding Specialist Group (CBSG) of IUCN's Species Survival Commission (SSC) has developed and applied a series of scientifically-based tools and processes to expedite species management. These tools, based on small population and conservation biology (biological and physical factors), human demography, and the dynamics of social learning are used in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in situ* and *ex situ* population management.

Our Workshop processes provide an objective workshop environment and a neutral facilitation process that supports sharing of available information, reaching agreement on the issues and available information, and then making useful and practical management recommendations for the taxon and habitat system under consideration. The process has been remarkably successful in unearthing and integrating previously unpublished information; its proven heuristic value and constant refinement and expansion have made it one of the most imaginative and productive organizing forces for species conservation today (Conway, 1995).

Integration of Science, Management, and Stakeholders

The CBSG PHVA Workshop process is based upon biological and sociological science. Effective conservation action is best built upon a synthesis of available biological information, but is dependent on actions of humans living within the range of the threatened species as well as established international interests. There are characteristic patterns of human behavior that appear cross-disciplinary and cross-cultural: 1) in the acquisition, sharing, and analysis of information; 2) in the perception and analysis of risk; 3) in the development of trust among individuals; and, 4) in 'territoriality' (personal, institutional, local, national). Each of these has strong emotional components that shape our interactions. Recognition of these patterns has been essential in the development of processes to assist people in working groups to reach consensus on needed conservation actions.

Frequently, needed management actions have been identified by local management agencies, consultants, and local experts. An isolated approach, however, seems to have little effect on the needed political and social changes (social learning) for effective management and conservation of protected areas and their species components. CBSG workshops are organized to bring together the full range of groups with a strong interest in conserving and managing the species in its habitat. One goal in all workshops is to reach a common understanding of the state of scientific knowledge available and its possible application to needed management actions. We have found the workshop process with stochastic simulation modelling, risk assessment, and scenario testing to be a powerful tool in extracting, assembling, and exploring this information and developing a shared understanding across wide boundaries of training and expertise. This tool also supports consensus and instills ownership and pride during the workshop process. As participants appreciate the complexity of the problems as a group, they have a tendency to take more ownership of the process as well as the ultimate recommendations to achieve solutions. This is essential if the management recommendations generated by the workshops are to succeed.

CBSG has learned a host of lessons in its more than 100 workshop experiences. Our traditional approaches have tended to emphasize our lack of information and the need for additional research. This has been coupled with a hesitancy to make risk assessments of species status and a reluctance to make immediate or non-traditional management recommendations. The result has been long delays in preparing action plans or broad recommendations that do not provide useful guidance to the managers.

CBSG's interactive and participatory workshop approach produces positive effects on management decision-making and in generating political and social support for conservation actions by local people. Modelling is an important tool as part of the process and to provide a continuing test of assumptions, data consistency, and of scenarios. It recognizes that the present science is imperfect and that management policies and actions need to be designed as part of a biological and social learning process. The Workshop process essentially provides a means for designing management programs on the basis of sound science while allowing new information (that eventually becomes available) to be used to adjust and further refine management practices.

Workshop Processes and Multiple Stakeholders

Experience: The Chairman and Program Officers of CBSG have conducted and facilitated more than 100 species and ecosystem Workshops in 35 countries including the USA during the past 5 years. *Reports from these workshops are available from the CBSG Office*. We have worked on a continuing basis with agencies on some taxa (e.g., Florida panther) and have assisted in the development of national conservation strategies for other taxa (e.g., Sumatran tiger, Indonesia). Our *Population Biology Program Officer (Dr. P. Miller)* received his doctoral training with Dr. P. Hedrick and is familiar with the genetic and demographic aspects of a range of vertebrate species. He has worked extensively with VORTEX and other population models.

Facilitator's Training and Manual: A manual has been prepared to assist CBSG workshop conveners, collaborators, and facilitators in the process of organizing, conducting, and completing a CBSG workshop. It was developed with the assistance of two management science professionals and 30 people from 11 countries experienced in such workshops. These facilitator's training workshops have proven very popular with 3-4 per year planned for 1996 and 1997 in several countries including the USA. *Copies of the facilitator's manual are available from the CBSG Office.*

Scientific Studies of Workshop Process: The effectiveness of these workshops as tools for eliciting information, assisting the development of sustained networking among stakeholders, impact on attitudes of participants, and in achieving consensus on needed management actions and research has been extensively debated. We initiated a scientific study of the process and its long term aftermath three years ago in collaboration with an independent team of researchers (Vredenburg and Westley, 1995). A survey questionnaire is administered at the beginning and end of each workshop. *Three manuscripts on CBSG Workshop processes and their effects are available from the team and the CBSG office.* The study also is undertaking follow up at one and two years after each workshop to assess longer term effects. To the best of our knowledge there is no comparable systematic scientific study of conservation and management processes. *We will apply the same scientific study tools to the workshops in this program and provide an analysis of the results after each workshop.*

Stochastic Simulation Modeling

Integration of Biological, Physical and Social Factors: The Workshop process, as developed by CBSG, generates population and habitat viability assessments based upon in-depth analysis of information on the life history, population dynamics, ecology, and population history of the populations. Information on demography, genetics, and environmental factors pertinent to assessing population status and risk of extinction under current management scenarios and perceived threats are assembled in preparation for and during the workshops. Modeling and simulations provide a neutral externalization focus for assembly of information, identifying assumptions, projecting possible outcomes (risks), and examining for internal consistency. Timely reports from the workshop are necessary to have impact on stakeholders and decision makers. Draft reports are distributed within 3 weeks of the workshop and final reports within 60 days.

Human Dimension: We have collaborated with human demographers in 4 CBSG workshops on endangered species and habitats. They have utilized computer models incorporating events at the local level in order to provide projections of the likely course of population growth and the utilization of local resources. This information was then incorporated into projections of the likely viability of the habitat of the threatened species and used as part of the population projections and risk assessments. We have prepared a draft manual on the human dimension of population and habitat viability assessment. It is our intention to further develop these tools during the course of this project and to utilize them as part of the scenario assessment process.

Risk Assessment and Scenario Evaluation: A stochastic population simulation model is a kind of model that attempts to incorporate the uncertainty, randomness or unpredictability of life-history and environmental events into the modeling process. Events whose occurrence is uncertain, unpredictable, and random are called stochastic. Most events in an animal's life have some level of uncertainty. Similarly, environmental factors, and their effect on the population process, are stochastic - they are not completely random, but their effects are predictable within certain limits. Simulation solutions are usually needed for complex models including several stochastic parameters.

There are a host of reasons why simulation modeling is valuable for the workshop process and development of management tools. The primary advantage, of course, is to simulate scenarios and the impact of numerous variables on the population dynamics and potential for population extinction. Interestingly, not all advantages are related to generating useful management recommendations. The side-benefits are substantial.

- Population modeling supports consensus and instills ownership and pride during the workshop process. As groups begin to appreciate the complexity of the problems, they have a tendency to take more ownership of the process and the ultimate recommendations to achieve solutions.
- Population modeling forces discussion on biological and physical aspects and specification of assumptions, data, and goals. The lack of sufficient data of useable quality rapidly becomes apparent and identifies critical factors for further study (driving research), management, and monitoring. This not only influences assumptions, but also the group's goals.
- Population modeling generates credibility by using technology that non-biologically oriented groups can use to relate to population biology and the "real" problems. The acceptance of the computer as a tool for performing repetitive tasks has led to a common ground for persons of diverse backgrounds.
- Population modeling explicitly incorporates what we know about dynamics by allowing the simultaneous examination of multiple factors and interactions - more than can be considered in analytical models. The ability to alter these parameters in a systematic fashion allows testing a multitude of scenarios that can guide adaptive management strategies.
- Population modeling can be a neutral computer "game" that focuses attention while providing persons of diverse agendas the opportunity to reach consensus on difficult issues.
- Population modeling results can be of political value for people in governmental agencies by providing support for perceived population trends and the need for action. It helps managers to justify resource allocation for a program to their superiors and budgetary agencies as well as identify areas for intensifying program efforts.

Modeling Tools: At the present time, our preferred model for use in the population simulation modeling process is called VORTEX. This model, developed by Lacy et al., is designed specifically for use in the stochastic simulation of the small population/extinction process. It has been developed in collaboration and cooperation with the CBSG PHVA process. The model simulates deterministic forces as well as demographic, environmental, and genetic events in relation to their probabilities. It includes modules for catastrophes, density dependence, metapopulation dynamics, and inbreeding effects. The VORTEX model analyzes a population in a stochastic and probabilistic fashion. It also makes predictions that are testable in a scientific manner, lending more credibility to the process of using population modeling tools.

There are other commercial models, but presently they have some limitations such as failing to measure genetic effects, being difficult to use, or failing to model individuals. VORTEX has been successfully used in more than 70 PHVA workshops in guiding management decisions. VORTEX is general enough for use when dealing with a broad range of species, but specific enough to incorporate most of the important processes. It is continually evolving in conjunction with the PHVA process. VORTEX has, as do all models, its limitations which may restrict its utility. The VORTEX model analyzes a population in a stochastic and probabilistic fashion. It is now at Version 7 through the cooperative contributions of dozens of biologists. It has been the subject of a series of both published and in press validation studies and comparisons with other modeling tools. More than 2000 copies of VORTEX are in circulation and it is being used as a teaching tool in university courses.

It is our plan to use this model and the experience we have with it as a central tool for the population dynamic aspects of this project. Additional modules building on other simulation modelling tools for human population dynamics (which we have used in 3 countries) with potential impacts on water usage, harvesting effects, and physical factors such as hydrology and water diversion will be developed to provide input into the salmon population model whose outputs can then be used to evaluate possible effects of different management scenarios. No such composite models are available. There is a lack of general acceptance among stakeholders of the available salmon population models.

CBSG Resources as Unique Asset

Expertise and Costs: The problems and threats to salmon are complex and interactive with a need for diverse specialists. No agency or country encompasses all of the useful expert knowledge. Thus, there is a need to include a wide range of people as resources and analysts. It is important that the invited experts have reputations for expertise, objectivity, initial lack of local stake, and for active transfer of wanted skills. CBSG has a volunteer network of more than 700 experts with about 250 in the USA. More than 3,000 people from 400 organizations have assisted CBSG on projects and participated in workshops on a volunteer basis contributing tens of thousands of hours of time. We will call upon individual experts to assist in all phases of this project.

Indirect cost contributions to support: Although not detailed in the proposal, use of CBSG resources and the contribution of participating experts will provide a documented matching contribution more than equaling the proposed budget request for the project. We also have not requested indirect costs for overhead.

Manals and Reports: We have manuals available which provide guidance on the goals, objectives, and preparations needed for our workshops. These will reduce startup time and costs and allow us to begin work on organizing the project immediately with proposed participants and stockholders. We have a process manual for use by local organizers which goes into detail on all aspects of organizing, conducting, and preparing reports from the workshops. Draft reports are prepared during the workshop so that there is agreement by participants on its content and recommendations. Reports will also be prepared on the mini-workshops (working groups) that will be conducted in information gathering exercises with small groups of experts and stakeholders. We can print reports within 24-48 hours of preparation of final copy. We also have CD-ROM preparation facilities, software and experience.

GENETICS GLOSSARY

DNA
Deoxyribonucleic Acid; a chain of molecules contain units known as nucleotides. The material that stores and transmits information inherited from one cell or organisms to the next. The principle DNA is located on the chromosomes in the nucleus of cells. Lesser but still significant DNA is located in the mitochondria.

GENE
The segment of DNA that constitutes a functional unit of inheritance.

LOCUS
The section of the DNA occupied by the gene. Gene and locus (plural: loci) are often used interchangeably.

ALLELE
Alternative forms of a gene. Most strictly, allele refers to different forms of a gene that determine alternative characteristics. However, allele is used more broadly to refer to different copies of a gene, i.e. the 2 copies of each gene that every diploid organism carries for each locus.

ALLELE OR GENE FREQUENCY
The proportion of all copies of a gene in the population that represent a particular allele.

GENOTYPE
The kinds of alleles that an individual carries as its two copies of a gene. As an example, if there are two alleles (A, a) possible at a locus, there are then three genotypes possible: AA, Aa, and aa.

GENOTYPIC FREQUENCY
The proportion of individuals in the population that are of a particular genotype.

HETEROZYGOSITY
The proportion of individuals in the population that are heterozygous (i.e., carry functionally different alleles) at a locus.

HARDY-WEINBERG EQUILIBRIUM
A principle in population genetics that predicts frequencies of genotypes based on the

frequencies of the alleles, assuming that the population has been randomly mating for at least one generation. In the simplest case, where there are two alleles (A, a) at a locus and these alleles occur in the frequency p_A and p_a, the Hardy-Weinberg law predicts that after one generation of random mating the frequencies of the genotypes will be: $AA = p_A^2$; $Aa = 2p_Ap_a$; $aa = p_a^2$.

EXPECTED HETEROZYGOSITY = GENE DIVERSITY
The heterozygosity expected in a population if the population were in Hardy-Weinberg equilibrium. Expected heterozygosity is calculated from allele frequencies, and is the heterozygosity expected in progeny produced by random mating. 1 - SUM p_i's, where p_i = the frequency of allele i.

GENOME
The complete set of genes (alleles) carried by an individual.

GENETIC DRIFT
The change in allelic frequencies from one generation to the next due to the randomness (chance) by which alleles are actually transmitted from parents to offspring. This random variation becomes greater as the population, and hence sample of genes, transmitted from one generation to the next, becomes smaller.

BOTTLENECK
A generation in the lineage from a founder when only one or a few offspring are produced so that not all of the founder's alleles may be transmitted onto the next generation.

FOUNDER
An animal from a source (e.g., wild) population that actually produce offspring and has descendants in the living derived (e.g., captive) population.

FOUNDER REPRESENTATION
The percentage or fraction of all the genes in the population at any given time that have derived from a particular founder.

EXISTING REPRESENTATION
The existing percentage representation of founders in the population.

TARGET REPRESENTATION
The desired or target percentage representation of founders. These target figures are

proportional to the fraction of each founder genome that survived in the population. Achieving target representation will maximize preservation of genetic diversity.

ORIGINAL FOUNDER ALLELES
The total number of alleles (copies) of each gene carried at each locus by the founders. The number of original founder alleles is twice the number of original founder genomes.

ORIGINAL FOUNDER GENOMES
The set of all genes in a founder. The sum of all such sets are the founder genomes. The number of original founder genomes is half the number of original founder alleles.

FOUNDER ALLELES SURVIVING
The number of alleles still surviving at each locus in the population assuming that each founder carried two distinct alleles at each locus into the derived (captive) population.

FOUNDER GENOMES SURVIVING
The number of original founder genomes still surviving in the population. This metric measures loss of original diversity due to bottlenecks in the pedigree of the population.

FOUNDER GENOME EQUIVALENTS
The number of newly wild caught animals required to obtain the genetic diversity in the present captive population. This metric reflects loss due to both bottlenecks and disparities in founder representation.

FOUNDER EQUIVALENTS
The number of equally represented founders that would produce the same gene diversity as that observed in the surviving population, acknowledging the founder alleles that have already been lost due to bottlenecks. Founder equivalents measures the loss of genetic diversity due to the uneven representation of founder lineages in the surviving population.

EFFECTIVE POPULATION SIZE
A concept developed to reflect the fact that not all individuals in a population will contribute equally or at all to the transmission of genetic material to the next generation. Effective population size is usually denoted by N_e and is defined as the size of an ideal population that would have the same rate of genetic drift and of inbreeding as is observed in the real population under consideration. An ideal population is defined by: sexual reproduction; random mating; equal sex ratio; Poisson distribution

of family sizes, i.e. total lifetime production of offspring; stable age distribution and constant size, i.e. demographic stationariness.

COEFFICIENT OF RELATEDNESS
The probability that an allele selected at random from one individual in the population is present in a second individual because of inheritance of that allele from a common ancestor. Equivalently, the proportion of genes in two individuals that are the same because of common descent. The inbreeding coefficient of an animal is equal to 1/2 the relatedness of the parents.

AVERAGE RELATEDNESS
The average or mean coefficient of relatedness between an animal and all animals (including itself) in the living, descendant (i.e., excluding the founders) population. The mean relatedness is twice the proportional loss of gene diversity of the descendant population relative to the founders and is also twice the mean or average inbreeding coefficient of progeny produced by random mating.

DEMOGRAPHY GLOSSARY

Age Age class in years.

Px Age-specific survival.

Probability that an animal of age x will survive to next age class.

Lx Age-specific survivorship.

Probability of a newborn surviving to a age class x.

Mx Age-specific fertility.

Average number of offspring (of the same sex as the parent) produced by an animal in age class x. Can also be interpreted as average percentage of animals that will reproduce.

r Instantaneous rate of change.

If $r < 0$ ...... Population is declining

If $r = 0$ ...... Population is stationary (no change in number)

If $r > 0$ .... Population is increasing

lambda Percent of population change per year.

If lambda < 1 ...... Population is declining

If lambda = 1 ...... Population is stationary

If lambda > 1 ...... Population is increasing

R_o Net reproductive rate. The rate of change per generation.

If $R_o < 1$ ...... Population is declining

If $R_o = 1$ ...... Population is stationary

If $R_o > 1$ ...... Population is increasing

G Generation Time.

Average length of time between the birth of a parent and the birth of its offspring. Equivalently, the average age at which an animal produces its offspring).

DRAFT GUIDELINES FOR RE-INTRODUCTIONS

Introduction

These policy guidelines have been drafted by the Re-introduction Specialist Group of the IUCN's Species Survival Commission (Guidelines for determining procedures for disposal of species confiscated in trade are being developed separately by IUCN for CITES.) in response to the increasing occurrence of reintroduction projects world-wide, and consequently, to the growing need for specific policy guidelines to help ensure that the re-introductions achieve their intended conservation benefit, and do not cause adverse side-effects of greater impact. Although the IUCN developed a Position Statement on the Translocation of Living Organisms in 1987, more detailed guidelines were felt to be essential in providing more comprehensive coverage of the various factors involved in re-introduction exercises.

These guidelines are intended to act as a guide for procedures useful to re-introduction programmes and do not represent an inflexible code of conduct. Many of the points are more relevant to re-introductions using captive-bred individuals than to translocation of wild species. Others are especially relevant to globally endangered species with limited numbers of founders. Each re-introduction proposal should be rigorously reviewed on its individual merits. On the whole, it should be noted that re-introduction is a very lengthy and complex process.

This document is very general, and worded so that it covers the full range of plant and animal taxa. It will be regularly revised. Handbooks for re-introducing individual groups of animals and plants will be developed in future.

1. Definition of Terms

a. ''Re-introduction ":

An attempt to establish a species (The taxonomic unit referred to throughout the document is species: it may be a lower taxonomic unit [e.g. sub-species or race] as long as it can be unambiguously defined.) in an area which was once part of its historical range, but from which it has become extinct (CITES criterion of "extinct": species not definitely located in the wild during the past 50 years of conspecifics.). ("Re-establishment" is a synonym, but implies that the re-introduction has been successful) .

b. "Translocation ":

Deliberate and mediated movement of wild individuals or populations from one part of their range to another.

c. "Reinforcement/Supplementation":

Addition of individuals to an existing population.

d. Conservation/Benign Introductions:

An attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area.

2. Aims and Objectives of the Re-Introduction

a. Aims:

A re-introduction should aim to establish a viable, free-ranging population in the wild, of a species or subspecies which was formerly globally or locally extinct (extirpated). In some circumstances, a re-introduction may have to be made into an area which is fenced or otherwise delimited, but it should be within the species' former natural habitat and range, and require minimal long-term management.

b. Objectives:

The objectives of a re-introduction will include: to enhance the long-term survival of a species; to re-establish a keystone species (in the ecological or cultural sense) in an ecosystem; to maintain natural biodiversity; to provide long-term economic benefits to the local and/or national economy; to promote conservation awareness; or a combination of these.

Re-introductions or translocation of species for short-term, sporting or commercial purposes - where there is no intention to establish a viable population - are a different issue, beyond the scope of these guidelines. These include fishing an(I hunting activities.

3. Multi disciplinary Approach

A re-introduction requires a Multi disciplinary approach involving a team of persons drawn from a variety of backgrounds. They may include persons from: governmental natural resource management agencies; non-governmental organizations; funding bodies; universities; veterinary institutions; zoos (and private animal breeders) and/or botanic gardens, with a full range of suitable expertise. Team leaders should be responsible for coordination between the various bodies and provision should be made for publicity and public education about the project.

4. Pre-Project Activities

a. Biological:

(I) Feasibility study and background research

- An assessment should be made of the taxonomic status of individuals to be re-introduced. They must be of the same subspecies as those which were extirpated, unless adequate numbers are not available. An investigation of historical information about the loss and fate of individuals from the re-introduction area, as well as molecular genetic studies, should be undertaken in case of doubt. A study of genetic variation within and between populations of this and related taxa can also be helpful. Special care is needed when the population has long been extinct.

- Detailed studies should be made of the status and biology of wild populations (if they exist) to determine the species' critical needs; for animals, this would include descriptions of habitat preferences, intra specific variation and adaptations to local ecological conditions, social behavior, group composition, home range size, shelter and food requirements, foraging and feeding behavior, predators and diseases. For plants it would include biotic and abiotic habitat requirements, dispersal mechanisms, reproductive biology, symbiotic relationships (e.g. with mycorrhizae, pollinators), insect pests and diseases. Overall, a firm knowledge of the natural history of the species in question is crucial to the entire re-introduction scheme.

- The build-up of the released population should be modeled under various sets of conditions, in order to specify the optimal number and composition of individuals to be released per year and the numbers of years necessary to promote establishment of a viable population.

- A Population and Habitat Viability Analysis will aid in identifying significant environmental and population variables and assessing their potential interactions, which would guide long-term population management.

(ii) Previous Re-introductions

- Thorough research into previous re-introductions of the same or similar species and wide-ranging contacts with persons having relevant expertise should be conducted prior to and while developing re-introduction protocol.

(iii) Choice of release site

- Site should be within the historic range of species and for an initial reinforcement or re-introduction have very few, or no, remnant wild individuals (to prevent disease spread, social disruption and introduction of alien genes). A conservation/ benign introduction should be undertaken only as a last resort when no opportunities for re-introduction into the original site or range exist.

● The re-introduction area should have assured, long-term protection (whether formal or otherwise).

(iv) Evaluation of re-introduction site

● Availability of suitable habitat: re-introductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the for-seeable future. The possibility of natural habitat change since extirpation must be considered. The area should have sufficient carrying capacity to sustain growth of the re-introduced population and support a viable (self-sustaining) population in the long run.

● Identification and elimination of previous causes of decline: could include disease; over-hunting; over-collection; pollution; poisoning; competition with or predation by introduced species; habitat loss; adverse effects of earlier research or management programmes; competition with domestic livestock, which may be seasonal.

● Where the release site has undergone substantial degradation caused by human activity, a habitat restoration programme should be initiated before the reintroduction is carried out.

(v) Availability of suitable release stock

● Release stock should be ideally closely-related genetically to the original native stock.

● If captive or artificially propagated stock is to be used, it must be from a population which has been soundly managed both demographically and genetically, according to the principles of contemporary conservation biology.

● Re-introductions should not be carried out merely because captive stocks exist, nor should they be a means of disposing of surplus stock.

● Removal of individuals for re-introduction must not endanger the captive stock population or the wild source population. Stock must be guaranteed available on a regular and predictable basis, meeting specifications of the project protocol.

● Prospective release stock must be subjected to a thorough veterinary screening process before shipment from original source. Any animals found to be infected or which test positive for selected pathogens must be removed from the consignment, and the uninfected, negative remainder must be placed in strict quarantine for a suitable period before retest. If clear after retesting, the animals may be placed for shipment.

● Since infection with serious disease can be acquired during shipment, especially if this is intercontinental, great care must be taken to minimize this risk.

● Stock must meet all health regulations prescribed by the veterinary authorities of the recipient country and adequate provisions must be made for quarantine if necessary.

• Individuals should only be removed from a wild population after the effects of translocation on the donor population have been assessed, and after it is guaranteed that these effects will not be negative.

b. Socio-Economic and Legal Activities

• Re-introductions are generally long-term projects that require the commitment of long-term financial and political support.

• Socio-economic studies should be made to assess costs and benefits of the e-introduction programme to local human populations.

• A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long term protection of the re-introduced population, especially if the cause of species' decline was due to human factors (e.g. over-hunting, over-collection, loss of habitat). The programme should be fully understood, accepted and supported by local communities.

• Where the security of the re-introduced population is at risk from human activities, measures should be taken to minimize these in the re-introduction area. If these measures are inadequate, the re-introduction should be abandoned or alternative release areas sought.

• The policy of the country to re-introductions and to the species concerned should be assessed. This might include checking existing national and international legislation and regulations, and provision of new measures as necessary. Re-introduction must take place with the full permission and involvement of all relevant government agencies of the recipient or host country. This is particularly important in re-introductions in border areas, or involving more than one state.

• If the species poses potential risk to life or property, these risks should be minimized and adequate provision made for compensation where necessary; where all other solutions fail, removal or destruction of the released individual should be considered.

In the case of migratory/mobile species, provisions should be made for crossing of international/state boundaries.

5. Planning. Preparation and Release Stages

• Construction of a Multi disciplinary team with access to expert technical advice for all phases of the programme. IUCN/SSC Draft Reintroduction Guidelines 6

• Approval of all relevant government agencies and land owners, and coordination with national and international conservation organizations.

- Development of transport plans for delivery of stock to the country and site of re-introduction, with special emphasis on ways to minimize stress on the individuals during transport.

- Identification of short-and long-term success indicators and prediction of programme duration, in context of agreed aims and objectives.

- Securing adequate funding for all programme phases.

- Design of pre- and post- release monitoring programme so that each re-introduction is a carefully designed experiment, with the capability to test methodology with scientifically collected data.

- Appropriate health and genetic screening of release stock. Health screening of closely related species in re-introduction area.

- If release stock is wild-caught, care must be taken to ensure that: a) the stock is free from infectious or contagious pathogens and parasites before shipment and b) the stock will not be exposed to vectors of disease agents which may be present at the release site (and absent at the source site) and to which it may have no acquired immunity.

- If vaccination prior to release, against local endemic or epidemic diseases of wild stock or domestic livestock at the release site, is deemed appropriate, this must be carried out during the "Preparation Stage" so as to allow sufficient time for the development of the required immunity.

- Appropriate veterinary or horticultural measures to ensure health of released stock throughout programme. This is to include adequate quarantine arrangements, especially where founder stock travels far or crosses international boundaries to release site.

- Determination of release strategy (acclimatization of release stock to release area; behavioral training - including hunting and feeding; group composition, number, release patterns and techniques; timing).

- Establishment of policies on interventions (see below).

- Development of conservation education for long-term support; professional training of individuals involved in long-term programme; public relations through the mass media and in local community; involvement where possible of local people in the programme.

- The welfare of animals for release is of paramount concern through all these stages.

6. Post-Release Activities

- Post release monitoring of all (or sample of) individuals. This most vital aspect may be by direct (e.g. tagging, telemetry) or indirect (e.g. spoor, informants) methods as suitable.

- Demographic, ecological and behavioral studies of released stock.

- Study of processes of long-term adaptation by individuals and the population.

- Collection and investigation of mortalities.

- Interventions (e.g. supplemental feeding; veterinary aid; horticultural aid) when necessary.

- Decisions for revision rescheduling, or discontinuation of programme where necessary.

- Habitat protection or restoration to continue where necessary.

- Continuing public relations activities, including education and mass media coverage.

- Evaluation of cost-effectiveness and success of re- introduction techniques.

- Regular publications in scientific and popular literature.

IUCN RED LIST CATEGORIES

Prepared by the

IUCN Species Survival Commission

As approved by the
40th Meeting of the IUCN Council
Gland, Switzerland

30 November 1994

IUCN RED LIST CATEGORIES

I) Introduction

1. The threatened species categories now used in Red Data Books and Red Lists have been in place, with some modification, for almost 30 years. Since their introduction these categories have become widely recognised internationally, and they are now used in a whole range of publications and listings, produced by IUCN as well as by numerous governmental and non-governmental organisations. The Red Data Book categories provide an easily and widely understood method for highlighting those species under higher extinction risk, so as to focus attention on conservation measures designed to protect them.

2. The need to revise the categories has been recognised for some time. In 1984, the SSC held a symposium, 'The Road to Extinction' (Fitter & Fitter 1987), which examined the issues in some detail, and at which a number of options were considered for the revised system. However, no single proposal resulted. The current phase of development began in 1989 with a request from the SSC Steering Committee to develop a new approach that would provide the conservation community with useful information for action planning.

In this document, proposals for new definitions for Red List categories are presented. The general aim of the new system is to provide an explicit, objective framework for the classification of species according to their extinction risk.

The revision has several specific aims:

- to provide a system that can be applied consistently by different people;
- to improve the objectivity by providing those using the criteria with clear guidance on how to evaluate different factors which affect risk of extinction;
- to provide a system which will facilitate comparisons across widely different taxa;
- to give people using threatened species lists a better understanding of how individual species were classified.

3. The proposals presented in this document result from a continuing process of drafting, consultation and validation. It was clear that the production of a large number of draft proposals led to some confusion, especially as each draft has been used for classifying some set of species for conservation purposes. To clarify matters, and to open the way for modifications as and when they became necessary, a system for version numbering was applied as follows:

Version 1.0: Mace & Lande (1991)
The first paper discussing a new basis for the categories, and presenting numerical criteria especially relevant for large vertebrates.

Version 2.0: Mace *et al.* (1992)
A major revision of Version 1.0, including numerical criteria appropriate to all organisms and introducing the non-threatened categories.

Version 2.1: IUCN (1993)

Following an extensive consultation process within SSC, a number of changes were made to the details of the criteria, and fuller explanation of basic principles was included. A more explicit structure clarified the significance of the non-threatened categories.

Version 2.2: Mace & Stuart (1994)

Following further comments received and additional validation exercises, some minor changes to the criteria were made. In addition, the Susceptible category present in Versions 2.0 and 2.1 was subsumed into the Vulnerable category. A precautionary application of the system was emphasised.

Final Version

This final document, which incorporates changes as a result of comments from IUCN members, was adopted by the IUCN Council in December 1994.

All future taxon lists including categorisations should be based on this version, and not the previous ones.

4. In the rest of this document the proposed system is outlined in several sections. The Preamble presents some basic information about the context and structure of the proposal, and the procedures that are to be followed in applying the definitions to species. This is followed by a section giving definitions of terms used. Finally the definitions are presented, followed by the quantitative criteria used for classification within the threatened categories. It is important for the effective functioning of the new system that all sections are read and understood, and the guidelines followed.

References:

Fitter, R., and M. Fitter, ed. (1987) The Road to Extinction. Gland, Switzerland: IUCN.

IUCN. (1993) Draft IUCN Red List Categories. Gland, Switzerland: IUCN.

Mace, G. M. *et al.* (1992) "The development of new criteria for listing species on the IUCN Red List." Species 19: 16-22.

Mace, G. M., and R. Lande. (1991) "Assessing extinction threats: toward a reevaluation of IUCN threatened species categories." Conserv. Biol. 5.2: 148-157.

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II) Preamble

The following points present important information on the use and interpretation of the categories (= Critically Endangered, Endangered, etc.), criteria (= A to E), and sub-criteria (= a,b etc., i,ii etc.):

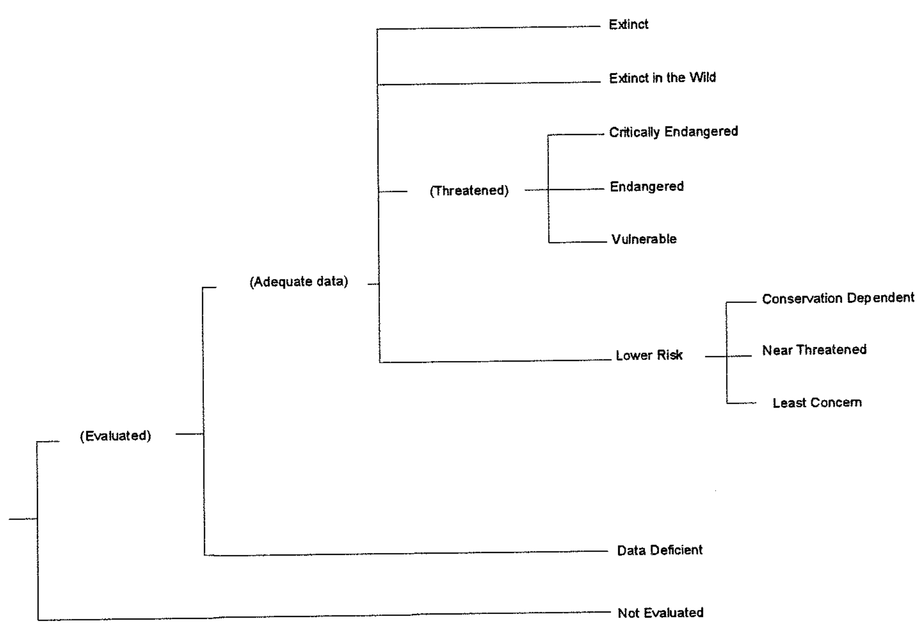
1. Taxonomic level and scope of the categorisation process

The criteria can be applied to any taxonomic unit at or below the species level. The term 'taxon' in the following notes, definitions and criteria is used for convenience, and may represent species or lower taxonomic levels, including forms that are not yet formally described. There is a sufficient range among the different criteria to enable the appropriate listing of taxa from the complete taxonomic spectrum, with the exception of micro-organisms. The criteria may also be applied within any specified geographical or political area although in such cases special notice should be taken of point 11 below. In presenting the results of applying the criteria, the taxonomic unit and area under consideration should be made explicit. The categorisation process should only be applied to wild populations inside their natural range, and to populations resulting from benign introductions (defined in the draft IUCN Guidelines for Re-introductions as "..an attempt to establish a species, for the purpose of conservation, outside its recorded distribution, but within an appropriate habitat and eco-geographical area").

2. Nature of the categories

All taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all listed as Endangered qualify for Vulnerable. Together these categories are described as 'threatened'. The threatened species categories form a part of the overall scheme. It will be possible to place all taxa into one of the categories (see Figure 1).

Figure 1: Structure of the Categories



3. **Role of the different criteria**

For listing as Critically Endangered, Endangered or Vulnerable there is a range of quantitative criteria; meeting any one of these criteria qualifies a taxon for listing at that level of threat. Each species should be evaluated against all the criteria. The different criteria (A-E) are derived from a wide review aimed at detecting risk factors across the broad range of organisms and the diverse life histories they exhibit. Even though some criteria will be inappropriate for certain taxa(some taxa will never qualify under these however close to extinction they come), there should be criteria appropriate for assessing threat levels for any taxon (other than micro-organisms). The relevant factor is whether any one criterion is met, not whether all are appropriate or all are met. Because it will never be clear which criteria are appropriate for a particular species in advance, each species should be evaluated against all the criteria, and any criterion met should be listed.

4. **Derivation of quantitative criteria**

The quantitative values presented in the various criteria associated with threatened categories were developed through wide consultation and they are set at what are generally judged to be appropriate levels, even if no formal justification for these values exists. The levels for different criteria within categories were set independently but against a common standard. Some broad consistency between them was sought. However, a given taxon should not be expected to meet all criteria (A-E) in a category; meeting any one criterion is sufficient for listing.

5. **Implications of listing**

Listing in the categories of Not Evaluated and Data Deficient indicates that no assessment of extinction risk has been made, though for different reasons. Until such time as an assessment is made, species listed in these categories should not be treated as if they were non-threatened, and it may be appropriate (especially for Data Deficient forms) to give them the same degree of protection as threatened taxa, at least until their status can be evaluated.

Extinction is assumed here to be a chance process. Thus, a listing in a higher extinction risk category implies a higher expectation of extinction, and over the time-frames specified more taxa listed in a higher category are expected to go extinct than in a lower one (without effective conservation action). However, the persistence of some taxa in high risk categories does not necessarily mean their initial assessment was inaccurate.

6. **Data quality and the importance of inference and projection**

The criteria are clearly quantitative in nature. However, the absence of high quality data should not deter attempts at applying the criteria, as methods involving estimation, inference and projection are emphasised to be acceptable throughout. Inference and projection may be based on extrapolation of current or potential threats into the future (including their rate of change), or of factors related to population abundance or distribution (including dependence on other taxa), so long as these can reasonably be supported. Suspected or inferred patterns in either the recent past, present or near future can be based on any of a series of related factors, and these factors should be specified.

Taxa at risk from threats posed by future events of low probability but with severe consequences (catastrophes) should be identified by the criteria (e.g. small distributions, few locations). Some threats need to be identified particularly early, and appropriate actions taken, because their effects are irreversible, or nearly so (pathogens, invasive organisms, hybridization).

7. **Uncertainty**

The criteria should be applied on the basis of the available evidence on taxon numbers, trend and distribution, making due allowance for statistical and other uncertainties. Given that data are rarely available for the whole range or population of a taxon, it may often be appropriate to use the information that is available to make intelligent inferences about the overall status of the taxon in question. In cases where a wide variation in estimates is found, it is legitimate to apply the precautionary principle and use the estimate (providing it is credible) that leads to listing in the category of highest risk.

Where data are insufficient to assign a category (including Lower Risk), the category of 'Data Deficient' may be assigned. However, it is important to recognise that this category indicates that data are inadequate to determine the degree of threat faced by a taxon, not necessarily that the taxon is poorly known. In cases where there are evident threats to a taxon through, for example, deterioration of its only known habitat, it is important to attempt threatened listing, even though there may be little direct information on the biological status of the taxon itself. The category 'Data Deficient' is not a threatened category, although it indicates a need to obtain more information on a taxon to determine the appropriate listing.

8. **Conservation actions in the listing process**

The criteria for the threatened categories are to be applied to a taxon whatever the level of conservation action affecting it. In cases where it is only conservation action that prevents the taxon from meeting the threatened criteria, the designation of 'Conservation Dependent' is appropriate. It is important to emphasise here that a taxon require conservation action even if it is not listed as threatened.

9. **Documentation**

All taxon lists including categorisation resulting from these criteria should state the criteria and sub-criteria that were met. No listing can be accepted as valid unless at least one criterion is given. If more than one criterion or sub-criterion was met, then each should be listed. However, failure to mention a criterion should not necessarily imply that it was not met. Therefore, if a re-evaluation indicates that the documented criterion is no longer met, this should not result in automatic down-listing. Instead, the taxon should be re-evaluated with respect to all criteria to indicate its status. The factors responsible for triggering the criteria, especially where inference and projection are used, should at least be logged by the evaluator, even if they cannot be included in published lists.

10. **Threats and priorities**

The category of threat is not necessarily sufficient to determine priorities for conservation action. The category of threat simply provides an assessment of the likelihood of extinction under current circumstances, whereas a system for assessing priorities for action will include numerous other factors concerning conservation action such as costs, logistics, chances of success, and even perhaps the taxonomic distinctiveness of the subject.

11. **Use at regional level**

The criteria are most appropriately applied to whole taxa at a global scale, rather than to those units defined by regional or national boundaries. Regionally or nationally based threat categories, which are aimed at including taxa that are threatened at regional or national levels (but not necessarily throughout their global ranges), are best used with two key pieces of information: the global status category for the taxon, and the proportion of the global population or range that occurs within the region or nation. However, if applied at regional or national level it must be recognised that a global category of threat may not be the same as a regional or national category for a particular taxon. For example, taxa classified as Vulnerable on the basis of their global declines in numbers or range might be Lower Risk within a particular region where their populations are stable. Conversely, taxa classified as Lower Risk globally might be Critically Endangered within a particular region where numbers are very small or declining, perhaps only because they are at the margins of their global range. IUCN is still in the process of developing guidelines for the use of national red list categories.

12. **Re-evaluation**

Evaluation of taxa against the criteria should be carried out at appropriate intervals. This is especially important for taxa listed under Near Threatened, or Conservation Dependent, and for threatened species whose status is known or suspected to be deteriorating.

13. **Transfer between categories**

There are rules to govern the movement of taxa between categories. These are as follows: (A) A taxon may be moved from a category of higher threat to a category of lower threat if none of the criteria of the higher category has been met for 5 years or more. (B) If the original classification is found to have been erroneous, the taxon may be transferred to the appropriate category or removed from the threatened categories altogether, without delay (but see Section 9). (C) Transfer from categories of lower to higher risk should be made without delay.

14. **Problems of scale**

Classification based on the sizes of geographic ranges or the patterns of habitat occupancy is complicated by problems of spatial scale. The finer the scale at which the distributions or habitats of taxa are mapped, the smaller will be the area that they are found to occupy. Mapping at finer scales reveals more areas in which the taxon is unrecorded. It is impossible to provide any strict but general rules for mapping taxa or habitats; the most appropriate scale will depend on the taxa in question, and the origin and comprehensiveness of the distributional data. However, the thresholds for some criteria (e.g. Critically Endangered) necessitate mapping at a fine scale.

III) Definitions

1. **Population**
Population is defined as the total number of individuals of the taxon. For functional reasons, primarily owing to differences between life-forms, population numbers are expressed as numbers of mature individuals only. In the case of taxa obligately dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used.

2. **Subpopulations**
Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little exchange (typically one successful migrant individual or gamete per year or less).

3. **Mature individuals**
The number of mature individuals is defined as the number of individuals known, estimated or inferred to be capable of reproduction. When estimating this quantity the following points should be borne in mind:

- Where the population is characterised by natural fluctuations the minimum number should be used.

- This measure is intended to count individuals capable of reproduction and should therefore exclude individuals that are environmentally, behaviourally or otherwise reproductively suppressed in the wild.

- In the case of populations with biased adult or breeding sex ratios it is appropriate to use lower estimates for the number of mature individuals which take this into account (e.g. the estimated effective population size).

- Reproducing units within a clone should be counted as individuals, except where such units are unable to survive alone (e.g. corals).

- In the case of taxa that naturally lose all or a subset of mature individuals at some point in their life cycle, the estimate should be made at the appropriate time, when mature individuals are available for breeding.

4. **Generation**
Generation may be measured as the average age of parents in the population. This is greater than the age at first breeding, except in taxa where individuals breed only once.

5. **Continuing decline**
A continuing decline is a recent, current or projected future decline whose causes are not known or not adequately controlled and so is liable to continue unless remedial measures are taken. Natural fluctuations will not normally count as a continuing decline, but an observed decline should not be considered to be part of a natural fluctuation unless there is evidence for this.

6. **Reduction**
A reduction (criterion A) is a decline in the number of mature individuals of at least the amount (%) stated over the time period (years) specified, although the decline need not still be continuing. A reduction should not be interpreted as part of a natural fluctuation unless there is good evidence for this. Downward trends that are part of natural fluctuations will not normally count as a reduction.

7. **Extreme fluctuations**
Extreme fluctuations occur in a number of taxa where population size or distribution area varies

widely, rapidly and frequently, typically with a variation greater than one order of magnitude (i.e., a tenfold increase or decrease).

8. **Severely fragmented**
Severely fragmented is refers to the situation where increased extinction risks to the taxon result from the fact that most individuals within a taxon are found in small and relatively isolated subpopulations. These small subpopulations may go extinct, with a reduced probability of recolonisation.

9. **Extent of occurrence**
Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy. This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g., large areas of obviously unsuitable habitat) (but see 'area of occupancy'). Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).

10. **Area of occupancy**
Area of occupancy is defined as the area within its 'extent of occurrence' (see definition) which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may, for example, contain unsuitable habitats. The area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon (e.g. colonial nesting sites, feeding sites for migratory taxa). The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological aspects of the taxon. The criteria include values in km^2, and thus to avoid errors in classification, the area of occupancy should be measured on grid squares (or equivalents) which are sufficiently small (see Figure 2).

11. **Location**

Location defines a geographically or ecologically distinct area in which a single event (e.g. pollution) will soon affect all individuals of the taxon present. A location usually, but not always, contains all or part of a subpopulation of the taxon, and is typically a small proportion of the taxon's total distribution.

12. **Quantitative analysis**
A quantitative analysis is defined here as the technique of population viability analysis (PVA), or any other quantitative form of analysis, which estimates the extinction probability of a taxon or population based on the known life history and specified management or non-management options. In presenting the results of quantitative analyses the structural equations and the data should be explicit.

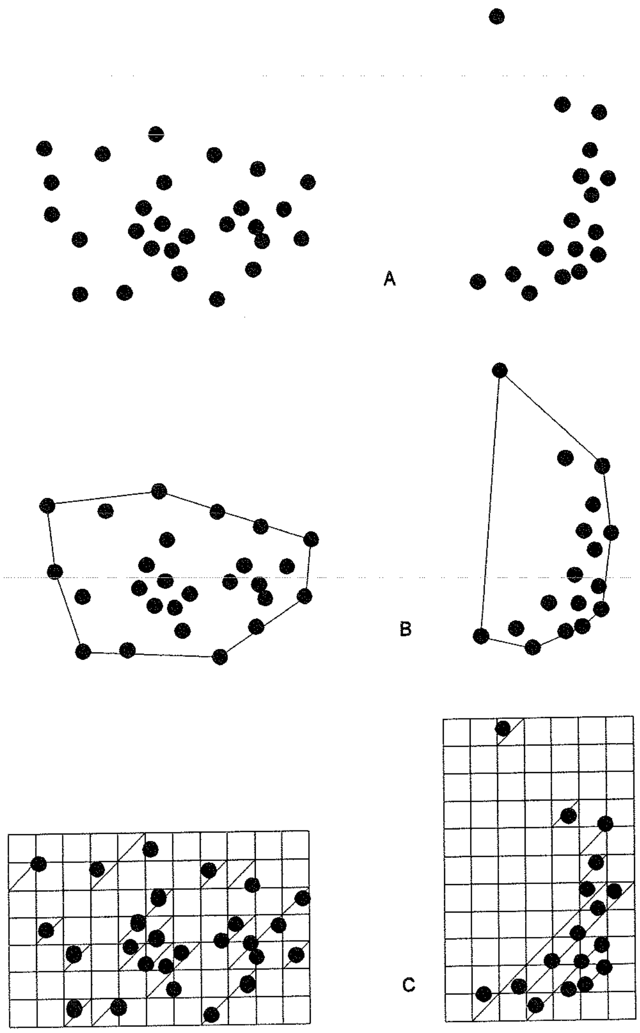


Figure 2:

Two examples of the distinction between extent of occurrence and area of occupancy. (a) is the spatial distribution of known, inferred or projected sites of occurrence. (b) shows one possible boundary to the extent of occurrence, which is the measured area within this boundary. (c) shows one measure of area of occupancy which can be measured by the sum of the occupied grid squares.

IV) The categories [1]

EXTINCT (EX)
A taxon is Extinct when there is no reasonable doubt that the last individual has died.

EXTINCT IN THE WILD (EW)
A taxon is Extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)
A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria (A to E) on pages 12 and 13.

ENDANGERED (EN)
A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria (A to E) on pages 14 and 15.

VULNERABLE (VU)
A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria (A to D) on pages 16 and 17.

LOWER RISK (LR)
A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:

1. **Conservation Dependent (cd).** Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.

2. **Near Threatened (nt).** Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.

3. **Least Concern (lc).** Taxa which do not qualify for Conservation Dependent or Near Threatened.

DATA DEFICIENT (DD)
A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is lacking. Data Deficient is therefore not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important

[1] Note: As in previous IUCN categories, the abbreviation of each category (in parenthesis) follows the English denominations when translated into other languages.

to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)
A taxon is Not Evaluated when it is has not yet been assessed against the criteria.

V) The Criteria for Critically Endangered, Endangered and Vulnerable

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the following criteria (A to E):

A) Population reduction in the form of either of the following:

1) An observed, estimated, inferred or suspected reduction of at least 80% over the last 10 years or three generations, whichever is the longer, based on (and specifying) any of the following:

a) direct observation
b) an index of abundance appropriate for the taxon
c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
d) actual or potential levels of exploitation
e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

2) A reduction of at least 80%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), (d) or (e) above.

B) Extent of occurrence estimated to be less than 100 km^2 or area of occupancy estimated to be less than 10 km^2, and estimates indicating any two of the following:

1) Severely fragmented or known to exist at only a single location.

2) Continuing decline, observed, inferred or projected, in any of the following:

a) extent of occurrence
b) area of occupancy
c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals.

3) Extreme fluctuations in any of the following:

a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations
d) number of mature individuals.

C) Population estimated to number less than 250 mature individuals and either:

1) An estimated continuing decline of at least 25% within 3 years or one generation, whichever is longer or

2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:

a) severely fragmented (i.e. no subpopulation estimated to contain more than 50 mature individuals)
b) all individuals are in a single subpopulation.

D) Population estimated to number less than 50 mature individuals.

E) Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or 3 generations, whichever is the longer.

ENDANGERED (EN)

A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the following criteria (A to E):

A) Population reduction in the form of either of the following:

1) An observed, estimated, inferred or suspected reduction of at least 50% over the last 10 years or three generations, whichever is the longer, based on (and specifying) any of the following:

a) direct observation
b) an index of abundance appropriate for the taxon
c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
d) actual or potential levels of exploitation
e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

2) A reduction of at least 50%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), (d), or (e) above.

B) Extent of occurrence estimated to be less than 5000 km^2 or area of occupancy estimated to be less than 500 km^2, and estimates indicating any two of the following:

1) Severely fragmented or known to exist at no more than five locations.

2) Continuing decline, inferred, observed or projected, in any of the following:

a) extent of occurrence
b) area of occupancy
c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals.

3) Extreme fluctuations in any of the following:

a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations
d) number of mature individuals.

C) Population estimated to number less than 2500 mature individuals and either:

1) An estimated continuing decline of at least 20% within 5 years or 2 generations, whichever is longer, or

2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:

a) severely fragmented (i.e. no subpopulation estimated to contain more than 250 mature individuals)
b) all individuals are in a single subpopulation.

D) Population estimated to number less than 250 mature individuals.

E) Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or 5 generations, whichever is the longer.

VULNERABLE (VU)

A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the following criteria (A to E):

A) Population reduction in the form of either of the following:

1) An observed, estimated, inferred or suspected reduction of at least 20% over the last 10 years or three generations, whichever is the longer,, based on (and specifying) any of the following:

a) direct observation
b) an index of abundance appropriate for the taxon
c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
d) actual or potential levels of exploitation
e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

2) A reduction of at least 20%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), (d) or (e) above.

B) Extent of occurrence estimated to be less than 20,000 km^2 or area of occupancy estimated to be less than 2000 km^2, and estimates indicating any two of the following:

1) Severely fragmented or known to exist at no more than ten locations.

2) Continuing decline, inferred, observed or projected, in any of the following:

   a) extent of occurrence
   b) area of occupancy
   c) area, extent and/or quality of habitat
   d) number of locations or subpopulations
   e) number of mature individuals.

3) Extreme fluctuations in any of the following:

   a) extent of occurrence
   b) area of occupancy
   c) number of locations or subpopulations
   d) number of mature individuals.

C) Population estimated to number less than 10,000 mature individuals and either:

1) An estimated continuing decline of at least 10% within 10 years or 3 generations, whichever is longer, or

2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:

   a) severely fragmented (i.e. no subpopulation estimated to contain more than 1000 mature individuals)
   b) all individuals are in a single subpopulation.

D) Population very small or restricted in the form of either of the following:

1) Population estimated to number less than 1000 mature individuals.

2) Population is characterised by an acute restriction in its area of occupancy (typically less than 100 km^2) or in the number of locations (typically less than 5). Such a taxon would thus be prone to the effects of human activities (or stochastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future, and is thus capable of becoming Critically Endangered or even Extinct in a very short period.

E) Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

THE IUCN POLICY STATEMENT ON OF CAPTIVE BREEDING

Prepared by the
SSC Captive Breeding Specialist Group

As approved by the 22nd Meeting of the IUCN Council Gland, Switzerland

4 September 1987

SUMMARY: Habitat protection alone is not sufficient if the expressed goal of the World Conservation Strategy the maintenance of biotic diversity, is to be achieved. Establishment of self-sustaining captive populations and other supportive intervention will be needed to avoid the loss of many species, especially those at high risk in greatly reduced, highly fragmented, and disturbed habitats captive breeding programmes need to be established before specks are reduced to critically low numbers, and thereafter need to be coordinated Internationally according to sound biological principles, with a view to the maintaining or re establishment of viable populations in the wild.

PROBLEM STATEMENT

IUCN data indicate that about 3 per cent of terrestrial earth is gazetted for protection. Some of this and much of the other 97 per cent is becoming untenable for many species, and remaining populations are being greatly reduced and fragmented. From modern population biology one can predict that many species will be lost under these conditions. On average more than one mammal, bird, or reptile species has been bst in each year this century. Since extinctions of most taxa outside these groups are not recorded, the loss rate for all species is much higher.

Certain groups of species are at particularly high risk, especially forms with restricted distribution, those of large body size, those of high economic value, those at the top of food chains, and those which occur only in climax habitats. Species in these categories are likely to be bst first, but a wide range of other 10rms are also at risk. Conservation over the bng term will require management to reduce risk, including *ex situ* populations which could support and interact demographically and genetically with wild populations.

FEASIBILITY

Over 3,000 vertebrate species are being bred in zoos and other captive animal facilities. When a serious attempt is made, most species breed in captivity, and viable populations can be maintained over the long term. A wealth of experience is available in these institutions, including husbandry, veterinary medicine, reproductive biology, behaviour, and genetics. They offer space for supporting populations of many threatened taxa, using resources not competitive with those for *in situ* conservation. Such captive stocks have in the past provided critical support for some wild populations (e.g. American bison, *Bison bison*), and have been the sole escape from extinction for others which have since been re-introduced to the wild (e.g. Arabian oryx, *Otyx leucoryx*).

RECOMMENDATION

IUCN urges that those national and international organizations and those individual institutions concerned with maintaining wild animals in captivity commit themselves to a general policy of developing demographically self-sustaining captive populations of endangered species wherever necessary.

SUGGESTED PROTOCOL

WHAT: The specific problems of the species concemed need to be considered, and appropriate aims for a captive breeding programme made explicit.

WHEN: The vulnerability of small populations has been consistently under estimated. This has erroneously shifted the timing of establishment of captive populations to the last moment, when the crisis is enormous and when extinction is probable. Therefore, timely recognition of such situations is critical, and is dependent on information on wild population status, particularly that provided by the IUCN Conservation Monitoring Centre. Management to best reduce the risk of extinction requires the establishment of supporting captive populations much earlier, preferably when the wild population is still in the thousands. Vertebrate taxa with a current census below one thousand individuals in the wild require close and swift cooperation between field conservationists and captive breeding specialists, to make their effort complementary and minimize the likelihood of the extinction of these taxa.

HOW: Captive populations need to be founded and managed according to sound scientific principles for the primary purpose of securing the survival of species through stable, self-sustaining captive populations. Stable captive populations preserve the options of reintroduction and/or supplementation of wild populations.

A framework of international cooperation and coordination between captive ˜ breeding institutions holding species at risk must be based upon agreement to cooperatively manage such species for demographic security and genetic diversity. The IUCN/SSC Captive Breeding Specialist Group is an appropriate advisory body concerning captive breeding science and resources.

Captive programmes involving species at risk should be conducted primarily for the benefit of the species and without commercial transactions. Acquisition of animals for such programmes should not encourage commercial ventures or trade. Whenever possible, captive programmes should be carried out in parallel with field studies and conservation efforts aimed at the species in its natural environment.

Approved by the 27th Meeting of IUCN Council

IUCN POLICY STATEMENT ON RESEARCH INVOLVING SPECIES AT RISK OF EXTINCTION

PROLOGUE

IUCN holds that all research on or affecting a threatened species carries a moral responsibility for the preservation or enhancement of the survival of that species. Conservation of the research resource is clearly in the interest of the researchers.

IUCN recognizes that the taking and trading of specimens of threatened species are covered by international agreements and are normally included in national legislation which provides authorized exemptions for the purpose of scientific research.

Basic and applied research is critically needed on many aspects of the biology of animal and plant species at risk of extinction (e g. those listed by IUCN as Vulnerable, Rare, Endangered, or indeterminate) to provide knowledge vital to their conservation.

Other scientific interests may involve the use of threatened species in a wide variety of studies. Taking into account the importance of many kinds of research, as well as potential threats such species could be subject to in such activities, IUCN, after careful consideration, adopts the following statements as policy.

POLICY

IUCN encourages basic and applied research on threatened species that contributes to the likelihood of survival of those species.

When a choice is available among captive-bred or propagated, wild-caught or taken, or free-living stock for research not detrimental to the survival of a threatened species, IUCN recommends the option contributing most positively to sustaining wild populations of the species.

IUCN recommends that research programmes on threatened species that do not directly contribute to conservation of the species should acknowledge an obligation to the species by devoting monetary or other substantial resources to their conservation, preferably to sustaining populations in the natural environment.

Whether animals involved are captive-bred, wild-caught, or free living, or whether plants involved are propagated, taken from the wild, or in their natural habitat, IUCN opposes research that directly or indirectly impairs the survival of threatened species and urges that such research not be undertaken.

PROTOCOLS

In this context IUCN urges researchers to accept a personal obligation to satisfy themselves that the processes by which research specimens are acquired (including transportation) conform scrupulously to procedures and regulations adopted under international legal agreements. Further, researchers should adopt applicable professional standards for humane treatment of animal specimens, including their capture and use in research.

IUCN urges that any research on threatened species be conducted in conformity with all applicable laws, regulations and veterinary professional standards governing animal acquisition, health and welfare, and with all applicable agricultural and genetic resource laws and regulations governing acquisition, transport, and management of plants.

DRAFT GUIDELINES FOR THE DISPOSITION OF CONFISCATED LIVE ANIMALS[2]

STATEMENT OF PROBLEM

When live animals are confiscated, the government holding these specimens must dispose of them appropriately. Disposition should maximise conservation value and concurrently provide a humane solution to the problem of ultimate placement of the specimens involved. In these guidelines, we hope to offer advice on what constitutes appropriate disposition.

STATEMENT OF NEED

With improved interdiction of the illegal trade in animals there is an increasing demand for information to guide confiscating agencies in the disposal of specimens. This need has been reflected in the formulation of specific guidelines for several groups of organisms such as parrots (Birdlife International in prep) and primates (Harcourt in litt.). However, no general guidelines exists.

Signatories to the Convention of the International Trade in Endangered Species (CITES) are legally required to return illegally traded, CITES listed, animals to the "state of export . . . or to a rescue centre or such other place. " (Article VIII, para. 4(d). There is ambiguity as to what should be done with these animals once repatriated. The Netherlands, in an attempt to clarify this section of the convention, submitted a draft resolution to the Eighth Meeting of the Conference of the Parties in Kyoto in March of 1992 entitled "Return to the Wild of Confiscated Live Animals of the Species Included in Appendices II & II. " The resolution was withdrawn, but the need for interpretation and/or amendments to this section was generally agreed on by the Parties[3]. The following guidelines do not attempt to interpret whether"repatriation"necessarily implies "reintroduction, " but our working assumption is that it does not.

The lack of specific guidelines has meant that disposition of confiscated animals has been done

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[2] Drafting Committee: Josh Ginsberg, Institute of Zoology, Zoological Society of London, Bill Conway, NYZS The Wildlife Conservation Society, Mike Woodford, Chairman, IUCN Veterinary Specialist Group, Oliver Ryder, CRES, San Diego Zoological Society.

[3] The Cites Animals Committee, while meeting in Harare, Zimbabwe, in 1992, established a Working Group to draft guidelines. In discussion with members of this committee, it was decided that the IUCN-

in an inconsistent manner (Appendix I). In some cases, release of confiscated animals into existing wild populations has been made after careful evaluation and with due regard for existing guidelines (IUCN 1987). In other cases, such releases have been made without adequate consideration of the health and safety of the existing wild population.

MANAGEMENT OPTIONS

In determining the disposition of confiscated animals, priority must be given to the well-being and conservation of existing wild populations of the species involved, with all efforts made to ensure the humane treatment of the confiscated individuals. Options for disposition include:

Return to the Wild

1) Re-introduction[4], or an attempt to establish the confiscated individuals in an area which was once part of the range of the species but from which it has become extirpated.

2) Supplementation or Reinforcement of an Existing Population: the addition of confiscated individuals to an existing population of the same taxa.

3) Conservation/Benign Introductions: an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area.

There are several benefits of returning animals to the wild, either through re-introduction or supplementation of an existing population:

a) In situations where the existing population is severely threatened, such an action might improve the long-term conservation potential of the species.

b) Such action makes a strong political/educational statement concerning the fate of animals and may serve to promote strong conservation values (e.g. Aveling & Mitchell 1982, but see Rijksen & Rijksen-Graatsma 1979).

Problems which must be considered and accounted when returning animals to the wild for include but are not limited to (see IUCN-RISG in prep).:

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[4] In this discussion, we will follow the definitions a set forth in IUCN-SSC RISG (in prep). Definitions have been lifted verbatim or with slight modification. Throughout the document we refer to species, however for species with well defined sub-species and races, lower taxonomic units may be

a) Disease. Animals held in captivity and illegally transported may be exposed to a variety of pathogens. Release of these animals to the wild may result in introduction of disease to con-specifics or unrelated species with potentially catastrophic effects.

b) Cost. The cost of returning animals to the wild in an appropriate manner can be prohibitive for all but the most endangered species (Stanley Prince 1989; Seal et al 1989, IUCN-RISG in prep).

c) Source of individuals. If provenance of the animals is not known, or if there is any question of the source of animals, supplementation may lead to inadvertent pollution of distinct genetic races or sub-species.

d) Welfare. While release to the wild may appear to be humane, it may be nothing more than sentence to a slow death. Survival prospects for released animals must at least approximate those of wild animals of the same sex and age class (Int. Academy of Animal Welfare Sciences 1992).

Captivity

4) Captivity: placement through donation of the confiscated animals in captivity, either in the country of origin, the country of export (if different), the country of confiscation, or in a country with adequate and/or specialised facilities for the species in question.

5) Sale of the animals to the pet trade, or to local zoos. Direct sale of the confiscated animals to traders, or sale of the animals to foreign or local zoos or research facilities.

The benefits of placing the animal in captivity include:

a) Educational value.

b) Potential for captive breeding to replace wild-caught animals as a source for trade.

c) Potential for captive breeding for eventual reintroduction.

d) Revenue from sale to offset costs of confiscation and holding.

Disadvantages of placing animals in captivity, but not in an established programme for captive breeding and reintroduction include:

a) Encouraging further trade. In his discussion of primates, Harcourt (in litt) strongly argues that ANY trade is likely to promote further illegal trade either directly, by promoting a market, or more commonly indirectly by sending the signal to illegal traders that the State is involved in trade. Birdlife International (in prep), is ambivalent about the severity of this problem when it concerns animals commonly traded in the country of confiscation. They offer the following requirements which must be met for permissible sale by the confiscating authority:

1) The species to be sold is already available in the confiscating country in commercial quantities; and

2) Importers and dealers under indictment for, er convicted of, crimes related to import of wildlife are prevented from purchasing the animals in question.

b) Disease. Confiscated animals may serve as vectors for disease and, thus, must be subject to extremely stringent quarantine. The potential consequences of the introduction of alien disease to a captive facility are equally serious as that of introducing disease to wild populations.

c) Cost of placement. We do not believe that it would encourage trade significantly if the institution receiving a donation of confiscated animals were to reimburse the confiscating authority for costs of care and transport. However, for common species, or species with no great display interest, it is unlikely that there will be funds and/or cage space available to maintain these animals.

d) Use of Cage Space. Increasingly, the international zoo community is setting conservation priorities for cage space (Seal & Foose 1992). Although placing animals of low conservation priority in limited cage space may benefit those individuals, it may detract from conservation efforts as a whole.

Killing or "Sacrificing" Animals

6) Euthanasia: the humane killing of the confiscated animals.

7) Research: donation of the animals involved to accredited universities or medical laboratories for research purposes.

Killing confiscated animals is clearly the least palatable option for disposition. In many circumstances, however, the confiscating authorities will encounter the following circumstances:

a) Placement in captivity is impossible, or will further promote trade, thus resulting in increased threat to the wild populations

b) Return to the wild in some manner is either impossible, or prohibitively expensive as a result of the need to conform to biological (IUCN-SSC RISG in prep) and animal welfare guidelines (International Academy of Welfare Sciences.

In these circumstances, euthanasia, or donation of the animals to an in-country research facility, may offer both the best solution from the point of view of conservation and often, the welfare of the animals involved.

DETERMINATION OF APPROPRIATE DISPOSITION

Each of the above options have advantages and disadvantages, both in terms of their conservation value for a particular species, and in terms of the level of humane treatment afforded the confiscated animals. The decision as to which option to employ will depend on various legal, social, economic and biological factors. In Figure One we provide a flow diagram to assist in making decisions concerning the disposition of confiscated animals. We have written the diagram so that it may be used for both threatened and common species. The conservation status of a species, however, will influence whether or not it is part of an active conservation breeding/reintroduction programme, and whether or not local or international agencies will be willing to make an investment in expensive and difficult tasks such as genetic determination of provenance or the establishment of reintroduction, benign introductions, or supplementation of extant wild populations.

Transfer of Animals to Captive Breeding/Reintroduction Programmes

For those species where active captive breeding and reintroduction programmes exist (see Appendix II), and for which further breeding stock/founders are required, we suggest that confiscated animals be transferred to appropriate holding facilities after consultation with the appropriate scientific authorities. If necessary, costs of transfer and maintenance in holding facilities should be borne by the programme. If the species in question is part of a captive breeding programme, but the taxa (sub-species or race) is not part of this programme (e.g. Magquire & Lacy 1990), other methods of disposition must be considered.

Return to the Wild

For those species or taxa which can not be transferred to existing programmes, return to the wild, following appropriate guidelines, will only be possible if 1) appropriate habitat exists for such an operation and 2) sufficient funds are available, or can be made available, for this action. In the majority of cases, at least one, if not both of these requirements will fail to be met. In this situation, donation, sale, use of the animals in medical research, or euthanasia of the animals involved must be considered. If a particular species or taxa is confiscated with some frequency, and such confiscations are recorded (e.g. CITES listed specimens), it may prompt planning for reintroduction/supplementation/benign introduction programmes.

Captivity

Transfer or sale of the confiscated animals to a captive facility, or to the pet trade, will occasionally provide a solution to the disposition of confiscated animals. For the concerns discussed above, however, sale may be inappropriate, and captive facilities may be unwilling to accept animals of little conservation or display interest. In these circumstances, placement of the animals in a medical research facility, or euthanasia, will be the only alternatives.1315193, Page 5

Euthanasia

Euthanasia of confiscated animals will ra;rely be a popular choice for confiscating authorities. From the point of view of conservation of the species involved, however, euthanasia carries far fewer risks when compared to retuluing animals to the wild. Euthanasia will also act to discourage trade in the animals as traders will soon learn that animals illegally imported do not reach the rnarket at any price. Euthanasia may also be the most humane option: unless adequate finances are available for rehabilitation of confiscated animals, the "hard release" (release without any provisioning, training, or support) of these species may result in a slow death due to starvation, disease, or predation.

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Flow Chart for the Disposition Of Confiscated Animals