CONSERVING THE CHIMPANZEES OF UGANDA

Population and Habitat Viability Assessment for *Pan troglodytes schweinfurthii*

Entebbe, Uganda: January, 1997

BRITISH AIRWAYS

BORN FREE

Columbus Zoo

ZOO

NOAHS!

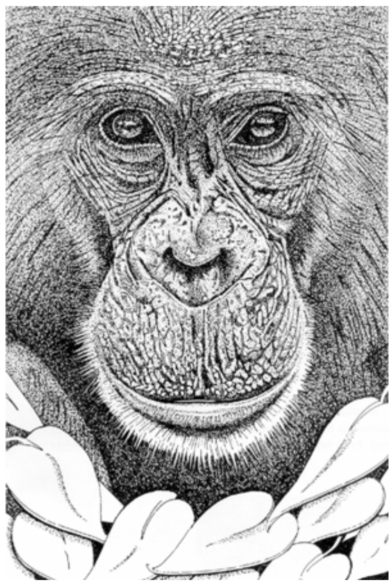
Primate Conservation, Inc.

CONSERVING THE CHIMPANZEES OF UGANDA

Population and Habitat Viability Assessment for *Pan troglodytes schweinfurthii*

6 - 9 January 1997
Entebbe, Uganda

Eric Edroma, Norm Rosen, and Philip Miller, Editors



Sponsored By:
Columbus Zoo, Copenhagen Zoo
Dian Fossey Gorilla Fund - Europe
Born Free Foundation, Primate Conservation, Inc.
NOAHS Center / British Airways

In Collaboration With:
Uganda Wildlife Authority
Uganda Forest Department
The Primate Specialist Group (SSC/IUCN)
The Conservation Breeding Specialist Group (SSC/IUCN)

A contribution of the IUCN/SSC Conservation Breeding Specialist Group in collaboration with the Uganda Wildlife Authority, Uganda Forest Department, and the IUCN Primate Specialist Group.

The sponsors of the PHVA workshop were the Columbus Zoo, the Copenhagen Zoo, the Dian Fossey Gorilla Fund-Europe, the Born Free Foundation, Primate Conservation, Inc., the CRC / NOAHS Center, and British Airways**.**

Cover Illustration: Photo of adult and juvenile chimpanzees in Budongo Forest courtesy of Vernon Reynolds. Chimpanzee artwork courtesy of the Jane Goodall Institute.

Edroma, E. L., N. Rosen and P.S. Miller (eds.). 1997. Conserving the Chimpanzees of Uganda: Population and Habitat Viability Assessment for *Pan troglodytes schweinfurthii*. IUCN/SSC Conservation Breeding Specialist Group: Apple Valley, MN.

Additional copies of this publication can be ordered through the SSC/IUCN Conservation Breeding Specialist Group, 12101 Johnny Cake Ridge Road, Apple Valley, MN 55124-8151, USA. Send checks for US$35.00 (to cover printing and shipping costs) payable to CBSG; checks must be drawn on a US Bank. Payment by Visa or MasterCard is also acceptable.

The CBSG Conservation Council

These generous contributors make the work of CBSG possible

Benefactors ($20,000 and above)

Columbus Zoological Gardens
MetropolitanToronto Zoo
Minnesota Zoological Gardens
Omaha's Henry Doorly Zoo
SeaWorld, Inc.
White Oak Conservation Center

Conservators ($15,000 -$19,999)

Walt Disney's Animal Kingdom
World Zoo Organization (WZO)

Guardians ($7,000-$14,999)

Chicago Zoological Society
Cincinnati Zoo
Fossil Rim Wildlife Center
Saint Louis Zoo
Toledo Zoological Society
Wildlife Conservation Society - NYZS
Zoological Parks Board of
New South Wales (Taronga)
Zoological Society of London
Zoological Society of San Diego

Protectors ($1,000-$6,999)

Albuquerque Biological Park
Allwetter Zoo Munster
Audubon Zoological Gardens
Bristol Zoo
Caldwell Zoo
Calgary Zoo
Chester Zoo
Cleveland Zoological Society
Copenhagen Zoo
Currumbin Sanctuary
Denver Zoological Gardens
Detroit Zoological Park
Durrell Wildlife Conservation Trust
El Paso Zoo
Everland Zoo
Federation of Zoological Gardens of
Great Britain and Ireland
Fort Wayne Zoological Society
Fort Worth Zoo
Gladys Porter Zoo
Greater Los Angeles Zoo Association
Houston Zoological Garden
Indianapolis Zoo
Jacksonville Zoological Park
Japanese Association of Zoological
Parks & Aquariums
Living Desert
Loro Parque
Lubee Foundation
Marwell Zoological Park
Milwaukee County Zoo
North Carolina Zoological Park
Oklahoma City Zoo
Oregon Zoo
Paignton Zool. & Botanical Gardens
Parco Natura Viva Garda Zool. Park
Perth Zoo
Philadelphia Zoological Garden
Phoenix Zoo
Pittsburgh Zoo
Rotterdam Zoo
Royal Zoological Society of Antwerp
Royal Zoological Society of Scotland
Royal Zoological Society of S.Australia
San Antonio Zoo
San Francisco Zoo
Schonbrunner Tiergarten
Sedgwick County Zoo
Sunset Zoo (10 year commitment)
Taipei Zoo
Territory Wildlife Park
The WILDS
Thrigby Hall Wildlife Gardens
Twycross Zoo
Union of German Zoo Directors
Urban Services Dept. of Hong Kong
Wassenaar Wildlife Breeding Centre
Wilhelma Zoological Garden
Woodland Park Zoo
Zoo Atlanta
Zoological Parks & Gardens Board
Of Victoria
Zoologischer Garten Koln
Zoologischer Garten Zurich

Stewards ($500-$999)

Aalborg Zoo
Alameda Park Zoo
Arizona-Sonora Desert Museum
Aukland Zoo
Banham Zoo & Sanctuary
Bee Barksdale
Camperdown Wildlife Center
Cotswold Wildlife Park
Dickerson Park Zoo
Dutch Federation of Zoological Gardens
Fota Wildlife Park
Givskud Zoo
Granby Zoo
Great Plains Zoo
Hamilton Zoo
Knoxville Zoo
Lowry Park
National Aviary in Pittsburgh
National Zoological Gardens of Pretoria
Odense Zoo
Ouwehands Dierenpark
Prudence P. Perry
Riverbanks Zoological Park
Rolling Hills Refuge Conservation Center
Staten Island Zoo
The Zoo
Tierpark Rheine
Wellington Zoo
Welsh Mountain Zoo
World Parrot Trust
Zoologischer Garten Rostock

Curators ($250-$499)

Ellen Dierenfield
Elaine Douglass
Emporia Zoo
International Animal Exchange
Lee Richardson Zoo
Lincoln Park Zoo
Marc Miller
Orana Park Wildlife Trust
Dr. Edward & Marie Plotka
Racine Zoological Society
Rainforest Habitat
Philip Reed
Roger Williams Park Zoo
Tokyo Zoological Park Society
Topeka Zoo, Friends of
Zoo de la Casa de Campo

Sponsors ($50-$249)

African Safari
Alice Springs Desert Park
American Loriinae Conservancy
Apenheul Zoo
Arbeitskreis Natur-u Artenschutz in den
Belize Zoo
Bighorn Institute
Brandywine Zoo
Sherman Camp
Richard Chen
Steven Conant
Darmstadt Zoo
Folsom Children's Zoo & Botanical
Garden
Jardin aux Oiseaux
Marvin Jones
Kew Royal Botanic Gardens
Lisbon Zoo
Michael Meeks
Memphis Zoo
Miller Park Zoo
National Birds of Prey Centre
Steven J. Olson
PAAZAB
Palm Beach Zoo at Dreher Park
Parc Zoologique de Thoiry
Pearcedale Conservation Park
Potter Park Zoo
Safari Parc de Peaugres
Teruko Shimizu
Steinhart Aquarium
Tautphaus Park Zoo
Touro Parc-France

Supporters ($25-$49)

Robert Fry
Paul MacLeman
Don Moore
Oglebay's Good Children's Zoo

Thank You!!!

March 2000

CONSERVING THE CHIMPANZEES OF UGANDA
(*Pan troglodytes schweinfurthii*)

Population and Habitat Viablility Assessment

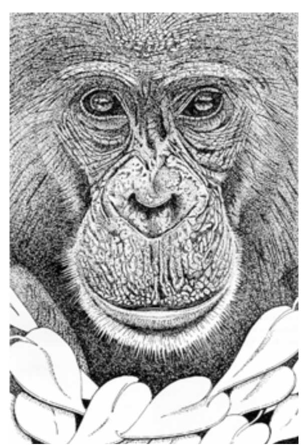
TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997

Section 1
Executive Summary And Recommendations



EXECUTIVE SUMMARY

The current distribution of the chimpanzee (*Pan troglodytes*) is thought to extend into approximately 21 countries throughout equatorial Africa. This distribution, however, has become considerably fragmented over the past few decades as human populations have rapidly expanded through economic and agricultural development. A primary example of this phenomenon occurs in Uganda, where about 3,000 to 4,000 chimpanzees of the eastern subspecies *Pan troglodytes schweinfurthii* are thought to exist in 12 isolated forest blocks. The capacity for natural exchange of individuals between these isolated subpopulations is very limited, thereby destabilizing the populations and ultimately putting them at considerably greater risk of local extinction. Development of a practical conservation management and research program for *P. t. schweinfurthii* has been hampered by a lack of detailed information regarding current distribution, problems of protecting animals in remote areas, uncertain priorities and a persistent lack of funding to assist proper conservation action. Perhaps most importantly, a management plan must address the rapidly expanding human impacts resulting from five newly created chimpanzee tourist sites in Uganda.

The Conservation Breeding Specialist Group (CBSG) was officially invited by Dr. Eric L. Edroma, Director of the Uganda Wildlife Authority (UWA), to conduct a Population and Habitat Viability Assessment (PHVA) for the chimpanzee in Uganda, 6-9 January, 1997. Mr. Norman Rosen, Department of Anthropology at the University of Southern California, worked closely with CBSG and Dr. Edroma in organizing the course and workshop, which was held at the Windsor Lake Victoria Hotel in Entebbe. The objectives of the PHVA course and workshop are to assist local managers and policy makers to: 1) formulate priorities for a practical management program for survival and recovery of the chimpanzee in wild habitat; 2) develop a risk analysis and population simulation model for the chimpanzee which can be used to guide and evaluate management and research activities; 3) identify specific habitat areas that should be afforded strict levels of protection and management; 4) identify and initiate useful technology transfer and training; 5) assess the current status of the captive program and assist in the formulation of future directions of this component of the overall conservation strategy; and 6) identify and recruit potential collaborators from Uganda, Africa and the greater international community.

A total of 57 participants, including Ugandan biologists, researchers, wildlife managers, and many of the world leaders in the study of chimpanzee population biology and ecology, attended the 4-day workshop. Countries represented included Uganda, Kenya, Zaire, Gabon, Denmark, Sweden, Australia, the United Kingdom, and the United States. Briefing books were distributed to all participants on the first day of the meeting, and a preliminary draft report was prepared during the meeting with all recommendations reviewed and agreed upon by all participants. After a welcoming ceremony by a representative from the Ministry of Tourism, Wildlife and Antiquities and Dr. Edroma of UWA, a series of short presentations were made summarizing recent history and current knowledge of the biology, threats, and management of wild populations of the chimpanzee in Uganda. Many of these presentations are included in this report. A wealth of unpublished information was made available for use in the workshop discussions and many of the gaps in our knowledge of the species' biology were identified.

The participants were divided into five working groups reflecting their interests, expertise and the key problems for chimpanzee conservation. The majority of the tasks performed during the remaining three days of the workshop were accomplished by these groups. The groups included: Distribution and Habitat, Threats, Population Biology and Modelling, Ecotourism and Education, and Captive Management. Each group developed an outline of its tasks and then developed key areas with extensive review of the available information and a discussion of necessary actions. Each group presented the results of their work in three plenary sessions to assure that everyone had an opportunity to contribute to the work of the other groups and to assure that all issues were carefully reviewed and discussed by all workshop participants. This process allows for a full review of all of the recommendations that are a part of this Executive Summary and for agreement and acceptance by all participants. In this way, the following recommendations represent a concensus of the workshop participants.

SUMMARY OF RECOMMENDATIONS

Wild Population Distribution and Habitat Priorities

1. Based on our current knowledge, we consider the following areas to have a high priority for chimpanzee conservation in Uganda: Budongo Forest Reserve, Kibale National Park, Kasyoha-Kitomi Forest Reserves, and Bugoma Forest Reserve.

2. The extent of forest cover status and numbers of chimpanzees in the following areas should be determined by transect nest counts in the following priority areas (listed in order of implementation schedule):

   <u>Priority 1.</u>
   Area: Kagombe-Kitechura-Matiri Forest Reserves and neighboring forests.
   Time: 6 months (July-December 1997)
   Costs: $1000 per block, estimated $4000 total.

   <u>Priority 2.</u>
   Area: Kasato Forest Reserve and neighboring forests
   Time: Six months (January-June 1998)
   Costs: $1000 per block, estimated $4000 total.

   Field direction: Dr. Gil Basuta
   Participants: Makerere University students
   Possible funding: Wildlife Conservation Society, IPS, IPPL, Australian Primate Society, WSPA, USAID / Biodiversity Support, Care for the Wild.

   Continued monitoring of major chimpanzee populations should be encouraged.

3. UWA should develop a policy for chimpanzees that occur outside of protected areas.

4. A policy for the protection of gallery forests used by chimpanzees in agricultural or other non-forested areas should be developed.

5. Conservation education programs focusing on chimpanzees should be developed in collaboration with Local Government Councils.

Chimpanzee Population Threat Priorities

A. Habitat Loss/Change

1. Strengthen forestry extension services.

2. When timber is harvested by pitsawyers keep disturbance to a mimimum. For example, restrict timber removal by porters to one or two days per week. This is especially applicable to forest reserves. Instruct head rangers to develop authorized pitsawing procedures that will reduce disturbance.

B. Poaching

3. Carry out a study at two sites (e.g. Kibale and Budongo) that focuses on snaring as a major threat to chimpanzee populations. This study should look at a number of approaches to eliminate snares and assess their effectiveness and feasibility. For example, the effects of finding and removing snares - either to pay a bonus for snare retrieval or to increase snare patrolling; the effects of education in surrounding villages; a study of the feasibility of "chimpanzee-friendly" snares which minimize or eliminate injury; document relative damage to snared chimpanzees from different snaring materials; set up small game-animal ranching projects, e.g. cane rats, in villages around protected areas.

C. Diseases

4. Training of field staff to report diseases and deaths.
   Veterinarian of Uganda Wildlife Authority (UWA) will organize seminars to train, explain and equip park staff and researchers to monitor disease and health in chimpanzees. UWA will contract out veterinarians to carry out a similar programme in the forest department.

5. Development of post-mortem protocol for testing for certain infectious diseases such as: polio, measles, Rubella, Ebola, TB, Hepatitis, Influenza, SIV and HIV , and Rabies. Using cadavers for research purposes to learn more about chimpanzee diseases.

6. Development of research on diseases impacting chimpanzee populations. This includes non-invasive monitoring of the health status using 1) routine faecal examinations for parasitology, bacteriology; 2) opportunistic serology, skin samples, urine samples, nasal swabs, faecal swabs which will also include virology (it is difficult to obtain a CITES permit, and this needs to be addressed especially in the face of an outbreak). Keep a serum bank (as long as 20 years) which will be useful when a disease outbreak occurs; 3) analysis of field observations on frequency of disease; and 4) analysis of post-mortem data collections. These plans could be developed through collaboration of UWA with

appropriate organizations both local (e.g., Makerere University Faculties of Medicine and Veterinary Medicine, Uganda Virus Research Institute, etc.) and global (e.g., Kenya Medical Research Institute (KEMRI), United States National Institutes of Health, etc.). It will be important for inter-ministerial cooperation in Uganda to involve from time to time the Veterinary Public Health section of the Ministry of Health.

D. Political Instability

7. Conservation education to politicians and, whenever appropriate, senior security officials.

8. Develop a trust to deal with emergencies so that park management continues in the face of war. For example, NGOs or similar agencies pay rangers to continue patrolling and antipoaching.

E. Tourism Activites

9. Control of tourist activities and movements. (Rules and regulations to come from tourism and education working group).

F. Human-Chimpanzee Conflicts

10. Identify rogue males in order to capture them and destroy them or place them in a captive environment.

G. Ignorance of the Population

11. Make available literature regarding chimpanzee behaviour and ecology for managers. For example, distribute briefing books and organize seminars. Translation of literature into local languages would be advantageous for better flow of information.

H. Legislation (both existent and nonexistent)

12. Encourage communication and memoranda of understanding between relevant departments, for example, between Forestry Department and the National Environmental Management Authority (NEMA).

J. Lack of Scientic Research/Information/Management

13. Increase awareness among researchers of the need to submit reports and publications that result from chimpanzee research conducted in Uganda. Submit these materials to national bodies (e.g., UNCST, UWA, NEMA, etc.) but also to the managers of the site where the research occurred. Make this requirement clear during the process of granting research permits.

14. Encourage applied research projects that are relevant to management concerns, e.g. effects of snaring (see B. Poaching); impact of tourism.

Population Biology and Modelling Priorities

1. It is important that small populations of chimpanzees (i.e., 25-100 individuals) are actively protected against those factors—habitat loss, lack of protected status, and the local human population increase—that act to reduce and destabilize wild populations.

2. Detailed research studies should be designed and carried out that will help to provide a more accurate estimate of the age at which female chimpanzees begin to produce offspring. This information can be obtained through continued longitudinal studies of a set of chimpanzee family groups, as well as from a careful preliminary analysis of data from captive chimpanzee populations.

3. Because of the great potential danger to chimpanzee populations posed by outbreaks of human-transmitted diseases, minimum distances should be maintained between fully habituated chimpanzees and either tourists or researchers in order to minimize the potential for disease outbreaks. Where appropriate, a signpost giving minimum distances could be erected to inform those concerned.

4. Because poaching impacts adult age classes most severely and the loss of adult females constitutes the most severe demographic threat to wild populations, poaching and snaring controls should be enhanced (see associated recommendations under Threats).

5. Wildlife managers should monitor the status of wild populations, through comprehensive nest-counting and other census methodologies, so that if an increase in annual mortality rates is observed, appropriate measures can be taken to reduce the causes of this mortality. Such actions might include a general increase in anti-poaching and/or anti-snaring controls.

Ecotourism and Education Priorities

Ecotourism

1. Chimpanzee tourism is a beneficial and desirable management program in Uganda and should be maintained as a viable conservation alternative.

2. Chimpanzee tourism should be managed under a standardised set of rules and regulations to be presented in pre-walk briefings, and widely distributed in advance to tourists, tour operators and travel agents to facilitate adherence.

3. Chimpanzee tourism management factors should also be standardised across tourism sites, but should also take account of local circumstances.

4. Protocols must be developed that aim to reduce corruption among tourism staff through an awareness of and belief in the rules and regulations that they are enforcing. In addition, these protocols must ensure a sense of motivation among the staff to ensure their adherence.

5. Chimpanzee tourism should be selective. The current number of sites marketing tourism is considered sufficient; no new sites should be opened or planned pending market review and the drafting of an Environmental Impact Assessment.

6. Wild chimpanzee tourism and captive-based tourism should have complementary roles as part of an overall conservation program.

7. Tourism and chimpanzee population research ideally should be done in different groups.

8. Protected Area authorities should strive to view ALL chimpanzee populations in Uganda as important and in need of protection, not just those providing tourism income.

9. Local community participation must be stressed as part of any chimpanzee tourism project.

10. Creative financing for chimp conservation should emerge from tourism-based projects.

11. Uganda should promote and/or market chimpanzee tourism at its current sites.

12. Private-sector management of endangered species conservation (i.e., concessions) should be avoided.

13. Standardisation of chimpanzee tourism management between the two primary responsible authorities, Forest Department and UWA, should be encouraged and strongly linked.

14. Chimpanzee tourism development and management should be guided by management plans / tourism development plans and should be part of a nation-wide strategy.

<u>Education</u>

15. In addition to the implementation of conservation education, there should be a specific emphasis on chimp ecology in the national curriculum at the primary school level. This integration would enhance sensitivity among the children and their parents regarding endangered species and habitat laws. It is recommended that WCU, NEMA, and the Uganda Wildlife Education Centre (UWEC) should work to write such programs in collaboration with the Curriculum Development Centre (CDC) to set a national precedent in formal education.

16. Humans and chimps in Uganda are often found in close proximity often resulting in conflict. Humans must therefore be informed of laws regarding protected areas and management of endangered species when encountered. Workshops should be conducted by UWA and the Forest Department to better inform Local Council members so that they are more aware of their rights and responsibilities regarding Protected Areas and endangered species.

17. UWA and the Forest Department should establish a national standardised training program for Protected Area staff to ensure consistency in information presented to the public.

Education on key issues affecting the chimps such as snares and crop raiding will then be addressed through workshops for the local communities surrounding Protected Areas, conducted by better informed Protected Area staff, local councils and NGO's.

18. Education centres targeting Ugandans, schoolchildren in particular, should be developed, with transport facilities available for those visitors wanting to reach the centres. The opportunity to see wild chimpanzees will have a great impact on their attitudes towards conservation in Uganda.

Captive Population Management Priorities

<u>Holding of confiscated chimps</u>

1. A memorandum of understanding should be signed between UWA, WD and UWEC with the understanding that UWEC has (currently) the only holding facilities for confiscated chimps in Uganda. UWEC should be issued with an official holding permit. Chimps will be looked after at UWEC in Entebbe. Financial implications will be matched by Government of Uganda until the end of the court case. This should be achieved by June 1997.

   Once the animal(s) are no longer required as evidence, UWEC will be given offical and financial responsibility for chimpanzees that are not to be repatriated.

2. UWEC recognises the State as ultimate guardian. However, as a stakeholder UWEC will have a say in the final disposal of the animals.

   It should become a policy that captive chimps should not be used for the following:
      1. medical research (except for non-invasive research such as faecal sampling);
      2. in the entertainment industry;
      3. pet trade;
      4. private holding;
      5. display at schools and fairs.

3. Holding of captive chimps should follow the guidelines of international zoo regulations.

4. Management of captive chimps should be done under the guidance of a recognised management committee. This committee should be formed as soon as possible.

5. Education of concerned bodies (police, customs, etc.) should start as soon as possible and should be an ongoing process.

6. Only non-invasive studies should be allowed on captive chimps, with emphasis on research which will benefit their management.

7. Re-introduction or the welfare releases of chimps in Uganda should not take place but instead efforts made to manage existing wild populations.

Sanctuaries

8. Sanctuaries should be established outside the protected areas, away from wild populations and not immediately adjacent to human settlements. Accessibility for tourists must be considered before designating a site for a sanctuary.

9. No sanctuary should be built without adequate holding facilities. A uniform set of guidelines must be followed for facility design according to standards set by the international zoo community for captive chimpanzees.

10. Establishment of new sanctuary in Lake Victoria is proposed by UWEC. This sanctuary should have adequate holding facilites to deal with a carrying capacity of 30 chimps.

11. Due to the fundamental problems of Isinga, this sanctuary should be considered a short-term solution and closed down within approximately one year. The chimpanzees are to be relocated to the proposed new sanctuary in Lake Victoria. Potential effects of relocation on these chimps should be assessed in consultation with relevant national and international organizations.

Management

12. The formation of a management committee of persons specialising in chimpanzees in captivity is necessary. At a minimum, this committee should include a veterinarian with chimpanzee experience, an expert in captive chimpanzee management and, to facilitate policy issues, representatives of UWA and the Forest Department.

13. Before any new chimp is introduced to the captive community of Uganda, their subspecies designation should be identified. If they are not *P. t. schweinfurthii*, they should be relocated according to the recommendations under the sub heading of international captive management. Individuals who prove unsuitable for sanctuary situations and are asocial will be maintained at UWEC.

14. Any introductions of confiscated infants to existing groups should be conducted according to international captive management guidelines and should be monitored closely.

15. Some controlled breeding should be allowed. The amount of potentially breeding females is not known at this point in time. This number will depend on the maximum carrying capacity, and the expected number of newly confiscated chimps in the lifetime of the sanctuary. UWEC management measures aim at available space for 15 arrivals in 20 years.

16. Male chimps should not be castrated. This operation will inevitably affect the hormone levels and consequently the animal's behaviour. Males should only be vasectomised. If they are to be sterilised permanently, females should only be tubal ligated, not given a full hysterectomy. Again, temporary sterilisation in the form of contraception is recommended. Oral is relatively safer than implants but is not as reliable due to the chances of females not coming to the holding facility on a regular basis. For this reason it is recommended

that implants be used and that the risk factor of accidental permanent sterilation is accepted.

17. All chimpanzees from Isinga Island will be translocated to a proposed Lake Victoria island, together with 5 pairs of chimpanzees from UWEC. All 19 individuals have been housed together previously at UWEC. The translocation of 7 male and 12 female chimpanzees to the Lake Victoria sanctuary allows for management of a large group under semi-natural conditions. This leaves one male and three females at UWEC.

18. Extremely limited breeding will be allowed at Lake Victoria sanctuary with a maximum of five offspring in twenty years, allowing for flexibility due to excess confiscations and mortality.
19. UWEC is to be maintained as a receiving facility for new arrivals. Therefore breeding will be limited to the two offspring in twenty years.

20. At present there is no estimated need for an international captive breeding programme for conservation purposes for *P. t. schweinfurthii*. As the presumed bulk of this subspecies is located in Zaire, future needs are uncertain. Ongoing assessments for the need of a captive breeding programme are necessary.

21. The international zoo community should be contacted if individuals confiscated in Uganda are not *P. t. schweinfurthii*, for possible relocation to a captive breeding programme if return to the country of export is not deemed appropriate.

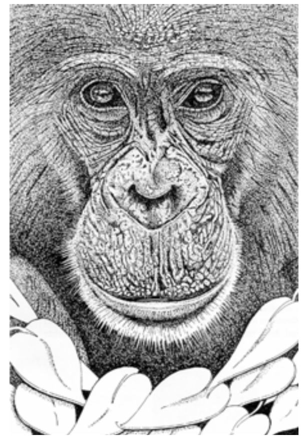
22. The captive breeding community will continue to liaise with the international zoo community on chimpanzee management techniques.

23. UWEC should continue to maintain responsibility for fundraising and develop the conservation education programme in consultation with UWA.

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997

Section 2
Introduction



OFFICIAL WORKSHOP INVITATION

Introductory remarks by Dr. Eric L. Edroma at the opening of the Chimpanzee PHVA Workshop at the Windsor Lake Victoria Hotel, 6th of January, 1997 at 8.30 A.M.

I stand before you wearing two hats. Firstly, as the Executive Director of the Uganda Wildlife Authority, and the host this PHVA Workshop, I on the behalf of the Board, Management and staff of UWA, welcome you to the Workshop. Special welcome to those who travelled thousands of miles across the Atlantic Ocean.

The Workshop is organised by two groups of people. The American based Conservation and Breeding Specialist Group (CBSG) led by Professor Norman Rosen and the Uganda Wildlife Authority in collaborating with Forest Department as the host Institutions. Under the director of an Organising Committee consisting of Mr. Christopher Bakuneeta, Dr. Pantaleo Kasoma, Dr. Deborah Baranga, Mr. Alex Muhwezi, Mr. Willhelm Moeller, Mr. E. Mupada, Mr. P. Kizito and Mrs. Apophia Muhimbura, the preparation for the workshop became easier. I thank these American and Ugandan people for their time and constructive ideas which is resulting into what appears a successful beginning of the Workshop. If there are areas of disappointment, I take full responsibility.

In wearing my second hat, as the Regional Councillor of IUCN, I note with satisfaction the involvement of and financial contribution by the Union's CBSG for bringing us together and for facilitating the meeting. Both the Union and UWA take pride in financing such a technical meeting.

The chimpanzees form an important group of animals of tremendous biological, aesthetic, and economic benefit to mankind.

The current contribution of chimpanzees extends to 21 countries throughout tropical Africa including Uganda. This distribution has become considerably fragmented over the past few decades due to expanding populations and the resultant uncontrolled human activities including economic and agricultural development.

In Uganda, the eastern subspecies (*Pan troglodytes schweinfurthii*) exists in 12 isolated forest blocks. These are: Rabongo Forest and Kaniyo-Pabidi Forest both in Murchison Falls National Park, Semuliki National Park, Kibale National Park, Maramagambo Forest and Kyambura Gorge both in Queen Elizabeth National Park, Forest Reserves of Budongo, Bugoma, Itwara, Maramagambo and Kasyoha-Kitomi. Few groups of chimpanzees also exist outside these protected areas (e.g. in Bwamiramira (Kanaga) Forest in Kibale District) but we have poor or no records on their number and distribution.

Because of their isolation, the capacity for natural exchanges of individuals in these sub-populations is very limited. This destabilises the populations and puts them at a consideration risk of local extinction. In Uganda, we estimate a total population of 5,000 ± 1,000 chimpanzees. The highest number of chimpanzees is probably in Budongo Forest Reserve where about 600 chimpanzees are resident and probably another 500 in Kibale National Park. However, the experts on chimp populations are with us to put the records correct.

The major threat to chimpanzee populations in Uganda is habitat degradation through timber harvesting and agricultural encroachment. A secondary threat is capture of young chimpanzees for trade.

The Population and Habitat Viability Analysis is a management tool that enables prediction to be made on the chances of a given certain facts. It should be understood from the beginning that qualitative data on the chimpanzees in Uganda are incomplete. But I am made to understand that where these facts are lacking, assumptions are used.

This workshop is aimed at undertaking an in-depth assessment of factors that have an impact on chimpanzees (both wild and captive) populations. We hope to explore the effects of various management options and formulate explicit objectives for the management of chimpanzees in Uganda. We have tried to bring together Field Managers, Researchers, Populations Biologists and Ecological/Demographic modellers. A simulation model is to be developed that evaluates published and unpublished deterministic and stochastic and interactions of genetic, demographic, environmental and castrophic factors on the population dynamics and extinction risks of chimpanzees in Uganda. Assumptions will be formulated by concessus. The model (VORTEX) will serve as a basis continuing consideration of management alternatives and adoptive management of chimpanzees in this country. The model is to facilitate evaluation of various management scenarios and to evaluate the present research on chimpanzees and identify other options where data are lacking.

The overall objectives of the Workshop are:

1. Assessing the current status of chimpanzees in the wild and in captivity.

2. Assembling published and unpublished data on chimpanzee numbers, distribution, and habitat changes to facilitate development of conservation strategies.

3. Identifying and evaluating the deterministic and stochastic threats to the chimpanzee populations.

4. Reviewing life-history information of the species as need for simulation models.

5. Developing a risk analysis population simulation model for chimpanzees which could be used to guide and evaluate management and research activities.

6. Defining requirements for "viability" and "recovery". Metapopulation structure will be delineated that could be used to achieve viability and recovery.

7. Identifying and formulating priorities for practical management programme for survival and recovery of chimpanzees and evaluating the status of protected areas to support chimpanzees.

8. Assessing the impact of illegal trade on chimpanzees and evaluating the causes of inefficiency in trade controls.
9. Evaluating the current research programme on chimpanzees and recommending additional projects to benefit chimpanzee conservation.

CBSG has had a number of PHVAs for various primate species in Thailand (gibbon), India (lion-tailed macaque), Kenya (Tana River primates), Mexico (howler monkey), Brazil (golden lion tamarin) and Costa Rica (squirrel monkey). With such an in-depth experience, we cannot fail to achieve the objectives of the workshop.

Gathered here are politicians, University Professors, Wildlife and Forest Researchers, Managers, Administrators, Research Assistants, Rangers, etc., all of whom are individually and collectively deeply committed to the cause of conservation of the chimpanzee and its habitants. We constitute in this room a supermarket of knowledge on experience with the chimpanzee as a species. Despite our different employment status, I expect every participant in this Workshop to freely, frankly, and professional express his/her experience with chimpanzees. You must contribute and share with others present all that you know. I appeal to the facilitators to ensure that such an atmosphere of free discussion is maintained throughout the Workshop.

Remarks by the Minister of Tourism, Wildlife and Antiquities at the opening of the Population and Habitat Viability Analysis Workshop held in the Windsor Lake Victoria Hotel, 6th of January, 1997, at 8:30 A.M.

The Mayor of Entebbe;
Member of the Board of Trustees of UWA;
Senior Government Officials;
Members of the Local Organising Committees;
The Management of Lake Victoria Hotel;
Distinguished Participants;
Invited Guests;
Ladies and Gentlemen.

On behalf of the Ministry of Tourism, Wildlife and Antiquities (MTWA) and on my own behalf, I take this opportunity to welcome you to this Population and Habitat Viability Analysis Workshop. I am told this is the second workshop to be held in Africa. We are very privileged to host such a workshop and we hope more of such workshops will come to Africa as the Continent possesses viable populations of wildlife. Special thanks go to members of the Conservation and Breeding Specialist Group of USA who have not only come to educate us in Uganda on how the Population Habitat Viability programme operates, but have raised over 75% of the funding to make this workshop a reality.

Professor Norman Rosen from the Department of Anthropology at the University of Southern California who is amongst us initiated this workshop. He laboured to come to Uganda to sell the idea of the workshop. He laid the ground for what we are witnessing today. He has been working closely with the Conservation and Breeding Specialist Group and the officials of the Uganda Wildlife Authority in organising the workshop. We appreciate your efforts Professor Rosen to ensure that this workshop takes place and we shall remember you for this. I think this is a challenge to my fellow Ugandans. The conservation of our wildlife should not be left to the Wildlife Authority alone. Approach us with new innovative ideas as our door is wide open and responsive to changes that can lead to the improvement of wildlife conservation in the country.

Allow me to also pass the Government's appreciation to Dr. Jane Goodall and her Jane Goodall Institute for initiating a programme that supports chimpanzee research, cares for captive chimpanzees kept at the Uganda Wildlife Conservation Education Centre, Entebbe and a programme that provides facilities for educating the youth in chimpanzee conservation. You have the Government support in your activities in this country. Foreign institutions such as the Jane Goodall Institute, USAID, NORAD, the German GTZ, World Bank, etc, have done so much for us to whom we are grateful. I encourage however Government institutions to take care of our wildlife as external support rarely stays for ever. Hotels and tour companies which target nature based tourists should realise that without chimpanzees, gorillas, elephants, zebras, giraffes, crocodiles, etc, their businesses might not thrive. Sheraton Hotel (Kampala) has been giving support to the chimpanzees at the Wildlife Education Centre at Entebbe. Other Hotels and Tour Operators should follow suit in a similar manner. I encourage all institutions and individuals whose activities are related to wildlife conservation to support the wildlife cause. Become our partners and let us support one another.

Uganda has recently introduced policy, legislative and institutional reforms to ensure protection of its wildlife. It is regrettable that the rhinoceros disappeared forever from this country. But we are now determined not to let any other species to become extinct. That is why I think this workshop is timely. The intensification of conservation education especially for the local communities, the introduction of activities to enable wildlife to benefit the local communities, provision of wildlife use rights to the public in the 1996 Uganda Wildlife Statute, the direct involvement of local participation in the wildlife management, the translocation of wildlife species (e.g. recently of the elephant) to secure places, the veterinary treatment of sick animals in the wild, the consideration for introduction of captive breeding programme of endangered species, etc., all demonstrate our policy to revive the wildlife conservation on sound footing. But we need the support of everybody: Local Communities, Politicians, Researchers, Natural Resource Managers, NGOs, etc. I am optimistic that when each one of us does his/her best, the future of our natural renewable heritage is bright.

Although there was rampant illegal trafficking of chimpanzees and parrots in the past, this criminal practice has now been brought under control and Uganda is now a signatory to CITES. But joining CITES is not enough. Positive, practical and concerted efforts are needed continuously and collectively by all of us to totally eliminate the illegal trade in wildlife species. The chimpanzees must survive and thrive.

About five months ago, a merger between Uganda National Parks and Game Department was effected to create the Uganda Wildlife Authority. It has not been all that easy to bring two institutions which have been semi-autonomous to one institution. However, a good job has been done and we have high hopes in the new organisation and its administrative capability. Let me take this opportunity to thank the Board of Trustees of the Authority which has done a good job especially in the recently concluded recruitment of staff.

Chimpanzees are not found everywhere. In Uganda they are confined to those forests in the western region. Their status is still worrying because their habitats are being destroyed and degraded. We are concerned, for example, about Budongo Forest Reserve which has over 500 chimpanzees (probably the highest population in the country) and is being heavily logged. My Ministry is initiating a programme with the Ministry of Natural Resources to ensure peaceful coexistence of wildlife with timber harvesting in the forest reserves.

I am pleased to note that the workshop will address various issues that affect chimpanzees in the wild and in captivity. I trust you will come out with practicable and concise recommendations that will enable my Ministry to formulate management strategies for improving management of chimpanzees. It is my hope that this workshop will provide the ammunitions for the Government to come out with a comprehensive action plan for the conservation of the species.

The management of wildlife is an intricate and complex affair involving urgent issues that need the attention of all stakeholders to play their part. It is through such strategies that practical actions and solutions can be formulated and effected.

With these few remarks distinguished participants, ladies and gentlemen, I wish you successful deliberations. I now declare this Population and Habitat Viability Analysis Workshop open.

History of chimpanzee studies in Uganda

Vernon Reynolds
Institute of Biological Anthropology
Oxford University, U.K.
and
Budongo Forest project, Uganda.

In this short survey of the early studies of chimpanzees in Uganda, I want to focus on some of the highlights of those studies rather than give a comprehensive account of the details of what was discovered by the early workers, which would be extremely tedious and time consuming. I shall focus on the studies done in the 1960s rather that the later ones in the 1980s and 1990s because we shall be hearing more about the recent work in later sessions of this workshop.

Prior to 1962 there had been no field studies of wild chimpanzees in Uganda. Wild chimpanzees had been studied in Guinea, West Africa by H. Nissen (1931), and the well-know studies at Gombe in Tanzania by Jane Goodall had started in 1960. A. Kortland had made some preliminary studies of the chimpanzees near Beni in Eastern Zaire in 1961. The studies at Mahale were to start in 1965 (Nishida 1990:8). In Uganda V. and F. Reynolds did their field research form January to November 1962. After making a tour of all the western forests known to contain chimpanzees, they decided to do their field study in the Budongo Forest Reserve, at the northern end of the chimpanzees' range. The chimpanzees of the Budongo Forest were thus the first to be studied scientifically in Uganda. The Reynolds' work was followed by that of Y. Sugiyama from September 1966 to March 1967, published in 1968 and 1969, and this was followed by the work of A. Suzuki form May 1967 to an unknown date thereafter, published in 1971 and 1975. All three studies were made in the same area of the Budongo Forest, namely the area of the forest to the east and south of Busingiro Hill. Sugiyama divided this area into 2 chimpanzee communities, Regional Populations A and D, but he saw much interaction between them and concluded that they might be the same community (1968:244). Suzuki studied the same chimpanzees. So it is likely that the community studied was the same in all three cases over a period of about 8 years from 1962-1970.

In 1962, in a paper on the nest-building behaviour of chimpanzees, Goodall pointed out that the nesting groups of the Gombe chimpanzees were of variable composition, larger groups splitting up to nest or smaller groups joining together to nest (Goodall 1962). Reynolds (1963) described the variable composition of social groups in the Budongo Forest. The complete findings of the Reynolds' study were published in DeVore (ed.) (1965). Sugiyama was the first to recognise many of the chimpanzees in the community individually, and he published two main papers on their social behaviour and social organisation (Sugiyama 1968 and 1969). Suzuki was the first to draw attention to the need to conserve these chimpanzees, in a paper (1971a) in which he pointed out that a scientific researcher had killed one of his study animals (Mkono) by shooting it with at tranquilliser dart to get a blood sample. There was one other brief study, a census, by H. Albrecht, published in 1976.

What were the main findings of the three early studies? Perhaps the most interesting and novel was the discovery that chimpanzees did not live in permanent groups like baboons or macaques (which at the time were the best known other primate species) but had what later come to be known as a fission-fusion social system in which different individuals met up with each other to form ‘bands’ (the term used by Reynolds) or ‘parties’ (the term used by Sugiyama) or ‘nomadic groups’ (the term used by Suzuki), and then split up again, several times a day. These studies attempted to discover the principal types of grouping. All three agreed on the existence of all-male parties, adult parties, mixed parties, and mother parties, and Sugiyama additionally recognised all-female parties and juvenile-subadult parties (1968:231).

The early studies focused on ecological questions, in particular the question of how these animals exploited their food supply. Concepts such as ‘patchy distribution’ and ideas such as ‘optimal foraging’ or ‘feeding competition’ were not in existence in the 1960s. However, we discovered that the chimps ate a large number of species of plants, and all agreed that the principal item of their diet was fruits. Leaves were eaten as a fallback when fruits were not easily obtained. In addition Sugiyama first reported that in December and January the Budongo Chimps ate large numbers of seeds of the ironwood tree, *Cynometra alexandrii.* This was confirmed by Suzuki and we find the same thing in our present studies in the Budongo Forest Project. Other foods recorded were bark and stems and insects, notably ants (termite eating was not seen). No evidence was obtained for meat eating in the studies by Reynolds and Sugiyama, but Suzuki observed chimpanzees eating a young colobus monkey on 30 May 1968, blue monkey eating (on 13 May 1968), and was the first person ever to record and photograph cannibalism in chimpanzees, when he observed an adult male called Ropoka killing, eating and sharing the meat of an infant chimpanzee on 13 November 1967 (Suzuki 1971b). In all the cases of meat eating observed by Suzuki, the meat was shared, begging was observed and photographed (Photo 6 in Suzuki 1971b:48), and sharing diagrams were published (op.cit., Fig.4, p.39).

Tool use was seen by Sugiyama in the form of use of a leafy twig to fan away flies, and by Reynolds and Sugiyama in the form of breaking off a branch to drop on or throw at the observers. Since then we have observed use of leaf sponges by the Sonso chimpanzees on many occasions and a study by Prof. Duane Quiatt is in progress on this.

An interesting finding of the early studies was that when the fruit supply was good for example on a *Ficus mucuso* tree with ripe fruits, the chimpanzees formed large groups and made a lot of noise by hooting both on arrival at the tree and from time to time as they fed. Reynolds called these ‘panting hoots’, Sugiyama called them ‘booming’. We observed two things about these hoots. First, they were sometimes responded to by chimps from other parts of the forest, second they seemed sometimes to act as a magnet, attracting chimps to the callers’ tree. And we noticed that chimps hearing these calls from another part of the forest would often look towards them as if interpreting their significance. Reynolds drew the conclusion that these calls were announcing the presence of good food to other members of the community, while Sugiyama contented himself with the view that they were a means of communication between the chimpanzees of a number of small parties belonging to the same community.

The idea that the calls might be communication the presence of good food was not, at that time, acceptable to the biological community. It appeared to be an example of what was called 'group selection'. Wynne Edwards had written a book in 1962 in which he outlined the idea that social animals had mechanisms for exploiting their habitat in such a way that they would not over-exploit it. In short, these mechanisms worked for the good of the whole group, not of selfish individuals. This idea was hotly disputed by other biologists, notably George Williams (1966) who argued that animal societies and their behaviour were the product of competition between individuals. I recall giving a talk to the animal behaviour group at Oxford in or around 1966. I expounded the idea that the dominant male chimps formed an all-male group which moved around the forest and acted as the food finders for the rest of the community. When they found a tree with ripe fruits they made loud panting hoots to call the other males, the females and their young to the tree. Afterwards I had a long talk with Mike Cullen I which he explained to me that such ideas amounted to co-operation or even altruism and had been shown to be false, and some other explanation had to be found. I was very puzzled by this. It seemed obvious to me that males would call their companions, mates and children to the tree. Like Sugiyama, I was an anthropologist not a biologist and for us anthropologists group co-operation was the essential first ingredient in the make-up of any society, and competition between individuals was everywhere kept in check because it was mostly antisocial. I actually could not see the problem the biologists were having until some time later.

The difficulty of explaining pant-hooting remains to some extent, unresolved, though recent work at Kibale Forest has focused on it. In the 1970s the ideas of William Hamilton came to be known. He had shown (in 1964) that where animals are very closely related, as in insects, their co-operation and altruism could be explained by recourse to theories of gene frequencies in population genetics. That laid a basis for explaining co-operation in chimps, if the co-operating individuals were closely related genetically. It was not until much later, with the work at Gombe and Mahale, that the close genetic relatedness of the males in chimpanzee groups was discovered. There was still a problem, however. Whereas in insects such as ants or bees the genes controlled the behaviour rather closely, this was not thought to be the case in chimpanzees. So if they behaved altruistically there must be some kind of parallel process going on.

What other findings were made at that time that have significance for the present? For our meeting here this week it is important to known something about the population dynamics proposed by the early authors for the Budongo chimpanzees. I shall limit myself to what they said about 3 things: the size of their study community, the density of chimps in the forest, and the rate of reproduction of chimp females.

1. Community size: the Reynolds estimated that their study population numbered between 60 and 80 animals, and lived in approximately 8 square miles (=20.7 km^2) of forest. Sugiyama identified 41 individuals in his study group (RP-A) but with unidentified animals this amounted to 56. Because he was of the opinion that RP-A was not distinct from RP-D, a neighboring community to the west, he concluded that 56 was too low, but did not give a higher figure. Suzuki (1975) concurred with the figures for the size of the community given by the Reynolds (1965), namely 60-80 individuals. This compares

with the known size of our Sonso community today which has 50 chimpanzees, very similar in size to the Kanyawara community at Kibale Forest.

2. Population density in the forest: by extrapolation from their study community, the Reynolds reached a figure of 1700 chimpanzees for the whole of the Budongo Forest, but because of the problems of extrapolation we concluded that the population was between 1000 and 2000. We included the Siba Forest, the south-western extension of Budongo, in their calculations. If we assume that the forested area of Budongo is 487 km^2 containing 1000-200 chimpanzees, the density was 2.05-4.11 chimpanzees per km^2 in 1962. Sugiyama agreed with the figure of 1000-2000, but for one area he studied intensively (Regional Population A) he estimated the population to be 6.7 chimpanzees per km^2. These figures are much higher than our current estimate of 1.3 chimpanzees per km^2 in 1992, giving a total of between 425 and 711 chimpanzees for the whole forest area.

3. Rate of reproduction of females: Reynolds, on the basis of the estimated age of offspring whose mothers had resumed estrous cycling (n=47) estimated that the birth interval “was most often three years, but was commonly four years”. A second estimate was made by comparing the estimated ages of what appeared to be siblings. They found the commonest relationship observed was that of a juvenile-one with an adolescent (n=23), and concluded that the commonest inter-birth interval was 3 years, with 4 or 5 years also common. Sugiyama was in ‘general agreement’ with the Reynolds’ conclusion that the commonest IBI was 3 years, although in one case it could be 2 years. By modern standards, all these estimates appear to be on the short side, but we do not yet have a figure for Budongo. In Kibale the IBI appears to be as long as 7 years (Wrangham, pers. comm.).

Finally, in this historical survey, I will mention the work of Albrecht (1976). He did a chimpanzee survey in Budongo between September 1971 and May 1972, using old logging tracks which he walked systematically 80 times. He also compared logged with unlogged forest. He estimated numbers on the basis of the number of times he heard chimpanzees calling. His data show a higher calling frequency for chimpanzees in unlogged than in logged forest, the opposite of what he found for monkeys. It appears he did not see any chimpanzees, and therefore his paper has limited value, since calls cannot give data on actual numbers. He was, however, the first to compare logged with unlogged forest in Budongo, a theme taken up by the Budongo Forest Project.

From there we move on to what can be called the modern or recent period. Here there are two main projects, one at Kibale and the other at Budongo. We shall be hearing more about each of these later, so I will just mention them briefly here.

The Kibale Forest chimpanzees were first studied by Michael Ghiglieri from 1977 to 1978. He worked at Ngogo and made a special study of Chimpanzee social relations at an enormous *Ficus mucuso* tree growing near the camp site. He wrote two books based on that study, one more technical, published in 1984, and one more popular (1988). He was followed by Gil Isabirye Basuta in 1983. Richard Wrangham began work at Kibale in September 1987 and the project has been continuous since then. Its main focus has been on feeding ecology and social behaviour. Since 1987 the main field researchers besides Richard Wrangham have been Adam Clark Arcadi, Colin Chapman, and NancyLou Conklin at Kanyawara. In 1995 David Watts and John Mitani took over at Ngogo and this study is now independent of the one at Kanyawara. The Kanyawara community numbers 50 at present, but the size of the Ngogo community is not known, although it has at least 20 males some of which are habituated and can be followed on the ground. Besides these two study communities, an ecotourism site has been established at the Kafu River to the south of Kanyawara, with assistance from Frontier Uganda. It is run on a successful, long-term self-sustaining basis.

The current Budongo Forest Project started in 1990 when Chris Bakuneeta and I visited the forest and established the presence of chimpanzees in the area of the largely defunct Sonso sawmill. Chris Bakuneeta began work on the project at its present location and employed the first Field Assistants and Transect Cutters who set up our grid system of N-S and E-W trails at 100 metre intervals. Initial funding came from the Jane Goodall Institute. In 1991 Chris was joined by Andrew Plumptre, with core funding from ODA and support funding from the National Geographic Society. The main research on chimpanzees has been done by Chris Bakuneeta, working with Field Assistants, and a community of 50 individuals has been habituated. The focus of attention has been on feeding ecology in relation to logging, comparing logged and unlogged forest, and on social behavior. We have had a number of visiting researchers and students over the last 5 years, and they have studied a wide variety of species, as well as the local human population. In June 1997 ODA funding will cease and NORAD funding will come on line for the next three years. We shall continue to study the chimpanzees in the context of logging, which is now mainly pit-sawing, as well as continuing our studies of other species, and of the surrounding human population. In addition of the Budongo Forest Project based at Sonso, there are two ecotourism sites established by the Forest Department, one at Busingiro and the other at Pabidi. These were set up by Christine Herd and C.D. Langoya and are becoming self-sustaining as more tourists become aware of them. At each site there is a semi-habituated community of chimpanzees, and the Budongo Forest Project has helped with training for the Tourist Guides. We very much hope these two new ventures will succeed but I understand form C.D. Langoya that at present political unrest has reduced the numbers of tourists. We all hope the situation will return to normal in the near future.

Finally it is good to see new chimpanzee projects starting up at Bwindi Impenetrable Forest, in Semliki Forest and in the forest fragment at Rabongo where chimpanzees do occur at times. We are starting to find out how many chimpanzees there really are in Uganda, and where they live. All this is excellent news for the conservation and future survival of Uganda's chimps.

References

Albrecht, H. 1976. Chimpanzees in Uganda. Oryx **13**: 357-361.

Ghiglieri, M. 1984. The Chimpanzees of Kibale Forest: a Field Study of Ecology and Social Structure. New York: Columbia University Press.

Ghiglieri, M. 1988. East of the Mountains of the Moon. New York, Free Press.

Goodall, J.M. 1962. Nest building behaviour in the free-ranging chimpanzee. Ann. New York Acad. Sci. **102:**455-467.

Goodall, J.M. 1986. The Chimpanzees of Gombe. Cambridge University Press.

Hamilton, W. 1964. The genetical theory of social behaviour. J. Theor. Biol. **7:**1-52.

Kortlandt, A. 1962. Chimpanzees in the Wild. Sci. Amer. **206,** 5, 128-138.

Nishida, T. (ed.) 1990. The Chimpanzees of the Mahale Mountains. Univ. Tokyo Press.

Nissen, H. 1931. A field study of the Chimpanzee. Comp. Psych. Mon. **8**(1).

Reynolds, V. 1963. An outline of the behaviour and social organization of forest-living chimpanzees. Folia Primatologica **1:**95-102.

Reynolds, V and F. Reynolds 1965. Chimpanzees of the Budongo Forest. Primate Behavior: Field studies of Monkeys and Apes. New York, Holt, Rinehart and Winston.

Sugiyama, Y. 1968. Social organization of chimpanzees in the Budongo Forest, Uganda. Primates **9:**225-258.

Sugiyama, Y. 1969. Social behaviour of chimpanzees in the Budongo Forest. Primates **10:**197-225.

Suzuki, A. 1971a. On the Problems of Conservation of the Chimpanzees in East Africa and of the Preservation of Their Environment. Primates **12**(3-4):415-418.

Suzuki, A. 1971b. Carnivority and Cannibalism Observed Among Forest-Living Chimpanzees. Journal of the Anthropological Society of Nippon. **79**(1):30-48.

Suzuki, A. 1975. The Origin of Hominid Hunting: A Primatological Perspective. Socioecology and Psychology of Primates. Mouton Publishers. pp. 259-278.

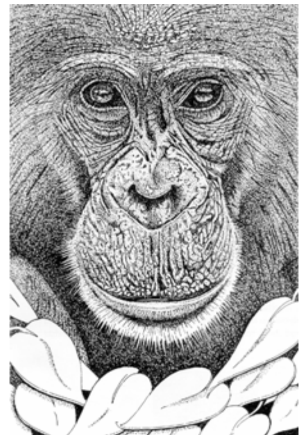
Williams, G.C. 1966. Adaptation and Natural Selection. Princeton Univ. Press, Princeton.

Wynne-Edwards, V.C. 1962. Animal Dispersion in Relation to Social Behavior. Oliver and Boyd, Edinburgh.

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997

Section 3
Distribution and Habitat Working Group Report



UGANDAN CHIMPANZEE DISTRIBUTION, STATUS, THREATS AND CONSERVATION PRIORITIES: CRITERIA AND DEFINITIONS FOR DATA FIELDS

The following key refers to the information presented in Tables 3-1 and 3-2, pages 39 and 40.

Sites

Site names refer to official designations of gazetted protected areas, National Park (NP), Central Forest Reserves (CFR), Wildlife Conservation Area (WCA). Non-protected areas (NP) are named for County or district in which they occur. For locations of numbered sites, refer to Figure 3-1 on page 43.

Blocks

Blocks are defined as *complexes* of sites linked by known or hypothesized movements of chimpanzees between sites. For locations of lettered blocks refer to Figure 3-1, page 43.

Areas

Area estimates for gazetted protected areas are taken from Howard (1991), Kigenyi (1997) and Uganda Forest Department documents. For Ruwenzori NP, area below 2250 m is given. For areas in which high forest occurs in a matrix of other wooded habitats utilized by chimps, figures are given for each habitat type separately if known.

Altitude

High: Areas with an average altitude above 1800 m.
Medium: Areas between 1200 - 1800 m.
Low: Areas below 1200 m.

Habitat Types

Major vegetation type in area in which chimpanzees are found. Tropical High Forest (THF) and Galleries (G) include forest strips along water courses, and Savanna Woodlands (W) include areas with extensive grass cover beneath trees with an open canopy. Areas containing significant areas of two habitat types are indicated by two abbreviations. Mosaics include areas with all three habitats.

Forest Continuity

Degree of forest fragmentation in the site is defined as Continuous (C) for forest areas with little disturbance or intermixed grasslands, woodland or cultivation. Fragmented (F) areas include small forest blocks separated by other habitat types, including agriculture. Riverine (R) areas refer to forests restricted to galleries along water courses in areas dominated by woodland or agriculturally derived landscapes. Note, some areas contain significant proportion of more than one habitat continuity class.

Chimpanzee Population Estimates

Chimpanzee Presence

Confirmed occurrence (+). Presence not confirmed but probable (?).

Data Quality

Quality of data base used to estimate chimpanzee densities. Censuses (C): include estimates based on systematic nest counts. Surveys (S): are estimates based on forest site visits, surveys for other wildlife in which nest counts were not made. Extrapolated densities (E) are densities applied to sites where habitat type, degree of fragmentation and altitude are similar to other Ugandan sites where survey or census estimates are available, or from data from chimpanzee populations in similar habitats in Gabon, (Tutin & Fernandez 1984) and eastern Zaire (Hart & Hall 1996) for eastern Zaire. For references for Ugandan survey and census data see Plumptre, CBSG Uganda Chimpanzee PHVA Final report (1997).

Densities

Low (L) densities, <1.0 / km^2 . A value of 0.4/km^2 is used for the model. This figure is the average density recorded in Ituri, Kahuzi-Biega, Maiko and Gabon across a range of forest types and altitudes.

High (H) densities, (> 1.0 / km^2). A value of 1.3 / km^2 is used for the model. This figure is the lowest density estimate at sites where censuses yielded mean densities > 1.0 / km^2 were recorded.

Site Populations

Published site figures are used for areas for which census data are available. Extrapolated densities multiplied by total area are used to provide estimated total numbers for sites with survey coverage only. Population estimates for sites which have not been surveyed are not given.

Population numbers shown are lowest, most conservative estimate.

Priority for Survey

High priority (1). secondary priority (2). Low priority (3). These priorities are assigned based on size of unsurveyed area and potential for significant chimpanzee populations.

Protection / Patrols

Frequent: (F): Rangers assigned to site and permanently present. Some (S): No permanent guards present. Private (P): Patrols assured by commercial enterprise. None (0): No rangers or patrols present.

Human Populations

Density

Low (L): < 30 / km^2
Medium (M): 30 - 150 / km^2
High (H): > 150 / km^2.

Immigration
Significant current human movements into site area or adjacent region (+). Current Immigration into area low (-).

Cultivation
Occurrence of current cultivation within site area utilized by chimpanzees. None (0): Some (S): < 25 % area under cultivation. High (H): > 25 % of area cultivated. Other than Mwenge (Site 12) and Kibale (Site 13), most cultivation is devoted to subsistence food crops.

Threats

Habitat Loss
Projected habitat loss (L) over next 10-year period: 1997 - 2007:

$$L = (a)(b)(c), \text{ where}$$

a = Human population density (Low = 1, Medium = 5; High = 10).
b = Cultivation (None = 1; Some = 2; High = 5).
c = Protected status (Private protection = 1.5; Some protection or site partially unproptected status = 2; No protection = 5).
Projected loss: Low ($L \leq 10$); Medium (L = 11 - 20); High ($L > 20$).

Poaching Losses
Percent of population lost annually. Figures are based on maximum mortality of 1.3 % / year due to snares reported in Wrangham (CBSG Ugandan Chimpanzee PVHA Report, 1997) and Reynolds (unpubl data). Levels ascribed to each site were adjusted for data on relative levels of human activity and hunting in each of the sites where surveys have been conducted.

Human-Induced Disease
None (0): No human-chimpanzee contact. Low (L): Human activities present in site, low human population densities; low poaching and agriculture; Medium (M): Medium human population density in region, multiple activities including agriculture in areas utilized by chimpanzees. High (H): High human population density. Frequent human activity in areas utilized by chimpanzees and/or chimpanzees living outside of protected areas, chimpanzee-livestock interaction likely.

Political Instability
Assessed as Low (L) and High (H), based on current proximity of civil unrest.

Tourism Potential for Chimpanzees

Assessed as None (0); Low (L); or High (H).

Ugandan Chimpanzee Distribution, Status, Threats and Conservation Priorities: Recommendations

The Status and Distribution Working Group produced the following conclusions and recommended actions:

<u>A. Priority Areas for Chimpanzee Conservation</u>

Based on current knowledge, we consider the following areas to have a high priority for chimpanzee conservation in Uganda:

Budongo Forest Reserve
Kibale National Park
Kasyoha-Kitomi Forest Reservess
Bugoma Forest Reserve

<u>B. Surveys</u>

The extent of forest cover status and numbers of chimpanzees in the following areas should be determined by transect nest counts in the following priority areas:

<u>Priority 1</u>
Area: Kagombe-Kitechura-Matiri Forest Reserves and neighboring forests.
Time: 6 months (July-December 1997)
Costs: $1000 per block, estimated $4000 total.

<u>Priority 2</u>
Area: Kasato Forest Reserve and neighboring forests
Time: Six months (January-June 1998)
Costs: $1000 per block, estimated $4000 total.

Field direction: Dr. Gil Basuta
Participants: Makerere University students
Possible funding: WCS, IPS, IPPL, Australian Primate Society, WSPA, USAID/Biodiversity Support, Care for the Wild.
Continued monitoring of major chimpanzee populations should be encouraged.

<u>Additional Recommendations</u>

1. UWA should develop a policy for chimpanzees that occur outside of protected areas.

2. A policy for the protection of gallery forests used by chimpanzees in agricultural or other non forested areas should be developed.

3. Conservation education programs focusing on chimpanzees should be developed in collaboration with Local Government Councils.

Table 3-1. Ugandan Chimpanzees: Status and Distribution

								Chimpanzee Populations						Human Populations		
Site	No.	Blk.	Status	Area (km²)	Altitude	Habitat	Continuity	Presence	Quality	Density	N	Survey	Patrols	Density	Immig.	Cult.
Mt. Kei	1	A	CFR	200?	Medium	W	C	?		L?	0?	3	0	L	-	0
Otzi	2	B	CFR	50?	Medium	W	C	+		L?	0?	3	0	L	-	0
Rabongo	3	C	NP	2.5 (200 tot)	Medium	G	R/C	+	S	L	20		F	L	-	0
Budongo	4	C	CFR	430 (825 tot)	Medium	THF/G	C/R	+	C	H	650		F	L	+	0
South of Budongo	5	D	CFR & no protect	10	Medium	W	F/R	?		L	0?	3	0	L	+	S
Bujaawe-Wanibubaya	6	E	CFR & no protect	15	Medium	G	F/R	?		L	25	3	0	L	-	S
Bugoma	7	E	CFR	365	Medium	THF/G	C	+	S	H	450	2	S	M	+	S
Kasato	8	E	CFR & no protect	250?	Medium	Mosaic	F/R	?		L?	100?	1	0	M	+	S
Kagombe-Kitechura-Matiri-Ibambaro	9	E	CFR & no protect	300?	Medium	Mosaic	C/F/R	+	S	L?	100?	1	S	M	+	S
Itwara and surroundings	10	E	CFR & no protect	> 87	Medium-High	THF	C	+	S	H	100		S	H	-	S
Buyaga area (N)	11	E	No protect	400?	Medium	W	F	?		L?	50?	3	0	M	-	H
Mwenge	12	E	No protect & private	700?	Medium	G/W	F	+		L?	50?	3	S/0	H	-	H
Kibale	13	E	NP	400 (760 tot)	Medium-High	THF/G	C	+	C	H	550		F	H	-	S
Semliki Valley	14	F	WCA	15 (200 tot)	Low	G	R	+	S	L	60		F/0?	L	-	0
Semuliki	15	G	NP	219	Low	THF	C/F	+	S	L	150	2	F	L	-	0
Ruwenzori North	16	G	CFR	2.5	High	THF/G	C	+	S	L	0		0	H	-	0
Ruwenzori	17	G	NP	120 (966 tot)	High	THF/G	C	+	S	L	50	2	F	H	-	0
Dura R., E. Kasese	18	H	NP	200?	Medium	G	R	+		L	30	3	S	M	-	0
Kasyoha-Kitomi, Kyambura	19	I	CFR & NP	399	Medium	THF/G	C/R	+	S	H	500	2	S	H	-	0
Kalinzu-Maramagambo	20	I	CFR & NP	580	Medium-Low	THF	C	+	C/S	H/L	350		S	H	-	0
Ishasha	21	I	NP	0.2	Low	G	R	+	S	L?	25	3	F	H	-	0
Bwindi	22	J	NP	321	High	THF	C	+	S	L	100		F	H	-	0

Notes (Refer to text for details):

Number: refer to map, page 43
Status: CFR, Central Forest Reserve; NP, National Park; WCA, Wildlife Conservation Area
Block: refer to map, page 43
Area: Chimpanzee habitat. Numbers in parentheses show total protected area of site if larger than suitable chimpanzee habitat area
Altitude: Low, < 1200m; Medium, 1200 - 1800m; High, > 1800m
Habitat: W, Woodland; G, Galley forest; THF, Tropical high forest
Continuity: C, Contiguous habitat block; R, Riverine strips; F, Fragmented forest habitats
Data Quality: C, Census data; S, Survey only
Density: L, Low; H, High
Patrols: 0, None; S, Some; F, Frequent
Immig. (Human Density): L, Low; M, Medium; H, High
Cult. (Cultivation): 0, None; S, Some; H, High levels

Table 3-2. Ugandan Chimpanzees: Threats and Conservation Priorities

			Threats				
Site	No.	Block	Habitat Loss[a]	Poaching[b]	Disease[c]	Political Instability[d]	Tourist Potential[e]
Mt. Kei	1	A	L	0	0	H	0
Otzi	2	B	L	0	0	H	0
Rabongo	3	C	L	0	L	L	L
Budongo	4	C	L	1.3	H	L	H
South of Budongo	5	D	L	0	L	L	0
Bujaawe-Wanibubaya	6	E	L	0.5	M	L	0
Bugoma	7	E	L	2.5	M	H	L
Kasato	8	E	M	?	H	L	0
Kagombe-Kitechura-Matiri-Ibambaro	9	E	M	2.5	H	H	?
Itwara and surroundings	10	E	H	2.5	H	L	L
Buyaga area (N)	11	E	H	?	H	L	0
Mwenge	12	E	H	0.5	H	L	0
Kibale	13	E	M	1.3	H	L	H
Semliki Valley	14	F	L	0.5	L	H	L
Semuliki	15	G	L	5	M	H	L
Ruwenzori North	16	G	L	2.5	L	H	0
Ruwenzori	17	G	L	2.5	M	H	L
Dura R., E. Kasese	18	H	L	0.5	L	L	0
Kasyoha-Kitomi, Kyambura	19	I	L	0.5	L	L	L
Kalinzu-Maramagambo	20	I	L	1.3	H	L	H
Ishasha	21	I	L	0	L	H	0
Bwindi	22	J	L	1.3	H	L	L

[a] (Unprotected areas): L, Low; M, Medium; H, High
[b] Percent of total population annually
[c] Probability of human-induced disease epidemic: L, Low; M, medium; H, High
[d] H, High; L, Low
[e] 0, None; L, Low; H, High

From these data the following areas are designated high priority for chimpanzee conservation in Uganda:
1. Budongo; 2. Kibale; 3. Kasyoha-Kitomi; 4. Kalinzu-Maramagambo; 5. Bugoma.

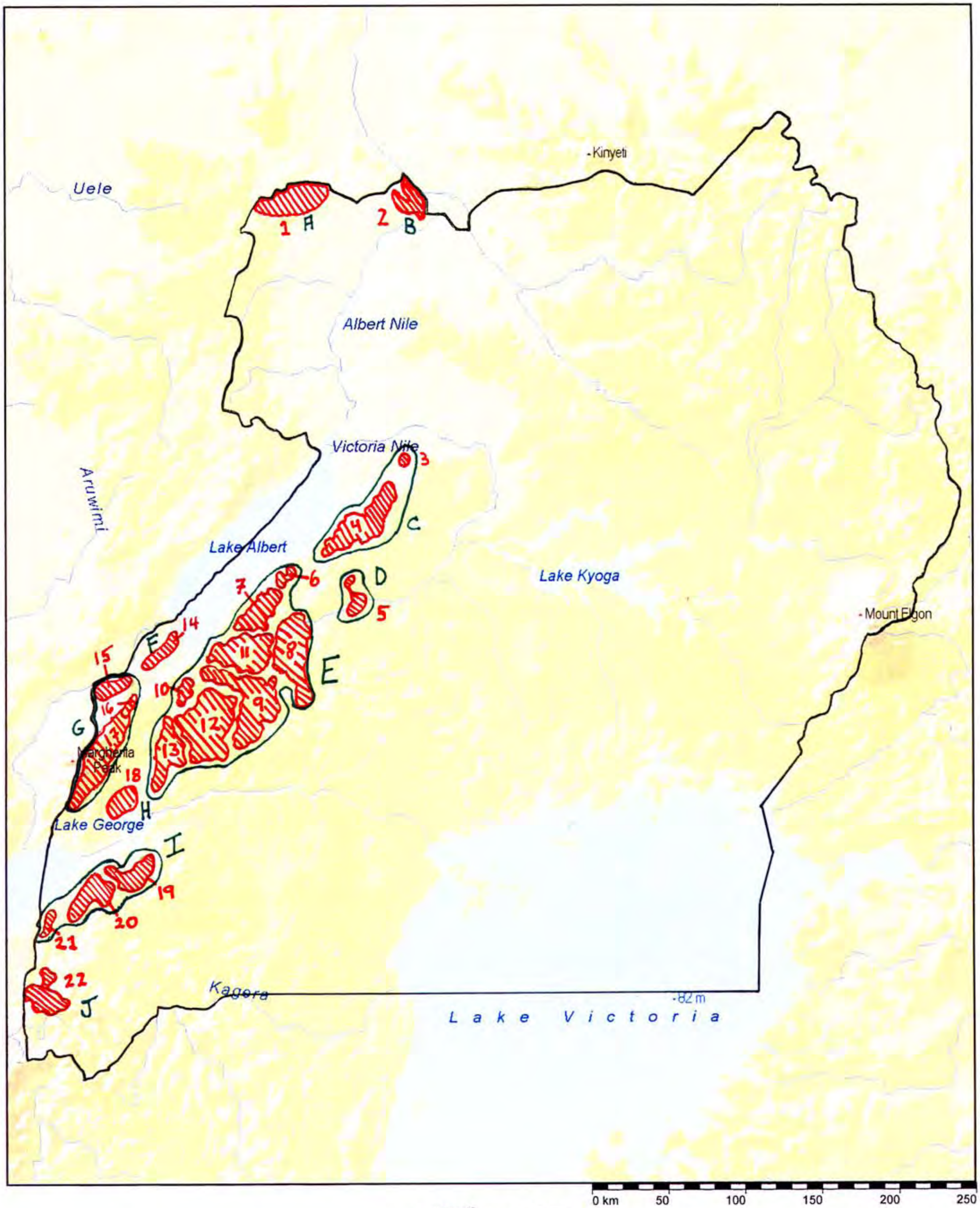
The following areas have a high priority for further surveys and represent potential chimp conservation areas:

Table 3-3. Chimpanzee Habitat Characteristics in Uganda

Site	Status	Area (km^2)	Rain (mm)	Temp. °C	Veg. Types	Tree spp	Food Types	Fig spp	THV Diversity	Herbivores*	Predators	Threats
Budongo	CFR	825	1500	17-29	6	350+	81+	21		?m; 5p	leopard	Hunting/logging
Bugoma	CFR	365	1100	18-29	7	158		2		18m, 5p	?	Sawmill/logging
Itwara	CFR	> 87	1400	15-27	7	143		10		12m, 6p	lion/leopard	Hunting/logging
Kibale	NP	760	1700	14-25	8	209	51	13	13	9m, 6p	rare felines	Hunting/agriculture
Rwenzori	NP	966	Wet	Cold	5	75		1		11m, 4p	leopard	Hunting
Semliki	NP	219	1250	18-30	4	168		13		19m, 8p	leopard	Hunting
Kasyoha-Kitomi	CFR	399	1400	13-26	6	204		13		10m, 6p	?	Sawmill/agriculture
Kalinzu	CFR	137	1400	14-28	8	242		9		12m, 6p	leopard	Hunting/sawmill
Maramagambo	NP/CFR	580	1400	14-28	8	242		9		12m, 6p	leopard	Hunting/sawmill
Bwindi	NP	321	1900	7-27	9	163		1		?, 7p	?	Hunting/mining

* m, mammals; p, diurnal primates

Figure 3-1 (following page). Distribution of Pan troglodytes schweinfurthii in Uganda. Adapted from a larger map developed by workshop participants. Numbered areas in red indicate sites, while areas outlined in green denote larger habitat blocks. See pages 33-40 for more information concerning the areas indicated.

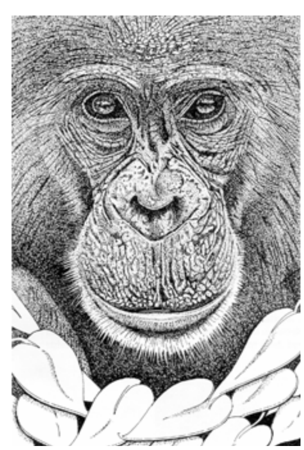

Kinyeti
Uele
Albert Nile
Victoria Nile
Aruwimi
Lake Albert
Lake Kyoga
Mount Elgon
Margherita Peak
Lake George
Kagera
-82 m
L a k e V i c t o r i a
0 km 50 100 150 200 250
1 A
2 B
3
4 C
D
5
6
7
8
9
10
11
12
13
E
14 F
15
16
17
18
G
H
I
19
20
21
22 J
ENCARTA 97 WORLD ATLAS

Uganda

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997

Section 4
Threats Working Group Report



THREATS TO CHIMPANZEE POPULATIONS

I. Main Issues to Consider

A. Habitat Loss/Change
B. Poaching
C. Diseases
D. Political Instability
E. Tourism Activites
F. Human-Chimpanzee Conflicts
G. Ignorance of the Population
H. Legislation (both existent and nonexistent)
I. Habituation
J. Lack of Scientic Research/Information/Management
K. Lack of Funds

A. <u>Habitat Loss/Change</u>

- Human population increase results in a high demand for land for housing, agriculture, and grazing animals.
- The use of the forest for its products such as vines for basketry, medicine, collection of food (honey and mushroom), and firewood.
- Logging the forest for timber, especially by the use of power saws which can take 6 trees in a day, compared to pitsaws which can take 1 tree in a week.
- Possibility of climatic change (short and long-term effects). Global changes in temperature might effect the fruiting cycle of some trees (minimum temperature has been found to trigger flowering in Lope, Gabon). Variation in fruiting patterns of certain species have been observed in the Budongo Forest.
- Industrialization/Urbanization such as the Katwe salt works and cobalt factories. The building of roads for these and other industries (e.g. tourism, local populations - Buhoma - Nteko road in Bwindi).
- Inter-species competition or habitat destruction by other large bodied mammals, such as elephants and potentially gorillas.

Solutions:
Throughout this section under *Solutions* the letters <u>SR</u> are sometimes used. This indicates a <u>Specific Recommendation.</u>

1. Encourage people to plant trees/vines as substitutes for natural forest products, especially for sources of firewood.
2. <u>SR</u> Strengthen forestry extension services.
3. <u>SR</u> When timber is harvested by pitsawyers keep disturbance to a mimimum. For example, restrict timber removal by porters to one or two days per week. This is especially applicable to forest reserves. Instruct head rangers to develop authorized pitsawing procedures that will reduce distrurbance.

4. Gazetting some areas that contain unprotected populations of chimpanzees.
5. Conservation education.
6. General development projects around protected areas- e.g., encourage brick building instead of pole building.
7. EIA (environmental impact assessment) whenever there is any development project.
8. Control human population growth - family planning, etc.
9. Community participation in chimpanzee protection.

B. Poaching

- Snaring which causes injury or death. Accidental captures since snares are primarily set for ungulates and other prey. Examples are Kibale and Budongo
- The killing of adults for infants for illegal sale and trade both national and international (pets, zoos, medical research).
- Habituation may increase the risk of poaching (i.e, make them more vulnerable). For example, in Bwindi all gorillas poached were from habituated groups.
- Roads within protected areas (such as logging roads within forest reserves) may give easy access and an easy way for poachers to escape.
- Hunting of chimpanzees for food. This may occur at Semuliki Forest.

Solutions:

1. Increase patrolling in protected areas.
2. Employment of local people in areas surrounding parks or reserves.
3. Collaborative management - community involvement.
4. Conservation education.
5. Encourage alternative protein resource - switch from wild to domestic sources.
6. "Negative" publicity/ information disemination, e.g. eating chimpanzees may give you ebola virus (?!).
7. SR Carry out an applied research study at two sites (e.g. Kibale and Budongo) that focuses on snaring as a major threat to chimpanzee populations. This study should look at a number of approaches to eliminate snares and assess their effectiveness and feasibility. For example, the effects of finding and removing snares - either to pay a bonus for snare retrieval or to increase snare patrolling; the effects of education in surrounding villages; study the feasibility of "chimpanzee-friendly" snares which minimize or eliminate injury; when chimpanzees are snared, document relative damage to chimpanzees from different snaring materials; set up small game-animal ranching projects, e.g. cane rats, in villages around protected areas.

C. <u>Diseases</u>

Transmission
Human to chimpanzee
Chimpanzee to chimpanzee
Chimpanzee to human
Other primate to chimpanzee
Other animals to chimps
Human to chimp to chimp

Non-infectious Diseases (Trauma/Injury)
Snare injuries
Hunting injuries, e.g. spearing, dog attacks
Accidents/Injuries/Aggression
Poisoning of chimpanzees that raid crops, etc. (agricultural "pests")

Injuries like snare injuries cause morbidity which can result in an increased susceptibility to opportunistic diseases and decreased fecundity. If it results in a loss of a hand or foot, or even just deformation of limbs, the chimpanzees' quality of life is affected, for example in Budongo forest it has been recorded that chimpanzees with snare injuries reuse nests more often possibly because it is more difficult for them to make new nests. This could also mean that the longevity of snared chimpanzees especially those with severe injuries is reduced.

Infectious Diseases
- Sources of infectious diseases (for chimps)
  - Habituation that results from:
    - Development of tourism
    - Long-term research
    - Presence of field assistants
    - Other human activities which include:
      - Poaching
      - Pitsawing
      - Harvesters of forest products
      - Rebels/Military activities
  - Primate predation (chimpanzees eating other primates that carry infectious diseases)
  - Problem chimpanzees who crop raid
  - Other animals to chimpanzees
  - Feeding of chimpanzees by tourists
- Sources of infectious diseases (for humans)
  - Veterinary postmortems/examinations
  - Predation on chimpanzees for human diet (Semuliki Forest)
  - Chimp attacks on humans

Examples of proven or potential transmission of infectious diseases

Proven diseases

- Ebola (Gabon, chimpanzee to human, a dietary source) (Ivory Coast, chimpanzee to human during a veterinary post-mortem examination, possible route of infection could have been, primate to chimpanzee followed by chimpanzee to human)
- Polio (Gombe, Tanzania, human to chimpanzee)(polio-like paralysis once and it is more likely that humans from a nearby village where there was an outbreak transmitted the disease). 9 out of 32 chimpanzees were affected, and in 1 group 6 out of 15 died of the disease.
- Other respiratory diseases, e.g. flu-like (Gombe and Mahale, Tanzania, human to chimpanzee) Bronchopneumonia like type of infection every 3 years; which is different from ordinary respiratory problems which is natural. In the last bronchopneumonia outbreak there was a mortality of 9 chimpanzees. It coincides with a similar outbreak in humans in the nearby village in conditions of wet weather so it could be human-caused.
- One case of Yaws in Gombe (there was a baboon epidemic, around the same time) and several baboons died. The Yaws was probably got from humans and spread to baboons which spread to the chimpanzee.
- One death from Strongyloides spp. (Humans, chimps and baboons share it)
- Chimpanzee diseases:- (all recorded at Gombe).
- Dental and peridontal abscesses frequently occur and are not human caused.
- There was a case of Goitre in a chimpanzee, which is common among the human population. It is not infectious and is nutritional.
- Skin disease which is fungal, one case which was severe, but probably not human caused.

Potential diseases

The following diseases cause morbidity which results in reduced fecundity and increased susceptibility to opportunistic diseases. Some of them frequently cause death of the animal.

- Intestinal diseases (human to chimpanzee and chimpanzee to human). Causes morbidity which can result in death.
- Skin diseases (scabies, human to chimpanzee). Causes extreme morbidity which can result in death in the advanced stages.
- Rabies (dog to chimpanzee). Causes death.
- Tuberculosis (occurred in Orang Utans in Indonesia when captive orangutans were released into a wild population, TB spread with some fatalities in the wild population). Causes morbidity and death.
- Measles. Causes morbidity and death.
- Yaws. Is a syphilis-like infection which also causes facial tissue damage. Can cause morbidity and death. On top of the chimpanzee at Gombe, it has also been recorded in western lowland gorillas in Gabon and baboons in Gombe.

Solutions:

Preventative Medicine

1. Adequate tourist, research, and field staff regulations and implementation (liase with tourist group regarding specific regulations)
2. Training of field staff to recognize and monitor disease and health in chimpanzees - in consultation with veterinarians.
3. Training of field staff to report diseases and deaths.
4. SR Veterinarian of UWA will organize seminars to train, explain and equip park staff and researchers to monitor disease and health in chimpanzees. UWA will contract out veterinarians to carry out a similar programme in the forest department.
5. Veterinary post-mortem examinations as a routine procedure. Ensure protective clothing during post-mortem and interventions.
6. Development of post-mortem protocol for testing for certain infectious diseases such as: polio; measles; Rubella; Ebola; TB; Hepatitis; Influenza; SIV and HIV; Rabies and using cadavers for research purposes to learn more about chimpanzee diseases.

a. SR Development of research on diseases impacting chimpanzee populations. This includes non-invasive monitoring of the health status using the following methods:
   - routine faecal examinations for parasitology, bacteriology
   - opportunistic serology, skin samples, urine samples, nasal swabs, faecal swabs which will also include virology (it is difficult to obtain a CITES permit, and this needs to be addressed especially in the face of an outbreak). Keep a serum bank (as long as 20 years) which will be useful when a disease outbreak occurs.
   - analysis of field observations on frequency of disease
   - analysis of post-mortem data collections

7. Educate pitsawers regarding personal hygience - e.g., adequate latrines.
8. Regular health checks/vaccination of field staff and researchers (e.g. TB testing, 6 monthly health checks, hepatitis vaccinations).

Treatment/Intervention

9. Development of policies concerning veterinary interventions/treatment:
   What to do if human caused injury? e.g., snare injuries.
   What to do if human caused diseases? e.g., infectious epidemic diseases like polio.
   What to do if there is a life-threatening disease outbreak in a chimpanzee population but etiology of disease is unknown?
   It requires an adequately equipped veterinary unit and support diagnostic laboratories (local or through overseas collaborations).

   These are the policies for gorillas, is it directly applicable to chimps as there is a species difference and status difference, and a difference in feasibility.

   - In developing policies it is crucial to consider the level of disturbance that will be created by medical intervention.
   - Before any intervention, evaluation and consultation with protected areas and other concerned parties such as the veterinary Public Health division of the Uganda Ministry of Health and UWA should be undertaken.

* Flexibility in policies - Would policies alter if the popultaion became severely endangered?

Reintroduction/Translocation
(See recommendations of IUCN - Veterinary and Reintroduction Specialist Groups)

Veterinary Involvement in Captive Chimpanzees
(See Captive Management Group Report)

D. Political Instability

- Breakdown of law and order leads to environmental degradation. For example, forests and reserves are encroached upon for firewood, trees are cleared for agricultural uses. Poaching may become rampant when patrols are no longer in place.
- Loss of revenue(s) from tourism and donors. For example foreign aid from other governments or NGO's may be grossly curtalied or even stopped.
- Diversion of funds by internal government that were meant for conservation but are shifted to deal with political problems/instability.
- Political interference in conservation decisions and policies (e.g., MPs/Ministers degazetting protected areas during rallies).
- Refugees and other displaced people creating settlements in protected areas (can result in outbreaks of disease and habitat loss).
- War in protected areas; rebels use protected areas within which to hide.

Solutions:
1. Responsible voting for good governance (if applicable).
2. Encourage political will and commitment to the conservation of the chimpanzee in the face of war.
3. SR Conservation education to politicians, senior security officials, etc.
4. Develop contacts in the press to prevent inaccurate reporting.
5. SR Develop a trust to deal with emergencies so that park management continues in the face of war. For example, NGOs or similar agencies pay rangers to continue patrolling and antipoaching.
6. Proper resettlement of refugees outside protected areas. Consult with government and NGOs. Monitor refugees and their movements.

E. Tourism Activities

- Tourists visiting groups can
  1) spread disease (see also C. Diseases)
  2) cause stress
  3) change chimp behavior (e.g. Gombe males become more aggressive to children)
  4) trample and change the habitat
  5) encourage poaching for pets

- Abuse of regulations by politicians, tourists, staff, NGOs, tour operators, donors and other stake holder.

Solutions:

1. SR Control of tourist activities and movements. (Rules and regulations to come from tourism and education working group).
2. Hygenics infrastructure - e.g. adequate latrines and lavatories, hygenic water sources, etc.
3. Posters regarding risk of transmission of infectious diseases, especially respiratory.
4. Maintain discipline within management system - encourage solidarity from top to bottom in bureaucracy, i.e. ranger to minister.
5. Comment cards for feedback for guides; assessement of facilities, etc.

F. Human-Chimpanzee Conflicts

- Chimps raiding crops and stealing children may lead to people retaliating and killing the chimpanzees.
- Humans using chimpanzees for food (e.g., Semuliki)
- Aggression between chimps and humans leading to injury and/or death
- Disease transmission
- Conservation efforts on the chimpanzees may inconvenience local people and they may become resentful.
- Competition with humans for both space and food

Solutions:

1. Suggest alternative crops to farmers close by to chimpanzee populations, ie. bordering on national parks. For example, plant crops that are not attractive to chimpanzees, non-chimpanzee foods, e.g. tea.
2. SR Identify rogue males in order to capture them and destroy them or place them in a captive environment.
3. Emphazise penalities for poaching and eating chimpanzees where this has occurred, e.g. Semuliki.

G. Ignorance

- Some protected area managers may have little knowledge about chimp ecology and behavior.
- Some local communities are ignorant of objectives of chimpanzee protection.
- Ignorance of influential leaders from other disciplines (e.g. bank managers) about conservation issues.
- Illiteracy of many local communities surrounding protected areas
- Negative beliefs towards chimpanzees due to religion, myth, or superstition which may influence peoples attitudes about conserving the chimps.

Solutions:

1. SR Make available literature regarding chimpanzee behaviour and ecology for managers. For example, distribute briefing books and organize seminars (use of local languages is advantageous).
2. Community conservation education (see also A. Habitat loss, B. Poaching, and C. Disease).
3. Increase knowledge and sensitivity of legislators and politicians regarding chimpanzee conservation especially habitat preservation.

H. Inadequate Legislation

- Inadequate implementation of legislation to protect chimpanzees outside protected areas.
- Fear of responsibilities by parties concerned with the protection of chimpanzees ouside protected area.
- Inadequate implementation of regulations in protected areas.
- Lack of coordination in policies of departments of Forestry, National Parks and local authorities, for example, percentage of revenue that is directed to local people.

Solutions:

1. Clarify who are the responsible individuals for enforcing laws for the protection of chimpanzees who live outside protected areas.
2. Recruit committed and serious personnel and pay and support them adequately.
3. SR Encourage communication and memoranda of understanding between relevant departments, for example, between Forestry Department and NEMA.

I. Habituation

see B. Poaching, C. Disease, E. Tourism.

J. Lack of Scientific Research/Information/Management

- Lack of exchange of information.
- Unwillingness to share information. Selfish behaviour and territoriality about information.
- Lack of applied research relevant for management, e.g., the effects of tourism and the perception of importance of chimps by local communities.
- Lack of veterinary information on chimpanzee biology and diseases.
- Lack of coordination of researchers in the field.

Solutions:

1. Create research positions for members of staff.
2. SR Increase awareness among researchers of the need to submit reports and publications that result from chimpanzee research conducted in Uganda. Submit these materials to national bodies but also to the managers of the site where the research occurred. Make this requirement clear during the process of granting research permits.

3. SR Encourage applied research projects that are relevant to management concerns, e.g. effects of snaring (see B. Poaching); impact of tourism.
4. Encourage expectations of <u>sharing</u> of information.

K. <u>Lack of Funds</u>

- The chimpanzee is not a priority for internal funds within Uganda.
- Lack of follow through on financial commitments on the part of donors or government agencies.
- Failure to generate funds to support management.

Solutions:

1. Publicize the conservation status and kinship of chimpanzee/human relationship in order to promote tourism.
2. Demonstrate to the government that chimpanzee tourism can generate income so that government agencies will commit more internal funding.
3. Creation of a trust fund for Ugandan chimpanzees to deal with crisis situations when an area becomes politically unstable. For example, a trust may ensure that patrolling and antipoaching activitities will continue. Proper oversight concerning the use of these trust funds is important.

II. Summary of Specific Recommendations

A. <u>Habitat Loss/Change</u>

1. Strengthen forestry extension services.
2. When timber is harvested by pitsawyers keep disturbance to a mimimum. For example, restrict timber removal by porters to one or two days per week. This is especially applicable to forest reserves. Instruct head rangers to develop authorized pitsawing procedures that will reduce distrurbance.

B. <u>Poaching</u>

3. Carry out a study at two sites (e.g. Kibale and Budongo) that focuses on snaring as a major threat to chimpanzee populations. This study should look at a number of approaches to eliminate snares and assess their effectiveness and feasibility. For example, the effects of finding and removing snares - either to pay a bonus for snare retrieval or to increase snare patrolling; the effects of education in surrounding villages; study the feasibility of "chimpanzee-friendly" snares which minimize or eliminate injury; document relative damage to snared chimpanzees from different snaring materials; set up small game-animal ranching projects, e.g. cane rats, in villages around protected areas.

C. <u>Diseases</u>

4. Training of field staff to <u>report</u> diseases and deaths.

Veterinarian of UWA will organize seminars to train, explain and equip park staff and researchers to monitor disease and health in chimpanzees. UWA will contract out veterinarians to carry out a similar programme in the forest department.

5. Development of post-mortem protocol for testing for certain infectious diseases such as: polio, measles, Rubella, Ebola, TB, Hepatitis, Influenza, SIV and HIV , and Rabies. Using cadavers for research purposed to learn more about chimpanzee diseases.
6. Development of research on diseases impacting chimpanzee populations. This includes non-invasive monitoring of the health status using 1) routine faecal examinations for parasitology, bacteriology, 2) opportunistic serology, skin samples, urine samples, nasal swabs, faecal swabs which will also include virology (it is difficult to obtain a CITES permit, and this needs to be addressed especially in the face of an outbreak). Keep a serum bank (as long as 20 years) which will be useful when a disease outbreak occurs, 3) analysis of field observations on frequency of disease, and 4) analysis of post-mortem data collections.

g. Veterinary interventions/treatment should be attempted when the chimpanzees are affected by: i). a human-caused injury, e.g., snare injuries; ii). human-caused diseases, e.g., infectious epidemic diseases like polio; iii). life-threatening disease outbreaks in chimpanzee populations with unknown etiologies.

D. <u>Political Instability</u>

7. Conservation education to politicians.
8. Develop a trust to deal with emergencies so that park management continues in the face of war. For example, NGOs or similar agencies pay rangers to continue patrolling and antipoaching.

E. <u>Tourism Activites</u>

9. Control of tourist activities and movements. (Rules and regulations to come from tourism and education working group).

F. <u>Human-Chimpanzee Conflicts</u>

10. Identify rogue males in order to capture them and destroy them or place them in a captive environment.

G. <u>Ignorance of the Population</u>

11. Make available literature regarding chimpanzee behaviour and ecology for managers. For example, distribute briefing books and organize seminars.

H. <u>Legislation (both existent and nonexistent)</u>

12. Encourage communication and memoranda of understanding between relevant departments, for example, between Forestry Department and NEMA.

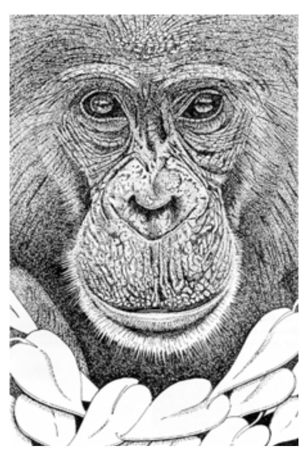
J. <u>Lack of Scientic Research/Information/Management</u>

13. Increase awareness among researchers of the need to submit reports and publications that result from chimpanzee research conducted in Uganda. Submit these materials to national bodies but <u>also</u> to the managers of the site where the research occurred. Make this requirement clear during the process of granting research permits.
14. Encourage applied research projects that are relevant to management concerns, e.g. effects of snaring (see B. <u>Poaching</u>); impact of tourism.

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997

Section 5
Population Biology and Modelling Working Group Report



POPULATION BIOLOGY AND MODELLING OF THE CHIMPANZEE IN UGANDA (*Pan troglodytes schweinfurthii*)

Introduction

Current estimates indicate that about 3,000 eastern chimpanzees (*Pan troglodytes schweinfurthii*) inhabit the remaining forest blocks of eastern Uganda. These populations vary widely in size from just a few tens of individuals to as many as about 600 animals. Moreover, the capacity for natural exchange of individuals bertween these individual forest blocks may be limited, thereby destabilizing the populations and putting them at considerably greater risk of local extinction, even if by random chance, i.e., simply bad luck.

The need for and consequences of intensive management strategies can be modeled to suggest which practices may be the most effective in conserving the chimpanzee in Uganda. VORTEX, a simulation software package written for population viability analysis, was used as a tool to study the interaction of a number of life history and population parameters treated stochastically, to explore which demographic parameters may be the most sensitive to alternative management practices, and to test the effects of a suite of possible management scenarios.

The VORTEX package is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wild populations. VORTEX models population dynamics as discrete sequential events (e.g., births, deaths, sex ratios among offspring, catastropes, etc.) that occur according to defined probabilities. The probabilities of events are modeled as constants or random variables that follow specified distributions. The package simulates a population by stepping through the series of events that describe the typical life cycles of sexually reproducing, diploid organisms.

VORTEX is not intended to give absolute answers, since it is projecting stochastically the interactions of the many parameters which enter into the model and because of the random processes involved in nature. Interpretation of the output depends upon our knowledge of the biology of the chimpanzee, the conditions affecting the populations, and possible future changes in these conditions.

Input Parameters for Simulations

Mating System: Polygynous. Behavioral and genetic data provide consistent evidence of polygyny. It is possible that alpha-males sometimes have higher paternity than other males, but current genetic evidence points to paternity being spread widely throughout the social group (community), and even into neighboring groups (Tai, Ivory Coast: Gagneux et al. 1996).

Age of First Reproduction: VORTEX precisely defines breeding as the time at which offspring are born, not simply the age of sexual maturity. In addition, the program uses the mean (or median) age rather than the earliest recorded age of offspring production. The age of first reproduction (AFR) for females is 13 years (12-16); AFR for males is 13 years.

No Ugandan female chimpanzees of known age have initiated reproduction while being observed, and sample sizes are small from all sites because most females breeding in study communities come from neighbouring unhabituated groups and are therefore of unknown age. In Gombe, four known-age females have bred, at an average age of 13.3 years (range 11-17) (Wallis in press). Although, since reproductive rates in Gombe appear high, growth rates may also be high, i.e. the 13.3-year figure for Gombe female AFR may therefore be low compared to many populations.

The AFR for males is unknown, but is of little importance in VORTEX analysis unless males are exeptionally rare. Male chimpanzees initiate spermatogenesis around the age of ten years, and copulate regularly from the age of one year onwards. The estimate of 13 years is conservative, such that in a dwindling population, the presence of a 13-year old would allow breeding.

In our baseline model we use an AFR of 13 years but construct additional simulations with AFR's of 11 and 17 years.

<u>Age of Reproductive Senescence</u>: VORTEX assumes that animals can breed (at the normal rate) throughout their adult life.

Maximum age or reproduction is estimated around 40 years for both males and females, though females may live longer without reproducing (Dyke et al. 1995). 40 years is the age we use as age of last reproduction (ALR) in the baseline model though we also run simulations with ALR of 35 and 45 years.

<u>Sex Ratio at Birth</u>: Sex ratio at birth is 0.50.

It is possible that sex ratios are adjusted accordingly to population growth or decline, with relatively more males being born to mothers in a relatively good condition (van Schaik and Hrdy 1991). However, small sample sizes make such effects hard to discern. Present data from wild study sites indicates no sex bias in the longterm sex ratio (Kibale, Uganda: 12 males to 10 females; Mahale, Tanzania: 54 males to 55 females, Nishida et al. 1990; GT 30 mles to 29 females in 18 years, Table 5.1 in Goodall 1986; overall sex ratio = 0.51 males per birth).

<u>Maximum Number of Offspring</u>: We assume that maximum number of offspring is one per female though the recorded rates of twinning per parturition are 1 in 59 (Gombe), 1 in 135 (Mahale), and 22 in 1311 i.e.1 in 59.6, in captivity (Matsumoto-Oda 1995, citing Seal et al.1985 for captivity and Goodall 1986 for Gombe). We do this assumption because the effect is going to be quite small, i.e., around 2%.

<u>Offspring Production</u>: Since we assume that all litters are singletons, the proportion of females producing offspring in a given year can be estimated from the interbirth interval (IBI). This estimate is based on a five-year IBI. IBIs in Uganda are only known from Kanyawara, where

they are estimated at 7-8 years (Wrangham et al. 1996.) Elsewhere they are lower (Gombe, 5.2; Mahale, 6.0; Bossou, Guinea, 4.4). Even within Kibale the IBI is probably shorter than in Kanyawara (i.e. at Ngogo, where the frequency of mothers attending a juvenile and infant simultaneously is higher than at Kanyawara). The frequency and intensity of seasonal fruit shortages appear particulary high in Kanyawara compared to Bossou, Gombe, Mahale, and Ngogo (based on informal comparisons). If, as we hypothesize, the long Kibale IBI is a result of frequent periods of fruit scarcity, the typical IBI for Ugandan populations is therefore expected to be shorter, e.g. 4-6 years, with 5 years taken as our baseline figure. However, there may be important exceptions, such as the high-altitude populations in Ruwenzori and Bwindi.

It should be noted that following infant death, the mother's interbirth interval falls dramatically. For example, Wallis (in press) found that in Gombe, sexual cycles were resumed within 35 days of an infant death, compared to 3.9 years after the birth of a surviving infant. Wallis also found that it took 1.3 years following the resumption of cycle until the next birth. These figures suggest that if an infant died at 6 months of age, the interbirth interval will be 0.5 + 1.3 = 1.8 years. This rapid response means that the effect of infant mortality on population growth rates may be quite small, as long as the mother is not harmed by whatever causes the infant's death. Since the baseline infant mortality is set to 16% and only 91% of the females are fertile (frequency of sterile females is set to 9%) the corrected IBI should be:

$$IBI_{(corr)} = \frac{(0.84)(5) + (0.16)(2)}{0.91} = 4.97$$

Based on this interbirth interval, the proportion of adult females producing litters of different sizes each year will then be:

P (no litter) = 79.9%
P (litter = 1) = 20.1%

Annual variation in female reproduction is modeled in VORTEX by entering a standard deviation (SD) for the proportion of females that do not reproduce in a given year (SD (P(litter = 1) = 6%). VORTEX then determines the proportion of females breeding each year of the simulation by sampling from a binomial distribution with the specified mean (e.g., 20.1%) and standard deviation (e.g., 6%).

<u>Density-Dependent Reproduction:</u> Density dependence in reproduction (proportion of females breeding in a given year) is modelled in VORTEX according to the following equation:

$$P(N) = (P(0) - [(P(0) - P(K))(\frac{N}{K})^B])\frac{N}{N+A}$$

in which $P(N)$ is the percent of females that breed when the population size is N, $P(K)$ is the percent that breed when the population is at carrying capacity (K, to be entered later), and $P(0)$ is the percent of females breeding when the population is close to 0 (in the absence of any Allee effect). *B* can be any positive number. The exponent *B* determines the shape of the curve relating percent breeding to population size, as population size gets large. If *B* is 1, the percent breeding changes linearly with population size. If *B* is 2, *P*(*N*) is a quadratic function of *N*. The term *A* in the density-dependence equation defines the Allee effect. One can think of *A* as the population size at which the percent of females breeding falls to half of its value in the absence of an Allee effect (Akçakaya and Ferson 1990, p. 18).

Chimpanzees are assumed to show a density-dependent reproduction pattern. There is a 20% reduction in female breeding when the population size is at least 75% of carrying capacity. The Allee parameter (*A*) is equal to zero and the exponential steepness parameter is set to 14. A graphical representation of this density dependence is shown below.

Male Breeding Pool: All males are available for breeding.

Mortality: Gombe data suggest a correlation between juvenile and adult survivorship, but it is suggested that it has little relevance for Ugandan chimpanzees, as follows.

Seasonal variation in Gombe mortality has been reported (twice the rate in wet than dry months, Goodall 1986, p. 106), possibly coincident with low food availability. In Kibale, mortality has been too low to allow trends correlated with food, season or weather to be detected. However, we believe this difference between Gombe and Kibale reflects more than a difference in the size of the database, because preliminary data show lower and less seasonal frequencies of illness and parasite loads in Kibale than Gombe. We hypothesize that Kibale chimpanzees indeed have higher survivorship and are less subject to seasonal loss of condition than Gombe chimpanzees. This hypothesis is supported by the higher availability of fall back foods in Kibale than in Gombe, i.e. herbs that buffer the effects of fruit shortage (especially pith: e.g. Cyperaceae, Gramineae, Marantaceae, Zingiberaeae). The significance of this hypothesis is that if it is correct, it suggests that there will be a general difference between Uganda (because such herbs are generally common in chimpanzee habitats) and Tanzania (where herbs are more scarce). These points are elaborated below Catastrophes.

Deaths are therefore assumed to be isolated events, except for occasional catastrophic diseases (recorded in Gombe and Tai, Ivory Coast). Outbreaks (e.g. polio-like disease, pneumonia/respiratory diseases, Ebola) do not necessarily spread beyond particular social communities, and have so far killed less than 50% of community members (maximum recorded appears to be the Mitumba-Gombe episode of April 1996, i.e. 9 out of 22+).

Based on these considerations, we therefore set baseline infant mortality to 16% (SD 5%). If we include death caused by catastrophic events the total annual infant mortality is 20% but we prefer to look on catastrophic events and their effects separately. We assume that 20% of total infant mortality is explained by catastrophes and that leaves us with a “normal”, baseline infant mortality equal to [(total mortality) - (catastrophic mortality)] = [0.2 - (0.2)(0.2)] = 0.16.

There is no easy way to estimate this figure. During the first year of life, mortality in Gombe was 33% for females, 23% for males (Goodall 1986, p.113). However, as discussed earlier, Gombe may not represent Ugandan populations well. The probability of infants surviving from birth to 4 years is known to vary among populations (0.42 (Mahale), 0.65 (Gombe), 0.81 (Guinea); Wrangham 1992). In Kanyawara, current data show low infant mortality compared to previously studied populations (4.5% in first year, N = 22; 1987- present).

Overall age- and sex-specific mortalities were estimated based on the expectation of stable population dynamics, i.e., a population with an instantaneous growth rate near zero. This was achieved by setting annual mortalities according to the following table. The higher male mortalities were set to reflect observed biased adult sex ratios skewed towards females. Additional models were developed which used slightly higher rates of mortality in order to simulate the potential impacts of, for example, increased rates poaching and/or snaring. These “hunting” mortality levels are based on best guesses and are not the result of direct field measurements. However, the estimates were developed in an attempt to explicitly investigate the impact of increased mortality from hunting and poaching on chimpanzee population dynamics. The mortality estimates used are included in the table below.

	Mortality Rates (%)					
Age Class	Baseline		Level A		Level B	
	–	–	–	–	–	–
0 - 1	16.0	16.0	18.0	18.0	20.0	20.0
5 - 13	3.4	3.0	3.7	3.3	4.0	3.6
13 -	2.4	1.6	3.2	2.4	4.0	3.2

Catastrophes: Catastrophes are singular environmental events that are outside the bounds of normal environmental variation affecting reproduction and/or survival. Natural catastrophes can be tornadoes, floods, droughts, disease, or similar events. These events are modeled in VORTEX by assigning a probability of occurrence and a severity factor ranging from 0.0 (maximum or absolute effect) to 1.0 (no effect).

Catastrophes were modeled as two primary types: "natural" and "human-induced". The natural catastrophe considered in these models was a severe food shortage. Chimpanzee diets are dominated by ripe fruits, principally from trees, and their geographic distribution is limited to places where such ripe tree-fruits can be found essentially year-round. Preferred fruits generally have soft pulp and a high sugar content, e.g., Annonaceae, Apocynaceae, and Sapotaceae. When soft fruits are not available, chimpanzees turn to drier fruits including especially figs (Ficus: Moraceae). When even these are hard to find, chimpanzees buffer their diets with vegetative material, i.e. leaves and stems of trees or herbs. However, unlike gorillas, chimpanzees never switch to a purely vegetative diet. Instead, even when fruits are scarce, they search widely for them. At these times these groups break up into small parties or lone individuals.

There are no records of fruit shortages in Uganda so extreme as to cause the death of chimpanzees. As noted above, however, seasonal fruit shortage in Gombe appear important. We hypothesize that in Uganda, in contrast to Tanzania, the presence of abundant herbs provides sufficient food buffer to allow chimpanzees to withstand periods of fruit shortage without elevated mortality. This suggestion is based on observations at Kanyawara (Kibale), where chimpanzees fail to exhibit ketosis (catabolism of endogenous fats) even during periods of fruit shortages. We also suggest that during periods of fruit shortage, rates of net energy gain are low. Frequent periods of well-buffered fruit shortage would explain why Kanyawara chimpanzees combine a low reproductive rate with a high survival rate.

The Kanyawara model needs to be tested with other populations. If correct in identifying frequency of fruit shortage as a predictor of reproductive rate, it suggests that populations at higher altitudes will have lower reproductive rates, since fruiting appears to be less regular, and fruiting species are less dense, at higher altitudes.

Similarly, if the presence of edible herbs predicts survival during periods of fruit scarcity, populations in drier habitats, or those with prolonged dry seasons (more than three months), will have lower survival. Most Ugandan populations occur in sufficiently wet habitats that fall-back foods are unlikely to be seriously scarce. Possible exceptions are Kyambura and perhaps the fringe lowland forests of Maramagambo and Budongo.

Human-induced catastrophic events involve the spread of disease and the outbreak of war. Occasional outbreaks of disease have afflicted two communities in Gombe, including a polio-like disease (one in 30+ years, killing at least 5 individuals) and respiratory problems (five in 12 years, killing up to 5 per year, Goodall 1986, p. 105); and in Tai, a series of chimpanzee deaths were linked to an outbreak of ebola (12 deaths out of 40 suspected from ebola; Morell 1995). Such eruptions may be part of the natural ecology of the disease, but they are suspected to have been of human origin and to have been promoted by the proximity of humans to chimpanzees. Two different disease types were considered: a relatively mild but more frequent outbreak, and a much more rare but serious outbreak that can increase average mortality across age classes by about 90%. While there have been no specific instances of such a catastrophic disease outbreak among chimps in Uganda and surrounding regions, the workshop participants were interested in evaluating the effect of such an outbreak of populations of various size, particularly since the frequency of chimp-human interactions continues to increase in Uganda and elsewhere.

One way to assess the potential importance of catastrophic events is to document how many potential suitable habitats are not occupied by chimpanzees, or are occupied at low density, even though there have been no pressures from humans. The only such “empty” forests appear to be outside the geographic range of the species, so that biogeographic factors, rather than intermittent disasters, appear reasonable (e.g., Mabira). At present, it remains unclear if natural empty forests occur within the chimpanzee range.

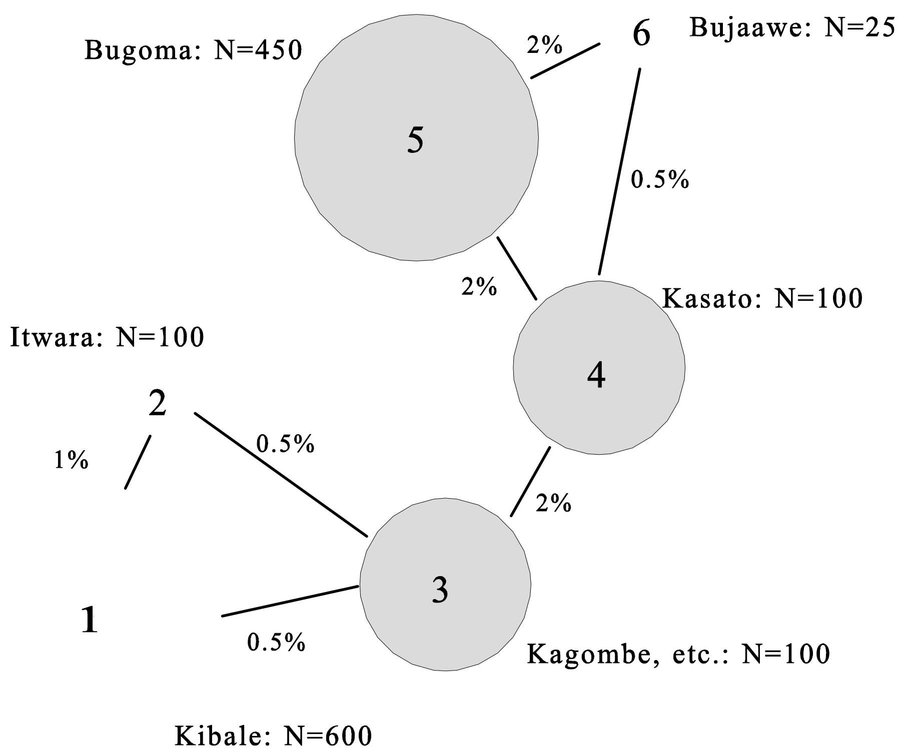
There are of course many different types of catatrophes which could be mediated by humans. Chimpanzee populations can also be affected by the outbreak of civil unrest and even war, for example through increased habitat loss or increased mortality because of hunting. A tabulation of the four catastrophes used in the modelling process, with annual probabilities of occurrence and severity factors for both reproduction and mortality, is given below.

Catastrophe 1(mild disease):	Probability of occurrence 10% per year. Survival Factor 0.9; Reproduction Factor 0.0
Catastrophe 2 (food shortage):	Probability of occurrence 2% per year Survival Factor 0.9; Reproduction Factor 1.0
Catrastophe 3 (serious disease):	Probability of occurrence 1% per year. Survival Factor 0.1; Reproduction Factor 1.0
Catastrophe 4 (war):	Probability of occurrence 10% per year. Survival Factor 0.97; Reproduction Factor 0.97

Initial Population Size: Based on information on the distribution and status of chimpanzee populations across Uganda, models were developed with a series of initial population sizes approximately corresponding to actual population sizes estimated for known forest regions in the country. Moreover, the population sizes were chosen in order to span the range of chimpanzee populations known to exist in Uganda. These estimates are given below.

Representative Population	Population Size (N_0)
Bujaawe	25
Semliki FR/Toro GR	60
Bwindi NP	100
Semuliki NP/Ruwenzori NP	200
Budongo	600

In addition to modelling this series of isolated populations, a small series of metapopulation models were constructed. This metapopulation consisted of six subpopulations, each connected to the other by varying rates of migration. A basic graphical representation of this metapopulation is shown below with subpopulation identifiers and migration rates between subpopulations indicated.



Therefore, a migration rate among adult females of 1.0% means that, in a population of 100 adult females, a single adult female (on average) moves from population A to population B each year. In a population of 25 adult females, a female will migrate on average once every four years.

Migration as a means of gene flow was judged to be a critical factor in the preservation of both genetic diversity and the potential for repopulating forests emptied of chimpanzees by disease outbreaks. Unfortunately, very little is known about migration in wild chimpanzees. Migration is always by adolesent or adult females and occurs into the range of adjacent or nonadjacent (leap-frogged) communities. Eighteen immigrations have been recorded in 25 years of data collection in the Mahale Mountain of Tanzania.

This, however, refers only to migration among communities. Migration between subpopulations within a larger metapopulation is even more poorly understood. For purposes of the VORTEX model, we estimated that the populations were distinct if the migration rate between subpopulations was less than 10% per year. For such distinct populations we estimated migration rates as a function of distance, with rates between 0.5% and 2% used initially. To assess the importance of this migration for metapopulation viability, a second set of metapopulation models were run with migration rates set to double the original rates.

Carrying Capacity: The carrying capacity, K, for a given habitat patch defines an upper limit for the population size, above which additional mortality is imposed across all age classes in order to return the population to the value set for K. VORTEX has the capability of imposing density-dependent effects on reproduction that change as a function of K.

All populations modelled here were assumed to be at carrying capacity; therefore, carrying capacity was set to the initial population size for each set of models.

Iterations and Years of Projection: All scenarios were simulated 500 times, with population projections extending for 100 years. Output results were summarized at 10-year intervals for use in some of the figures that follow. All simulations were conducted using VORTEX version 7.3 (December 1996).

Results from Simulation Modeling

The Baseline Model
The demographic and environmental parameters discussed above were assembled in the VORTEX model to assess the status of a chimpanzee population free from any human-mediated threats to its persistence. This is considered the chimpanzee baseline population model.

All subsequent model results will be compared initially to our baseline model. To review, the baseline scenario modelled a chimp population with a reproductive lifespan of 27 years (beginning at age 13 and ending at age 40); an average of 20.1% of adult females breeding in a given year (an interbirth interval of nearly 5 years) with a density-dependence function built in that would increase the proportion of females breeding as population density decreases; a mortality schedule outlined earlier in this section; and a single “natural” catastrophe, namely, severe food shortage occurring on average every ten years with the elimination of reproduction in the year of the event and a 10% increase in mortality across all age-sex classes. This baseline and all subsequent scenarios were run with a range of five initial population sizes.

Under these conditions, a population is expected to show a deterministic growth rate, in the absence of any random annual variation in birth and death rates, of 1.7% per year (i.e., File#301, Table 5-1). This growth rate corresponds to a doubling of population size about every 45 years. However, because the population’s vital rates are subjected to annual stochastic variation, these simple deterministic estimates provide an overestimate of the growth potential of the population. This is illustrated by noting that, in all models shown in Tables 5-1 through 5-10, the stochastic growth rate (r_s) calculated directly from the VORTEX simulations is less than the deterministic growth rate calculated from static Leslie matrix algorithms. The baseline model with an initial population size of 25 individuals (File#301, Table 5-1) shows a stochastic growth rate of 1.0% which is about 40% less than the determinstic projection. A population with an annual growth rate of 1.0% can be expected to double in about 70 years. It is important to note, however, that there is a subtantial degree of variation around this mean annual growth rate, as shown by the standard deviation around mean r_s in this same baseline scenario (File#301, Table 5-1). In other words, some of the simulated populations displayed negative growth because of particularly strong year-to-year variation in the mean birth and death purely by chance.

As a result of this variation in population growth, there is a chance that the simulated population may become extinct. In our small-population baseline scenario, this risk is small at only 1.2% over 100 years. But this observation of a non-zero risk of population extinction despite a positive mean population growth rate dramatically illustrates the impacts that stochastic variation around mean demographic rates can exert on small populations of wildlife.

Sensitivity Analysis

Since many of the demographic parameter estimates for the simulated chimpanzee populations are based on our best educated guesses from field data, it is instructive to use the simulation modelling approach in an investigation of the relative sensitivities of the populations to changes in a range of demographic parameters. In other words, we can determine which parameters are more influential in determining the future viability of chimpanzee populations and utilize this information to help prioritize the collection of additional population data. A total of four variables were chosen for study in this analysis: population size, number of catastrophes, reproductive lifespan (including age of first and age of last reproduction separately), and mortality schedule. Results of the analyses for each of these parameters, and some of their interactions, are discussed in detail below.

Population size

The baseline models for each of the five initial population sizes are shown at the top of Tables 5-1 (File#301), 5-3 (File#337), 5-5 (File#373), 5-7 (File#409), and 5-9 (File#445). With the exception of the smallest population (N_0 = K = 25), all populations showed a stochastic growth rate of about 1.0% annually and no extinction risk. It is important to emphasize once again that the smallest population has a slight but non-zero risk of extinction with the same set of demographic parameters as those models with larger population sizes. In other words, the smallest populations are at risk precisely *because* they are small. Also note that the deterministic growth rate is identical for each of these models; this parameter is independent of population size and based solely on mean rates of birth and death.

Because of the positive mean growth rates present in all of these models, the populations remain very near carrying capacity throughout the duration of the simulations. As expected, the degree of heterozygosity retained in these populations after 100 years is a strong function of their size. The largest population (N_0 = 600) retains 99.3% of its original heterozygosity, while the smallest (N_0 = 25) retains just 81.5%. This increased loss of genetic variation in very small populations may lead to a reduced capacity to respond to long-term environmental changes (i.e., to evolve).

Catastrophes

As described above, the suite of catastrophes we investigated were broken out into a single “natural” food shortage catastrophe and three “human”-introduced catastrophes, namely, moderate and serious disease and an outbreak of war. Each baseline scenario just discussed was run with the “baseline” condition of a natural food shortage as well as with all four catastrophes included in order to assess the impact of close contact between human and chimpanzee populations.

Under the conditions modelled here, the human-introduced catastrophes have a profound impact on the viability of chimpanzee populations. Moreover, the extent of this impact is tightly linked to population size. When all catastrophes are included in the model, the deterministic growth rate is reduced from 0.017 to -0.003 (see, for example, File#310, Table 5-1); in other words, the inclusion of these human-introduced events shifts the expected long-term deterministic behavior of these population from one of expected growth to expected decline. The picture is made worse with the addition of stochastic demographic and environmental variation into the model. Each simulated population size shows a stochastic growth rate under baseline mortality of about -2.0%, again with considerable variation present around this mean (i.e., File#346, Table 5-3). Perhaps of greatest importance, however, is the considerable increase in the risk of population extinction and its association with population size. This is best summarized in Figure 5-1. The extinction risk for the smallest population is more than 61% (File#310, Table 5-1) while a population of 600 individuals shows a risk of about 15% (File #454, Table 5-9). Even if a simulated population does not become extinct, the final population size is considerably reduced relative to the baseline condition. For example, when the initial population size is set at 200 (Table 5-7), the final size under the impact of all catastrophes is reduced from the baseline value of 194 to just 94 individuals. Associated with this reduction in final population size is a reduction from 98% to 91% in the amount of genetic variation retained. Similar results are seen in models starting with different initial population sizes (Figure 5-2).

Although a detailed investigation of the characteristics of each of the “human”-introduced catastrophes and their specific impacts was not conducted, observation of individual model runs made it clear that the vast majority of the impact could be attributed to the severe disease event. A 90% increase in mortality, even for just a single year, has a very dramatic impact on the growth dynamics of a population. Since an event of this magnitude has not been directly observed in a chimpanzee population, this level of severity may be an overestimate. However, the increasing frequency of close contact between human and chimp populations makes the introduction of a severe disease into a chimp population more likely.

Reproductive lifespan

Both the age of first reproduction and the age of reproductive senescence were investigated in an attempt to determine which variable was more important in determing the growth dynamics of chimpanzee populations. Throughout all the scenarios modelled, a change in the age of first reproduction produced a greater change in the stochatic growth rate than a similar change in the age of final reproduction. For example, in a population of 25 individuals subjected only to “natural” catastrophes (top half of Table 5-1), a one-year change in the age of first reproduction produces a change in the stochastic growth rate of 0.0023 ({0.010-0.001} / 4 years). In contrast, the same change in the age of final reproduction changes r_s by just 0.0012 ({0.017-0.005} / 4 years). We can conclude, therefore, that uncertainty in the age of first reproduction has a larger impact on our projections of population growth than the same uncertainty in our estimates of the age of reproductive senescence. This is best explained by noting the simple fact that a delay in the onset of breeding reduces the reproductive output of a larger cohort of females alive at age 12 or 13 compared to changes in final reproductive age affecting a relatively smaller cohort of 41- to 42-year old females alive at the onset of reproductive senescence. More specifically, given the baseline mortality schedule used in these models, about 58% of all females (on average) are expected to reach 13 years of age while just 37% are expected to reach 42 years of age. It should be noted that, under all population sizes studied, the most pessimistic estimate of the reproductive lifespan—age of first reproduction at 17 years, age of senescence at 35 years—resulted in a negative stochastic growth rate ranging from -0.7% to -0.3%.

The larger role played by uncertainty in age of first reproduction is displayed graphically in Figures 5-3 and 5-4 for N_0 = 25. Note that the final population sizes under variable AFR tend to be more spread out than those under variable ALR. This relationship is slightly obscured, however, by the relatively large variation in population sizes normally seen in the smaller populations. The relationship is clearer when N_0 = 100 (Figures 5-5 and 5-6): different AFR-values result in a wider dispersion of final population sizes, both with and without human-introduced catastrophes, compared to changes in ALR. Taken together, these results suggest that if studies on the reproductive lifespan of chimpanzees are deemed a priority in conservation research, more effort should be directed toward a more accurate estimate of the age of first reproduction.

Additional mortality
In the presence of both natural and human-induced catastrophes, the addition of human-caused mortality through direct hunting and poaching, as well as through incidental snaring, has a measurable impact on the dynamics of chimpanzee populations, particularly (as expected) in the smaller populations. For example, added mortality in populations of just 25 individuals increases the risk of extinction from a baseline level of 61% (File#310, Table 5-1) to nearly 77% (File#328, Table 5-2). This general observation is characteristic of all simulated population sizes (Figure 5-7).

While the additional mortality we modelled is distributed across nearly all age classes, it is important to appreciate that a large proportion of this impact is due to the removal of adult females from the population. In fact, in a population of 100 individuals, the mortality Level A simulated here corresponds to the removal of just one additional adult female every year. These models indicate that the annual removal of a single female, as well as her associated offspring if she has recently reproduced, can have a real detrimental effect on the growth potential of chimpanzee populations subjected to these additional mortality threats.

In addition to the increased extinction risk, additional mortality imposed by human activities causes a decline in the mean population size over time compared to the baseline mortality scenarios. For example, Figure 5-8 shows a time series of population size for the case where N_0 = K = 100. It is evident from this graph that a large proportion of the total decrease in population trajectory over the baseline model is the addition of human-induced catastrophes; however, the additional poaching/snaring mortality results in a further reduction in population size and, consequently, a further reduction in the level of heterozygosity retained within the population.

Metapopulation Analysis
When populations are linked together by corridors, allowing for periodic migration of adult females between them, extinction risk for each population is reduced in nearly all cases compared to the situation in which the same population is isolated from its nearest neighbors. These metapopulation model results are shown in Table 5-11. As an example, under standard

migration levels and all catastrophes included, the extinction risk for Population #3 (Kagombe: N_0 = 100) is reduced by as much as 55% over a similar population of 100 individuals with no migration possible (Migration File#482: P(E)=0.174; Isolation File#382: P(E)=0.386). This reduction in the risk of extinction is a direct consequence of the ability of adult females from surrounding populations—in this case, Itwara, Kibale, and Kasato—to periodically move into the Kagombe region and supplement the existing population or perhaps even recolonize the area following a local extinction event. A doubling of the migration rate among all subpopulations does not appear to have a significant benefit for the majority of patches: of the 24 scenarios presented in Table 5-11, extinction risk increases in 9 of the scenarios, remains the same in 8 scenarios and decreases in 7. These results suggest that the baseline migration rates estimated in this analysis are effective in reducing population extinction risk. The unexpected *increase* in extinction risk in the smallest population (Bujaawe: Population 6) under baseline conditions (File#481 and 485) is as yet unexplained and under further investigation.

In addition to the reduction in extinction risk, the influx of new individuals into a subpopulation by migration leads to an increase in the level of heterozygosity that is retained within that subpopulation. This increase in H_{100} is most notable in the smaller populations. Overall, modelling these populations as components of a larger metapopulation appears to have both demographic and genetic benefits that lead to a general increase in their general viability. However, it is important to consider the potential negative impacts of migration between subpopulations, such as the increased risk for disease transmission.

Conclusions and Recommendations

- Stochastic simulation modelling of chimpanzee populations in Uganda using the VORTEX software package indicates that risk of extinction is considerably greater in very small populations (i.e., 25-100 individuals) of chimpanzees compared to larger populations (450-600 individuals) due exclusively to the action of random, unpredictable variation in demographic rates such as those for birth and death. Consequently, it is important that these small populations are actively protected against those factors—habitat loss, lack of protected status, human population increase—that act to reduce and destabilize wild populations.

- Under the demographic and environmental conditions modelled in this workshop, chimpanzee populations appear to be reasonably well buffered with respect to natural catastrophes such as periodic severe food shortages. However, outbreaks of severe disease—primarily introduced following close human contact—can cause devastating mortality to chimpanzee populations. Populations surviving these disease outbreaks can be reduced in size up to 90%, leaving them vulnerable to other stochastic demographic factors that ultimately increase the risk of extinction over 100 years. Other human-induceded catastrophes, such as the periodic outbreak of war and more moderate disease epidemics, also have a relatively more severe effect than do natural catastrophes.

- An analysis of the sensitivity of chimpanzee population dynamics to uncertainty in female reproductive lifespan revealed that variation in the age of first reproduction leads to a greater population response than variation in the age of final reproduction. As a result of this conclusion, it is recommended that detailed research studies be designed and carried out that will help to provide a more accurate estimate of the age at which female chimpanzees begin to produce offspring. This information can be obtained through additional longitudinal studies of a set of chimpanzee family groups, as well as from a careful preliminary analysis of data from captive chimpanzee populations.

- The additional chimpanzee mortality across a range of age classes, due primarily to poaching, hunting, and perhaps incidental snaring intended for human food items, acts to further destabilize chimpanzee populations. As expected, this increase in mortality has a more severe consequence for small populations through the interaction of higher mortality and greater sensitivity to random variation in demographic rates. Mortality of adult females tends to most severely impact population growth; the loss of even a few adult females annually can cause a measurable decrease in population size.

- Large populations are always better able to survive severe catastrophes or increased mortality rates so it is vitally important to maintain large populations or, if this option has limited potential, to at least provide an opportunity for exchange of individuals between populations through a type of metapopulation structure. The possibility of migration between components of a metapopulation allows for a greater level of overall genetic diversity to be retained as well as the potential for recolonization of habitats that have undergone recent localized extinction.

Based on these general conclusions resulting from our modelling efforts, we recommend that the greatest attention be paid to those human-related factors that can have a severe and perhaps even catastrophic effect on the future viability of chimpanzee populations but whose impacts can, through active management, be held in check. Specifically, we recommend the following:

1. Minimum distances should be maintained between fully habituated chimpanzees and either tourists or researchers in order to minimize the potential for disease outbreaks.
2. Because poaching impacts adult age classes most severely and the loss of adult females constitutes the most severe demographic threat to wild populations, poaching and snaring controls should be enhanced (see associated recommendations in Section 4, Threats).
3. Wildlife managers should monitor the status of wild populations, through comprehensive nest-counting and other census methodologies, so that if an increase in annual mortality rates is observed, appropriate measures can be taken to reduce the causes of this mortality. Such actions might include a general increase anti-poaching and/or anti-snaring controls.

Literature Cited

Akçakaya, H.R., and S. Ferson. 1990. RAMAS/Space. Spatially structured population models for conservation biology. Applied Biomathematics, Setauket, New York.

Dyke, B. T.B. Gage, P.L. Alford, B. Swenson, and S. WIlliams-Blangero. 1995. Model life table for captive chimpanzees. American Journal of Primatology 37:25-37.

Gagneux, P., C. Boesch, and D.S. Woodruff. 1996. Genetics of wild chimpanzee communities in West Africa: Paternity, community structure and gene flow. International Primatological Society XVIth Congress Abstracts, 609.

Goodall, J. 1986. The Chimpanzees of Gombe: Patterns of Behavior. Harvard University Press, Cambridge, MA.

Matsumoto-Oda, A. 1995. First record of a twin birth in chimpanzees of the Mahale Mountains National Park, Tanzania. African Study Monographs 16:159-164.

Morell, V. 1995. Chimpanzee outbreak heats up search for Ebola origin. Science 268-974-975.

Nishida T., H. Takasaki, and Y. Takahata. 1990. Demography and reproductive profiles. Pages 63-98 in: Nishida, T. (ed.). The Chimpanzees of the Mahale Mountains: Sexual and Life History Strategies. University of Tokyo Press, Tokyo.

Seal, U.S., N. Flesness, and T. Foose. 1985. Neonatal and infant mortality in captive-born great apes. Pages 193-205 in: Graham, C.E., and J.A. Bowen (eds.). Clinical Management of Infant Great Apes. Alan Liss, New York.

Wallis, J. 1995. Seasonal influence on reproduction in chimpanzees of Gombe National Park. International Journal of Primatology 16:435-451

Wrangham, R.W. 1992. Living naturally: Norms and extremes of chimpanzee environments in the wild. Pages 71-91 in: Erwin, J. (ed.) Chimpanzee Conservation and Public Health: Environments for the Future. Rockville, Maryland: Diagnon.

Wrangham, R.W., C.A. Chapman, A.P. Clark, and G. Isabirye-Basuta. 1996. Social ecology of Kanyawara chimpanzees: Implications for understanding the costs of great ape groups. Pages 45-57 in: McGrew, W.C., L.F. Marchant, and T. Nishida (eds.). Great Ape Societies. Cambridge University Press, Cambridge, MA.

Sample VORTEX Input File

```
CHIMP310.OUT     ***Output Filename***
Y      ***Graphing Files?***
N      ***Each Iteration?***
500      ***Simulations***
100      ***Years***
10      ***Reporting Interval***
1      ***Populations***
N      ***Inbreeding Depression?***
N      ***EV correlation?***
4      ***Types of Catastrophes***
P      ***Monogamous, Polygynous, or Hermaphroditic***
13      ***Female Breeding Age***
13      ***Male Breeding Age***
40      ***Maximum Age***
0.500000     ***Sex Ratio***
1      ***Maximum Litter Size (0 = normal distribution) *****
Y      ***Density Dependent Breeding?***
25.000000     ***Density dependence term P(0)***
20.100000     ***Density dependence term P(K)***
14.000000     ***Density dependence term B***
0.000000     ***Density dependence term A***
100.000000     ***Population 1: Percent Litter Size 1***
6.000000     ***EV--Reproduction***
16.000000     ***Female Mortality At Age 0***
5.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 1***
1.000000     ***EV--FemaleMortality***
```

```
3.000000     ***Female Mortality At Age 2***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 3***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 4***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 5***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 6***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 7***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 8***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 9***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 10***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 11***
1.000000     ***EV--FemaleMortality***
3.000000     ***Female Mortality At Age 12***
1.000000     ***EV--FemaleMortality***
1.600000     ***Adult Female Mortality***
0.500000     ***EV--AdultFemaleMortality***
16.000000     ***Male Mortality At Age 0***
5.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 1***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 2***
```

Sample VORTEX Input File (Cont'd.)

```
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 3***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 4***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 5***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 6***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 7***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 8***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 9***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 10***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 11***
1.000000     ***EV--MaleMortality***
3.400000     ***Male Mortality At Age 12***
1.000000     ***EV--MaleMortality***
2.400000     ***Adult Male Mortality***
0.800000     ***EV--AdultMaleMortality***
10.000000     ***Probability Of Catastrophe 1***
1.500000     ***Severity--Reproduction***
0.900000     ***Severity--Survival***
2.000000     ***Probability Of Catastrophe 2***
0.000000     ***Severity--Reproduction***
```

```
0.900000     ***Severity--Survival***
1.000000     ***Probability Of Catastrophe 3***
1.000000     ***Severity--Reproduction***
0.100000     ***Severity--Survival***
10.000000     ***Probability Of Catastrophe 4***
0.970000     ***Severity--Reproduction***
0.970000     ***Severity--Survival***
Y     ***All Males Breeders?***
Y     ***Start At Stable Age Distribution?***
25      ***Initial Population Size***
25      ***K***
0.000000     ***EV--K***
N     ***Trend In K?***
N      ***Harvest?***
N     ***Supplement?***
Y     ***AnotherSimulation?***
```

Sample VORTEX Output File

```
VORTEX -- simulation of genetic and demographic stochasticity

CHIMP310.OUT
Tue Feb  4 20:33:32 1997


  1 population(s) simulated for 100 years, 500 iterations

  No inbreeding depression

  First age of reproduction for females: 13   for males: 13
  Age of senescence (death): 40
  Sex ratio at birth (proportion males): 0.50000


Population 1:

  Polygynous mating; all adult males in the breeding pool.

  Reproduction is assumed to be density dependent, according to:
  % breeding = (25.00*[1-(N/K)^14.00]+20.10*[(N/K)^14.00]) * N/(0.00+N)
   EV in reproduction (% breeding) = 6.00 SD

   Of those females producing litters, ...
   100.00 percent of adult females produce litters of size 1

   16.00 (EV = 5.00 SD) percent mortality of females between ages 0 and 1
    3.00 (EV = 1.00 SD) percent mortality of females between ages 1 and 2
    3.00 (EV = 1.00 SD) percent mortality of females between ages 2 and 3
    3.00 (EV = 1.00 SD) percent mortality of females between ages 3 and 4
    3.00 (EV = 1.00 SD) percent mortality of females between ages 4 and 5
    3.00 (EV = 1.00 SD) percent mortality of females between ages 5 and 6
    3.00 (EV = 1.00 SD) percent mortality of females between ages 6 and 7
    3.00 (EV = 1.00 SD) percent mortality of females between ages 7 and 8
    3.00 (EV = 1.00 SD) percent mortality of females between ages 8 and 9
    3.00 (EV = 1.00 SD) percent mortality of females between ages 9 and 10
    3.00 (EV = 1.00 SD) percent mortality of females between ages 10 and 11
    3.00 (EV = 1.00 SD) percent mortality of females between ages 11 and 12
    3.00 (EV = 1.00 SD) percent mortality of females between ages 12 and 13
    1.60 (EV = 0.50 SD) percent annual mortality of adult females (13<=age<=40)
   16.00 (EV = 5.00 SD) percent mortality of males between ages 0 and 1
    3.40 (EV = 1.00 SD) percent mortality of males between ages 1 and 2
    3.40 (EV = 1.00 SD) percent mortality of males between ages 2 and 3
    3.40 (EV = 1.00 SD) percent mortality of males between ages 3 and 4
    3.40 (EV = 1.00 SD) percent mortality of males between ages 4 and 5
    3.40 (EV = 1.00 SD) percent mortality of males between ages 5 and 6
    3.40 (EV = 1.00 SD) percent mortality of males between ages 6 and 7
    3.40 (EV = 1.00 SD) percent mortality of males between ages 7 and 8
    3.40 (EV = 1.00 SD) percent mortality of males between ages 8 and 9
    3.40 (EV = 1.00 SD) percent mortality of males between ages 9 and 10
    3.40 (EV = 1.00 SD) percent mortality of males between ages 10 and 11
    3.40 (EV = 1.00 SD) percent mortality of males between ages 11 and 12
    3.40 (EV = 1.00 SD) percent mortality of males between ages 12 and 13
    2.40 (EV = 0.80 SD) percent annual mortality of adult males (13<=age<=40)
    EVs may have been adjusted to closest values
        possible for binomial distribution.
```

Sample VORTEX Output File (Cont'd.)

```
    EV in mortality will be correlated among age-sex classes
       but independent from EV in reproduction.

  Frequency of type 1 catastrophes: 10.000 percent
    with 1.500 multiplicative effect on reproduction
     and 0.900 multiplicative effect on survival

  Frequency of type 2 catastrophes: 2.000 percent
    with 0.000 multiplicative effect on reproduction
     and 0.900 multiplicative effect on survival

  Frequency of type 3 catastrophes: 1.000 percent
    with 1.000 multiplicative effect on reproduction
     and 0.100 multiplicative effect on survival

  Frequency of type 4 catastrophes: 10.000 percent
    with 0.970 multiplicative effect on reproduction
     and 0.970 multiplicative effect on survival

  Initial size of Population 1:       25
    (set to reflect stable age distribution)
 Age 1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19
     20  21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38
     39  40  Total
     1   0   1   1   0   1   0   1   0   0   1   0   1   0   0   1   0   0   0
       1   0   0   0   1   0   0   0   0   1   0   0   0   0   0   0   1   0   0
         0   0  12  Males
     1   0   1   1   0   1   0   1   0   1   0   0   1   0   0   1   0   0   1
       0   0   1   0   0   0   1   0   0   0   0   1   0   0   0   0   0   1   0
         0   0  13  Females

  Carrying capacity = 25 (EV = 0.00 SD)

Deterministic population growth rate (based on females, with assumptions of
  no limitation of mates, no density dependence, and no inbreeding depression):

     r =  -0.003     lambda = 0.997     R0 =     0.937
   Generation time for:  females = 24.02    males = 23.52

Stable age distribution:  Age class    females    males
                              0        0.032      0.032
                              1        0.026      0.026
                              2        0.025      0.025
                              3        0.024      0.023
                              4        0.022      0.022
                              5        0.021      0.021
                              6        0.020      0.020
                              7        0.019      0.019
                              8        0.018      0.018
                              9        0.017      0.017
                             10        0.016      0.016
                             11        0.016      0.015
                             12        0.015      0.014
                             13        0.014      0.013
                             14        0.013      0.013
                             15        0.013      0.012
                             16        0.013      0.012
```

Sample VORTEX Output File (Cont'd.)

```
                             17        0.012      0.011
                             18        0.012      0.011
                             19        0.011      0.010
                             20        0.011      0.010
                             21        0.010      0.009
                             22        0.010      0.009
                             23        0.010      0.008
                             24        0.009      0.008
                             25        0.009      0.008
                             26        0.009      0.007
                             27        0.008      0.007
                             28        0.008      0.007
                             29        0.008      0.006
                             30        0.007      0.006
                             31        0.007      0.006
                             32        0.007      0.006
                             33        0.007      0.005
                             34        0.006      0.005
                             35        0.006      0.005
                             36        0.006      0.005
                             37        0.006      0.004
                             38        0.005      0.004
                             39        0.005      0.004
                             40        0.005      0.004

Ratio of adult (>= 13) males to adult (>= 13) females: 0.871

Population 1

Year 10
     N[Extinct] =      23, P[E] = 0.046
     N[Surviving] =   477, P[S] = 0.954
     Population size =            21.27 (   0.19 SE,    4.26 SD)
     Expected heterozygosity =    0.953 (  0.001 SE,   0.029 SD)
     Observed heterozygosity =    1.000 (  0.000 SE,   0.000 SD)
     Number of extant alleles =   29.28 (   0.26 SE,    5.76 SD)

Year 20
     N[Extinct] =      53, P[E] = 0.106
     N[Surviving] =   447, P[S] = 0.894
     Population size =            19.72 (   0.27 SE,    5.68 SD)
     Expected heterozygosity =    0.930 (  0.002 SE,   0.044 SD)
     Observed heterozygosity =    0.998 (  0.001 SE,   0.011 SD)
     Number of extant alleles =   21.24 (   0.26 SE,    5.51 SD)

Year 30
     N[Extinct] =      94, P[E] = 0.188
     N[Surviving] =   406, P[S] = 0.812
     Population size =            18.60 (   0.28 SE,    5.66 SD)
     Expected heterozygosity =    0.912 (  0.002 SE,   0.042 SD)
     Observed heterozygosity =    0.989 (  0.001 SE,   0.027 SD)
     Number of extant alleles =   16.87 (   0.22 SE,    4.41 SD)
```

Sample VORTEX Output File (Cont'd.)

```
Year 40
     N[Extinct] =     130, P[E] = 0.260
     N[Surviving] =   370, P[S] = 0.740
     Population size =           17.97 (   0.33 SE,    6.26 SD)
     Expected heterozygosity =    0.886 (  0.003 SE,   0.057 SD)
     Observed heterozygosity =    0.973 (  0.002 SE,   0.041 SD)
     Number of extant alleles =   13.71 (   0.21 SE,    3.95 SD)

Year 50
     N[Extinct] =     168, P[E] = 0.336
     N[Surviving] =   332, P[S] = 0.664
     Population size =           17.67 (   0.34 SE,    6.24 SD)
     Expected heterozygosity =    0.864 (  0.004 SE,   0.066 SD)
     Observed heterozygosity =    0.953 (  0.003 SE,   0.062 SD)
     Number of extant alleles =   11.70 (   0.19 SE,    3.45 SD)

Year 60
     N[Extinct] =     210, P[E] = 0.420
     N[Surviving] =   290, P[S] = 0.580
     Population size =           17.13 (   0.38 SE,    6.43 SD)
     Expected heterozygosity =    0.843 (  0.004 SE,   0.072 SD)
     Observed heterozygosity =    0.934 (  0.005 SE,   0.083 SD)
     Number of extant alleles =   10.30 (   0.18 SE,    3.13 SD)

Year 70
     N[Extinct] =     238, P[E] = 0.476
     N[Surviving] =   262, P[S] = 0.524
     Population size =           16.65 (   0.40 SE,    6.54 SD)
     Expected heterozygosity =    0.823 (  0.005 SE,   0.079 SD)
     Observed heterozygosity =    0.916 (  0.006 SE,   0.099 SD)
     Number of extant alleles =    9.03 (   0.18 SE,    2.86 SD)

Year 80
     N[Extinct] =     257, P[E] = 0.514
     N[Surviving] =   243, P[S] = 0.486
     Population size =           15.87 (   0.43 SE,    6.63 SD)
     Expected heterozygosity =    0.800 (  0.006 SE,   0.093 SD)
     Observed heterozygosity =    0.900 (  0.007 SE,   0.116 SD)
     Number of extant alleles =    8.00 (   0.16 SE,    2.53 SD)

Year 90
     N[Extinct] =     287, P[E] = 0.574
     N[Surviving] =   213, P[S] = 0.426
     Population size =           16.18 (   0.47 SE,    6.83 SD)
     Expected heterozygosity =    0.779 (  0.007 SE,   0.107 SD)
     Observed heterozygosity =    0.872 (  0.009 SE,   0.130 SD)
     Number of extant alleles =    7.35 (   0.16 SE,    2.38 SD)

Year 100
     N[Extinct] =     307, P[E] = 0.614
     N[Surviving] =   193, P[S] = 0.386
     Population size =           15.87 (   0.52 SE,    7.25 SD)
     Expected heterozygosity =    0.752 (  0.009 SE,   0.120 SD)
     Observed heterozygosity =    0.845 (  0.011 SE,   0.146 SD)
     Number of extant alleles =    6.72 (   0.16 SE,    2.27 SD)
```

Sample VORTEX Output File (Cont'd.)

```
In 500 simulations of Population 1 for 100 years:
  307 went extinct and 193 survived.

This gives a probability of extinction of 0.6140 (0.0218 SE),
  or a probability of success of          0.3860 (0.0218 SE).

307 simulations went extinct at least once.
Median time to first extinction was 76 years.
Of those going extinct,
    mean time to first extinction was 48.09 years (1.51 SE, 26.43 SD).

Mean final population for successful cases was 15.87 (0.52 SE, 7.25 SD)
Age 1    2    3    4    5    6    7    8    9   10   11   12   Adults Total
    0.48 0.40 0.38 0.36 0.30 0.30 0.34 0.27 0.26 0.24 0.28 0.19 3.86  7.65 Males
    0.44 0.37 0.35 0.35 0.36 0.25 0.27 0.33 0.27 0.28 0.30 0.23 4.42  8.22 Females

Across all years, prior to carrying capacity truncation,
  mean growth rate (r) was -0.0194 (0.0012 SE, 0.2222 SD)

Final expected heterozygosity was      0.7524 ( 0.0087 SE,  0.1205 SD)
Final observed heterozygosity was      0.8451 ( 0.0105 SE,  0.1459 SD)
Final number of alleles was              6.72 (   0.16 SE,    2.27 SD)
*************************************************************************
```

Table 5-1. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under baseline mortality levels. Initial population size (N_0) = K = 25 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: Severe food shortage only									
301	13	40	Baseline	.017	.010 (.068)	0.012	22 (4)	0.815	71
302		35		.012	.005 (.073)	0.030	20 (5)	0.805	79
303		45		.024	.017 (.065)	0.000	23 (3)	0.827	
304	11	40		.024	.015 (.067)	0.012	22 (4)	0.819	80
305		35		.019	.011 (.070)	0.002	21 (4)	0.801	53
306		45		.027	.018 (.066)	0.004	23 (3)	0.823	72
307	17	40		.007	.001 (.073)	0.056	18 (6)	0.811	76
308		35		.000	-.007 (.083)	0.180	14 (6)	0.782	78
309		45		.011	.005 (.069)	0.016	20 (5)	0.827	84
Catastrophes: All									
310	13	40	Baseline	-.003	-.019 (.222)	0.614	16 (7)	0.752	48
311		35		-.008	-.025 (.224)	0.708	14 (7)	0.738	49
312		45		.001	-.018 (.229)	0.626	18 (7)	0.771	49
313	11	40		.004	-.016 (.234)	0.618	18 (7)	0.765	48
314		35		-.001	-.020 (.226)	0.630	15 (7)	0.738	48
315		45		.007	-.012 (.231)	0.594	18 (7)	0.766	51
316	17	40		-.014	-.031 (.225)	0.754	12 (7)	0.742	48
317		35		-.021	-.036 (.209)	0.838	9 (5)	0.725	51
318		45		-.009	-.027 (.230)	0.706	14 (7)	0.763	49

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-2. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under elevated mortality levels. Initial population size (N_0) = K = 25 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: All									
319	13	40	Level A	-.008	-.026 (.228)	0.702	15 (7)	0.738	48
320		35		-.013	-.033 (.230)	0.778	12 (7)	0.702	49
321		45		-.005	-.022 (.223)	0.672	15 (7)	0.740	49
322	11	40		-.002	-.020 (.228)	0.632	16 (7)	0.742	49
323		35		-.007	-.025 (.228)	0.674	14 (7)	0.716	46
324		45		.001	-.019 (.235)	0.624	17 (7)	0.765	48
325	17	40		-.019	-.036 (.229)	0.814	10 (6)	0.730	47
326		35		-.026	-.042 (.214)	0.886	7 (5)	0.688	48
327		45		-.015	-.031 (.217)	0.752	11 (7)	0.751	50
Catastrophes: All									
328	13	40	Level B	-.014	-.031 (.226)	0.768	12 (7)	0.693	50
329		35		-.019	-.036 (.212)	0.832	9 (6)	0.657	50
330		45		-.011	-.027 (.217)	0.704	13 (7)	0.715	48
331	11	40		-.008	-.025 (.221)	0.686	13 (7)	0.700	48
332		35		-.013	-.030 (.221)	0.766	12 (6)	0.693	49
333		45		-.006	-.023 (.227)	0.682	15 (7)	0.728	47
334	17	40		-.024	-.039 (.209)	0.872	7 (5)	0.684	49
335		35		-.031	-.047 (.205)	0.940	5 (3)	0.650	46
336		45		-.020	-.039 (.226)	0.870	9 (5)	0.712	49

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-3. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under baseline mortality levels. Initial population size (N_0) = K = 60 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: Severe food shortage only									
337	13	40	Baseline	.017	.011 (.047)	0.000	56 (6)	0.926	
338		35		.012	.006 (.049)	0.000	53 (8)	0.924	
339		45		.024	.014 (.046)	0.000	58 (4)	0.929	
340	11	40		.024	.016 (.048)	0.000	57 (4)	0.925	
341		35		.019	.011 (.049)	0.000	56 (6)	0.921	
342		45		.027	.019 (.047)	0.000	59 (3)	0.927	
343	17	40		.007	.002 (.047)	0.000	50 (10)	0.929	
344		35		.000	-.004 (.053)	0.010	39 (13)	0.912	87
345		45		.011	.006 (.046)	0.000	55 (7)	0.934	
Catastrophes: All									
346	13	40	Baseline	-.003	-.020 (.229)	0.450	35 (20)	0.859	55
347		35		-.008	-.029 (.251)	0.576	31 (18)	0.854	52
348		45		.001	-.019 (.240)	0.438	36 (21)	0.853	52
349	11	40		.004	-.015 (.232)	0.420	38 (21)	0.847	58
350		35		-.001	-.022 (.245)	0.510	37 (21)	0.845	50
351		45		.007	-.013 (.237)	0.430	39 (22)	0.846	59
352	17	40		-.014	-.033 (.246)	0.590	25 (16)	0.853	53
353		35		-.021	-.038 (.235)	0.642	17 (12)	0.823	53
354		45		-.009	-.029 (.247)	0.570	30 (19)	0.863	53

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-4. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under elevated mortality levels. Initial population size (N_0) = K = 60 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: All									
355	13	40	Level A	-.008	-.028 (.242)	0.528	30 (18)	0.839	52
356		35		-.013	-.031 (.236)	0.576	27 (17)	0.847	53
357		45		-.005	-.024 (.236)	0.512	35 (20)	0.858	54
358	11	40		-.002	-.023 (.246)	0.496	34 (20)	0.837	51
359		35		-.007	-.024 (.233)	0.492	34 (18)	0.848	54
360		45		.001	-.019 (.236)	0.444	36 (21)	0.850	56
361	17	40		-.019	-.037 (.238)	0.612	17 (12)	0.825	55
362		35		-.026	-.044 (.231)	0.736	13 (9)	0.791	55
363		45		-.015	-.031 (.232)	0.568	24 (15)	0.855	55
Catastrophes: All									
364	13	40	Level B	-.014	-.032 (.234)	0.592	25 (15)	0.837	53
365		35		-.019	-.037 (.241)	0.642	19 (13)	0.807	52
366		45		-.011	-.031 (.248)	0.556	28 (17)	0.844	52
367	11	40		-.008	-.029 (.250)	0.560	29 (18)	0.835	52
368		35		-.013	-.031 (.240)	0.588	26 (16)	0.840	55
369		45		-.006	-.023 (.229)	0.478	36 (18)	0.864	51
370	17	40		-.024	-.043 (.238)	0.718	12 (8)	0.795	54
371		35		-.031	-.050 (.241)	0.804	7 (5)	0.737	54
372		45		-.020	-.036 (.227)	0.614	17 (11)	0.826	54

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-5. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under baseline mortality levels. Initial population size (N_0) = K = 100 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: Severe food shortage only									
373	13	40	Baseline	.017	.011 (.041)	0.000	96 (6)	0.957	
374		35		.012	.006 (.042)	0.000	92 (9)	0.955	
375		45		.024	.014 (.040)	0.000	97 (6)	0.958	
376	11	40		.024	.015 (.041)	0.000	97 (5)	0.955	
377		35		.019	.011 (.042)	0.000	96 (6)	0.954	
378		45		.027	.019 (.041)	0.000	98 (4)	0.955	
379	17	40		.007	.002 (.040)	0.000	88 (13)	0.959	
380		35		.000	-.003 (.043)	0.000	69 (19)	0.952	
381		45		.011	.007 (.039)	0.000	94 (7)	0.962	
Catastrophes: All									
382	13	40	Baseline	-.003	-.021 (.232)	0.386	55 (36)	0.886	59
383		35		-.008	-.025 (.231)	0.416	48 (32)	0.874	59
384		45		.001	-.019 (.238)	0.380	56 (37)	0.886	61
385	11	40		.004	-.015 (.229)	0.312	60 (37)	0.886	56
386		35		-.001	-.020 (.234)	0.372	57 (36)	0.878	58
387		45		.007	-.012 (.229)	0.294	60 (39)	0.868	59
388	17	40		-.014	-.033 (.238)	0.512	38 (27)	0.878	59
389		35		-.021	-.039 (.244)	0.588	26 (18)	0.867	56
390		45		-.009	-.028 (.241)	0.462	45 (32)	0.885	57

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-6. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under elevated mortality levels. Initial population size (N_0) = K = 100 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: All									
391	13	40	Level A	-.008	-.026 (.234)	0.424	47 (33)	0.865	61
392		35		-.013	-.029 (.226)	0.450	38 (26)	0.870	59
393		45		-.005	-.024 (.239)	0.428	54 (35)	0.883	58
394	11	40		-.002	-.020 (.230)	0.360	57 (36)	0.879	56
395		35		-.007	-.026 (.243)	0.454	49 (33)	0.867	58
396		45		.001	-.018 (.227)	0.366	58 (36)	0.884	62
397	17	40		-.019	-.036 (.230)	0.552	29 (18)	0.882	58
398		35		-.026	-.044 (.236)	0.646	18 (11)	0.856	58
399		45		-.015	-.034 (.246)	0.550	34 (25)	0.867	61
Catastrophes: All									
400	13	40	Level B	-.014	-.031 (.231)	0.496	38 (26)	0.876	60
401		35		-.019	-.037 (.239)	0.570	28 (19)	0.853	57
402		45		-.011	-.028 (.232)	0.468	44 (29)	0.876	60
403	11	40		-.008	-.028 (.239)	0.458	43 (31)	0.855	58
404		35		-.013	-.032 (.246)	0.510	39 (27)	0.863	57
405		45		-.006	-.024 (.237)	0.420	50 (34)	0.870	59
406	17	40		-.024	-.043 (.245)	0.622	19 (13)	0.846	55
407		35		-.031	-.049 (.232)	0.708	11 (8)	0.803	58
408		45		-.020	-.037 (.237)	0.548	25 (16)	0.878	58

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-7. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under baseline mortality levels. Initial population size (N_0) = K = 200 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: Severe food shortage only									
409	13	40	Baseline	.017	.010 (.035)	0.000	194 (9)	0.979	
410		35		.012	.006 (.036)	0.000	189 (15)	0.978	
411		45		.024	.014 (.035)	0.000	196 (9)	0.979	
412	11	40		.024	.015 (.036)	0.000	195 (9)	0.977	
413		35		.019	.011 (.036)	0.000	194 (10)	0.977	
414		45		.027	.018 (.035)	0.000	197 (6)	0.978	
415	17	40		.007	.002 (.034)	0.000	183 (19)	0.980	
416		35		.000	-.003 (.036)	0.000	144 (34)	0.976	
417		45		.011	.006 (.034)	0.000	190 (13)	0.981	
Catastrophes: All									
418	13	40	Baseline	-.003	-.020 (.232)	0.236	94 (77)	0.913	63
419		35		-.008	-.026 (.233)	0.306	79 (68)	0.893	64
420		45		.001	-.019 (.239)	0.256	105 (80)	0.915	59
421	11	40		.004	-.016 (.237)	0.236	109 (79)	0.913	59
422		35		-.001	-.018 (.229)	0.216	102 (80)	0.910	65
423		45		.007	-.014 (.241)	0.244	112 (80)	0.917	63
424	17	40		-.014	-.030 (.233)	0.354	65 (55)	0.901	65
425		35		-.021	-.038 (.232)	0.478	42 (34)	0.903	65
426		45		-.009	-.027 (.238)	0.354	82 (68)	0.912	64

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-8. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under elevated mortality levels. Initial population size (N_0) = K = 200 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: All									
427	13	40	Level A	-.008	-.025 (.230)	0.306	83 (66)	0.904	65
428		35		-.013	-.032 (.246)	0.392	67 (56)	0.892	65
429		45		-.005	-.024 (.239)	0.296	88 (74)	0.907	61
430	11	40		-.002	-.020 (.231)	0.248	95 (76)	0.910	62
431		35		-.007	-.024 (.229)	0.270	85 (69)	0.898	66
432		45		.001	-.018 (.238)	0.250	104 (78)	0.917	63
433	17	40		-.019	-.034 (.224)	0.388	45 (35)	0.896	65
434		35		-.026	-.043 (.239)	0.544	30 (22)	0.887	64
435		45		-.015	-.031 (.230)	0.360	58 (52)	0.889	65
Catastrophes: All									
436	13	40	Level B	-.014	-.031 (.231)	0.368	64 (52)	0.889	66
437		35		-.019	-.035 (.229)	0.428	50 (41)	0.886	66
438		45		-.011	-.026 (.225)	0.320	79 (64)	0.909	66
439	11	40		-.008	-.026 (.235)	0.302	79 (67)	0.896	66
440		35		-.013	-.030 (.235)	0.366	66 (55)	0.892	64
441		45		-.006	-.023 (.233)	0.282	92 (74)	0.908	62
442	17	40		-.024	-.040 (.228)	0.494	31 (25)	0.883	67
443		35		-.031	-.046 (.229)	0.568	20 (14)	0.873	65
444		45		-.020	-.039 (.239)	0.478	41 (33)	0.887	64

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-9. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under baseline mortality levels. Initial population size (N_0) = K = 600 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: Severe food shortage only									
445	13	40	Baseline	.017	.010 (.031)	0.000	584 (29)	0.993	
446		35		.012	.005 (.031)	0.000	576 (36)	0.993	
447		45		.024	.013 (.031)	0.000	590 (22)	0.993	
448	11	40		.024	.015 (.032)	0.000	591 (21)	0.993	
449		35		.019	.010 (.032)	0.000	586 (26)	0.992	
450		45		.027	.018 (.032)	0.000	593 (17)	0.993	
451	17	40		.007	.002 (.030)	0.000	557 (45)	0.994	
452		35		.000	-.003 (.030)	0.000	455 (86)	0.992	
453		45		.011	.006 (.030)	0.000	577 (33)	0.994	
Catastrophes: All									
454	13	40	Baseline	-.003	-.019 (.225)	0.148	293 (238)	0.957	67
455		35		-.008	-.026 (.244)	0.188	202 (205)	0.945	67
456		45		.001	-.020 (.245)	0.166	270 (245)	0.948	69
457	11	40		.004	-.014 (.230)	0.116	299 (243)	0.953	73
458		35		-.001	-.021 (.244)	0.184	268 (232)	0.947	69
459		45		.007	-.013 (.234)	0.114	305 (247)	0.952	62
460	17	40		-.014	-.031 (.238)	0.218	158 (159)	0.942	70
461		35		-.021	-.038 (.237)	0.294	93 (93)	0.928	72
462		45		-.009	-.024 (.226)	0.170	235 (207)	0.954	70

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-10. Ugandan *Pan troglodytes schweinfurthii* simulated population dynamics under elevated mortality levels. Initial population size (N_0) = K = 600 individuals. See text for a more complete description of the model conditions.

File#	AFR	ALR	Mortality	r_d	r_s (SD)	P(E)	N_{100} (SD)	H_{100}	T(E)
Catastrophes: All									
463	13	40	Level A	-.008	-.026 (.239)	0.216	227 (210)	0.951	71
464		35		-.013	-.031 (.243)	0.254	173 (163)	0.941	65
465		45		-.005	-.025 (.245)	0.206	251 (231)	0.946	69
466	11	40		-.002	-.020 (.236)	0.122	234 (233)	0.946	72
467		35		-.007	-.025 (.238)	0.186	229 (217)	0.937	72
468		45		.001	-.017 (.228)	0.130	289 (243)	0.955	70
469	17	40		-.019	-.033 (.228)	0.208	103 (102)	0.931	69
470		35		-.026	-.041 (.232)	0.320	64 (59)	0.919	72
471		45		-.015	-.033 (.248)	0.266	153 (153)	0.946	68
Catastrophes: All									
472	13	40	Level B	-.014	-.030 (.234)	0.214	166 (157)	0.938	68
473		35		-.019	-.034 (.231)	0.242	113 (108)	0.925	68
474		45		-.011	-.027 (.232)	0.212	216 (187)	0.952	68
475	11	40		-.008	-.027 (.241)	0.220	219 (207)	0.942	71
476		35		-.013	-.030 (.242)	0.220	164 (163)	0.936	67
477		45		-.006	-.024 (.237)	0.174	236 (225)	0.945	72
478	17	40		-.024	-.039 (.231)	0.304	77 (71)	0.925	70
479		35		-.031	-.047 (.235)	0.406	42 (38)	0.904	72
480		45		-.020	-.036 (.234)	0.248	96 (96)	0.927	69

AFR, age of first reproduction; ALR, age of last reproduction; r_d, deterministic growth rate calculated from life-table data; r_s (SD), mean stochastic growth rate (standard deviation) calculated from the simulations; P(E), probability of population extinction within 100 years; N_{100} (SD), mean (standard deviation) final extant popuation size after 100 years; H_{100}, mean proportional heterozygosity retained within the population after 100 years; T(E), mean time to extinction for those populations becoming extinct during a given simulation.

Table 5-11. Ugandan *Pan troglodytes schweinfurthii* simulated metapopulation dynamics. The table shows extinction risk (P(E)), final population size (N_{100}), and retention of heterozygosity (H_{100}) for each of the six subpopulations collectively making up the metapopulation. The baseline demographic conditions hold for the first model in each of the four-model sets (i.e., File#481). The second model in the set incorporates all catastrophes, while the third and fourth models incorporate all catastrophes and additional mortality levels A and B, respectively.

	P(E) (Population)						N_{100} (Population)						H_{100} (Population)					
File#	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Standard Migration (see text)																		
481	0.000	0.000	0.000	0.000	0.000	0.054	575	98	97	98	360	24	0.993	0.977	0.977	0.979	0.990	0.941
482	0.116	0.196	0.174	0.182	0.188	0.510	212	63	55	50	88	19	0.953	0.935	0.931	0.926	0.938	0.872
483	0.162	0.240	0.244	0.230	0.174	0.524	138	53	46	40	55	18	0.939	0.920	0.919	0.917	0.915	0.869
484	0.188	0.276	0.294	0.312	0.308	0.560	97	39	34	29	37	14	0.931	0.905	0.907	0.899	0.906	0.834
Standard Migration Doubled																		
485	0.000	0.000	0.000	0.000	0.000	0.140	544	99	97	94	158	24	0.993	0.980	0.980	0.980	0.985	0.936
487	0.124	0.144	0.174	0.202	0.214	0.504	147	62	53	41	37	18	0.954	0.939	0.940	0.320	0.920	0.872
487	0.150	0.240	0.218	0.230	0.236	0.546	94	51	39	29	27	16	0.942	0.926	0.924	0.919	0.909	0.857
488	0.206	0.238	0.246	0.302	0.356	0.584	63	39	28	20	18	13	0.926	0.914	0.909	0.894	0.880	0.835

Figure Legends

Figure 5-1. Probability of extinction of simulated Ugandan chimpanzee populations of various sizes under conditions of "natural" catastrophic food shortage (dark bars) and under conditions where "human-induced" catastrophes such as major disease and war are added to the food shortage catastrophe (light bars).

Figure 5-2. Retention of heterozygosity in simulated Ugandan chimpanzee populations of various sizes under conditions of "natural" catastrophic food shortage (dark bars) and under conditions where "human-induced" catastrophes such as major disease and war are added to the food shortage catastrophe (light bars).

Figure 5-3. Population size as a function of time for a simulated Ugandan chimpanzee population initiated with 25 individuals and under different ages of first reproduction (AFR). The closed symbols indicated models run with only the "natural" food shortage catastrophe, while the open symbols (also marked AFR*) denote models run with both "natural" and "human-induced" catastrophes included.

Figure 5-4. Population size as a function of time for a simulated Ugandan chimpanzee population initiated with 25 individuals and under different ages of last reproduction (ALR). The closed symbols indicated models run with only the "natural" food shortage catastrophe, while the open symbols (also marked ALR*) denote models run with both "natural" and "human-induced" catastrophes included.

Figure 5-5. Population size as a function of time for a simulated Ugandan chimpanzee population initiated with 100 individuals and under different ages of first reproduction (AFR). The closed symbols indicated models run with only the "natural" food shortage catastrophe, while the open symbols (also marked AFR*) denote models run with both "natural" and "human-induced" catastrophes included.

Figure 5-6. Population size as a function of time for a simulated Ugandan chimpanzee population initiated with 100 individuals and under different ages of last reproduction (ALR). The closed symbols indicated models run with only the "natural" food shortage catastrophe, while the open symbols (also marked ALR*) denote models run with both "natural" and "human-induced" catastrophes included.

Figure 5-7. Probability of extinction of simulated Ugandan chimpanzee populations of various sizes under conditions of natural, baseline age-specific mortality (gray bars), moderately increased age-specific mortality (Level A: light gray bars), and more severely increased age-specific mortality (Level B: dark gray bars). See page 54 of the accompanying text for exact age-specific mortalities.

Figure 5-8. Population size as a function of time for a simulated Ugandan chimpanzee population initiated with 100 individuals and subjected to simple baseline mortality with only "natural" catastrophes (circles), all catastrophes (squares), Level A added mortality with all catastrophes (triangles), and Level B added mortality with all catastrophes (inverted triangles). See page 54 of the accompanying text for exact age-specific mortalities.

Figure 5-3. Ugandan Chimpanzee Population Viability: Influence of Age of First Reproduction - N_0=K=25

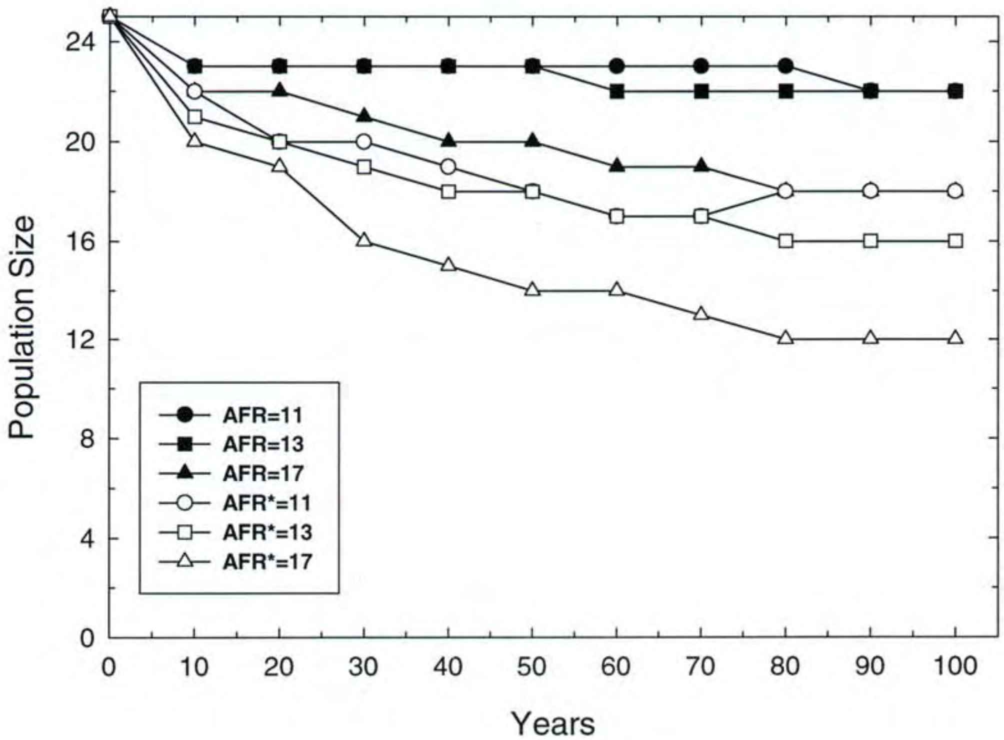


Figure 5-4. Ugandan Chimpanzee Population Viability: Influence of Age of Last Reproduction - N_0=K=25

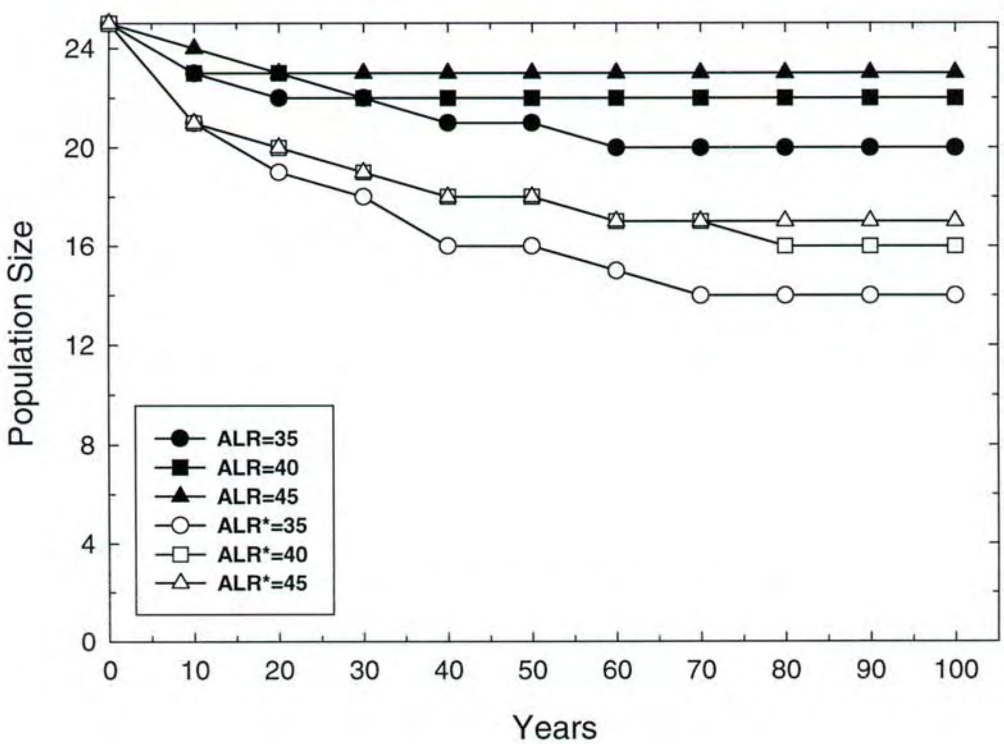


Figure 5-5. Ugandan Chimpanzee Population Viability: Influence of Age of First Reproduction - $N_0 = K = 100$

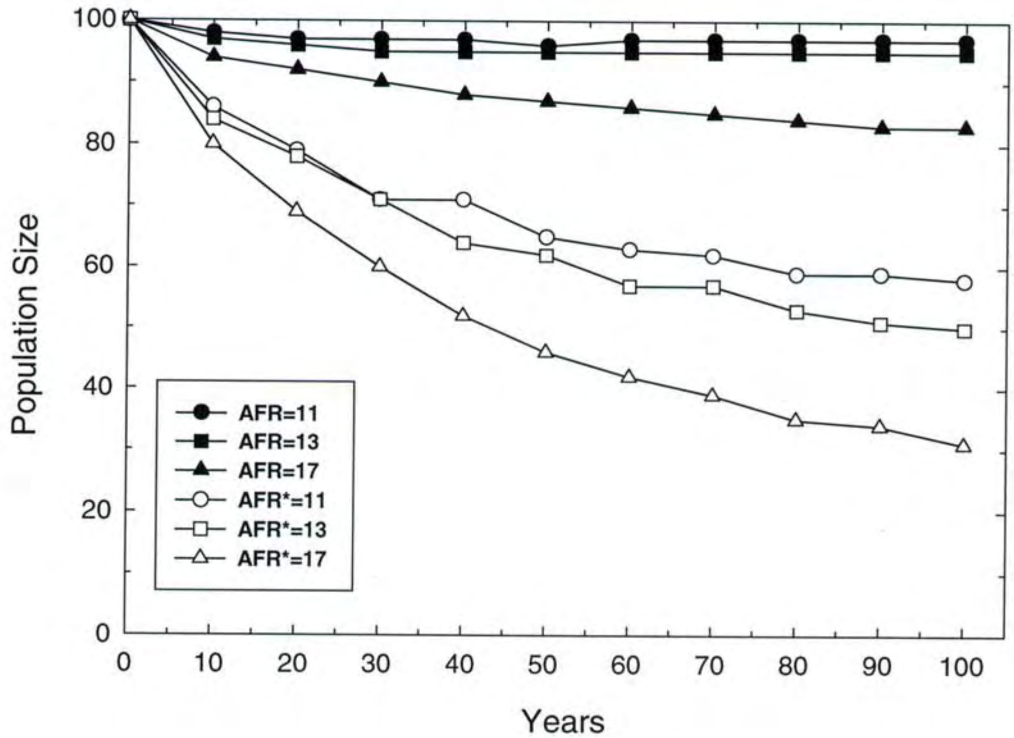


Figure 5-6. Ugandan Chimpanzee Population Viability: Influence of Age of Last Reproduction - $N_0 = K = 100$

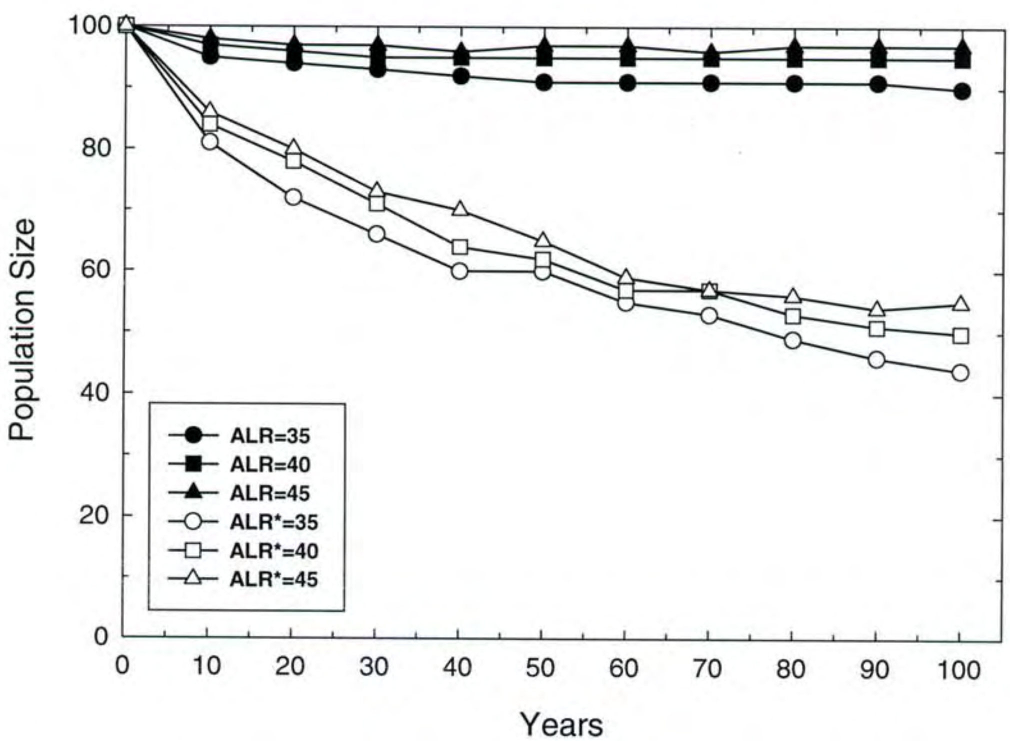


Figure 5-7. Ugandan Chimpanzee Population Viability: Impact of Increased Mortality on Extinction Risk

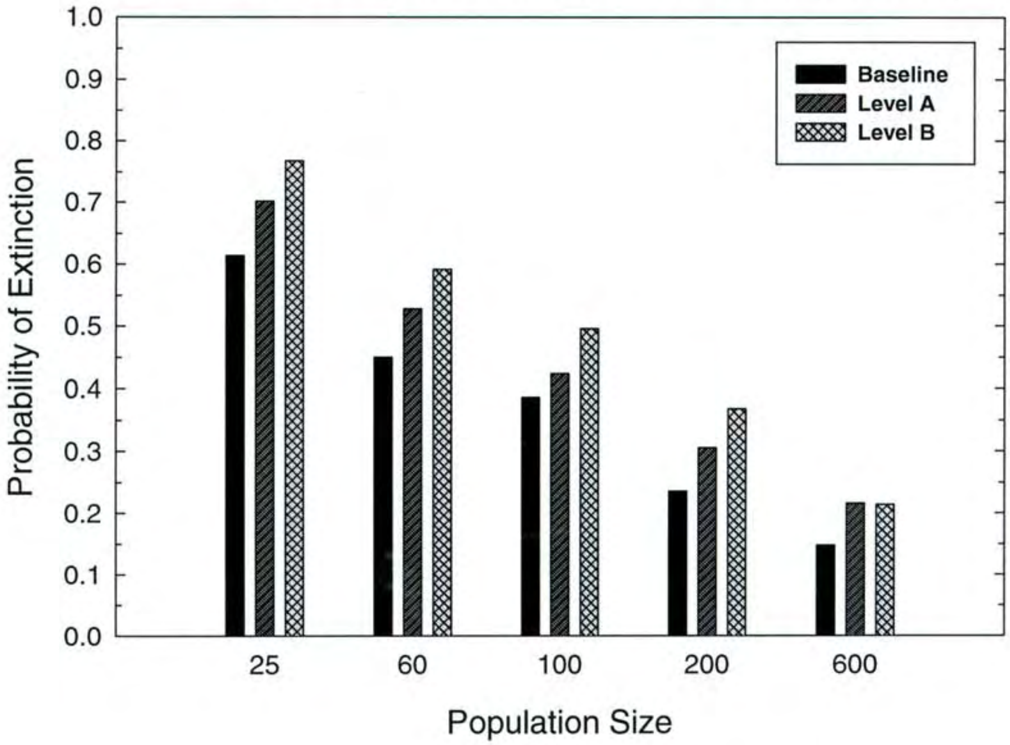
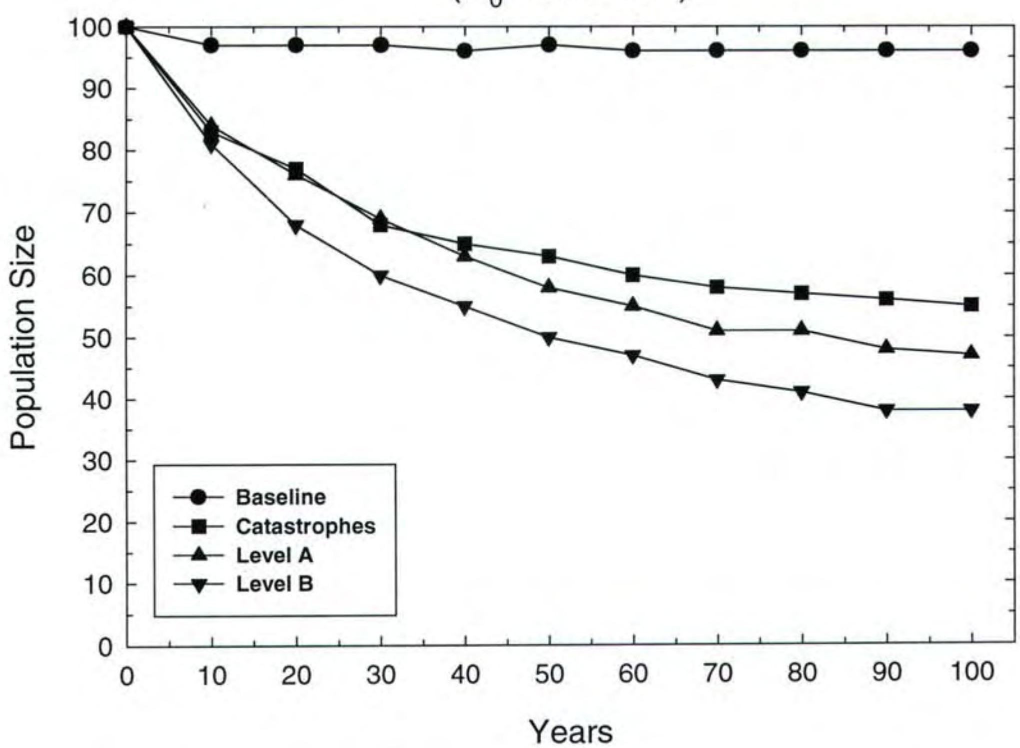


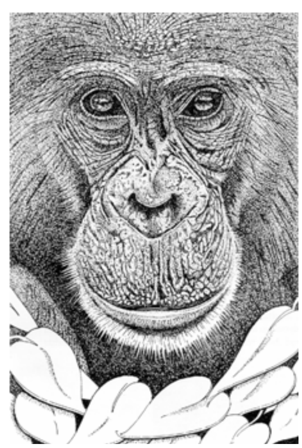
Figure 5-8. Uganda Chimpanzee Population Viability: Impact of Increased Mortality on Population Size ($N_0 = K = 100$)



POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997

Section 6
Ecotourism and Education Working Group Report



CHIMPANZEE ECOTOURISM AND LOCAL COMMUNITY EDUCATION

The Tourism Group made a list of 14 recommendations, which are listed below in bold-face with expanded details and supporting text. Priority recommendations are 2, 5, 8 and 14.

1. Chimpanzee Tourism (CT) is a beneficial & desirable management programme in Uganda. However, CT tourism also carries with it a risk of over-exploitation leading to negative outcomes such as introduction of human diseases and behavioural distortion, etc. If CT is controlled and limited by following the remaining recommendations below, it can be an essential method of enhancing sustainable chimpanzee conservation in Uganda.

2. CT should be managed under a standardised set of Rules & Regulations to be presented in pre-walk briefings, and widely distributed in advance to tourists, tour operators and travel agents to facilitate adherence.
   Species differences between chimps and gorillas allow some variation from gorilla tourism. Behavioural differences between chimps and gorillas need to be taken into account, e.g chimpanzees with fission-fusion society in contrast to gorilla stable group society. Variation in limits is recommended based on level of habituation, spatial proximity to chimps, and type of viewing available. For example "guaranteed" viewing, vs. nature walk with probability of chimp sighting. These will be referred to below as High Level Habituation (similar to gorilla viewing) vs. Low Level (nature walk including possible chimp viewing).
   The following specific regulations should be included:
   a) Right to refuse visit if tourist is ill. — Agreed for all habituation levels.
   b) Limit of 6 tourists to a group — High Habituation: Once a day. Low Habituation: Two groups per day.
   c) Limit of Length of Visit — High Habituation: 1 hr. (time with chimps) Low Habituation: 1.5-2 hrs
   d) Distance kept between humans and chimps — All habituation levels: greater than 5 m
   e) Minimum Age of Visitors (If chimps present in area) — High Habituation: at least 15 years. Low Habituation+nature walks: at least 12 yrs.
   f) Faecal Material Burial: — All humans required to bury faecal material
   g) General Health Rules: — As per gorilla rules: rubbish removal from forest and surroundings; try to turn away to sneeze or cough near chimps; no eating, improper disposal of food and no smoking near chimps.
   h) Flash Photography: — prohibited
   i) Tourists remain grouped within 5 metres
   j) Tourist noise kept to a minimum: — Whispering etc..

   Guides should explain reasons for all rules above and should take responsibility for enforcement. In addition, local media should be discouraged from publishing photos that promote violations of these regulations.

3. <u>Chimpanzee Tourism management factors should also be standardised across CT sites, but take account of local circumstances:</u>
   a) Tipping of guides should be collective instead of individual.
   b) Minimise impact on habitat by maximising use of established trail/grid systems and minimising off-trail cutting and trampling of vegetation
   c) CT sites should regularly exchange information on techniques etc.
   d) Interpretation displays and briefings should present information to tourists on chimp ecology.
   e) CT populations should be monitored closely for health status, and veterinary consultation requested immediately if necessary - Forests should call on UWA vet unit. The health of tourism staff should, as much as possible, be monitored as an attempt to prevent possible cross-infection of chimps from staff.
   f) CT regulations should be translated into most commonly required languages.
   g) Training of tourist guides should result in a standard of excellence common across sites.
   h) Entry / Guide fees should be standardised across similar habituation/success rate CT sites. Higher prices can be charged for "guaranteed" than for "nature walk" CT. The "guarantee" should be that the chimps will be found, but not necessarily in view. Current fee levels:
      "Guaranteed" wild CT - i.e. Kyambura (96% success)= $40 for non-resident.
      Nature Walks vary $7 to $15 - should standardise based on quality / type of experience.
      Subsidized entry fees for local communities could be developed to encourage local tourism.

4. <u>Corruption Prevention / Motivation and Incentives for Tourism Staff / Training</u>
   a) CT is most beneficial if managed by tourism staff who understand and believe in the rules and regulations that they are enforcing, and who are motivated to ensure their adherence. Tourists may offer bribes to get around rules, but this can be prevented in the following ways:
      - On-time payment of reasonable living-wage salaries to staff in whom management is placing its trust for the protection of this endangered species. The group recognised a general trend of under-paid tourism staff which can enhance corrupt tendencies. Salaries should be commensurate with levels of responsibility over such a critical species.
      - Additional financial motivation incentives for tourism staff such as:
        "Chimp Conservation Component" included within tourism price - used for motivation of staff in ALL chimp sites, not just those with tourism.
        Performance related bonuses - source of funds as above
      - Training / Team Building - CT staff should be trained on all aspects of regulations, theory behind regulations, and empowerment techniques for enforcing regulations. Guides should feel part of a cohesive team that is protecting chimps. A Code of Conduct for staff should be developed and reinforced with bonuses and penalties.
      - Management issues - efficient supervision of tourism staff is essential by Tourism Officer / Warden. Frequent meetings with tourism staff should be held to reinforce

effective management. If tourism officer / warden absent - head ranger or guide should be responsible. Tourism officers/wardens need to be remunerated as well.
- Communal tipping should minimise excessive tipping,which is really a bribe. Tourism staff should be discouraged from pressurising tourists to give tips.

5. <u>CT should be selective. Current number of sites marketing CT is sufficient - no new sites should be opened or planned pending market review and EIA.</u>
   a) Five field sites now identify tourism activities as CT. These fall along a spectrum of habitats, and are found in established tourism circuits. No new sites should be developed until the current five are fully operational in order to assess impact and market forces. The following five provide a range of options and are not redundant: Kibale, Budongo, Kyambura, Semliki GR, Isinga Island
   - Status: 4 wild, 1 captive (Isinga)
   - Habitats of Interest: 2 rainforest (Kibale, Budongo), 1 Riverine (Semliki), 1 Gorge (Kyambura)
   - Management Status: One Forest Dept, Four UWA
   - Tourism Circuits: Lake Mburo-QENP-Bwindi/Mgahinga (Kyambura)
Murchison Falls - Budongo (Budongo)
Kibale - Rwenzori (Kibale)
Lowland - west - (Semliki)

   Efforts should be made at these 5 sites to upgrade standards of service, infrastructure, and other factors that enhance visitor satisfaction and chimpanzee conservation. Financial investment concentrated in these sites should alleviate over-stretched resources and low occupancy rates. Periodic market reviews and environmental impact assessments (EIAs) should be carried out to see if more sites need to, or should be, developed. Sites with chimps, but no CT (i.e. Kagombe-Kitechura, Kalinzu, Rabongo) should meanwhile search for alternative attractions to enhance revenues.

6. <u>Wild chimp tourism and captive based tourism should have complementary roles.</u>
   a) For example Isinga Island attracts a different average visitor, and has a significant education value, but explicit information should be provided that these are captive-managed, not wild chimpanzees. Captive chimp-based tourism should serve to promote conservation of wild chimpanzees.

7. <u>Tourism and research ideally should be done in different groups.</u>
   Scientific data collection, especially observation, is often incompatible with tourist viewing, to the detriment of both. Exceptions should be made for the collection of research data on impact of tourism for EIA and monitoring, which are essential components of CT management.

8. <u>Protected Area authorities should strive to view ALL chimpanzee populations in Uganda as important and in need of protection, not just those providing tourism income.</u>
   Staff in non-tourism sites should be given similar incentives to protect chimps. Revenues from CT sites should be distributed to non CT chimp sites.

9. Local communities should be closely involved in CT:
   a) Local access to chimpanzee tourism sites should be promoted and encouraged.
   b) Benefits of CT should be shared, providing benefits from CT to local communities adjacent to CT sites. Methods include sharing a percentage of tourism revenue (UWA has policies on this), local individuals or community NGOs involved in provision of tourist services, and spin off community tourism outside protected area (e.g. Magombe - Kibale).
   c) Community education initiatives should strengthen the awareness of benefits flowing to communities from CT and the existence of chimps, and explain the costs e.g. the possibility of increased crop raiding.

10. Creative financing for chimp conservation should emerge from CT
    a) e.g. donations at tourist site for trust fund for non-visited chimp populations.
    b) Chimpanzee Conservation Component of tourism price.
    c) Private sector companies profiting from CT (i.e. tour operators, hotels) should be encouraged to sponsor conservation projects (i.e. Sheraton Going Green Fund)

11. Marketing Issues - Uganda should promote/market chimpanzee tourism at its current sites.
    However, we need to avoid over-marketing of chimps to prevent pressure on chimpanzee conservation from over-tourism.

12. Private sector management of endangered species conservation (i.e. concessions) should be avoided.
    If a concession is offered in a chimpanzee area, the Protected Area Authority must ensure that concessionaire follows the standardised rules set out above.

13. Standardisation of CT management between the two main authorities that manage chimp tourism areas, Forest Department and UWA, should be strongly linked.
    Modality exists for this: the Commissioner for Forestry sits on the UWA Board of Trustees.

14. Chimpanzee Tourism development and management should be guided by management plans / tourism development plans and should be part of a nation-wide strategy.
    Factors to be taken into account in any future selection of sites for tourism development should be (list not exclusive):
    - represented habitat — e.g. rainforest vs. woodland
    - geography — e.g. northern vs. southern
    - tourism policies — e.g. tourism zonation
    - special features — e.g. Kyambura gorge
    - diversity — genetic, cultural, etc..
    - degree of threat — small, but critical populations
    - diversity of alternative tourism options available on site

RECOMMENDATIONS REGARDING CHIMPANZEE EDUCATION IN UGANDA

Aim: One focus of this workshop is to make recommendations about increasing public awareness regarding chimpanzees and their habitats. The ultimate aim of public awareness is promoting conservation of this endangered species.

Background: Uganda is unique in that it possesses the largest chimpanzee population in East Africa. Currently, most of the chimpanzees are not exploited either for tourism or for other educational purposes. The lack of public awareness is hindering the protection of the country's chimp population. Presently in Uganda, there is lack of a standardised curriculum regarding conservation education, let alone chimpanzee awareness. It is imperative to develop not only a national curriculum for Uganda's schools, but also to develop an adequate service for tourism education.

Currently, it has been identified that the general public and Ugandan schools are both interested in and have a need for further education on chimpanzees and issues surrounding this species. It is imperative to present chimpanzees as an integral part of an entire ecosystem rather than simply an isolated species.

In addition to the necessity of formal education regarding chimps, there is a need for informal public awareness with respect to controversial issues. Poaching/trafficking, the use of snares, habitat encroachment and crop raiding, for example, are prevalent within Uganda.

Following is a matrix that identifies the issues, target groups, suggested recommendations and organisations responsible for implementing the development of chimp education and the promotion of chimp conservation within Uganda.

Priority Recommendations

Among the recommendations put forward in the matrix, we feel that the following five should receive the highest priority in the development of chimpanzee education in Uganda.

Include "Chimp Ecology" in national curriculum:

In addition to the implementation of conservation education, there should be a specific emphasis on chimp ecology in the national curriculum. This integration would enhance sensitivity among the children and their parents regarding endangered species and habitat laws. It is recommend that WCU, NEMA, UWEC should work to write such programs in collaboration with the CDC to set a national precedent in formal education. Within the setting of this workshop, however, our aim is not to write the educational curriculum for the schools, but to emphasise the need for its development instead.

Enhance public awareness regarding laws protecting endangered species and their habitats:

Humans and chimps in Uganda are often found in close proximity often resulting in conflict. Humans must therefore be informed of laws regarding protected areas and management of endangered species when encountered. Workshops should be conducted by UWA and the FD to better inform LC members so that they are more aware of their rights and responsibilities regarding PA's and endangered species. With issues dealing with trafficking and poaching, UWA, NEMA, and NGO's should conduct regular workshops for those customs officials and security officers at airports and borders. Fact sheets containing appropriate contact names and numbers regarding these trafficking laws will be beneficial for quick reference by border and customs officers. A general information poster stating Uganda's position against poaching and trafficking should be placed at the airport and borders. Posters might appear ineffective, but their visibility in public venues will further deter any possibility of infractions of the law while strengthening Uganda's stance on conservation issues.

Workshops/dramas focusing on chimp ecology:

UWA and the FD should establish a national standardised training program for PA staff to ensure consistency in information presented to the public. Education on key issues affecting the chimps such as snares and crop raiding will then be addressed through workshops for the local communities surrounding PA's, conducted by better informed PA staff, local councils and NGO's.

Develop current and new education centres in Protected Areas

Very few Ugandan citizens visit protected areas at present. (See accompanying tables in this section). However, many people have expressed an interest in doing so, but are deterred by lack of resources and the impression that such visits are for tourists only. Education centres targeting Ugandans, schoolchildren in particular, should be developed, with transport facilitates made available for those visitors to reach the centres. The opportunity to see wild chimpanzees will have a great impact on their attitudes to conservation in Uganda.

Captive chimp populations as prime education venues:

Currently, 95% of visitation at the Uganda Wildlife Education Centre is that of Ugandans and 65% of those are children. Chimpanzee viewing is 100% and is therefore an excellent educational resource. UWEC is the most accessible place in the country for Ugandan citizens to see chimpanzees, and it attracts a wider range of visitors than the protected areas. UWEC receives visitors with little or no initial interest in conservation, and so is an ideal place for communicating a chimp conservation message to sections of the public that the PA education centres will not reach.

Due to limitations of time, the recommendations listed here are a preliminary proposal only. It is appreciated that some of the priorities listed will require financial and logistical commitments from the implementers and so may take time to be initiated. However, some are already underway. Education centres are being established at Kasoyha-Kitomi, Budongo, Kyambura Gorge, Kanyanchu and UWEC. Representatives of each of these sites have attended this workshop and will be co-ordinating future developments.

Abbreviations:

PA	Protected area
UWEC	Uganda Wildlife Education Centre
CDC	Curriculum Development Centre
UWA	Uganda Wildlife Authority
FD	Forest Department
NGO	Non-governmental organisation
NEMA	National Environmental Management Authority
LC	Local council
TTC	Teachers' Training College
NTC	National Teachers' College

TABLE 6-1. Chimpanzee Sites in Uganda: Tourism Factors

	Current		Planned New		Tourism	Guarantee	Limits on
SITE	Chimp Tourism?	STATUS	Chimp Tourism	Booking	Setup	Chimp Viewing?	Tourism
Budongo	Yes (2 sites)	FR	No	No booking	2 sites-2groups of Tourists at each	No	4 T gps @6 = 24/day - each chimp max 6 visitors/day
Bugoma	-	FR	No				
Itwara	-	FR	No				
Kibale	Yes	NP	No	possible, not common	4 gps of 6 pax, am & pm	No - nature walk	6/group for 2hr walk
Sebitole	-	NP (KFNP)	Yes ?				
Rwenzori	-	NP	No				
Semliki	-	NP	No				
Semuliki GR	No	GR	Yes	concession	2 gps chimps. Plan? 2hrs tourism then research	Plan chimp + nature walks	?? - exclusive tourism so expect low group size
Kasyoha-Kitomi	-	FR	Yes				
Kalinzu	-	FR	Yes				
Maramagambo	-	NP (QENP)	?				
Maramagambo	-	FR	?				
Rabongo/Murchison	-	NP (MFNP)	Still trying	possible - Paraa or HQ	NW - poss see chimps	No	6 pax per walk, am and pm = 12 max per day (CC-40max for NW)
Bwindi	-	NP	No				
Kyambura	Yes	NP	No - 6 is limit	Yes - Mweya (radio)	Nature walk - 1 gp / day - 3to5hrs	No	was 4 pax per day, now (Jan-Jun) 6 mo trial @ 6 pax
Captive:							
Isinga / QENP	Yes	NP - captive	No	No - Mweya in am.	Boat trip to platform - 2 trips /day 2-3 boats	Yes - feeding time	based on boat capacity (7) - 2 trips @ 21 pax = 42 maximum/day
UWEC - Entebbe	Yes	Zoo-captive	New Island??	No	Zoo visitors	Yes!!	No
	FR=Forest Reserve				(NW = NATURE WALKS)		
		NP = Natl Park					
	GR = Game (Wildlife) Reserve						

TABLE 6-1. (Continued)

SITE	Distance Limits?	Alternative activities available	Seasonality?	Occupancy	Visitors/mo	Type visitor
Budongo	15m from chimp	NW - accidental view possible	Depends Europe holiday season - linked to MFNP season	underutilised	80	most FR, individual,if NR=package,
Bugoma						
Itwara						
Kibale	??	NW - Magombe swamp (local NGO) - birds	(jun-aug, oct-dec)high season for success (fruit availability)	seasonally full	300	most=NR, then FR, then Citizen (most NR=overland)
Sebitole						
Rwenzori						
Semliki						
Semuliki GR	5m?	Game Drives, boat trips, NW	rainy season is low tourists, corr with loss of contact w/grp			not yet, but expect "exclusive"
Kasyoha-Kitomi						
Kalinzu						
Maramagambo						
Maramagambo						
Rabongo/Murchison	5m	other primates, birds, ethnobot, butterfly	Not yet analysed, occasionally chimps not found	-	-	not yet, but expect package tours
Bwindi						
Kyambura	5m	NW only	success easier in July (fruit seasonality) / lowest May	40%	28	most NR, mainly Tour operator (transport)
Captive:						
Isinga / QENP	20-30m (platform-shore)	none	normal QENP seasons	50% (full in season)		non-hiker, avg tourist, low budget, chimp enthusiasts
UWEC - Entebbe	5m	zoo	Public Holidays = max		100,000/yr	95% Ugandans, schools, foreigners
					15,000/mo	

TABLE 6-1. (Continued)

SITE	Tourist requests (Desired activity)	Fees	Generated revenues go to	Fee structure based on?	Viewing success??
Budongo	1/2 chimps, 1/2 general T	am(12,000)>pm (10,000). If guarantee view - suggest 30,000	FD - 40% all earnings to District	local analysis	40% annual avg
Bugoma					
Itwara					
Kibale	most want chimps,	NW + Entry + Camping	UWA HQ - 12%-20%RS	FD-local analysis, UNP hier led to lower tourism	~75% in season
Sebitole					
Rwenzori					
Semliki					
Semuliki GR	prob. not just chimps	??	Entry fee + % to UWA - rest to concessioner		
Kasyoha-Kitomi					
Kalinzu					
Maramagambo					
Maramagambo					
Rabongo/Murchison		UWA std - entry + guide($7)	UWA park	national UWA	
Bwindi					
Kyambura	most want chimp viewing	$40 + entry fee to park	UWA policies (RS planned)	local analysis -	96% in season / avg 70%
Captive:					
Isinga / QENP	chimps 100%	$15 per person (+entry)	UWA policies = 12% to communities	CP Warden + UWEC	100%
UWEC - Entebbe		500/=	UWEC		100%
				(FD = Forest Dept)	

TABLE 6-1. (Continued)

	Exposed			
SITE	chimp pop'n?	Technique		
Budongo	N50-70, S~60	no radios		
Bugoma				
Itwara				
Kibale	??	radios used, but walk on loops		
Sebitole				
Rwenzori				
Semliki				
Semuliki GR	20	??		
Kasyoha-Kitomi				
Kalinzu				
Maramagambo				
Maramagambo				
Rabongo/Murchison	10-20	nature walks - plan to use radio		
Bwindi				
Kyambura	27-30	early location - radio back -		
Captive:				
Isinga / QENP	9	island pop'n , boat viewing		
UWEC - Entebbe	14	zoo		
			General Reccomendations:	
			Tourism Circuit based planning - i.e. 1chimp site / circuit??	
				QE circuit - many
				Kidepo circuit - none
				BINP/MGNP - none - plan 1?
				Murchison area - one OK
			HQs should emphasize non-chimp tourism. Reduce marketing pressure on chimps	
			Ecotourism - ecology should be given prime importance - sell entire ecosystem - not just one part	
			Research and Tourism to same groups?	
				causes a lot of problems in Tanzania at Gombe and Mahale

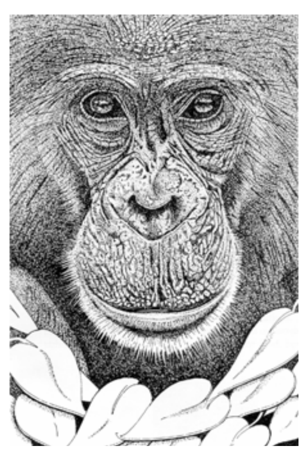
Table 6-2. Local Population Education: Chimpanzee Conservation Problems and Solutions

Issues	Target Groups	Recommendations	Implemented By:
Crop raiding	LC's, local communities	Find existing info on status of level of crop raiding	PA staff and NGO's
		Workshop on prevention measures alternative crops	NGO's and LC's
Snares	local comm, LC's, hunters	Posters demonstrating effects of snares	schools....contests???...
		Workshops on effects of snaring..as part of some other workshop	PA staff and NGO's
		Media-radio, newspapers, photos	LC's
		Practical demos with snares??	NGO's and PA staff
		Visits to UWEC and Isinga Island	
Trafficking/poaching	customs/security officers	Posters in airports and at borders	UWA and NEMA
		Fact sheets for officials and security personnel	UWA and NGO's
		Workshops	UWA and NGO's
Chimpanzee ecology	schools, CDC, local comms, tourists,	national standardized intergration into curriculum	CDC, Education Centres, T/NTC
	PA staff, political leaders	Posters, leaflets	NGO's, local schools, Ed. centres
		Puppet shows	NGO's, local schools, Ed. centres
		Guide books, fact sheets	PA staff
		adequate PA staff training	NGO's, UWA, FD
		Visits to PA's	
Animal rights	religious leaders and schools	Discussions w/ religious and respected comm leaders, teachers	NGO's and PA's
Threats to habitat	local comm, resource users,	Extension workshops	PA staff, UWA, FD
	landlords, politicians	Organized visits to PA's by schools	
		Workshops for resource users - alt. income sources	
		develop more ed. centres w/in PA's	
Laws	General public, LC's, police	produce leaflets	UWA, FD
		LC workshops	
		Media- radio, newspaper	

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997

Section 7
Captive Management Working Group Report



Chimpanzee Captive Management in Uganda

Captive chimp situation in Uganda: Initial workshop notes

Questions:

1. Breeding allowed or not allowed? If so, how much?
2. Flow from Zaire..How to stop it?
3. Offical policies on confiscations, how?, where?
4. What are our limits to captive chimps, sub species
5. Benefits of ecotourism for captive chimps
6. Long term future
7. Number limit of captive chimps Uganda can look after
8. Role of chimps in conservation education
9. Requirements for a sanctuary, food, space, location, financial etc,
10. Financial committment...responsibilities
11. Ownership

Aim: To provide suitable facilities and management policies for orphan chimps of East Africa. To discourage further illegal and hunting of the species. To promote co-operation with the International Zoo community

Objectives / Needs:

1. Current situation: increase of confiscated animals?
2. Safe haven for East African chimps-genetics similar
3. 23 chimps in Uganda (captive) with no confiscation in the past 18 months
   (Update: one infant (probably < 1 year) orphan confiscated in February 1997)
4. If no breeding there will be no captive chimps left in 40 years,
5. Importance for conservation education,
6. Females to breed to allow normal social develop, adoption of infants by orphaned females if possible,
7. Some breeding good education,

Government policy on confiscation IUCN guidelines on confiscation, live animals. CITES...Take more responsibility for the trade in chimps and other wildlife ownership...Once the court case is dealt with...Do institutions like UWEC need a holding permit to keep these animals for the goernment?.

Committee to run sancturies in case of war/political instability.
Emergency international trust for dealing with orphaned chimps in Africa, to pay for transportation and short term running costs for the chimps. Need institutions to provide their facilities in emergencies. International zoo community to help with accessability to transport crates, plus have some on the continent ready to go.

Roles of chimps in conservation

Day 2:

Additional questions:
1. Rate of confiscation of chimps coming into Uganda...30 in 50 years: 1 in 18months
2. Island habitat viable and environmental enrichment
3. Evidence of chimps coming from Zaire
4. Chimps for medical research???? Any evidence
5. Ownership of island

Sanctuaries:

Current: Isinga Island, Lake Edward, QENP, problems with sanctuaries being close or in protected areas...disease transmission, accidental escape
Carrying capacity: n=9, size 12 acres

UWEC: Temporary holding facility for confiscated chimps. N=15; 2,500m^2 + night quarters

Proposed new sanctuary: Lake Victoria, 100 acres, carrying capacity N= 30, 90% forested

Repatriation of chimps back to country of origin (verified) is an option if the country in question has adequate facilities to care for the animals and is viable.

Breeding allowed?
Each female allowed one infant in her life time. Minimum breeding age 15-20 years. This is to allow normal social development, adoption of infants by mature females could be possible. Must be genetically managed...Both in regard to sub species and in breeding.

International captive management:
No need for the international captive managent program to play a role for *Pan troglodytes schweinfurthii*...maybe needed for other subspecies. Would liase with the international community if a different subspecies comes into Uganda.

Law Enforcement:
Need for better enforcement of laws by neighbouring countries and Uganda. Networking with other institutions, capacity building, awareness, education, etc.

Wider distribution of IUCN Guidelines for Confisction of Live Animals.

Advocacy: Source and receiving countries included, and transit points (eg. NGO's and TRAFFIC)

Recommendation that UWEC br recognised as offical holding facility for exhibits for court cases, trials, etc.

Policies:
Responsibility of chimps...needs to be clarified (UWA/UWEC).
Implement an MOU/agreement for this situation.
Drafting a managment plan for captive chimps for Uganda

Tourism:
Location is very important. It should not be near a protected area that has chimps. There is a need to establish sanctuaries in areas where paid visitors will be numerous enough to cover recurrent cost of the sanctuaries. Sustainablility (long-term future) and education is a must for a successful sanctuary.

Long term sustainability:
Sanctuaries as a forum for fund raising for wild populations eg. Snare removal. Income above operating costs to go into an international Trust Fund to ensure the long term care of the chimps if paid visitation is below running costs.

Education:
Chimps should be viewed as a flagship species for conservation education.

Re-introductions:
Any re-introductions to follow guidelines prepared by the IUCN/SSC and the Re-introduction Specialist Group. If reintroduction of a group is an option, then they are not to be put in an area with wild populations and humans.

Captive Chimpanzee Policy for Uganda

Policies

The present Uganda procedures that apply to chimpanzees confiscations and holding is as follows:

As a member state of CITES (since 1991) the Ugandan Government, through its Ministry of Tourism Wildlife and Antiquities (MTWA), is responsible for the enforcement of the regulations and laws.

Trade: Confiscation of chimpanzees at the airport and border posts is carried out under the leadership of the Wildlife Department (MTWA) with the assistance of other Government bodies (UWA, police, customs, military). Technical assistance and support is requested of UWEC.

Poaching: Inside and outside Protected Areas the UWA is responsible for law enforcement. Investigations and confiscations are carried out by UWA often with the assistance of the police, in some cases assistance of UWEC is requested.

Holding: Confiscated chimpanzees are kept at the Entebbe Wildlife Education Centre. There is no official policy about the disposition of confiscated chimpanzees.

Recommendations

- A memorandum of understanding will be signed between UWA, WD and UWEC with the understanding that UWEC has (currently) the only holding facilities for confiscated chimps in Uganda. UWEC should be issued with an official holding permit. Chimps will be looked after at UWEC in Entebbe. Financial implications will be matched by Government of Uganda until the end of the court case. This should be achieved by June 1997.

Once the animals are no longer required as evidence, UWEC will be given offical and financial responsibility for chimpanzees that are not to be repatriated.

- UWEC recognises the State as ultimate guardian. However, as a stakeholder UWEC will have a say in the final disposal of the animals.

It should become a policy that captive chimps should not be used for the following:

1. medical research;
2. in the entertainment industry;
3. pet trade;
4. private holding;
5. young chimps should not be used on display at schools and fairs.

- Holding of captive chimps should follow the guidelines of international zoo regulations.

- Management of captive chimps should be done under the guidance through a recognised management committee. This committee should be formed as soon as possible.

- Education of concerned bodies (police, customs etc) should start as soon as possible and should be an ongoing process.

- Only non-invasive studies should be allowed on captive chimps, with emphasis on research which will benefit their management.

Additional Note: There is an urgent need to establish a CITES liaison or focal unit within the UWA. This office should work closely with the MTWA to educate, through seminars, customs officials at major border posts, ports and airports on the identification of specimens. Posters should be produced and issued to customs posts within Uganda. International laws should be clearly explained to the customs staff and, in the case of Zaire and Uganda, agreements should be made for such issues.

The UWA can also form an animal rescue unit that can respond to confiscations.

In areas where chimp confiscation are numerous laws relating to fines and imprisonment should be relayed to local communities.

Re-introduction

The IUCN/SSC Re-introduction Specialist Group (RSG) has developed policy guidelines so that re-introductions achieve their intended conservation benefit. Re-introductions can be defined as follows:-

- "*Re-introduction*": an attempt to establish a species in an area which was once part of its historical range, but from which it has become extirpated or extinct.

- "*Translocation*": deliberate and meditated movement of wild individuals or populations from one part of their range to another.

- "*Re-inforcement/supplementation*": addition of individuals to an existing population of conspecifics.

- "*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. This is a feasible conservation tool only when there is no remaining area left within a species' historic range.

In Uganda the following can be added in relation to chimps:

- "*Introduction*": the establishment of chimps in a captive situation in sanctuaries which are mainly on islands (fenced on the mainland or situated in water bodies).

There are two main issues that affect chimps in Uganda:
1. Confiscation
2. Reintroduction

<u>Confiscation</u>

Chimps are confiscated from illegal and irregular trade. Eighty-four percent of animals come from Zaire and 16% from within Uganda. When animals are confiscated they have to be disposed of in an appropriate manner. According to the Draft IUCN Guidelines for the Placement of Live Confiscated Animals the following three goals must be achieved:-

1. Maximise the conservation value of the specimens without endangering the health, behaviour, genetic characteristics and/or conservation status of wild or captive populations of the species.

2. To discourage further illegal or irregular trade.

3. To provide a humane solution such as providing lifetime care in captivity, return to the wild or euthanasia (i.e., humane lethal injection).

In Uganda, confiscated chimps are usually juveniles. These chimps have been separated from their mothers and it is impossible to return them to the wild and this would be of no conservation value. Euthanasia is a consideration under IUCN guidelines. But chimps are genetically related to humans and have a very wide appeal which would not make euthanasia a means of disposal. Euthanasia would only be a solution if an individual being maintained had serious physical, psychological and/or social defects. Euthanasia procedures should be in accordance with international guidelines (e.g. under sedation, animal given lethal injection). The only possible remaining solution is lifetime care.

Zoos and captive breeding institutions may not want these animals as zoo space is limited and needs to be devoted to sub species/individuals with a high conservation priority. Other captive options available are rescue centres and lifetime care facilities (sanctuaries). In Uganda confiscated chimps can initially be held in a holding facility such as the UWEC and it can then be sent to a sanctuary.

<u>Reintroduction</u>

The aim of the Reintroduction Specialist Group is to promote the re-establishment of **viable** populations of animals and plants to the wild. Primates have been generally recognised as difficult to re-introduce. This is because most of them have long life spans coupled with long learning periods. They are highly social and intelligent animals and re-introducing them would indeed be difficult. There have been very few successful re-introductions of primates. The golden-lion tamarins are an example.

Single individual welfare releases are on the increase and pose unnecessary risks to wild populations. The guidelines clearly state that the presence of surplus animals should not be the basis of a re-introduction. These releases can compromise the conservation status of wild populations at the expense of single or few individuals. There have been documented welfare releases of individual chimps into the wild and these have generally not been successful.

Releasing single individuals can easily result in the transmission of disease to wild populations, pollution of genetic lineage through the release of a different sub-species and through the introduction of abnormal behavioural patterns to wild populations.

Recommendation

Re-introduction or the welfare releases of chimps in Uganda should not take place and instead efforts made to manage existing wild populations.

The captive situation

Background

Sanctuaries

There are only a handful of sanctuaries that are in existence today including; Chimfunshi (Zambia), Baboon Islands(The Gambia), Sweetwaters Chimpanzee Sanctuary (Kenya), Tchimpounga & Concouati (Congo) and Isinga Island (Uganda). Two types of sanctuaries are being utilised: islands and mainland. Currently only mainland sanctuaries have holding facilities.

The definition of an island sanctuary is one where the land allocated for the sanctuary is totally surrounded by water (e.g. Isinga Island). "Mainland" sanctuaries on the other hand, can be part of an island or on the mainland. The difference being that you have access to the sanctuary without the need of a boat (e.g. Sweetwaters, Tchimpounga and Chimfunshi). There are advantages as well as disadvantages to both types of sanctuary, e.g. accessibility and barriers.

The size and natural vegetation of the site is important. Drier climates with sparse vegetation will require a larger area per animal than an area of dense vegetation and good regeneration growth rates.

Management:

Group types: Generally speaking there are two types of groups currently maintained:

Closed groups: The first intake of orphans into the sanctuary will be the only occupants. The reason others cannot be introduced is either due to restrictions in the size of the sanctuary, the inability to introduce due to inadequate holding facilities, or the chimpanzees themselves not willing to accept newcomers. i.e. Isinga Island and Baboon Island.

Open groups: The facilities and the chimpanzees will allow the introduction of new individuals to the community. i.e. Sweetwaters, Chimfunshi and Tchimpounga.

The type of group maintained depends primarily on the type of sanctuary built. If sanctauries are built without incorporating a holding facility that allows the caregivers some sort of control, then introducing newcomers is not really viable. The construction of suitable holding facilities within the sanctuary allows for the introduction of newcomers. Chimpanzees belong to a social society of fission -fusion, so accepting newcomers in general is possible. The problem will lie in the ability of the facility to allow for the integration of a new member and the acceptance of the group to the newcomer. In general young chimps and adult females are likely to be accepted into a group, but it normally takes several years for females to become established.

Introducing very young infants into a group of older animals can be a potential risk. Infanticide by adult males is known both in the wild and in captivity, e.g., Gombe, Mahale, Taronga Zoo, Chester Zoo and Jacksonville Zoo amongst others. Another problem is that although a female may accept an infant, she may not necessarily adopt or foster it. Adoption of a younger animal by an older female is possible, but that will depend on the individual female, the age of the youngster and the group composition.

Past experience with sanctuaries is that they reach saturation point very quickly as not enough space is available or maintained for new arrivals.

Breeding

The zoo world has been breeding chimps successfully for many years, and the present wild population in Uganda does not warrant sanctuary chimps being used for captive breeding for reintroduction . On the other hand, we cannot predict the future of the wild populations. To permanently sterilise chimpanzees is a radical option and a shortsighted management tool. Temporary sterilisation allows for a change in policy at a later date if the need arises. The issue of breeding needs to be considered for better behavioural, demographic and genetic management of the captive community. Areas of concern are overt male aggression, natural group composition as well as a dramatically reduced level of confiscations which could result in a non viable captive population if breeding is prohibited.

Captive chimpanzees in Uganda

Uganda currently has two sites that have captive chimpanzees, with a total of twenty three chimps. Isinga Island Sanctuary and The Uganda Wildlife Education Centre (UWEC). Isinga Island is situated on Lake Edward, within Queen Elizabeth National Park. This was set up by UWEC with UWA's consent. It has been in operation for eighteen months and presently contains nine animals (2 males, 7 females). Four keepers and one supervisor are needed for this operation. The two males have been permanently sterilised, and the age range is between 4 and 12 years. There is no holding facility found on the Island for veterinary procedures or further introductory procedures.

The Uganda Wildlife Education Centre (UWEC) is situated in Entebbe and currently has fourteen chimps (6 males and 8 females) in its care. It is in the process of building a new chimpanzee island exhibit for displaying chimps at the Centre in more appropriate conditions. The off exhibit holding facilities will have the holding capacity of fifteen animals. The building is designed to allow isolation of individuals for quarantine and the ability to introduce unknown individuals together.

UWEC is in the process of aquiring another Island in Lake Victoria as a second sanctuary site to cater to the ten youngest chimps in the Centre and any other confiscations in the future. All captive chimpanzees in Uganda have been identified as belonging to *Pan troglodytes schweinfurthii* by DNA anaylsis. No substantial research on behaviour has been conducted at either site.

Isinga Island Sanctuary

The sanctuary has proven to be financially viable. Within six months of operation it has broken even and to date has been making a profit each month. It has proven to be successful as a temporary solution, but Isinga Island is situated in a protected area (QENP), which poses a problem with disease transmission, accidental escape, misconception of protected areas, and outside pressures to create identical facilites in other protected areas.

The chimpanzees are now of an age that they are potentially dangerous to the caregivers. There have been incidences of minor attacks on caregivers. Introduction of newcomers is no longer an option.

Holding facilities need to be constructed if this sanctury is to be maintained for a long term project. In the event of disease it is not possible to isolate individuals. There have been three deaths in eighteen months.

The island's natural habitat is unsustainable as a chimpanzee sanctuary. There is evidence of permanent damage to the only suitable feeding trees on the island.

International Captive Management

In the June 1996 ISIS records 2,656 chimpanzees are reported to be held in captivity. 94% of these animals are only registered at the species level. There are ongoing efforts to identify pure sub specific individuals through DNA analysis. There is a portion in the European Endangered Species Programme to initiate a captive management programme on *Pan troglodytes verus.*

There is an ongoing involvement with the zoo community to provide expert advice and training of local staff in captive management techniques. The zoos presently involved are Taronga Zoo (Australia), Columbus Zoo (USA), North Carolina Zoo (USA).

Recommendations

Sanctuaries

- Sanctuaries to be established outside the protected areas, away from wild populations and not immediately adjacent to human settlements. Accessibility for tourists must be considered before designating a site for a sanctuary.

- No sanctuary to be built without adequate holding facilities. The establishment of a uniform set of guidelines for facilities according to standards set by the international zoo community for captive chimpanzees.

- Establishment of new sanctuary in Lake Victoria as proposed by UWEC. This sanctuary to have adequate holding facilites to deal with the carrying capacity of thirty chimps.

- Due to the fundamental problems of Isinga, this sanctuary should be considered a short term solution and closed down within approximately one year. The chimpanzees are to be re-located to the proposed new sanctuary in Lake Victoria.

Management

- The formation of a management committee of persons specialising in chimpanzees in captivity is necessary. This committee should at least include a veterinarian with chimpanzee experience and an expert in captive chimpanzee management.

- Before any newcomer is introduced to the captive community of Uganda, their sub species should be identified. If they are not *Pan troglodytes schweinfurthii*, they should be relocated according to the recommendations under the sub heading of international captive management. Individuals who prove unsuitable for sanctuary situations and are asocial will be maintained at the UWEC Centre.

- Any introductions of confiscated infants to existing groups should be conducted according to international captive management guidelines and should be monitored closely.

- Some controlled breeding should be allowed. The amount of potentially breeding females is not known at this point in time. The number will depend on the maximum carrying capacity, and the expected number of newly confiscated chimps in the lifetime of the sanctuary. UWEC management measures aim at available space for 15 arrivals in 20 years.

- Male chimps should not be castrated! This operation will inevitably affect the hormone levels and consequently the animal's behaviour. Males should only be vasectomised. Females if they are to be sterilised permanently should only be tubal ligated, not given a full hysterectomy. Again, temporary sterilisation in the form of contraception is recommended. Oral is relatively safer than implants but is not as reliable due to the chances of females not coming to the holding facility on a regular basis. For this reason it is recommended that implants be used and that the risk factor of accidental permanent sterilation is accepted.

- All chimpanzees from Isinga Island will be translocated to proposed Lake Victoria Island, together with 5:5 chimpanzees from UWEC. All 19 individuals have been housed together previously at UWEC. The translocation of 7:12 chimpanzes to the Lake Victoria sanctuary allows for management of a large group under semi-natural conditions. This leaves one male and three females at UWEC.

- Extremely limited breeding will be allowed at Lake Victoria sanctuary with a maximum of five offspring in twenty years, allowing for flexibility due to excess confiscations and mortality.

- UWEC is to be maintained as a receiving facility for new arrivals. Therefore breeding will be limited to the two offspring in twenty years.

- At present there is no estimated need for an international captive breeding programme for conservation purposes for *Pan troglodytes schweinfurthii.* As the presumed bulk of this sub species is located in Zaire, future needs are uncertain. Ongoing assessments for the need of a captive breeding programme are necessary.

- The international zoo community should be contacted if individuals confiscated in Uganda are not of *Pan troglodytes schweinfurthii,* for possible relocation to a captive breeding programme if return to the country of export is not deemed appropriate.

- The captive community will continue to liaise with the international zoo community on captive management techniques.

Fund raising

It is necessary for UWEC to raise funds:

1. To maintain, in captivity, those orphan chimpanzees for whom it is responsible.
2. To educate the general public, especially children, about the nature of chimpanzees and their plight in the wild.

1. <u>Sanctuaries</u>

At present the captive chimpanzee population of Uganda, as we have seen above, is maintained in one sanctuary and at the UWEC facility. There are plans for a new sanctuary.

A. *Isinga Island Sanctuary, Lake Edward*

Finance:The average number of visitors per month (August - November 1996) is 392.

Average Monthly Income	5.9 million USh*
average Monthly Expenditure	1.7 million USh
Tax 17%	1.0 million USh
Community share of 12%	0.7 million Ush
Average Monthly Profit	2.5 million Ush

* Currently, US$1 ≈ 1,000 USh

The current revenue obtained through tourist viewing is held in a separate UWA bank account. This is earmarked for recurrent expenditure - with monies over and above expenses being invested for long term care of the chimps.

UWA has agreed to maintain a credit balance in the account of 3 million USh (minimum) so that funds are immediately available to cover monthly expenditures even when tourist generated revenue is low.

Excess funds are presently being used to purchase necessary capital equipment - a boat, boat-engines, a vehicle and so on.

At present the on-site staff are supervised by an individual with captive chimp experience. Such a person will always be needed for supervising, training and education.

B. *UWEC, Entebbe*

The present facilities at the Centre are quite inadequate for the four adults and ten adolescent and juveniles that it currently houses.

A new enclosure is being constructed that will comprise a permanent exhibit for the four adults and a temporary holding facility for up to 11 additional confiscated chimpanzees.

Approximately 70-80,000 people visit UWEC per year. Income from entrance fees (currently set at 500 USh for an adult and 200 USh for a child) does not cover annual expenses.

Once the new facility is ready, entrance fees will be increased, to 1000 USh for adults and 500 USh for children, and the revenue from visitors is expected to contribute a far greater amount.

If additional chimpanzees are confiscated, Government funding through the UWA will cover costs of maintenance (at UWEC) pending the resolution of court cases, after which UWEC will take over full responsibility.

C. *New island sanctuary, Lake Victoria*

This location, 45 minutes from Kampala, will attract many visitors. It is expected that the maintenance of this sanctuary will eventually be covered by tourist revenues.

Funds for the purchase of the island and development of the sanctuary have been, and are being, solicited by UWEC and JGI.

2. Trust Fund

UWEC is setting up a Trust Fund in which money in excess of that needed for running costs of its various projects can be invested. The aim of this fund is to provide long term sustainability of these projects.

3. Additional Donations

In addition to fund-raising for the upkeep of the sanctuary and the UWEC chimp facility, UWEC hopes to solicit donations from visitors to help the wild chimpanzees. It is believed that visitors will feel pity for the orphans and that, when told about the dangers faced by wild chimpanzees, e.g. from wire snares, will want to help. Contributions from the orphan chimp sanctuary, therefore, will help to pay for programmes to remove snares from National Parks and Forest Reserves.

UWEC in collaboration with UWC and JGI will also raise funds for conservation education, focusing on chimpanzees and their plight.

Funds to be used for:	Equipment, such as slide projector, video, vehicle.
	Printed materials.
	Arranging school visits.

There is a possibility of financial support from the international zoo community in exchange for information on conservation efforts for use in zoo conservation education as a sort of "window to nature". There is good potential for this as zoos actively increase their efforts in this field and seek involvement in *in situ* conservation.

Conservation education

Chimpanzees, perhaps more than any other animal, fascinate children - they are so much like us.

Once children's interest and attention have been engaged, they are willing to listen to other wider conservation issues.

Visitors to a sanctuary will be educated as to the dangers facing wild chimpanzees during their tour. Printed information will be provided.
Books, videos etc. will be available for sale.
Visitors from local schools as well as residents and tourists, will visit the island sanctuaries by boat and observe from a pontoon or tower.

Guides responsible for the tours must receive extensive training. They must know the chimpanzees by name, know their histories and have a solid understanding of chimpanzee behaviour. They should also know a great deal about the dangers faced by wild chimpanzees.

Visitor viewing of chimp behaviour will be facilitated by observation at special feeding places. Their visits should be timed to coincide with a major feeding time.

Sanctuary visitors will have the opportunity to land on the island and be told the history of the orphans in more detail. They will learn about the terrible experiences a young chimp lives through from the time his / her mother is shot by a hunter in the forest.

Visitors will also learn why it is not only wrong but quite inappropriate to buy a chimpanzee as a pet.

UWEC:

At the Centre visitors will be able to see videos and slide shows.

Conservation education will be aimed at school groups. The chimpanzees and their plight will serve as a focus for learning about many other conservation issues in Uganda, particularly those relating to forests. This programme will be in the hands of well trained personnel.

We hope that this education programme will be developed by the Ugandan Wildlife Clubs, UWEC and JGI.

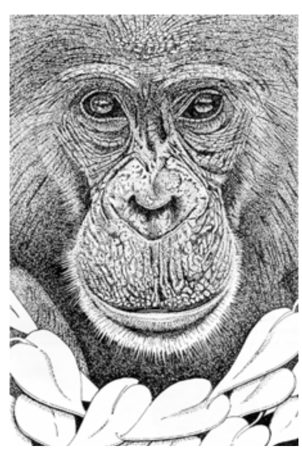
Recommendation

- UWEC should continue to maintain responsibility for fund raising and develop the conservation education programme.

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997

Section 8
Closing Remarks and Workshop Participants List



Remarks by the Ugandan Commisioner of Forestry at the closing of the Chimpanzee PHVA Workshop at the Windsor Lake Victoria Hotel, 9th of January, 1997.

The Mayor, Entebbe;
Senior Goverment Offcials;
Members of the Organising Committee;
The Management of Lake Victoria Hotel;
Distinguished Participants;
Invited Guests;
Ladies and Gentlemen.

On behalf of Uganda Forest Department and on my own behalf, I feel greatly honoured to be with you at this morning's discussion and to close this Chimpanzee Population Habitat Viability Analysis workshop. You are all aware that chimpanzees and forests are inseparable. I am happy the organisers put this into serious consideration and I hope the input of my staff in this workshop has been of great use and I am looking forward to receiving recommendations and the future plans for the chimpanzees in this country.

I believe that throughout your deliberations, you realised that survival of our forests is vital for the continued existance of chimpanzees and other wildlife in this country. This means that conserving our forest ecosystems should be our priority number one. My office is very much aware of this. Our major task currently is to get everybody involved: the academicians, the professionals, technicians, natural resource managers, and most important the local people around the forests. Forest management should not be left in the hands of forest officials only because these form a very tiny population of this country. I believe the way forward for each one of us (Ugandan or non-Ugandan) is to try and play your role.

Therefore I believe the best strategy that will save our forests so that chimpanzees and other forms of biological diversity survive in this country is through collaboration and networking. I am very happy to note that this Workshop is a joint effort of UWA, Forest Department and CBSG. I hope we shall continue building on these collaborative and networking initiatives to conserve chimpanzees and other biodiversity in the forest ecosytem. As Ugandan institutions charged with protecting wildlife, we should strive to conserve Uganda's natural resources together. In fact, scientists tell us that tropical forests have more species than other wildlife habitats.

I want to make everybody aware in this room that the chimpanzees that we have in this country have been protected by forest management practices early this century. Budongo Forest has been selectively logged since 1910 and I am very pleased to hear that it has the highest population of chimpanzees in this country. We also use ecotourism in this forest as a way of promoting non-consumptive use of Budongo Forest. Feel free to go there and enjoy. However do not forget the consumptive uses of our forests. The challenge is to develop and maintain sustainable use practices. I am sure with professionals, (and now the VORTEX modellers), managers, and academicians and cooperation and collaboration of locals communities living near these resources, the chimpanzees and their habitats in this country will survive.

Let me take this opportunity to thank the organisers of this workshop. Special thanks go to the the Conservation Breeding Specialist Group. Your input is a clear manifestation of your interest in saving the chimpanzees of this country. We still have very many animals and plant species which are threatened in this country. All these need population and habitat viability analyses! Come again and you will be welcome.

The Local organising Committee, without your good planning, this workshop would not have been successful.

Thanks also go to the Management of Windsor Lake Victoria Hotel for hosting our participants very well. Reports I have received indicate that your services have been very good. We shall consider holding future workshops/seminars here as long as the terms continue to be favourable.

Lastly I would like to end by wishing the participants a safe journey home. I hope those of you who come from outside Uganda will find some time to see some of our forests, chimpanzees and the Ugandan countryside before you leave.

With those words, allow me to declare this workshop closed.

Thank you.

CHIMPANZEE PHVA WORKSHOP PARTICIPANTS

Ignatius Achoka
Uganda Wildlife Authority
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

Karl Ammann
P.O. Box 437
Nanyuki, Kenya
Phone: 254-175-22448
Fax: 254-176-22145

Amwiine
Uganda Forestry Department
P.O. Box 1752
Kampala, Uganda

Chris Bakuneeta
Uganda Wildlife Authority
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

Deborah Baranga
Zoology Department
Makerere University
P.O. Box 7062
Kampala, Uganda

Gilbert Basuta
Makerere University
Biological Field Station
P.O. Box 409
Fort Portal, Uganda
Phone: 256-483-22881

Alexandra Berg
Stockholm University
Erik Dahlbergsgatan 35A
11522 Stockholm, Sweden
Phone: 46-8-6441853
Fax: 46-8-6461040

Franco Busenene
Uganda Wildlife Authority / UIE
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

Henry Busulwa
Uganda Wildlife Authority / UIE
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

George Bwere
Uganda Wildlife Authority / QENP
P.O. Box 22
Katwe, Uganda

Debby Cox
Jane Goodall Institute / UWEC
P.O. Box 369
Entebbe, Uganda
Phone: 256-42-20571
Fax: 256-42-20573
E-mail: chimpldy@jgi1.uu.imul.com

Eric Edroma, Director
Uganda Wildlife Authority
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

Robert Ekaju
Uganda Wildlife Authority / WCU
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

Jim Else
Uganda Ministry of Tourism,
Wildlife and Antiquities
P.O. Box 4241
Kampala, Uganda
Phone: 256-41-233852

P. Ezuma
Uganda Wildlife Authority
P.O. Box 22
Katwe, Uganda

Katie Fawcett
Edinburgh University
Budongo Forest Project
P.O. Box 362,
Masindi, Uganda

Michele Goldsmith
Department of Anthropology
Dartmouth College
Hanover NH 03755-3570 USA
Phone: 1-603-646-3436
Fax: 1-603-646-2810
E-mail: michele.goldsmith@dartmouth.edu

Jane Goodall
Jane Goodall Institute
15 Clarendon Park
Lymington, Hants
SO41 8AX England
Phone: 44-1-590-671188
Fax: 44-1-590-670887

Becky Harris
Born Free Foundation
Coldharbour, Dorking, Surrey
RH5 8HA England
Phone: 44-306-712899
Fax: 44-306-713350
E-mail: bornfree@pnu.co.uk

John Hart
Wildlife Conservation Society
International Programs
185th Street and Southern Boulevard
Bronx, New York 10460 USA
Phone: 1-718-220-5100
Fax: 1-718-364-4275

Frands Hjordt-Carlsen
Copenhagen Zoo
SDR Fasenvej 79
DK 2000 Frederiksberg, Denmark
Phone: 45-36-302555
Fax: 45-36-442455

Omari Ilambu
Attaché de Recherche
Institut Zairois pour la Conservation de la Nature
Kinshasa, Zaire

Simon Jennings
ITFC
P.O. Box 7487
Kampala, Uganda
Phone:
Fax: 256-486-22307
E-mail: vision@imul.com

Victoria Kakoko
Uganda Wildlife Authority Trustee
c/o Sean's Florist
Sheraton Hotel
P.O. Box 741
Kampala, Uganda

Gladys Kalema
Uganda Wildlife Authority
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

John Kasenene
Makerere University
Biological Field Station
P.O. Box 409
Fort Portal, Uganda
Phone: 256-483-22881
Fax: 256-483-33883

Panta Kasoma
Makerere University IENR
P.O. Box 7052
Kampala, Uganda
Phone: 256-41-533462

Fax: 256-41-530134
E-mail: mulenc@imul.com

Katago
Uganda Wildlife Authority
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

Stephen Khauka
Uganda Forest Department
P.O. Box 173
Masindi, Uganda
Phone: 256-465-20370

Fred Kigenyi
Uganda Forest Department
P.O. 1752
Kampala, Uganda

Pius Kizito
Uganda Forest Department
P.O. Box 7052
Kampala, Uganda
Phone: 256-41-543238
Fax: 256-41-533574

C.D. Langoya
Uganda Forest Department
P.O. 1752
Kampala, Uganda

Carla Litchfield
Adelaide University
P.O. Box 592
Willunga, 5172 SA
Australia
Phone: 61-885-567 367
Fax: 61-8-8346 9813
E-mail: psycalit@arts.adelaide.edu.au

Catherine Long
VSO
Nyabyeya Forest College
Private Bag
Masindi, Uganda

Liz Macfie
International Gorilla Conservation Project
P.O. Box 10950
Kampala, Uganda
Phone: 256-41-344510
Fax: 256-41-257945
E-mail: igcp@imul.com

Jeremy Mallinson
Jersey Wildlife Preservation Trust
Les Augres Manor, Trinity
JE3 6BF, Jersey, Channel Islands
Phone: 44-1-534-864666
Fax: 44-1-534-865161

Mapesa
Uganda Wildlife Authority
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

Linda Marchant
Dept. of Sociology and Anthropology
Miami University
Oxford, Ohio 45056

William McGrew
Dept. of Sociology and Anthropology
Miami University
Oxford, Ohio 45056

Philip Miller
Conservation Breeding Specialist Group
12101 Johnny Cake Ridge Road
Apple Valley MN 55124-8151 USA
Phone: 612-431-9325
Fax: 612-432-2757
E-mail: cbsg@epx.cis.umn.edu

Willhelm Moeller
Uganda Wildlife Education Center
P.O. Box 359
Kampala, Uganda
Phone: 256-42-20520

Fax: 256-42-20073
E-mail: uweczoo@imul.com

Alex Muhwezi
IUCN
P.O. Box 10950
Kampala, Uganda
Phone: 256-41-244508
Fax: 256-41-242298

Edward Mupada
Uganda Forest Department
P.O. Box 1752
Kampala, Uganda
Phone: 256-41-233485
Fax: 256-41-236016

Keith Musana
Uganda Wildlife Authority
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

Ann Oakenfull
Department of Genetics
Cambridge University
Downing Street
Cambridge CB2 3EH
England
Phone: 44-1-223-333986
Fax: 44-1-223-333992
E-mail: eao@mole.bio.cam.ac.uk

Andy Plumptre
Wildlife Conservation Society
International Programs
185th Street and Southern Boulevard
Bronx, New York 10460 USA
Phone: 1-718-220-5100

Vernon Reynolds
Biological Anthropology
Oxford University
58 Banbury Road
Oxford OX2 5QS
England
Phone: 44-1865-274693
Fax: 44-1865-274699
E-mail: vernon.reynolds@bioanth.ox.ac.uk

Norman Rosen
Dept. of Anthropology
University of Southern California
27 16th Street
Hermosa Beach CA 90254 USA
Phone: 310-318-3778
Fax: 310-798-0576
E-mail: nrosen@cmp.com

Linda Rothen
Jane Goodall Institute
P.O. Box 5244
Kampala, Uganda
Phone: 256-41-241574
Fax: 256-41-236852
E-mail: orothen@imul.com

Ulysses Seal
Conservation Breeding Specialist Group
12101 Johnny Cake Ridge Road
Apple Valley MN 55124-8151 USA
Phone: 612-431-9325
Fax: 612-432-2757
E-mail: cbsg@epx.cis.umn.edu

Pritpal Singh
IUCN
P.O. Box 48177
Nairobi, Kenya
Phone: 254-2-710367
Fax: 254-2-710372

Craig Stanford
Department of Anthropology
University of Southern California
Social Sciences 154
Los Angeles CA 90089-0032 USA

Zephyr Tuka
Budongo Forest Project
P.O. Box 362
Masindi, Uganda

Caroline Tutin
SEGI
BP 7847
Libreville, Gabon
Phone:
Fax: 241-77-5534

Dilys Vass
Jane Goodall Institute
15 Clarendon Park
Lymington, Hants
SO41 8AX England
Phone: 44-1-590-671188
Fax: 44-1-590-670887

Rachel Weiss
Semliki Reserve
P.O. Box 407
Fort Portal, Uganda

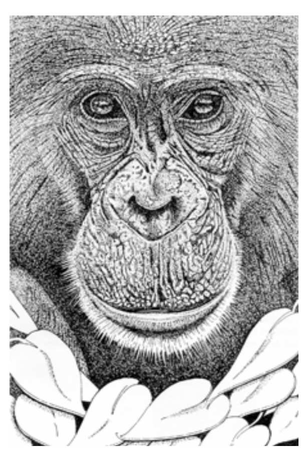
Samson Werikhe
Uganda Wildlife Authority
P.O. Box 3530
Kampala, Uganda
Phone: 256-41-530158
Fax: 256-41-530159

Richard Wrangham
Peabody Museum, Harvard University
11 Divinity Drive
Cambridge MA 02138 USA
Phone: 617-495-5848
Fax: 617-496-8041
E-mail: wrangham@husc.harvard.edu

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997

Section 9
Appendix I.
Workshop Presentations



I. Forest Conservation in Relation to Chimpanzees

F.W. Kigenyi
Deputy Commissioner for Forestry
Senior Nature Conservation Officer
EC Forestry Project

Introduction

Uganda's location in east-central Africa, in a zone of convergence of ecological communities characteristic of the dry East African savanna, and those of West African rain forests, makes her exceptionally ecologically diverse. In addition, her great topographical diversity ranging from 600m in the bottom of the western rift valley to 5000m in the Rwenzori Mountains is a contributory factor. As a result of the above two factors, 7 of the 18 mainland African phytochoria are represented in Uganda (vegetation assemblages), making it very unique in ecological diversity despite her small size.

Vegetation type has a major bearing on the diversity and occurrence of other species. In the faunal aspect, forests of a tropical nature have diverse wildlife populations compared to woodlands and grassland areas. In relation to chimpanzees, Uganda's forests—especially those in the wet mid-altitude areas—provide vital habitats.

Forest Policy

The first government forest policy in Uganda, adopted in 1929, placed emphasis on the role of forestry in the protection of the environment. Revision of policy over time has tended to place progressively greater emphasis on the realisation of short-term economic benefits from timber extraction activities. For example, the policy recommended over the period 1973-78 stated that one of the primary objectives was "...to capture the returns of the nation from the natural forest resource resulting from utilization of the remaining natural forest areas". In January 1988, the NRM government revised the Forest Policy to re-emphasize the importance of an ecosystem approach in forest management (Table I-1).

This has meant that forests are not just looked at as tree stands but in a holistic manner to include all forms of wildlife.

The Forest Department is the government agency responsible for the implementation of national forest policy. It is responsible for the gazetting and management of forest reserves, protection of reserved trees outside forest reserves, research and extension. This mandate has included the management of forest-related industries. Therefore the Department manages two conflicting aspects: conservation and utilisation.

Chimpanzee Occurrence and Distribution in Uganda Forests

The Forest Department has undertaken and encouraged surveys of wildlife populations since 1958 in addition to research of its habitats. This has helped the Department to develop management systems to ensure survival of various species. There have been studies of a number of primates, especially the chimpanzee and the mountain gorilla.

Chimpanzees occur in suitable habitats throughout western equatorial Africa. They occur in ten major forests un Uganda confined to the Western Albertine Rift below the Nile. There have been reports of some populations further north but this has not been verified by survey. There are also some forest remnants, especially in Masindi, Hoima, Kibale and Kabalore Districts which have some unverified populations.

Below is a list of major forest blocks where chimpanzee populations have been surveyed and known to occur (for more details see Table 3-1, page 39):

Site	Area (km^2)	Date Gazetted
Budongo	825	1932
Bugoma	365	1932
Bwindi	321	1932
Itwara	87	1932
Kalinzu	137	1932
Kasyoha-Kitomi	399	1932
Kibale	560	1932
Maramagambo	443	1932
Semliki	291	1932
Rwenzori	966	1940
Total	4394	

These forest blocks have been managed by the Forest Department since 1898, although their gazetting did not occur until 1932, three years after the first official Forest Policy was put in place. Although some changed to National Park status in 1990-1992, their condition as of today was influenced by the management practices of the Forest Department.

There is therefore a total of 4394 km^2 of forest providing a habitat for chimpanzees. Their distribution ranges from altitudes of 750m in Semliki Forest to about 2,750m in the Rwenzori Mountains.

Density Surveys in Forests

The forests that have been surveyed most are Kibale and Budongo Forests. However, there have been extensive surveys through Forest Department programs in all the other forest blocks with estimation of chimpanzee densities.

Surveys carried out between 1984 and 1992 by Dr. peter Howard and the Biodiversity Inventory Group revealed interesting trends in chimp populations and results have been used to derive densities. While the figures produced may not be very exact, they give a scale on which to guide decisions on important sites for chimpanzee protection.

Peter Howard's estimates are as follows:

Density Scale	Forest	Estimated Number of Chimps
Low	Semliki	150
Medium	Kibale	860
	Bugoma	600
	Bwindi	860
	Kasyoha-Kitomi	660
	Rwenzori (low elev.)	500
High	Kalinzu/Maramagambo	1820
	Itwara	220
	Budongo	1440

Since there is no recorded existence of chimpanzee populations outside of these forests, it can be assumed that Uganda has a population of chimps that is well over 6,000. Further surverys are required to get more accurate figures and to see whether there are any presence of chimpanzees in some of the forest fragments.

Forest Conservation in Relation to Chimpanzees

Uganda's forest policies have changed focus from time to time, depending on world outlook on conservation issues. However, compared to forest policies of other countries in the tropics and despite continued recognition of the importance of the forests in the nation's development which promotes consumptive use, holistic policy objectives have been promoted. There has been a balance between conservation and protectionism. Management based on scientific findings has been applied whenever research results are provided.

For example, research results in Bwindi in 1958 indicated that in order to sustain gorilla populations in the wild, the forest canopy should be slightly opened up to allow the growth of herbaceous materials on which the gorillas feed. As a result, the main objective of management was the maintenance of a good habitat for the gorillas. In doing so, light pitsawing of mature canopy trees was allowed. This activity, well-controlled, was found to enhance availability of gorilla food.

As for chimpanzees, research findings have revealed that they are more abundant in logged forests. Similarly, other primates have been found to be abundant in such areas. The unfortunate point is that some preservationists of keystone species take logging practices used in Malaysia or the United States as being standard logging practices world wide. Logging operations as practiced in Uganda have very little impact on the forest. They are far lighter and remove a smaller volume of trees compared to what is practiced in other countries. Budongo is a

living example of an assurance that forest management practices have been favourable to chimpanzee survival. Budongo has been actively logged from 1910 until today, yet is has one of the highest chimp populations in Uganda and also has the largest number of tree species.
Past Management in Some Major Chimpanzee Areas

Kibale Forest

— Officially gazetted in 1932
— Occupies 560 km2
— Tropical high forest broadly classified as:
  medium-altitude moist evergreen in the north;
  medium-altitude moist semi-deciduous at lower altitudes in the south.
— Past management objectives
- Production of timber from the natural forest and plantation forest in the woodland
- Production of wild coffee and woodfuel in some of the grasslands
- Preservation of the forest beneficial to environmental quality
- Research
- Preservation of representative ecosystem by creation of Nature Reserves
- Maintain amenity value
- Wild coffee has been exploited since 1932. During the active years it yielded over 40 tons per year. This has now declined to subsistence levels.
- Nature Reserve system amounting to 62 km^2 was established. This represents 11% of the forest. 16 km^2 of mostly undisturbed nature forest was established as research representing 3% of the forest.
- The production system was based on a 70-year rotation.

Harvesting started in 1950 when a sawmill was established in the north and operated continuously until 1984, utilising about 74 km^2.

A two-year interim management plan developed in 1990 to manage the forest as a Forest Park was a result of more information on the forest and the need to manage it as a ecosystem and just as a stand of trees. The main focus was to manage the area as an ecosystem, increasing its value beyond mere wood value. This saw the development of ecotourism at Kanyanchu to put value to chimps.

Budongo Forest

— Broadly classified as a medium moist semi-deciduous forest.
— Original cover was considered both of exceptional quality in terms of community richness and commercial value.
— This is Uganda's most important timber forest, which once supported 28% of the country's timber resources on only6% of its forest land.
— The forest has been commercially exploited since about 1910. A sawmill was established in 1925. Harvesting has been continuous since then and about 77% of the forest has been cut at lease once.

Only about 22% of the forest under two strict Nature Reserves remains unaffected. At first felling was done at modest level to create a 2-tier system with a 40-year rotation. This was replaced in 1959 in favour of a monocyclic system which removed more volume, and used chemical poisoning of undesirable species to create space for mahogany through enrichment planting. This envisaged a 70-year rotation. By 1964 about 120 km^2 had been treated with aborocides. This was abandoned in 1970.

— Management prescription of the time:
- Maximum yield of hardwoods
- Maintenance of representative ecosystem of Budongo, characteristic of the natural communities.

Research identified figs and other species which were being poisoned as undesirables as vital food for chimps and other primates. This resulted in stopping of the poisoning of trees in order to save other wildlife.

Currently, ecotourism has been developed in Budongo based on chimps, which is an insurance for their future as they are likely to produce more income per hectare than timber.

Kalinzu Forest

— On the floor of the western rift valley to the east of Lake Edward.
— Area = 137 km^2
— Medium altitude moist evergreen
— Harvested since 1950-1975 south of the reserve
— Centre north harvested since early 1970 through today
— Threats: charcoal burning, illegal pitsawing, gold panning
— Very high chimp densities

Maramagambo Forest

Relatively intact though affected by illegal hunting and pitsawing. Borders Queen Elizabeth National Park and Kigezi Game Reserve. Relatively little disturbance and not to be harvested until such time when there will be pressing demand for forest produce which cannot be supplied from elsewhere.

Kasyoha-Kitomi Forest

— Area = 399 km^2
— Medium altitude moist-deciduous in the northeast
— One of the least disturbed forests with over 70% remaining relatively intact
— Past management objectives include:
- Maximum sustained yield of timber
- Protection of important catchment

Unlike most of Uganda's forest reserves which are isolated by surrounding agricultural lands, the forests of Kalinzu-Kasyoha-Kitomi and Maramagambo form part of a major network of contiguous protected areas which has the potential to safeguard viable populations of the larger and rarer species including the elephant and leopard which are vulnerable elsewhere. In the long term this forest represents one of Uganda's best opportunities to preserve a "complete" forest ecosystem.

Bugoma Forest

- — Area = 365 km^2
- — Exploited from 1942 through 1976
- — Management aimed at maximum sustained wood production and plantation timber from grassland areas
- — Preservation of representative sample of forest ecosystem
- — Represents the most extensive tract of undisturbed remaining at this altitude

Bwindi Forest

- — Area = 321 km^2
- — Medium altitude moist evergreen; high altitude forest
- — Bwindi is especially important for the conservation of Afromontane fauna and is an important locality for many species that are endemic to the mountains for the western rift valley.
- — Past management objectives include:
    - Protection of the forest
    - Preservation of suitable mountain gorilla habitat
    - Production of sustainable quality of timber and protection of catchment

Rwenzori Forest

- — Gazetted in 1940
- — Area = 966 km^2
- — The main objective of management has been maintenance of vegetation cover to minimise soil erosion and protect water supplies

Condition of Major Chimpanzee Forests as of 1994

Kibale

Condition	Hectares
Undisturbed	347
Mechanically harvested	74
Severely encroached	99
Pitsawn	40
	560

Semliki

Condition	Hectares
Undisturbed	64
30% of forest cleared	65
5-30% of forest cleared	91
	220

Kalinzu - Maramagambo

Condition	Hectares
Undisturbed	457
Mechanically harvested	63
Lightly pitsawn	40
Heavily pitsawn	20
	580

Itwara

Condition	Hectares
Undisturbed	67.2
Mechanically harvested	13.2
Lightly pitsawn	3.0
Heavily pitsawn	3.5
	86.9

Bugoma

Condition	Hectares
Undisturbed	250
Pre-1950 harvesting	35
Post-1950 harvesting	80
	365

Bwindi

Condition	Hectares
Undisturbed	38
Lightly pitsawn	89
Heavily pitsawn	184
	321

Kasyoha-Kitomi

Condition	Hectares
Undisturbed	235
Lightly pitsawn	60
Heavily pitsawn	40
	335

Budongo

Condition	Hectares
Undisturbed	58
Pre-1950 mech. harvesting	90
Post-1950 mech. harvesting	250
Pitsawn	30
	428

(Source: Biological Inventory Team (FD 1994)

The Future of Chimpanzees in Managed Forest Areas

The history of management of the major forest blocks where chimps occur in Uganda is now coming to 100 years. The existence of chimps in healthy populations is a clear indication that as long as the present management systems remain the survival of chimps is assured.

The government of Uganda is signatory to a number of conventions such as the Convention on Biological Diversity and CITES and therefore committed to implementing Agenda 21's forest relevant obligations and The Forest Principles. All these instruments are intended to promote sustainable development and environmental protection. With global cooperation and availability of the necessary funds, there is no reason to doubt the sustenance of viable populations of chimpanzees.

The main threat is the increasing population that is putting pressure on resources including the actual resource base-land. Management systems will have to address the needs of people surrounding these increasingly isolated islands of conservation. Alternatives and enabling conditions must be created for people and form partnership with them in the conservation of all forms of wildlife. They must be beneficiaries and therefore given responsibility.

The current move to harness chimpanzees for ecotourism and sharing in the benefits that accrue is a step in the right direction.

The conflict resulting from resource use in areas with chimp populations need to be resolved by researchers. What is the level of disturbance of a chimp habitat in tropical forests that will not prohibit the sustenance of a viable population? If this is answered then human needs for resources and chimp conservation will be harmonized for the benefit of all.

The most important factor that will enhance sustainable chimp habitat and therefore their population is a joint effort by the conservation agencies, rather than sustaining conflict in mandates and competing for scarce resources.

Table I-1. The Forest Policy (taken from the Uganda Gazette 81(2), 15 January 1988).

1. To maintain and safeguard enough forest land so as to ensure that:
   i) sufficient supplies of timber, fule, pulp, paper and poles and other firest products are available in the long-term for the needs of the country, and where feasible for export;
   ii) water supplies and soils are protected, plants and animals (including endangered ones) are conserved in natural ecosystems, and forests are also available for amenity and recreation.

2. To manage the forest estate so as to optimise economic and environmental benefits to the country by ensuring that:
   i) the conversion of the forest resource into timber, charcoal, fuelwood, poles, pulp and paper and other products is carried out efficiently;
   ii) the forest estate is protected against encroachment, illegal tree cutting, pests, diseases and fires;
   iii) the harvesting of timber, charcoal, fuelwood, poles and other products applies appropriate silvicultural methods which ensures sustainable yields and preserves environmental services and biotic diversity;
   iv) research is undertaken to improve seed sources for planting stock and the silvicultural and protection methods needed to regenerate the forest and increase its growth and yield. Research is also carried out into new and existing forest products including tourism and education with the object of maximising their utilisation potential. Research is undertaken to monitor and promote the preservation of environmental services and conservation of biotic diversity.

3. To promote an understanding of forests and trees by:
   I) establishing extension and research services aimed at helping farmers, organisations and individuals to grow and protect their own trees for timber, fuel and poles and to encourage agro-forestry practices;
   ii) publicising the availability and sustainability of various types of timber and wood products for domestic and industrial use, and publicising the importance of environmental services provided by forests;
   iii) holding open days at regular intervals in all districts to demonstrate working techniques and bring attention to the positive benefits of forestry.

II. An Overview of Habitat Viability for Chimpanzees

John M. Kasenene
Department of Botany
Makerere University

General Overview

There are at least 21 countries in Africa which have or could hve populations of wild chimpanzees. Most of these fall in what is biogeographically called West Africa, i.e., Africa west of the Great Rift (Heltne and Marquardt 1989). These countries at least have suitable habitats in terms of vegetation and climate (Table II-1). These habitats range from rain and montane forests to dry woodlands and savannas with scattered trees. In low altitude tropical rain forests, the chimps live in moderate temperatures with mininal fluctuations, high relative humidity and wet conditions. However, in arid areas such as Senegal, southeast Tanzania, etc, they live at high temperatures up to about 42°C or low temperatures to about 17°C or lower at night in the Rwenzori (800m altitude) and the Bwindi Impenetrable Forest. Therefore, chimpanzees can live from sea level to as high as 3,000m elevation.

Historically, chimpanzees were perceived as strictly tropical forest species covering the tropical forest belt that once stretched nearly unbroken across most of equatorial Africa. Today, however, chimpanzees occupy many other habitats and not all tracts of tropical forests contain chimpanzees (Teleki 1989).

Survival options for chimpanzees and suitable chimp living in their natural environment are influenced by many factors such as:

- High food density (vegetable and animal proteins);
- Easy access to water;
- Unlimited supply of trees for sleeping, feeding locomotion and escape;
- Low density of feline predators;
- No hunting of chimps for meat by neighbouring communities; and
- Most importantly, the exceptional adaptive flexibility of chimpanzees.

Their adaptability makes it somewhat difficult to identify optimum habitats for the species. Chimpanzee densities in humid tropical forests vary as much as they do anywhere else and so tropical forests should not be viewed as the best habitats. Some sources suggest that open grassland - woodland - forest complex may form the most suitable habitat in which to maintain chimpanzee lifestyles (McGrew et al. 1981). However, chimpanzee country could be dry or moist but should have some form of tree cover and diversified vegetation in terms of vertical zonation and horizontal heterogeneity for chimp foraging, nesting, etc.

Such vegetation or habitat types could include:

- Savanna woodlands and forest ecotones (e.g., Kamia Pabidi)
- Dry savanna and deciduous woodlands
- Mosaic grassland forests
- Gallery forests at lower elevations and deciduous forests above (e.g., Gombe N.P.)
- Dense thickets of low shrub in grassy meadows
- Humid canopy medium-altitude tropical moist forests (e.g., Kibale N.P.)
- Selectively logged and secondary forest (e.g., North KNP)
- Abandoned old fields and colonizing forests (e.g., South KNP)

However, chimpanzees in small patches of forests or islands surrounded by a sea of cultivation meet several problems through a conflict of interests on the habitat between chimpanzees and man.

The Ugandan Perspective

In view of what has already been said and observed about chimpanzees in Uganda, the viable chimpanzee habitats in Uganda have to be included under protected area systems such as National Parks, Conservation Areas, Forest Reserves, etc. Needless to say, these have to be large enough areas to satisfy the ecological needs of the chimpanzees (see Table 3-3, page 41).

I want to characterize viable chimpanzee habitat according to:

a) The locality and status of the habitat
b) The area / size of the habitat
c) The climate (rain and temperature) of the area
d) Vegetation types
e) Density of trees and species
f) Chimp plant food types and species
g) Number of fig species (Proportion of total plant food types, above)
h) Diversity of terrestrial herbaceous vegetation (THV)
I) Abundance and diversity of herbivores and ungulates
j) Predators of chimpanzees (especially felines)
k) Human hunting pressure

The Kibale National Park as Viable Chimp Habitat

The Kibale Forest National Park is vegetatively similar to the TRF ecosystems of West Africa where chimpanzees abound. Its area coverage (760 km^2) and elevation from 1590m to 1110m is within the viable habitat range for chimps (Ghiglieri 1984).

Vegetationally, Kibale forms a complex of edaphic and topographic mosaics of:

- Grasslands
- Woodland thickets
- Colonizing forest
- Tropical high forest

- Swamp forest (palms, figs, *Neoboutonia* and *Symphonia*)
- Swamps of sedges and papyrus
- A diversity of ground story herbs, shrubs, vines etc.
- Secondary regenerating forest
- Forest-grassland colonizing ecotones

In the Kibale National Park, chimpanzees rarely utilise grasslands and papyrus swamps but all other types above. Within these vegetation/habitat types, priority chimpanzee tree food items, as in the case of KNP tropical high forest coul include (Table II-2).

Chimpanzees can be 90% frugivorous (Reynolds and Reynolds 1965). Higher percentages of foods are fruit pulp or pulp with seeds where trees play a major part. However, other plant food types eaten by Kibale chimps include tree seeds, bark, pith, leaf buds and young leaves of terrestrial herbaceous vegetation (THV). This implies that the forest ground vegetation cover (GVC) and composition is also a vital element in an ideal chimpanzee habitat.

Climatically, the KNP can be described as warm and rainy. The four distinct annual rainy seasons from March through May and September through November allow permanent rivers, streams and swamps in valleys. Water is never a limiting factor to chimpanzee ecological lifestyles. The moderate temperatures are ideal for chimpanzee activities, they are constant and rarely exceed 25°C.

Finally, an abundance and diversity of herbivores and ungulates in KNP form an important component of chimpanzee habitat. The rich Kibale mammalian fauna reflects an interface habitat containing wildlife typical of central and East Africa. Elephants and nine species of ungulates, e.g., bushbuck, buffalo, sitatunga, duikers, waterbuck, bushpig, forest hogs and warthogs occur there. Seven species of diurnal sympatric primates occur within the reserve: babboons, redtail monkeys, blue monkeys, L'Hoest monkeys, mangabeys, red colobus and black and white colobus monkeys. These are generally prey to the chimpanzee.

Hunting Pressure

The Bakonzo used to hunt game including primates (chimpanzees as well) for meat prior to 1962. However, the hunting pressure on chimpanzees for meat is no longer a problem since the neighbouring Batooro consider all primates unfit for human consumption. However, chimps are snated and maimed accidentally while the Batooro are trapping for other edible ungulates in the KNP ecosystem.

References

Ghiglieri, M.P. 1984. The Chimpanzees of Kibale Forest. New York: Columbia University Press.

Heltne, P.G. and L.A. Marquardt. 1989. Understanding Chimpanzees. Cambridge, MA: Harvard University Press.

Howard, P.C. 1991. Nature Conservation in Uganda's Tropical Forest Reserves. IUCN, Gland, Switzerland and Cambridge, UK.

McGrew, W.C., P.J. Baldwin and C.E.G. Tutin. 1981. Chimpanzees in a hot, dry and open habitat. Mt. Asserik, Senegal, West Africa. Journal of Human Evolution 10:227-244.

Ransom, T.W. 1981. Beach Troop of Gombe. Bucknell University Press.

Reynolds, V. and F. Reynolds. 1965. Chimpanzees of the Budongo forest. Pages 368-424 in: de Vore (ed.). Primate Behavior. New York: Holt, Rinehart and Winston.

Teleki, G. 1989. Population status of wild chimpanzees (Pan troglodytes) and threats to survival. Pages 312-353 in: Heltne, P.G. and L.A. Marquardt (eds.). Understanding Chimpanzees. Cambridge, MA: Harvard University Press.

Table II-1. African countries that have or could have chimpanzees in the wild.

West	**Central**	**East**
P. t. verus	*P. paniscus; P. t. troglodytes*	*P. t. schweinfurthii*
Ivory Coast	Equatorial Guinea	Tanzania
Senegal	Zaire	Uganda
Guinea	Gabon	Zaire
Sierra Leon	Cameroon	Sudan
Liberia	Central African Republic	Rwanda*
Mali	Congo	Burundi*
Ghana	Nigeria*	Zambia*
Guinea Bussau	Angola*	Malawi*
Gambia*		Kenya*
Burkina Faso*		
Togo*		
Benin*		
Niger*		

* Absent or unconfirmed

Table II-3. Top twelve chimpanzee food species in Kibale National Park, ranked according to scores for feeding.

Food Species	Fruit	Seed	Rank	Other*
Ficus mucuso	131	131	1	24 (leaves)
Pterygota mildbraedii	95	37	2	21 (lf, bk, wd)
Ficus natalensis	49	49	3	1 (cambium)
Pseudospondias microcarpa	34	34	5	5 (lf, bk, bloss)
Uvariopsis congensis	34	-	6	
Ficus dawei	25	25	7	
Cordia millenii	28	-	8	13 (lf, bloss)
Mimusops bagshawei	19	19	9	
Ficus brachylepis	13	13	10	
Monodora myristica	6	6	11	
Celtis durandii	2	2		

* lf, leaves; bk, bark; wd, wood; bloss, blossoms.

III. An overview of chimpanzee conservation and management strategies[1]

Richard Wrangham and Tony Goldberg
Peabody Museum, Harvard University, USA

The importance of Uganda's chimpanzees

As a species, chimpanzees merit conservation because their world numbers are falling at a high rate, due both to hunting (in much of west and central Africa), and habitat loss (throughout their range). They hold special interest because of their close genetic relationship to humans, which combined with other evidence suggests that they resemble human ancestors about 5-6 million years ago. Conservation of every population is valuable because behavioral and cultural differences occur among all known populations (>20 sites), making them uniquely informative about the evolution of human behavior.

Uganda's chimpanzees are all members of the eastern subspecies, *Pan troglodytes schweinfurthii*, which occurs also in Zaire, Burundi, Rwanda, and Tanzania. Chimpanzees in Zaire are hunted and eaten, and there is little protection in most of their range; Zairean populations appear substantially threatened. Those in Burundi and Rwanda are confined to small areas of mostly threatened habitat. Two populations of Tanzanian chimpanzees are well-protected, one of about 1000 in Mahale Mountains National Park, and a smaller population in Gombe National Park (about 150). These parks are mosaics of an important chimpanzee habitat type, i.e. mixed forest, woodland, and grassland. Small numbers of Tanzanian chimpanzees occur also outside these parks, in drier country.

By contrast to these countries, Uganda has substantial numbers of well-protected chimpanzees living in a series of forest blocks, including six apparently substantial populations (Budongo-Rabongo, Bugoma, Itwara-Kibale, Ruwenzori-Semliki, Kashoya-Kitomi-Maramagambo-Kalinzu, Bwindi). Uganda appears to provide the best hope for managing a viable long-term metapopulation of forest-living *Pan troglodytes schweinfurthii.*

Relevance of conservation strategies for Uganda's chimpanzees

As a basis for discussion, we briefly discuss below eight potential strategies for conserving Uganda's chimpanzees.

---

[1]Pre-Conference Draft: Not for quotation.

1. Protecting habitat from destruction by humans

Chimpanzee habitats in Uganda fall into four main categories of conservation status.

A. National Parks (Bwindi, Queen Elizabeth (Maramagambo, Ishasha, Kyambura), Kibale, Ruwenzori, Semliki).
B. Forest reserves (Kasyoha-Kitomi, Kalinzu, Itwara, Bugoma, Budongo).
C. Game reserves (Toro).
D. Unprotected (e.g. village areas surrounding parts of Kibale N.P.).

Habitat protection has been generally effective in categories A, B and C, though some areas such as Bugoma F.R. warrant scrutiny. These areas undoubtedly contain the great majority of Uganda's chimpanzees (perhaps 98%), and there is no evidence of chimpanzee populations suffering from recent habitat destruction in categories A, B and C.

Chimpanzee habitats in unprotected areas, by contrast, are certainly dwindling, for example on the west side of Kibale National Park. Little is known about the chimpanzees in such zones. They probably occupy large home ranges (50-100 km^2), harvest agricultural crops extensively, and depend for cover and much food in strips of forest in valley bottoms. Currently such valley strips of forest are being removed by farmers, causing probable loss of chimpanzee populations. Total removal of such forest strips can be expected within a decade or so unless action is taken in the Kibale environs.

Protection of chimpanzee habitat does not necessarily mean that chimpanzee numbers are maintained at a constant level, even in the absence of external threats. Natural succession from more secondary and disturbed vegetation could in theory lead a protected forest to provide reduced food for chimpanzees, e.g. through fewer fig-trees. Thus, for maximal population densities, management that includes some disturbance to the natural succession may be beneficial.

2. Protecting habitat from natural destruction

Fire and other natural processes appear not to threaten chimpanzee habitats in Uganda. Apparently, there is no need to manage with respect to protecting habitats from natural processes.

3. Protecting populations from being hunted

There is no known deliberate hunting of chimpanzees for trade or meat in Uganda. However, hunters set bush-meat snares in much, perhaps most, of the total chimpanzee range in Uganda. One result is that many individuals have life-long wounds from snares, ranging from loss of knuckles to crippling or loss of hands or feet. From a humane point of view, this is a problem that requires action. From the conservation point of view, the question is how many individuals die from being snared.

The rate of death from snaring is unknown, but an estimate can be obtained form Kanyawara data. From 1988 to 1996, we have nine years of data on a total of 67 individuals from the Kanyawara community. “Snareable” individuals were considered to be those 6 years old or more, since younger chimpanzees are carried by their mothers or walk behind them. In 300 “snareable-chimpanzee-years” we recorded 11 new snares, i.e. a net rate of 3.7% probability of a new snare per year per snareable chimpanzee. During the 9 observation years, no individuals were known to be killed by a snare or snare wound. There were five deaths with attributable causes (3 old age; 1 killed by chimpanzees; 1 respiratory disease) whereas four individuals disappeared from unknown causes (Julian, young adult male; Marion, prime mother; Ruhara, juvenile male (7 years); Omugu, infant female (3 years)). On the worst-case assumption that all four died from snare wounds (even though Omugu was too young to be in the category of “snareable” chimpanzees) the maximum death rate from snares would be 4 deaths in 300 chimpanzee-years, i.e. 1.3% per year. The number of births (19) substantially exceeded the number of deaths during this period (9). These data indicate a low death rate from snaring.

However, the rate of acquiring snares (3.7%) per year and wounds was high. Out of 55 “snareable” individuals recorded from 1988 to 1996, 18 show damage that is probably the result of a snare (Table III-1).

There is some evidence of a sex difference in vulnerability to snares. Thus from all known snareable individuals, males have had more apparent snare-wounds (9/19 snareable individuals, i.e. 47%) than females (9/36 snareable individuals, i.e. 25%). A similar difference is seen if only newly observed snares are considered (1988-96: males 32%, females 11%). Behavioral differences between males and females responsible for this could include the longer travel of males, and the fact that they are more likely to be in the front of the line. The Kanyawara data suggests that if there is an effect of snares on mortality, it is stronger on males than on females.

Snares are currently being discovered at a higher rate in Kanyawara than at any other time during the observation period (1988-1996). Furthermore the rate of new snares on chimpanzees during 1996 (7.3% per snareable individual) was higher than in any other observation year. Kanyawara was formerly part of a forest reserve, but is now in Kibale National Park. National Parks methods for preventing snaring thus appear less effective than those of the Forest Department. This emphasizes that new strategies may be needed for reducing the setting of snares in chimpanzee habitats within National Parks.

4. <u>Protecting populations from disease</u>

Protection from natural disease epidemics is probably not warranted on conservation grounds alone, because there is no evidence of populations being eliminated, or even severely reduced, by diseases. However, on humane grounds it would clearly be desirable to protect from serious diseases. Unfortunately no way is known to monitor use health status of unhabituated chimpanzees. Even with habituated chimpanzees, monitoring is difficult because managers are normally restricted to non-invasive sampling, i.e. direct observation and collection of urine and dung. Intervention in the case of observed disease outbreaks, e.g. by injections or feeding drugs, has not been achieved in Uganda. Chimpanzees have been successfully darted with immobilizing drugs in Gombe (Tanzania), but the only such attempt in Uganda caused the death of the chimpanzee (adult male Mkono, who fell from a tree in Budongo ca. 1970). Thus intervention appears costly and risky.

Attempts to protect chimpanzees from human diseases are worth considering. Most populations of Ugandan chimpanzees are fringed by agriculture, and at least occasionally visit fields for food. Fields are reservoirs of humans pathogens, including parasites from human feces. Horizontal transmission of parasites from humans to chimpanzees is therefore to be expected, and preliminary evidence suggests it occurs in Kanyawara (L. Basse, pers comm). However the effort required to protect crop-raiding chimpanzees from picking up human parasites would be substantial.

5. Managing genetic diversity

Genetic variation among Ugandan chimpanzees was described by Goldberg (1996), based on the fast-evolving mitochondrial D-loop gene analyzed from hairs collected in Budongo, Bugoma, Kibale, Ruwenzori, and Semliki. There was no evidence of significant genetic differentiation between populations. However, Ruwenzori chimpanzees had the largest number of rare haplotypes, indicating that Ruwenzori may have acted as an important source population for Uganda when populations recovered following the last ice age (10-12,000 years ago). Thus, the Ruwenzori population has the greatest known genetic significance of any Ugandan population.

Genetic variation within populations was uniformly high, indicating no evidence of inbreeding threat in the studied populations.

6. Introduction into suitable habitats with few or no chimpanzees

Orangutan conservation strategies include introductions of captive individuals into both empty and occupied forests. For chimpanzees, however, this strategy appears not to be viable.

First, no empty habitats are currently known in Uganda capable of supporting a chimpanzee population within the historical range of the species. It is possible that some of the larger islands in Lake Victoria would permit self-sustaining populations, given the experience with Rubondo Island in Tanzania, where a population of chimpanzees was released in the 1960's and has become well established. However there appear to be no suitable islands within Uganda: all large forested islands are also peopled by farmers whose interests would be threatened by the chimpanzees. Because hunting and disease appear not to be important threats to entire populations, it seems unlikely that Ugandan chimpanzee habitats will lose their chimpanzees except as a result of habitat loss.

Second, introductions into occupied forests are not merited on conservation grounds: natural reproduction can be expected to maintain population density unless there is excess mortality from hunting or habitat loss, in which case introductions are not wise. However on humanitarian grounds, reintroductions of captive individuals are desirable. Unfortunately they are unlikely to be successful. Social groups will often be hostile to immigrants, except to young females. In the only attempted introduction in Uganda, a young female (Bahati, ca. 4 years) rescued from captivity was introduced to the Kanyawara community in 1994. Through much effort she was provided with physical training and knowledge of local foods, and she was socially accepted. However when the fruit supply became poor, she returned to human habitation in search of hand-outs (L. Naughton and A. Treves, pers comm).

A reintroduction strategy is therefore not recommended as a major tool of chimpanzee conservation.

7. Promoting public interest in conserving chimpanzees: eco-tourism

National Ugandan newspapers bear witness to substantial public interest in the status of wildlife conservation and in the humane treatment of wild and captive species. This is particularly true for chimpanzees, evidenced by the thousands of visitors per year to see chimpanzees at the Entebbe Wildlife Education Center, and the crusading journalism of Ndirakira Amooti and the New Vision, the national newspaper for with Amooti writes. Even so, however, there are conflicts between chimpanzee and human interests that threaten the good standing in which chimpanzees are often held. Promoting the interests of chimpanzees by showing that they can provide economic benefits is therefore of major significance.

The principal conflicts are over land use. Conservationists seek to maintain gazetted lands as protected areas; farmers seek extra land, and already have to be forcibly prevented from cutting in some areas. Conservationists hope that chimpanzees visiting fields will not be harmed; farmers protecting their crops seek redress from crop damage (which is generally minimal from chimpanzees). Extreme conflicts occur occasionally. In Ruteete village, west of Kibale N.P., four well-documented predatory attacks by a chimpanzee on children have occurred from 1994-1996, leading to two deaths. (These were probably the acts of a single “rogue” chimpanzee, since all were by a single adult male withing a small geographical range of 3-4 sq km where chimpanzees are rarely found). Conflicts over land use will surely intensify as Uganda’s rural population and agricultural needs grow.

Fortunately, chimpanzee habitats are mostly in gazetted areas where promotion of eco-tourism is already a key management strategy employed by the relevant authority (i.e. the Forest Department (for Forest Reserves) or the Uganda Wildlife Authority (for National Parks)). In theory, the benefits of eco-tourism are that gazetted habitats will be maintained at a steady profit for the managing authority and for the country, and that these profits will ultimately serve to ameliorate conflicts (e.g. by revenues returned to local people through Park Management Advisory Committees). These benefits depend on sufficient visitors coming, and the facility being sufficiently well maintained, that profits are sustained without damage to the habitat or population.

Uganda is now in an experimental stage with regard to chimpanzee-focused eco-tourism. Since 1991 facilities with semi-habituated chimpanzees have been developed in Kyambura (Queen Elizabeth NP), Kanyanchu (Kibale NP), and Kaniyo-Pabidi (Budongo FR). All appear to be developing well and are attracting sufficient visitors to merit the investment in these facilities. At present they provide important adjunct experiences for tourists whose main interest in Uganda is seeing gorillas in Bwindi or Mgahinga, i.e. they are often viewed as “fillers” on a gorilla-focused circuit of western Uganda. As the chimpanzees become more habituated and tourists are better serviced, chimpanzee-viewing should become a primary goal of more tourists. Dissemination of research data on Uganda’s chimpanzees can be expected to enlarge the constituency of tourists with special interests in visiting these populations.

As a conservation strategy, chimpanzee-focused eco-tourism has several benefits and appears to have a large potential future. As with gorilla-focused eco-tourism, it is important to manage human-ape contact so as to minimize stress to the apes, to reduce disease transmission in each direction, and to avoid aggression. Given these caveats, eco-tourism has great potential for linking the conservation of chimpanzees to local and national interests and thus for ameliorating human-chimpanzee conflicts.

8. Developing a nationally coherent management plan

Uganda’s chimpanzees are currently managed by two major authorities, the Uganda Wildlife Authority (responsible for national parks and game reserves) and the Forest Department (responsible for forest reserves), located in two different ministries (Tourism Wildlife and Antiquities; and Environmental Protection, respectively). In some respects it may be advantageous for managers to unite closely.

Examples of how this might help range from issues of how to manage conflict between chimpanzees and farmers, to the development of an integrated tourism facility. For instance, it might help tourism companies if they could evaluate the opportunities at different chimpanzee eco-tourism sites through a single channel, such as knowing which is the best site for viewing chimpanzees at a given time of year. Ultimately, therefore, a mechanism for facilitating close inter-departmental cooperation ins likely to assist chimpanzee conservation.

Concluding Discussion and Summary

This paper discusses eight strategies available of conserving and managing Uganda’s chimpanzees. We conclude that the critical overall factor is the amount of habitat, most of which is officially protected. Uganda has the advantage of a cultural disinterest in hunting primates, a managerial system that appreciates the merits of conservation, and a history of effective forest management. Losses in the past century appear to have been rather minor, even during the war-torn years of the 1970's and 1980's. The maintenance of habitats at current levels depends on support for existing national habitat conservation strategies. With respect to chimpanzees, special support for habitat protection can come from financial benefits (via eco-tourism), research (producing information that enlarges the constituency of interest), and monitoring (guarding against habitat loss, hunting or disease), as well as by vocal advocacy.

Acknowledgements

Among other acknowledgements, the Columbus Zoo deserves special mention for its assistance to the Kibale Chimpanzee Project and EWEC for conservation education posters and other materials, supporting research through providing video and other equipment, and funding efforts to reduce the number of snares in Kibale National Park.

Table III-1. Snare damage in the Kanyawara community

The table shows the number of individuals with permanent wounds known (N=9) or suspected (N=9) to be result of snares. “Crippling” refers to the damage that reduces the efficiency of ordinary locomotion or feeding.

Lost hand	4
Crippled hand	4
Lame hand	5
Lame finger	2
Crippled feet	2
Crippled toes	1

IV. Estimating Chimpanzee Populations

Andrew Plumptre

Estimating chimpanzee populations in forests is fraught with difficulties. Studies to date which have attempted to census chimpanzees have often made assumptions without testing them and when tests have been made these assumptions have been shown to be erroneous.

Unlike monkeys chimpanzees live at low densities, do not form stable groups, and can be very silent. These factors make censusing them difficult. Often a chimpanzee within its community will be on its own or with an infant and will freeze when it detects danger making it difficult to detect when censusing. Because of these problems chimpanzees have been censused with two main types of indirect method:

1. The home range estimate. This method is very labour intensive and involves the habituation of a chimpanzee community, determination of community size and the determination of the area this community uses. A density is then calculated from this information and extrapolated to a larger area. This method was used in the early studies in Budongo forest and has been used in Kibale forest. Ideally this method should look at several communities in the same area so that the variability in densities/home range sizes is measured and also look at what happens at the boundaries of the range between different communities. This has not been done. Goodall (1986) has looked at home range changes over time within one community and shown that it can very greatly between years even if the community does not change much in size. In addition, Gros *et al.* who used this method on cheetahs and could compare it with known densities based on individual recognition found it to be the most unreliable estimator of cheetah density of any of the methods they tried. Consequently I would argue that this method is unlikely to produce good estimates of density.

2. *Estimation of chimpanzee nest density* Gorillas, chimpanzees and orangutans have all been censused using counts of night nests. Censuses of gorillas have been the most accurate using this method because it is possible to identify stable groups from the nest counts and size of dung in or around the nest (Weber and Vedder 1983). Chimpanzees, however form parties within their community which split up and join together forming a "fission-fusion" society. Consequently, stable groups cannot be identified. Instead counts of nests are usually made along transects and these are used to calculate a density of nests and then this is extrapolated to a density of animals. The advantage of counting nests rather than chimpanzees is that they survive many days and hence are more likely to be seen than the animals themselves.

Standing crop counts

Most nest counts have used what Plumptre and Reynolds (1996) called "standing crop nest counts" or SCNC. These involved walking along transects, counting all nests seen within a certain width or by measuring perpendicular distances to the nests from the transect. It is recommended that nest groups are counted (Hashimoto 1995) as nests are often clumped in space. These counts calculate a density of nests in an area and then try to correct the total density by a rate of decay of the nests. This technique has been used in Kibale forest in Uganda (Ghiglieri 1984), all over Gabon (Tutin and Fernandez 1984; Wrogemann 1992) in Kalinzu forest in Uganda (Hashimoto 1995) and Budongo forest (Plumptre and Reynolds 1996). In Budongo and Kalinzu decay is approximately exponential (Plumptre and Reynolds 1996; Hashimoto 1995). If this is the case then a constant rate of decay can be calculated after the decay of about 80% of the nests that are monitored rather than following all of them to decay as is required if a mean decay rate is calculated (as has been done for all other studies). This can shorten the study period where time is scarce.

For these censuses it has been assumed that nest decay rate is constant but where this has been tested this has been shown to be false. Plumptre and Reynolds (1996) and Wrogemann (1992) showed seasonal differences in the decay rate of nests. The decay of nests also varies greatly ranging from 10 to 161 days in the Budongo forest.

<u>Marked nest counts</u>

One way to avoid the problems of calculating nest decay rates and to avoid the variation these rates contribute to the overall population density estimate (although the errors never have been incorporated into the calculations as they should be) was suggested by Plumptre and Reynolds (1996). This involves the repeated walking of transects and hence less area can be covered in the same time as a SCNC but we would argue that the benefits outweigh the extra costs involved. In addition a SCNC has to monitor nests for decay rates for up to 160 days and hence have to be in an area some time in any case. For the “marked nest count” (MNC) a transect is walked 3 times on successive days and all nests detected from the transect are marked with stakes below the nest. Tests of this method of marking in Budongo showed that few stakes were knocked down by animals in the forest and by measuring the distance a nest was along the transect and perpendicular to the transect it could be identified in the future even if a stake was lost. The transect is then walked every 3 weeks and newly constructed nests counted and marked until a reasonable sample size (at least 30 new nests) has been obtained. A density is then calculated by counting the total number of nests produced within the width of the transect and dividing this by the time period elapsed between the first marking and the last.

<u>Assumptions about nest building behavior</u>

Several assumptions have been made about how chimpanzees construct nests when converting nest densities to total animal densities. It is known that infants do not build night nests and in Kibale (Ghiglieri 1984) and Budongo (Plumptre and Reynolds 1996) this is about 17.5% of the populations. It is assumed for other studies that this proportion is similar.

In addition it is assumed that all adults and juveniles build a new night nest each night. Where this has been studied in Budongo this has been shown to be false. In the Sonso community 12.4% of night nests are reused (n = 482 nesting events). This value is lower than the percentage given in Plumptre and Reynolds (1996) but is based on a much larger sample size.

It is also assumed that the transect trails have no effect on the nesting behaviour of the chimpanzees. In the Sonso community in Budongo there is a trail system in a grid with trails every 100 metres. Studies of the position of nests constructed by habituated chimpanzees that have been followed to the nesting show that they nest significantly more than expected in the centre of the 1 hectare blocks and less than expected near the trails. It is possible that this is due to the observer following them but when they do nest they are fairly content to nest low down near the heads of the observers and hence this is unlikely. This has implications for the marked nest count where repeated visits along the transects are made. A census carried out in 1996 in the area used by the Sonso community using the same trails used in 1992 show a significant reduction in the population density despite the fact that we know that the community is about the same size. Therefore it appears that this effect was not operating over the three month period of the MNC in 1992 when the chimpanzees were not so habituated and there were fewer researchers following them. It is recommended therefore that for any nest count censuses that transects should not be those that are used regularly by people.

Chimpanzee density estimates for Uganda

Table IV-1 gives the estimated densities for chimpanzees in three forests in Uganda based on nest counts and home range estimates. There are large errors with these but they do provide a ballpark estimate form which we can work.

Table IV-1. Estimates of chimpanzee densities (No. Per km^2) in Uganda based on home range estimates and nest counts. Where several estimates were made using different techniques all are quoted.

	Forest	Year	Density
Home Range			
Reynolds & Reynolds 1965	Budongo	1962	3.9
Chapman & Wrangham 1993	Kibale	1987-92	2.8-5.3
Nest Counts - SCNC			
Ghiglieri 1984	Kibale	1978	2.4
Hashimoto 1995	Kalinzu	1992-93	2.8-4.0
Plumptre & Reynolds 1996	Budongo	1992	1.8-1.9
Nest Counts - MNC			
Plumptre & Reynolds 1996	Budongo	1992	1.3
Counts of Chimps seen			
Ghiglieri 1984	Kibale	1978	1.4
Plumptre & Reynolds 1996	Budongo	1992	2.5

I would recommend with any census that a method is chosen that minimises any errors in the estimate. Any correction factor has an error associated with it which should be included with the total population estimate but to date this has never been done for chimpanzee censuses. Consequently I would recommend the marked nest count method because it avoids the calculation of nest decay rates which are highly variable.

References

Chapman, C.A. and R.W. Wrangham. 1993 Range use of the forest chimpanzees of Kibale: implications for the understanding of chimpanzee social organisation. American Journal of Primatology **31**: 263-273.

Ghiglieri, M.P. 1984. The Chimpanzees of Kibale Forest: A Field Study of Ecology and Social Structure. New York: Columbia University Press.

Goodall, J. 1986. The Chimpanzees of Gombe. Cambridge, MA: Belknap Press.

Gros, P.M., M.J. Kelly, and T.M. Caro. 1996. Estimating carnivore densities for conservation purposes: indirect methods compared to baseline demographic data. Oikos **77:** 197-206.

Hashimoto, C. 1995. Population census of the chimpanzees in the Kalinzu forest, Uganda: comparison between methods with nest counts. Primates **36:** 477-488.

Plumptre, A.J. and V. Reynolds. 1996 Censusing chimpanzees in the Budongo forest, Uganda. *International Journal of Primatology* **17,** 85-99.

Tutin, C.E.G. And M. Fernandez. 1984. Nationwide census of gorilla (*Gorilla g. gorilla*) and chimpanzee (*Pan t. troglodytes)* populations in Gabon. American Journal of Primatology **6:** 313-336.

Weber, A.W. and A. Vedder. 1983. Population dynamics of the virunga gorillas: 1959-1978. Biological Conservation **26:** 341-336.

Wrogemann, D. 1992. Wild Chimpanzees in Lope, Gabon: Census Methods and Habitat Use. Unpublished PhD Thesis, Bremen University, Germany.

V. Chimpanzee General Ecology in Uganda

G. Isabirye Basuta
Department of Zoology, Makerere University

Introduction

From time to time reports have appeared in the local press about chimpanzees being found in different parts. These have included the Zoka Forest in West Nile, the Busitema Forest in Eastern Uganda, along the Jinja Tororo highway and even in the dry montane forest of Karamoja. The main problem here is that most people cannot distinguish the differences between apes and the non-human primates in general and between chimpanzees and baboons in particular. In this paper a critical examination on the distribution and abundance of chimpanzees in East Africa is given.

Distribution of Chimpanzees in East Africa

Chimpanzees occur in two distinct belts: along the Albertine system in Uganda and the Eastern shores of Lake Tanganyika. This represents the most easternly distribution of their range which stretches across the tropical forests of African from West Africa to Congo Basin (Kingdom 1984). In Tanzania chimpanzees occupy a mosaic of Braclystegia woodlands, thicket and riverine forest. The best known populations are found in two small national parks (Mahale mountains and Gombe). Within Uganda chimpanzees habitat is much more varied. It ranges montane forests associated with Bwindi and Rwenzori National Parks, medium altitude forests such as Kibale and Kalinzu to almost lowland forests such as Semliki (Howard, 1991).

Chimpanzee Distribution within Uganda

Some form of tropical forest is an essential requisite of chimpanzee habitat. In this regard tropical areas apparently suitable as chimpanzee habitat occur in Uganda in three distinct zones, that is along the Albertine Rift System, the shores of Lake Victoria and on highlands and mountains. However, the geographical range of chimpanzees is limited to forests of the Albertine system. The main chimpanzee populations are found in major forest reserves and national parks. Small isolated populations are found scattered among forest remnants and riverine forests and woodlands. What then does one make of claims of post chimpanzee distribution in areas for away from current range such as Mabira forest? (Kingdom 1984). It appears unlikely that chimpanzees ever occurred in Mabira forest since this forest lies far away from the traditional chimpanzee range in East Africa. Secondly what factors led to their extinction since chimpanzees are not traditionally hunted for food in Uganda?

Our knowledge of chimpanzee distribution even within their traditional range is far from complete. For example, little is known about chimpanzees within the woodlands and riverine forests associated with the Muzizi river close to the Bugoma Forest. Similarly chimpanzee distribution north of Kibale National Park is poorly known. In spite of occasional sightings of chimpanzees in forests such as Matiri it is far from clear as to whether they are also present in other nearby small forests.

Chimpanzees Populations Within Various Habitat

One of the most frequently asked questions is how many chimpanzees exist in Uganda. This question is also often asked in relation to particular forests such as Kibale. There are readily available answers. First chimpanzees cannot be counted using conventional methods of counting animals due to poor visibility within their forest habitat. Secondly, even within the same forest habitats occupied by chimpanzees vary tremendously in such key aspects as fruit and terrestrial herbaceous vegetation food resources. This makes it difficult to extrapolate data from one locality to the rest of the forest.

Chimpanzee populations are estimated using nest counts (Ghizlieni, 1984). Based on this technique intensive surveys have been carried out for Budongo and Kibale forests. Limited data are available from other forests (Howard, 1991). Based on these data the largest chimpanzee populations are found in Budongo, Kibale and Kalinzu forests.

VI. The Chimpanzees of Budongo Forest: A Case Study

Christopher Bakuneeta
Budongo Forest Project
P.O.Box 362, Masindi, Uganda

Introduction

The chimpanzees of Budongo Forest were the first to be studied in this country. Prof V. Reynolds and his wife worked in this forest for 8 months in 1962. They were followed by Sugiyama and Suzuki in 1967 and 1968 respectively. The three researchers came up with the highest densities ever recorded in the wild (Teleki, 1989). Although their densities have been queried, because of the methods used at that time, the recent census by Plumptre and Reynolds (1994) still makes it have a viable population of chimpanzees.

Suzuki (1971) was the first primatologist to observe carnivory and infanticide in chimpanzees in the wild. This happened in Budongo Forest.

Because most of these studies were short-lived, some of the conclusions drawn are being disputed. An example is Sugiyama's (1988) study where he reported that chimpanzees in Budongo Forest did not eat insects. I have observed chimpanzees feeding on *Cubitermes* in the forest.

Study Area

Budongo Forest is located in the western part of Uganda as shown in Figure VI-1. It has an area of 793 km^2 of which only 428 km^2 is forested. It was classified as a esmi-deciduous moist tropical rain forest (Langdale-Brown *et al*., 1964). Over 75% has been selectively logged. The study was conducted in two main compartments (N3 which was logged between 1947-52) and compartment N15 which has never been logged and was gazetted as a Nature Reserve as early as 1942 (Figure VI-2).

The area receives a mean annual rainfall of 1413.1 mm with peaks in April-May and September-November. The main dry season is in December-February.

Methods

A group of 52 chimpanzees has been habituated for research at Sonso and two other groups are being habituated at Kaniyo-pabidi and Busingiro for tourism.

Data collection was done concurrently with habituation. When habituation was successful, focal animal sampling was done on known individuals.

Data on feeding was collected by direct observations and through faecal washing and analysis. Rare food items such as tree resin, meat-eating, tree bark, insects, etc, were recorded by *ad lib* sampling (Altmann, 1974).

Fresh faecal samples were collected from the forest and the dung was washed and sieved (Tutin and Fernandez, 1985). Identification of the contents/ingredients was done by visual observation. The seeds found in the dung were counted and their germination succes was experimented on by planting them immediatelt after identification.

Results

<u>Food and feeding habits</u>

Figs form the staple diet for chimpanzees in Budongo (Figure VI-3). *Cynometra alexandri* is a keystone food during the dry season. Chimpanzees feed on its green beans before they are ripe at this time of the year. This reduces the species' ability to propagate itself. *C.alexandri* was poisoned with 2-4 D (Dichlorophenoxyacetic acid) and 1 2 4-T (Trichlorophenoxyacetic acid) by forest management in the past as "undesirable". Figs form a staple diet as they are in fruit throughout the year.

Broussonetia papyrifera (L) Vent. the second most important food species (after *Ficus)* in providing food for the chimpanzees of the Sonso community (Figure VI-3). This species was introduced in Uganda from S. East Asia (Polhill, 1989) on experimental purposes. The experiment failed and it was abandoned. The species is suspected to be invasive. According to Dawkins (1956), it is the fastest growing tree he recorded in Uganda. The forest management has not stated its policy on invasive species.

Out of the 32 episodes of feeding on tree bark, 20 (62.5%) were on the bark of *Khaya anthotheca* (Table VI-1). The second most important bark-eating was on *Cynometra alexandri* (5 times) where they strip off the phloem, chew and suck the liquid.

<u>Social structure</u>

Earlier researchers encountered large groups of 60-80 chimpanzees crossing the road at any one time. These are no longer observed in this forest.

<u>Seed dispersal</u>

Chimpanzees disperse over 20 tree species of trees in this forest (Table VI-2). The most interesting is *Cordia millenii* and *Mildbraediodendron excelsum* which have on other disperser apart from chimpanzees.

Carnivory and infanticide

Chimpanzees practice carnivory and infanticide but at lower rate than recorded in Gombe (Tanzania) and in West Africa. As Budongo has no Red Colobus, the Black and White Colobus is the main prey. (Table VI-3).

Medication

Our earlier records from faecal analyses reported of *Commelina* sp. This has been identified as *Aneilema aequinoctiale* (Commelinaceae). I have observed them in the field feeding on the species. On feeding on the species, the chimpanzees are mainly intersted in taking in the strong hairs. These hairs are on the petiole on the 2-4 leaves from the leaf bud (Figure VI-4).

Chimpanzees and timber harvesting

They are doing well in the logged forest (Table VI-4). Food density is higher in the logged than in unlogged areas. Fig density is highest in logged areas.

Threats

Chimpanzees in Budongo Forest are threatened by timber harvesting. The forest is the most productive forest in terms of natural timber and there is still more exploitable timber since only the mahoganies are harvested. The communities living around it are very poor and illiterate. They have no alternative sources of income but to depend on logging.

Discussion

Our studies show that Budongo Forest has a potential to support logging operations and also its wildlife population. This can be possible if the stakeholders realised that the two assets should coexist. There are many groups interested in this forest and the best way out is to allow all interested parties (including local communities) to participate in the decision-making and planning of this Forest. I am still not convinced that the current timber harvesting going on right now is well managed. A management plan is being drafted but it thinly involved all the stakeholders. There is need for more effort (especially from the top) to equip the field officers so that they have little excuse for not curbing the illegalities.

The future of chimpanzees in Budongo Forest is not worrying at the moment. But this state of affairs depends on two factors:

1. Logging rates remain constant. If we assume that the damage in the forest is correlated with the number of timber trees removed, any increase in the quantity of timber extracted will reduce the viability of the habitat to support chimpanzees.

2. There is no increase in hunting pressure. Johnson (1993) found that the injured chimpanzees in this forest are a result of hunting for forest antelopes and not chimpanzees. Since about 30% of the chimpanzees are maimed by trapping, an increase in hunting pressure is likely to have an adverse effect on the chimpanzee population in this forest.

Acknowledgements

The Budongo Forest Project has greatly benefitted from the Jane Goodall Institute (JGI), Overseas Development Administration (ODA)and USAID. NORAD is taking over from ODA this year. Seed funding was obtained from Boise Fund (UK). The project was imitiated by Prof. Vernon Reynolds and benefitted greatly from Dr. Andrew Plumptre who was the Project Co-Director for 5 years. Field data has been and continues to be collected by Field Assitants: Zephyr Tuka, John Tinka Gershom Muhumuza, Nabert Mutungire James Kakura and Dissan Kugonza. The project has more funding from NORAD for the next three years.

References

Altmann, J. 1974. Observational studies of behaviour: Sampling methods. Behavior 49(3-4): 227-267.

Goodall, J. 1986. Chimpanzees of Gombe: Patterns of Behavior. Cambridge, MA: Harvard University Press.

Langdale-Brown, I., H.A. Osmaston, and J.G. Wilson. 1964. The Vegetation of Uganda and its Bearing on Land Use. Entebbe: Government Printing.

Plumptre, A.J., and V. Reynolds. 1994. The effect of selective logging on the primate populations in the Budongo Forest reserve, Uganda. Journal of Applied Ecology 31:631-641.

Polhill, R.M. 1989. Flora of East Africa. Netherlands: A.A. Balkema.

Reynolds, V., and F. Reynolds. 1965. The chimpanzees of Budongo Forest. Pages 368-424 in: de Vore, (ed.). Primate Behavior. New York: Holt, Rinehart, and Winston.

Sugiyama, Y. 1968. Social organisation of chimpanzees in the Budongo Forest, Uganda. Primates 9:225-258.

Sugiyama, Y. 1969. Social behavior of chimpanzees in the Budongo Forest, Uganda. Primates 10:197-225.

Suzuki, A. 1971a. Carnivory and cannibalism observed among forest-living chimpanzees. Journal of the Anthropological Society of Nippon 79:30-48.

Suzuki, A. 1971b. On the problems of conservation of the chimpanzees in East Africa and the preservation of their environment. Primates 12:415-418.

Teleki, G. 1972. The omnivorous chimpanzee. Scientific American 228:33-42.

Teleki, G. 1989. Population status of wild chimpanzees (Pan troglodytes) and threats to survival. Pages 312-353 in: Heltne, P.G. and L.A. Marquardt (eds.). Understanding Chimpanzees. Cambridge, MA: Harvard University Press.

Table VI-1. The frequency of consumption of the bark of trees by chimpanzees in Budongo Forest, 1992-1994.

Species	Frequency
Khaya anthotheca	20
Broussonetia papyrifera	3
Ficus sur	3
Ficus exasperata	2
Ficus mucuso	2
Lannea welwitschii	1
Alstonia boonei	1
Pterygota mildbraedii	1
Cordia millenii	1

Table VI-2. Tree species whose seeds are dispersed by chimpanzees in Budongo

1. *Maesopsis eminii*
2. *Ficus* spp.
3. *Caloncoba schweinfurthii*
4. *Cleistopholis patens*
5. *Broussonetia papyrifera*
6. *Myrianthus holstii*
7. *Erythrophleum suaveolens*
8. *strychnos mitis*
9. *Mimusops bagshawei*
10. *Monodora angolensis*
11. *Coffea* spp.
12. *Cordia millenii*
13. *Chrysophyllum albidum*
14. *Chrysophyllum purpulchrum*
15. *Chrysophyllum pruniforme*
16. *Morus lactea*
17. *Celtis zenkeri*
18. *Celtis mildbraedii*
19. *Antiaris toxicaria*
20. *Uvariopsis congensis*
21. *Pseudospondias microcarpa*

Table VI-3. Episodes of meat-eating observed before, during and after the study in Budongo Forest Reserve.

Month, Year	Species Eaten	Observer
Nov. 1967	Infanticide	Suzuki 1971
May 1968	Black and white colobus	Suzuki 1971
May 1968	Blue monkey	Suzuki 1971
Sept. 1972	Black and white colobus	Suzuki 1975
Sept. 1972	Blue duiker	Suzuki 1975
Feb. 1973	Black and white colobus	Suzuki 1975
Sept. 1991	Infanticide	Bakuneeta et al. 1993
Feb. 1992	Blue monkey	Bakuneeta (this study)
Sept. 1993	Blue monkey	Bakuneeta (this study)
Apr. 1994	Black and white colobus	bakuneeta (this study)
Aug. 1994	Blue monkey	Smith and Lee (unpub.)
Feb. 1995	Infanticide	Muhumuza (unpubl.)
May 1995	Red-tailed monkey	Kiwedde (unpubl.)
Sept. 1995	Infanticide	Fisher (unpubl.)
Oct. 1995	Blue monkey	Tinka (unpubl.)
Oct. 1995	Elephant shrew	Muhumuza (unpubl.)
Dec. 1995	Black and white colobus	Kugonza (unpubl.)

Table VI-4. Densities of each species of primate in logged and unlogged forest, expressed as numbers per km^2. The results of Z-tests between these two estimates are given (*P<0.05, **P<0.01, ***P<0.001). An estimate of the population density in the 428-km^2 forest is also given with 95% confidence limits in parentheses. Density estimates from line transects are positively skewed and 95% confidence intervals are calculated assuming a log-normal distribution and are hence not symmetrical about the mean.

Species	Unlogged	Logged	Z-Test	Forest
C. mitis	15.6	58.2	***	43.9 (39.0 - 49.5)
C. ascanius	8.3	46.4	***	33.3 (28.0 - 39.7)
C. guereza	27.0	44.2	***	39.3 (34.4 - 44.8)
P. anubis	14.0	11.0	--	11.7 (6.6 - 20.7)
P. troglodytes (sighting)	3.2	2.8	--	2.9 (1.6 - 5.1)
P. troglodytes (daily nest building)	1.4	0.8	--	1.3 (1.0 - 1.7)

VII. Evaluation of Management Strategies for Chimpanzees in Protected Areas of Uganda

Dr. Eric L. Edroma
Director, Uganda Wildlife Authority

Introduction

Chimpanzee populations across Africa are dwindling at an alarming rate (Teleki, 1989) and it is estimated that out of 25 countries which used to have chimpanzee populations, the species has become extinct in 9 of them. The major cause of the decline is the rapid destruction of prime forest habitants (Whitmore and Saye, 1992); Turner and Corleett, 1996) leading to fragmentation of populations and reduction in genetic diversity (Avise, 1994).

Conservation strategies for most chimpanzees in tropical rainforests in Uganda have been largely circumstantial despite the fact that most primate species including the chimpanzee (*Pan troglodytes schweinfurthii*) are accorded the highest legal protection under our conservation laws. Chimp populations in Uganda are confined to the forests and wildlife protected areas associated with the Albertine Rift and these include Bwindi, Maramagambo, Kalinzu, Kasyoha-Mitoni, North Rwenzori, Semuliki, Kibale, Itwara, Bugoma and Budongo. Small riverine forests such as occur along Ishasha, Kyambura and Wassa rivers also have chimpanzees. Of unique occurrence not yet mentioned is the population recently discovered in the semideciduous Otze forest east of Moyo.

Exploitation of primary rain forests for timber, agriculture and mining are the major threats to chimpanzee survival. These activities, and lately, poaching of chimpanzees in forests not included in national parks or wildlife reserves, are the main points of contention among conservationists and stake holders in Uganda.

Though chimps have traditionally not been targets for poachers for meat, the recent international demand from research laboratories, circuses and the pet trade has greatly magnified the dangers that the chimps have been exposed to. Many adult chimps have perished at the hands of wildlife dealers in the process of capturing baby animals while many have been maimed by snares and gin traps permanently reducing their chances of survival. This paper tries to examine the effectiveness of some intermediate strategies that have been initiated in protected areas for the conservation of chimpanzees and other rare or endangered primates in Uganda.

Chimpanzee Management Strategies in Protected Areas

Before 1-2 decades ago, there were practically no ideas as to how primate abundance in some specific protected areas could be managed in a manner beneficial to both management and the local communities who had earlier viewed nearly all primates as vermin and enemies. Vernon Reynolds in 1962 and later the Makerere University Biological Field Station (MUBFS) in Kibale Forest (now Kibale National Park) through research on various rare primates and their role in forest ecology opened rare opportunities for specific management strategies for the protection of rare species such ans the chimpanzee. Great enthusiasm by primatologists to carry out research, and by tourists to view and track chimpanzees in particular, initiated studies in chimp ecology, ranging patters, social behaviour and habituation efforts which have all contributed to the evaluation of management strategies in protected areas. The sudden high demand for chimpanzees for AIDS research and circus entertainment in the late 1980's also resulted in large numbers of young chimps being confiscated from wildlife peddlers culminating in Uganda's signing and ratifying the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) in 1991 and the Convention on Biodiversity Conservation (Earth Summit / Rio Conference in 1992 at the Earth Summit).

The following strategies have been applied in different protected areas with varying degrees of success:

a) Security and Law Enforcement

Following the rampant illegal trafficking in young chimpanzees from the country which prevailed after the return of 4 young chimpanzees from Yugoslavia in 1991, strict measures were instituted at Entebbe Airport and the law enforcement organs including Police, Internal and External Security operatives, TRAFFIC, International Primate Protection League, Customs and the press, have all bee sensitised to intercept any smuggled chimps. A ban was also put in place for the issue of transit wildlife export permits thereby completely sealing off any exit routes for chimpanzee export.

The realisation that traps set by poachers for other edible species have had adverse effects in maiming chimpanzees have led to the institution of effective patrols in Karuma and Bugungu Wildlife Reserves. Large quantities of poaching gear have consequently been recovered from animal trails. Extensive patrols are being made by rangers to Kyambura Gorge, Maramagambo, Kibale and Wasa riverine forests to eliminate poaching and the laying of traps in the vicinity of the chimpanzee range.

b) Research

Pioneer work was undertaken in Kibale Forest with the primary aim of habituating the animals for tourist viewing. The prolonged hours of continuous observation from dawn to nesting time ensures that poachers and predators are kept away thereby enhancing the survival of the species. At the same time, valuable information on chimpanzee requirements in terms of space, food and social needs are understood. Basic requirements for chimps in Kibale, Kyambura Gorge, North Maramagambo and Budongo Forests where research and habituation have been undertaken successfully are now yielding fruitful results. In Budongo where many chimpanzees have actually been maimed and incapacitated by snares and gin traps, joint efforts are being made to eliminate poachers in the area.

Additionally chimpanzee-based modelling is being planned under the monitoring programme. Using the models or empirical data, we hope to predict the responses of

chimpanzee populations to future habitat changes. Models built on the behaviour of individuals may be one reasonable means of predicting the population's response to habitat change.
c) Resettlement of orphaned chimps

Efforts made by the Jane Goodall Institute and Kampala Sheraton - Green Peace Project to settle dozens of confiscated young chimpanzees which have been kept at Entebbe Wildlife Education Centre were rewarded in May 1995 when eleven chimps found home on Isinga Island in Lake Edward within Queen Elizabeth National Park. Apart from the sad incident when two of them fell in water and drowned at the beginning of last year, the island is now a very popular tourist destination. Efforts to find a new home for the remainder of the Entebbe chimps continue and their release to Rabongo Forest (Murchison Falls National Park) or Sese Islands are being pursued.

d) Diseases

Uganda's chimpanzees have been healthy and have not suffered from serious diseases in the recent past. However, management is aware of the outbreak of the polio-like disease that had hit the Gombe chimps in 1986 (Goodall, 1986). The UWA has created a veterinary service with improving capacity to handle situations of disease outbreak in future.

e) Chimp Tracking

The product of hundreds of hours of patient habituation process in Kibale/Kyambura/Budongo in Kibale National Park, Kanyancu, Kyambura Gorge and Budongo Forest is the opening of guided tourist chimp viewing/tracking in these areas. Full participation of local community in the provision of accommodation, has achieved a lot in winning the confidence of the public who now enjoy real economic benefits. This positive development is changing the attitudes of the local people who now advocate for the protection of chimpanzees. Some Ugandans have even approached UWA for Use Rights to enable them to develop their own private forests for stocking with chimps for tourist viewing. With decentralization gain root it is hoped that forest Management will encourage the serious local people to protect the privately owned forest fragments for managing chimpanzees. The UWA is statutely expected to assist local communities to protect or preserve threatened species in such fragmented habitats. Other areas which are being developed for chimp tracking include North Maramagambo in Queen Elizabeth National Park (Lake Nyamusingiri), Semuliki Valley Wildlife Reserve (Wassa river gorge) and Bwindi Impenetrable National Park as an alternative to gorilla viewing.

f) Management Plans

New management plans under preparation and old ones being reviewed have definite management action for chimpanzees wherever they occur. It is in this regard that particular attention is being paid on chimpanzee populations in Ishasha River Gorge, Kigezi Wildlife Reserve (South Maramagambo), Bugungu/Karuma Wildlife Reserves (Kamiyo Pabidi sector of Budongo) Rabongo forest in Murchison Falls National Park and Otze Forest Sanctuary on the Sudan border. Joint action plans have yet to be made with the Forest Department in respect of chimpanzee and other related populations in Bugoma, Itwara, Kalinzu and Kasyoha/Mitomi forests.

g) Possibility for translocation, conservation breeding and reintroduction.

Uganda's total of 4 - 5,000 chimpanzees populations are still viable with all the present strict management measures being enforced. We expect them to rise. However, should (for some unexpected reasons) their numbers decline consideration will be given for instituting a programme of translocation, conservation breeding and reintroduction.

Conclusion

The Chimp Population and Habitat Viability Analysis Workshop has come at a very opportune time when the Uganda Wildlife Authority (UWA) has inherited some of the richest forest reserves as part of its estate and it is a blessing that Uganda is the venue of the workshop. I do trust that the lifetime expertise of renowned personalities (like Dr. Jane Goodall, Dr. Norman Rosen, Dr. Richard Wrangham, Dr. Gilbert Basuta, Professor Vernon Reynolds, Dr. Ulysses Seal, Dr. Andy Plumpre and Dr. Phil Miller) here with us will be able to guide this workshop and in particular develop long term chimp management strategies based on the management applied in Gombe and Mahale National Parks. In a country where habitual management and the dependant wildlife populations are under different institutions, it takes considerable good will on both government and the respective institutions to come up with mutual management strategies. The very presence here of a team of all the stake-holders especially from Forest Department is a clear sign that natural forest conservation cannot be divorced from the conservation of wildlife that perpetuates its natural regeneration.

References

Curio, E. 1996. Conservation needs ethology. Trends in Ecology and Evolution, 11(6): 260-263.

Goldberg, T. 1996. Genetics and Biogeography of East African chimpanzees (*Pan troglodytes Schweinfurthhii)*. Ph.D. Thesis, Harvard University.

Kleiman, D.G., M.R. Stanley-Price, and B.B. Beck. 1994. Criteria for reintroductions. Pages 288-303 in: Olney, P.J.S., G.M. Mace, and A.T.C. Feistner, (eds.). Creative Conservation: Interactive Management of Wild and Captive Animals.Chapman and Hall.

Lesica, P. and F.W. Allendorf. 1992. Are small populations of plants worth preserving? Conservation Biology, 6(1): 135-139.

Teleki, G. 1989. Population status of wild chimpanzees (*Pan troglodytes)* and threats to survival. In: Heltne, P.G., and L.A. Marquardt (eds.). Understanding chimpanzees. Harvard University Press, Cambridge.

Turner, I.M. and R.T. Corlett. 1996. The conservation value of small, isolated fragments of lowland tropical rain forest. Trends in Ecology, 11(8): 330-333.

VIII. The Viability of Budongo Forest Reserve for Chimpanzees

C. Bakuneeta* andS. Khauka[†]

*Budongo Forest Project, P.O. Box 362, Masindi.
† Budongo Forest Office, P.O. Box 173, Masindi.

Introduction

Budongo Forest Reserve (BFR) has an area of 825 km^2 of which 459 km^2 is forest. The rest is woodland, grassland, swamp, etc. It is the largest remaining natural forest in the country at an altitude of 1250m. It is contiguous with Murchison Falls National Park, Bugungu and Karuma Wildlife Reserves. It therefore offers the opportunity to preserve a complete ecosystem and high potential to safeguard rare/threatened species such as chimpanzees.

Botanically it contains more species of trees that any other forest in the country. This makes it the most important for tree species conservation.

Past studies in the 1960s and 1970s recorded the density of about 4 chimpanzees per km^2 (Reynolds, 1965, Sugiyama, 1968, Suzuki, 1971) and group sizes of 60-80 individuals. These densities remain among the highest ever recorded in the wild.

Forest disturbance began around 1905 with the tapping of rubber from *Funtumia* tree species. It was during this extraction of rubber that the timber species were noted and led to logging in the 1920s. Over 75% of the entire forest has been logged at least once (Howard, 1991).

Because the area is sparsely populated, there is little encroachment.

Logging has been going since the 1920s and we hope it will continue into the next century. Why?

1. Because so far no study has shown the logging done in the last 60 years has led to the extinction of some species.
2. Despite over 60 years of logging, only the mahoganies have been selected. The forest has over 10 timber tree species that are not being harvested although forest management encourages loggers to harvest them.
3. Recent studies (Plumptre and Reynold, 1994; Bakuneeta, in prep.) reveal that chimpanzees and other primates prefer logged habitats to the unlogged. This means that if forest management does not lax in its management approaches, the forest has the potential to support selective logging and its flora and fauna.

Why BFR is viable for the chimpanzees

- It appears to have more food resources than Kibale, Bwindi, Semliki, Bugoma, Maramagambo, etc. A comparative study is needed here.

- Currently mechanical timber harvesting is on the decline and forest management has encouraged pitsawyying to mitigate the timber demand. Unlike mechanical logging, pitsawying removes less that mechanical logging. From October 1995 to September 1996, for instance, only 3,951.135 m^3 was recorded as removed. Even if we estimated the illegal loggers to take an equal amount as recorded, this gives a total of 79,022.7 m^3 for ten years which is nowhere near the 300,000 m^3 per decade as recorded in the 1960s (Plumptre et al., 1994).

- While Zaire and West Africa chimpanzees are hunted for meat, the community living in the periphery of Budongo Forest do not eat chimpanzees (Johnson, 1993). The Zairean migrants have probably abandoned their primate-eating habits as it is a taboo to eat primates in most tribes in Uganda.

- Unlike many other areas in Uganda, the forest is located in a region that is sparsely populated. There is little encroachment.

- The forest is contiguous with Murchison Falls National Park which has fragments of forest that contain chimpanzees (e.g. Rabongo Forest and Kaniyo - Pabidi). This gives the chimpanzees an outlet and can minimize inbreeding.

- There is no evidence of chimpanzee epidemics. No skeletons have been recorded in the forest. Only helminth parasites have been recorded (Kalema, 1992, Barrow, in prep.).

Current Status

Sawmilling and pitsawying still operate in the forest. At present pitsaywing is more active than sawmilling. The former is organised by a local association (Masidi Pitsawers and Woodusers Association) and members of the association pay the forest dues. Twenty licensed pitsawers are operating in compartments N6 and W21. Each pitsawer is allowed to use only 4 handsaws and employees a total of 200-250 to carry timber from the logging site to the loading bay.

However there are still pockets of illegal pitsawers operating in the forest. These include various cadres of people plus the locals who live near the forest edge. They have proved very difficult to eliminate as they are at “our doorsteps”.

The forest is locally used for firewood, building poles and medicinal plants. Hunting and trapping occur at subsistence levels. The species trapped are dukers, bushbacks, bushpigs, guinea fowls, and occasionally monkeys. Although Zaireans are known to feed on primates, we have never received a report of its occurrence in the Zaireans residing in the periphery of Budongo Forest. The forest has set up two tourist centres, Busingiro and Kaniyo-Pabidi.

IX. The Budongo Forest Ecotourism Project: Offering visitors ecotourism with an opportunity to see chimpanzees in a natural forest habitat

C. D. Langoya and C. R. Long
Nyabyeya Forestry College, Masindi

A brief introduction to the Project

The Budongo Forest Ecotourism Project has been running since February 1993. It is managed by the Forest Department, as a part of the overall management of Budongo Forest, and is staffed by local people from the parishes closest to the Forest.

The aim of the project it to promote the conservation of Budongo Forest by providing a sustainable income for local people through forest tourism and other income generating activities, and by running a conservation education programme which operates in the villages and schools closest to the forest.

The project runs two sites in Budongo Forest, one on each of the main roads running through the forest. At each site, there are trained guides who manage the site, lead guided walks, maintain the trails and carry out chimpanzee habituation. Each site has a camping area and an extensive trail network.

Chimpanzees and Tourism

In Budongo Forest, we offer visitors forest walks and "chimp tracking". The word *tracking* is emphasises rather than *viewing,* because we cannot guarantee a sighting of the chimps.

From the start, it has been a project policy to interfere with chimpanzees as little as is compatible with offering visitors some opportunity to see them. No provision is carried out, and strict guidelines have been laid down for groups wanting to track chimps. The guides carry out habituation, with two guides entering the forest every morning and afternoon. Guides also check for snares and other illegal activities within the Forest Reserve as they track the chimps.

Guidelines for Chimpanzees Tracking, Budongo Forest Ecotourism Project

The following guidelines were established after discussion with and advice from the Budongo Forest Project, and staff of Bwindi and Kibale National Parks

- Only 6 visitors in any one group, and only one group to be with any group of chimpanzees at any one time.
- Total time spent with one chimpanzee group to be a maximum of one hour in a day.
- All visitors going into the forest to be accompanied by a forest guide.
- Minimum distance between chimpanzee and visitors to be 5 metres.

- No children under 12 years.
- No one who is ill with e.g. colds, flu.
- No flash photography in the forest.

Chimpanzees and their Human Neighbours

Budongo Forest is surrounded by many villages, and has traditionally been used by local people as source of firewood, building poles, other non-timber forest products and for hunting. For the last 60 years, the forest has also been used for timber. (Information on timber extraction and its effect on chimpanzees is available from the Budongo Forest Project).

According to villages giving their opinions in meetings and informal interviews, the people next to Budongo Forest are fairly indifferent to chimpanzees. When chimps raid crops, they apparently take only what they need and then leave, and it happens extremely rarely. Baboons are seen as the real pests. The only other interaction between people an chimpanzees is when a chimp becomes trapped in a hunter's snare. Within the tourist zones, this has been observed by project staff three times in the last three years.

The Ecotourism Project has established Advisory Committee made up of local community representatives, and these committees are a forum to resolve conflicts that arise over the use of the forest. The Committees are an extremely valuable mechanism for sharing information with local people about the forest, its uses and its values, and for beginning to understand beliefs that local people have about chimpanzees and other forest wildlife.

What is Known of the Chimpanzees in the Tourism Zones

The Budongo Forest Ecotourism Project works closely with the Budongo Forest Project, and the tourism zones are included in the primates census carried out the BFP. In addition, the guides keep records of each chimpanzees sighting, including time and place of sighting, and details of behaviour. At both sites, they now have a good idea of where chimpanzees can be expected to be found at different times of the year, and are starting to identify individuals in the various groups.

Chimpanzees in Kaniyo Pabidi

Kaniyo Pabidi is an isolated block of the forest surrounded grassland and savannah woodland. It has never been logged or treated, and its only human uses in the last 100 years have been very low intensity hunting, rubber tapping and the harvesting of wild coffee. The three compartments which make up the tourism zone, KP 11,12 and 13, may be the closet Budongo has to primary forest.

The Budongo Forest Project has estimated the chimp population in Kaniyo Pabidi to be between 50 and 70 individuals. The largest group observed together has been 27 individuals, feeding on *Ficus* fruits in KP 11. It appears that the chimpanzees at Pabidi are in two distinct groups. One, which tends to stay in the mixed forest and nearby grassland of KP 11, is well habituated and is the group most commonly seen by our visitors. They usually divide themselves into three smaller groups. They have a few individuals who are now recognised, and infants are seen in this part of the forest at least twice a month. The other group moves in the northern part of the forest and is far more timid. They also move between forest and grassland, and tend to be seen in two smaller groups. In the months of October and November, all groups appear to spend most of their time in the grassland, only coming into the forest to sleep.

Table IX-1. Food Trees preferred by Kaniyo Pabidi Chimpanzees

Only those on which chimps were sighted more than 4 times are listed.

Trees Species	Number of sightings of chimps feeding	Plant part preferred by chimps	Months in which sightings have been made
Cynometra alexandri	153	leaves	March - May, Sept - Oct
Celtis mildbraedii	114	fruits young leaves	July, Dec Feb - June
Chrsysophyllum albidum	79	fruits	April - June
Ficus mucuso	39	fruits	March - April September Nov - Dec
Mildbraediodendrom	36	fruits	July - Sept
excelsum	24	fruits	April - May
Uvariospsis congensis	21	leaves	Nov - Dec
Celtis wightii	13	fruits	Dec - March
Ficus natalensis	15	fruits	Sept - Oct
Cordia millenii	12	fruits	Aug - Sept
Cola gigantea	8	fruits	March - April
Ficus sansibarica	6	fruits	March - April
Chrosonophilis africana	5	fruits	April - May
Maesopsis eminii	5	fruits	March
Ficus sauseriana	5	fruits	September
Sterculia			

The abundance of the food trees is slightly different in the three compartments of the forest. In all three, however, *Cynometra alexandrii* is the most abundant.

Chimpanzees in Busingiro

Busingiro is in the south of Budongo Forest, and the forest here is mixed forest, with dense undergrowth, and has been logged and pitsawn.

The tourism zone at Busingiro covers 4 compartments of the forest. B1 was logged in 1935 and again in 1981 - 2, and B4 was logged in 1941 - 2 and been intensively pitsawn, especially in the late 80s and early 90s. Both sites were treated with arboricides in the late 1950s to remove species considered uneconomic, such as *Cynometra alexandrii* and species of *Ficus*. Individuals of those species still surviving in these blocks tend to be in the steep sided valleys where logging would not have been practical, and so arboricide treatments were not used. S7 and S8 were not treated with aboricide, but S7 was logged in 1990, and S8 from 1979 to 1990.

Within the tourism zone of Busingiro, there appear to be two distinct groups of chimpanzees. One has its home range in the Siiba block of the Forest, (S7 and S8) and its range is estimated to be about 18 km^2. The greatest number of this group seen together in one place is 40 individuals, observed in January 1996 feeding on *Morus lactea*. The second group moves within the Biiso block, (B1 & 4), and its home range is estimated to be about 25 km^2. 35 individuals in this group have been seen together, feeding on *Ficus sauseriana*.

The Siiba chimps are less timid with humans. This may be because they move along the edges of the forest close to neighbouring villages and often come into contact with humans. People in Nyantonzi parish often see this group of chimps in the forest beside the Siiba river, which is an important local water supply.

Food trees preferred by chimpanzees at Busingiro

Only those trees on which chimps were sighted more than four times are listed. The ten species on which chimps were most often sighted were ranked in order of abundance, based on their frequency within the trail system. 1 is the most common, 10 the least.

Tree species	Abundance ranking	Number of sightings of chimps feeding	Part of tree being eaten	Months tree is preferred
Ficus natalensis	8	70	fruits	Aug - Nov
Ficus mucuso	7	36		Sept - Dec Feb - May
Ficus sur	4	27	fruits & shoots	Jul - Mar
Morus lactea	2	25	fruits and flowers	Feb - March
Ficus exasperata	10	23	young leaves and fruits	Nov - Dec Mar - April July - Sept (every 2 years)
Antiaris toxicaria	9	22	fruits	Dec - March
Pseudospondias microcarpa	5	17	fruits	May - June (every 2 years)
Chrysophyllum albidum	1	15	fruits	Aug - Oct Jan - March (every 2 years)
Maesopsis eminii	3	15	fruits	Sept - Nov April
Chrysophyllum muerense	6	11	fruits	Dec - April
Celtis mildbraedii		10	leaves fruits	March Sept - Oct
Cynometra alexandri		9	leaves fruits	May - Aug Dec - Jan
Anigeria altissima			fruits	Apr - May
Mangefera indica			fruits	Dec, May & June

X. A Survey of Intestinal Helminth Parasites of a Community of Wild Chimpanzees (*Pan troglodytes)* in the Budongo Forest, Uganda

Gladys Kalema, May 1993.
Royal Veterinary College
University of London

Abstract

A study was made of intestinal parasites in 2 communities of chimpanzees inside the Budongo Forest reserve of Uganda, East Africa. Laboratory analyses were conducted at the headquarters of the Budongo Forest Project, in the Sonso region of the forest. Faecal specimens were examined for microscopic parasites with the aid of a light microscope using the McMaster method. Parasite eggs of the nematodes *Oesphagostomum* and *Strongyloides fulleborni* together with one of an unidentified trematode were found. Over 75% of the faecal samples examined had parasite eggs.

Introduction

All nematodes gain access to the body through faecal-oral or accidental ingestion and are swallowed and settle in the intestines and develop into adults which lay eggs and are passed in the faeces to reinfect and continue the life cycle. *Strongyloides spp.* can also penetrate broken skin. An unidentified trematode was also found in this study and these gain access to the body through ingestion.

Nematodes (round worms)

Oesophagostomum spp.
Has a direct life cycle and the worms settle in the wall of the large intestine resulting in the formation of caseous nodules.
It is mainly associated with diarrhoea in chimpanzees and other animals (Soulsby 1982) with the exception of mountain gorillas, Gorilla gorilla beringei, where it is associated with colitis and the formation of mucoid dung with blood and mucus in the faeces (Hastings 1992).

Strongyloides spp.
Has a (i) direct lifecycle, (ii) indirect life cycle where the parasite can develop into free living rhabditiform larvae or if conditions are favourable develop into filariform infective larvae, it also involves an amplification phase in the soil of up to 20,000 times (iii) an auto-infection phase in the large intestine. After penetrating broken skin the worms travel in the blood to the lungs where they are coughed up and swallowed and end up in the small intestine, causing severe damage to the gut wall (Soulsby 1982).
It causes a severe diarrhoea which can be fatal (Soulsby 1982) and (from previous literature) was the most pathogenic parasite in this study.

Trematodes (Flukes)

Dicrocoelium dendriticum (D. Lanceolatum).
Has a direct lifecycle where the parasite is dependent on intermediate hosts for its transmission, which include snails and ants. Eggs are swallowed by snails, then miracidia hatch out of the eggs in the snail's gut and migrate in the body to form cercariae, these are expelled from the snail and adhere to vegetation where they are eaten by ants. The definitive host is infected by swallowing infected ants. *The metacercariae travel to the bile ducts and cause extensive damage to the liver. This can result in extensive cirrhosis and scarring of the liver surface, which can cause anaemia, oedema and emaciation. Eggs are laid by the mature flukes in the liver to restart the life cycle (Soulsby 1982). This is interesting as it indicates that the chimpanzees ingested ants either directly or accidentally.*

This was the first survey of intestinal parasites in Budongo forest. Faecal specimens were taken from natural groups of wild living chimpanzees with no artificial feeding. The prevalence of parasites in individual samples was noted and a comparison was made between a group exsisting in an area of forest logged in the past (PL) and a group exsisting in an area of forest recently logged (RL). A note was also made of the intensity/level of infection for each parasite and various comparisons made. The approximate numbers of chimpanzees in each group were 30 in group PL and 20 in group RL. The chimpanzees are in the process of habituation and identity of the chimpanzees from whom faecal samples were collected was largely unknown with a few exceptions. In total 33 faecal samples were collected of which 28 were from group PL inhabiting the Sonso region, and 5 were from group RL inhabiting the Kanyo-Pabidi region.

Method

The research was carried out over a period of 2 weeks in mid-September. Temperatures ranged from 16.8 to 27.1 degrees centigrade. Average rainfall received each day was 6.8 millilitres. Faecal samples were collected from 7.00 am until mid-morning and examined immediately or preserved in 10% formalin or kept in a cool place. I was aided by field assistants in collecting the faecal samples.

Dung analysis was conducted using a light microscope and the McMaster method. Fresh faeces were mixed in sugar solution (4.5 gm faeces to 40.5 ml sugar + formalin solution) (Thienpont et al. 1986). The mixture was then put in a McMaster slide and placed under a light microscope to check for the type and number of parasite eggs.

Only helminth parasites were investigated and were identified by the size, shape and contents of the eggs. The numbers of parasites were counted to detect the intensity/level of infection for each parasite. The McMaster method calculates the number of eggs per gram faeces by multiplying by a factor of 10 the total number of eggs recovered in each chamber of the McMaster slide.

Results

3 species of parasite eggs were found, the 2 major ones being nematodes and a trematode.
Oesophagostomum eggs were:-
(i) medium-sized round worm eggs
(ii) 75±5.0 (n=23) microns long by 43±1.5 (n=23) wide
(iii) ovoid with similar rounded poles, distinct barrel shaped walls and blastomere contents.

Strongyloides eggs were:-
(i) small sized round worm eggs
(ii) 55±5.0 (n=18) microns long by 33±1.5 (n=18) microns wide
(iii) elliptical shaped, with a very thin single wall. Some contained thick larvae. *S. fulleborni* eggs occur in fresh faeces while *S. stercoralis* eggs occur as larvae in fresh faeces and are a known parasite of humans. Thus *S.fulleborni* was the most likely egg in my study.

Dicrocelium dendriticum (lanceolatum) egg was:-
(i) very small egg
(ii) 35-40 microns long by 20-30 microns wide
(iii) was thick-shelled and had an operculum
However there was not enough evidence to confirm its true identity as it was covered in debris.

B) Prevalence of helminth eggs.

69.7% of the samples had *Oesophagostomum* eggs
54.5% of the samples had *Strongyloides fulleborni* eggs
75.8% of the samples had parasite eggs.
48.5% of the samples had 2 speciaes of parasite eggs.
24.2% of the samples had no parasites.

There was no correlation between the rate of infestaion of particular samples by the 2 species of nematode (Spearman's rank correlation - 0.088, p = 0.628).

Intergroup comparisons:-

The parasitic infection rate differed between PL (89.3%) and RL (0%). However the sample size for group RL was too small for rigorous statistical analysis.

Infection rates by 2 major parasites

Group	Oesoph	S.fulleb	Any parasite	No. of faecal samples
PL	23	18	28	28
RL	0	0	0	5
Total	23	18	28	33

Faecal samples from known chimpanzees.

2 of the samples collected were from a known chimpanzee, *Matoke*, who was a mother of the infant *Toto*. On one occasion I was able to see her suckling *Toto* (2 years old) shortly before she defaecated. On this occasion she had *Oesophagostomum* and *Strongyloides fulleborni* infestations of parasite eggs. On another occasion only *Oesophagostomum* eggs were found in her faeces. She had an average parasitic infestation compared with the rest of the chimpanzee population sampled. *Strongyloides fulleborni* eggs are known to be transmitted in the mother's milk to nursing young, in which heavy infections cause diarrhoeal disease (Noble 1989). No diarrhoea was seen in *Toto* on this occasion.

Discussion

1) Although parasite eggs were found in most of the samples, none of them showed signs of disease. Heavy infections of *Oesophagostomum spps* can cause severe diarrhoea, one of the samples had 230 per gram of faeces with 20 per gram of faeces of *Strongyloides* eggs, but was not diarrhoeic, possibly because *Strongyloides* which was more pathogenic was in very small numbers.

2) The short lifecycle and the ubiquitous presence of *Oesophagostomum spps.* in many other primate species indicate that it is possible for chimpanzees to acquire these worms in captivity if they are being kept in unhygienic conditions.

3) The absence of eggs in some of the faeces could be explained by a number of factors:-
   (i) development of a degree of immunity especially in adult chimpanzees, *leading to decreased egg output by the female worm and decreased establishment of worms in the body which are repelled as soon as they enter the body.*

   (ii) the ingestion of vermicidal plants in the course of day to day feeding (Wrangham and Nishida 1983, Huffman and Seifu 1989, Newton 1991), they acheive their effects, in some cases at least, through the action of high levels of condensed tannins (Taper, Zimmerman and Case 1986, Sears 1990).

4) Low egg count can also be explained by:-
   (i) infection of the chimpanzees in their pre-patent period (time taken for development from infection until mature adult parasites are producing eggs or larvae) and is of known duration for each nematode species.
   Strongyloides spps. is 8-14 days
   Oesophagostomum spps. is 45 days.
   Dicrocelium dendriticum is 47-54 days.
   However if an area is already colonized by a certain parasite the chimpanzees would be expected to be re-infected continuously so that eggs would be produced all the time.

   (ii) different levels of exposure to the parasite in groups PL (logged in distant past) and RL (recently logged) as they are in different levels of the forest which have also experienced different levels of human activity.

(iii) presence of Khaya bark, a vermicidal agent. *Khaya* is a common tree species in the Budongo Forest. However there was no clear connection between the bark found in the faeces (10 samples from PL) and the number of parasite eggs seen (one sample had no eggs and the rest had an average number of eggs per gram of faeces). * There was no ingestion of *Aspilia* leaves observed in the Gombe National Park and ther Mahale mountains in Tanzania (Wrangham and Nishida 1991). The Aspilia shrub is not common in this part of East Africa.

5) It is noted that the intestinal parasites *Trichuris* and *Troglydetella* which have been found in previous similar studies, were not found in this study. *2 previous studies have been carried out on intestinal parasites in free-living chimpanzees, Pan troglodytes in Gombe and Mahale (in Tanzania) and Pan paniscus in Wamba, Zaire. These studies were carried out over a longer period of time and a greater variety of parasite eggs were found. Strongyloides spp. and Oesophagostomum spp. were found in all 3 studies together with other parasite eggs. These studies also used different methods to the McMaster one for sampling.*

   A recent paper written by Hufmann et al (1996) in the International Journal of Primatology, Vol. 17, No. 4 entitled "Leaf-Swallowing by Chimpanzees: A Behavioural Adaptation for the Control of Strongyle Nematode Infections" indicates that swallowing of whole leaves by chimpanzees and other African apes, in this case Aspilia spp. is antiparasitic, but not chemically as previously thought. The adult nematode, Oesophagostomum stephanostomum was attached and trapped to the inside of a leaf that was found expelled in chimpanzee faeces, and the worm was whole. Thiarubine A, a potent nematocide was not present in the Aspilia leaf (A. mossambicensis), as previously thought.

With more time, a clearer idea of the parasitic infestations of chimpanzees in Budongo forest could be obtained. Sampling over the wet and dry seasons (in October amd April) might yield further information, as might a study of further regional differences in types and levels of infection. It might also have been possible to find out if the low egg count in some samples was due to the pre-patent period or the presence of Khaya bark. an anti-wormimg agent. However in this short two week survey the commonest parasites infecting the Budongo chimpanzees were identified.

Further Studies

(Michelle Barrows, Veterinary faculty, University of Glasgow).
4 years later a similar survey to continue this one was carried out in July to August 1996, over a period of 1 month by Barrows. Both *Oesophagostomum* and *Strongyloides spps.* were found. Additional parasites were found which include *Trichuris spp.* a nematode parasite that occurs in humans, and has been found in previous studies in Gombe, Mahale and Wamba. *Bertiella studeri*, a cestode (tapeworm) was also found, and possible other strongyle parasites like *Trichostrongylus*. There is an indication that the human hookworm, *Necator americanus* was found, but larvae are being cultured to distinguish the hookworm from *Strongyloides spps*. Protozoa were also investigated, but results are still pending.

Bertiella studeri is a tapeworm that causes no apparent signs of disease or lesions. Diagnosis is made by finding the proglottids or characteristic eggs in the faeces (Soulsby 1986).

Trichuris trichura has a direct lifecycle and penetrates the wall of the large intestine. It can cause disease if there is a large worm burden and is manifested as a greyish-looking mucoid diarrhoea (Soulsby 1986).

Implications

The chimpanzees of Budongo forest can cope with a certain number and type of parasite normally. From these 2 studies we are getting an indication of the normal intestinal fauna of chimpanzees in this forest. Some of the parasites found normally are also shared with humans like *Trichuris* and *Strongyloides spps.*, although it is mainly *S. stercoralis* found in humans and *S. fulleborni* in chimpanzees. This will make it easier to diagnose disease in abnormal chimpanzees by comparing the normal data with the abnormal sample. The fact that chimpanzees share parasites with man means that strict measures should be taken by people utilising the forest to bury faeces so that chimpanzees will not be exposed to this potential source of disease. What other measures can be taken to manage intestinal disease in chimpanzees? (any suggestions will be welcome).

References

Hufmann M.A., and M. Seifu 1989. Primates **30**: 51-63.

Newton, P.N. 1991. Trends Ecol. Evol. **6**: 297-299.

Noble, E.R. 1989. Chapter 15. Order *Strongylida*. Pages 168-191 in: Noble, E.R., G.A. Noble, A.S. Gerhard and A.J. MacInnes (eds.). Parasitology. London: Pub. Bailliere Tindall.

Sears, C. 1990. The chimpanzee's medicine chest. New Scientist (4 August 1990), 42-44.

Soulsby, E.J.L. 1982. Chapter 1. Helminths. Pages 168-191 in: Soulsby, E.J.L. (ed.). Helminths, Arthropods and Protozoa of Domesticated Animals. London: Pub. Bailliere Tindall.

Taper, M.L., E.M. Zimmerman and T.J. Case. 1986. Oecologia **68**: 437-445.

Thienpont, D., F. Rochette, and O.F.J. Vanparijs. 1986. Diagnosing Helminththiasis through Coprological Examination. Pub. Janseen Research Foundation, Beerse, Belgium, pp 25-165.

Wrangham, R.W. and T. Nishida. 1983. *Aspilia* spp. Leaves: A puzzle in the feeding behaviour of wild chimpanzees. Primates **24(2)**: 276-282.

Acknowledgements

Special thanks goes to my supervisor, Dr. Mark Fox of the Royal Veterinary College, University of London and field supervisor, Dr. Vernon Reynolds of the Budongo Forest Project. I would also like to thank Dr. Andrew Plumptree, Dr. Jake Reynolds, Dr. Peter Miller of the Budongo Forest Project; and the field assistants Kugonza Dissan and Tuka Zephyr. Finally I am grateful to the Uganda Forest Department for permission to work in the forest. Special thanks also goes to my mother and sister, Naki for all their support.

XI. Queen Elizabeth National Park
Kyambura River Gorge Chimpanze Project

George M. Bwere

Introduction

The Gorge is 16 km all the way from the main Katerere - Kyambura bridge up to the Kazinga Channel and 300 ft at its deepest point. The gorge is composed of papyrus, swamps, shrub forest and a low land forest. It is not a home for chimpanzees alone but also a home for some interesting hippos in the river, giant forest hogs, red tailed monkeys, black-and-white colobus baboons, velvets and fruit bats and many other mammals as well as large assorted birds, insects and snakes.

The Kyambura River Gorge Tourism Project is located in the Eastern part of Queen Elizabeth National Park at an out post called Fig Tree Camp along Mbarara - Kasese road.

The Tourism Project started in 1991 being funded by QENP in the following issues: buildings, guides, rangers and the US Peace Corps provided volunteers to start the management of the project.

Purpose of the Project

Habituation has been going on during some past years as well as data collection on chimpanzee in order to determine their behaviour during the presence of the tourists and even the guides.

Some of the main purpose was to provide the tourists opportunity to view chimpanzees and other wildlife in the natural environment and also to protect one of the smallest group of chimpanzees that are found in QENP for their survival within a unique settling of a river gorge. It marks the boundary of Kyambura Game Reserve and QENP in the East.

Chimpanzees have been observed leaving the gorge heading into the savannah to feed on fig trees when the food down in the gorge is not enough and even extending more in southern parts of the gorge where the community live. It is believed that the human presence destroyed a very big forest around that place towards Kasyoka Kitomi forest where Kyambura River originates.

Tourism Education

One of the big work that has been going on around the Park was to encourage conservation and education extension in school groups, local community in order to bring their attention towards the protection of the environment (chimps). The first focus was on the school groups because we found out how their younger generation of tomorrow with assistance of the Peace Corps. The second focus was on the local community with their local authorities in order to find some solutions so that the environment could be protected.

In 1990 poaching of hippos and antelopes for meat, also fishing and destruction of trees, was very high. A few years ago 11 Wildlife Clubs were formed 5 being the adult groups and 6 being school groups. They have helped through extension and education to reduce poaching and destroying of trees.

Tariffs

The charges are as follows:

Non Foreign Resident	US$ 40
Foreign Resident	US$ 30
Ugandans	Ug Shs 7,000
Local Community (around the park)	Ug Shs 3,000

Information that is being collected from out small group of chimps is different behaviour, tool use, medicinal plant used, feeding food type, hunting and who is involved in hunting females or males copulation to who.

From the information collected from the field by Guides the following have been observed since 1992 up to now:

- Hunting black-and-white colobus monkeys both successful and unsuccessful hunting.
- Fishing of termites along the gorge and inside the gorge.
- Collection of honey in the bee colony.
- Recently one female was sighted with two younger ones of the same size of 1 year old without any assistance of the group and more tracking of the group is still going on so that more information could be obtained.
- On 30th December 1996 we received a radio message from one of our group that had taken visitors into the gorge how one of our adolescent male copulated with the red-tailed monkey. The question goes what will happen if they continue?

We would like to thank the QENP Management especially Mr Latif Amooti, Chief Warden and Mr Willhem Moeller who assisted the Guides of Fig Tree during the chimpanzee studies on habituation in all the things that we were using in the field plus Workshops that have been arranged and funded both the Park and local people in order to come up with some solution on our environmental protection.

Rabongo Forest and its Chimpanzees

P. Ezuma and D. Owen
Rabongo Forest, Murchison Falls National Park,
P.O. Box 3530, Kampala

Introduction

Rabongo Forest is about 150 hectares but has other smaller patches (all less than 1 km^2) which total up an area of 250 km^2 (Figure 1). The forest is semi-deciduous, riverine forest with a generally open canopy at 15 - 25m. Between Rabongo and Budongo Forest is Kinyanga Forest which is an outlier of Budongo Forest. The surrounding countryside is a wooded bushland, stretching for many kms. through the surrounding National Park and its buffer zones.

Although no evidence has been reported, these forest areas have been isolated for a long period (probably hundreds of years). They can therefore be considered as relict areas of a once more extensive system of riverine forest along the Wairingo, Sambiya and other rivers. Fire and perhaps elephants have progressively reduced the area of forest to its present size. The Forest is still subject to annual fires.

Like Budongo Forest, elephants no longer visit Robongo Forest. However there is evidence (tusked trees) that they used to do so.

The area receives an average of 1150m of rainfall annually. The distribution is bimodal with peaks in March-May and September-November. This amount is rather marginal for forests.

History

The Forest gets its name from Rabongo Hill (1300m) which is the highest point in the Southern sector of Murchison Falls National Park. It is believed that it is a remnant of a once more extensive rain forest system that extended through the area.

Vegetation

Rabongo is a remnant of tropical rain forests which has climaxed to a *cynometra* type (Eggeling, 1947). Most of the species found in it are again found in Budongo Forest suggesting that species are "overmature". These are gradually dying out leaving a very open canopy. Among the tree species recorded is a mahogany species, *Khaya grandifoliola* which is known mainly from this forest and Kinyanga.

Chimpanzees

Although no census has been done, chimpanzees have been seen and are frequently heard in the forest. About 10-20 chimpanzees are resident in the forest. There are indications that they are sometimes absent for at least two weeks. Most of the time they are feeding in the savanna area adjacent to the forest.

Groups of 5-7 chimpanzees are common. It has become apparent that sometimes they don't make nests. Our search for nests following loud vocalisations in the night the following day revealed no nests found in the area. No evidence of predation from leopards and lions has been recorded.

It seems likely that the Rabongo group of chimpanzees at times get in contact with the chimpanzees from Kaniyo-Pabidi (22 km to the Southwest). On a number of occasions, they disappear from Rabongo.

Habituation

Limited habituation has been attempted but with little success.

Challenges for the Rabongo Chimpanzees

The greatest threat is the possibility of being cut off from other populations due to habitat destruction and encroachment. Such isolation from a larger gene pool would further limit Rabongo chimpanzees viability as a population.

Poaching, which is on the increase again in the protected area, is another threat to this population. They are particularly at risk form snares. In nearby Karuma Wildlife Reserve poaching is rife, and its not uncommon to see baboons crippled by snares. As such activity seems likely to reach deeper into the Parks as human populations along the boundary grow, the Rabongo chimpanzees will be increasingly at risk.

Supplementing the Local Chimpanzee Population

Rabongo Forest staff have been asked to comment on the possibility of releasing Chimpanzees from Entebbe Wildlife Education Centre in this forest to "supplement" the resident population. There are three reasons why this is not advisable.

1. The risk of disease transmission. The population is very small and cannot withstand an outbreak infection.
2. Since most of the Entebbe Chimpanzees are surgically prevented from reproducing, there can be little genetic benefit from "supplementing" the Rabongo population with "new" blood.
3. There is a high probability that the resident group would reject such translocated animals.

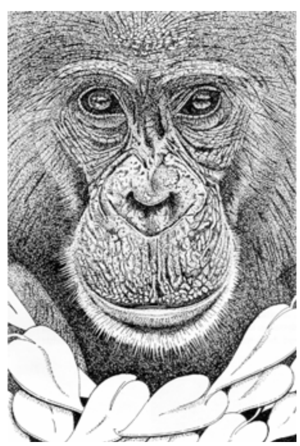
Recommendations

There are many unanswered questions about the Rabongo Chimpanzees; their population structure, the frequency of contact with Pabidi Chimpanzees, their foraging territory size, and the relative suitability of Rabongo Forest as Chimpanzee's habitat. It is recommended that study of the Rabongo chimpanzees continue.

The current policy of not developing Rabongo Forest as the chimpanzee tourism site be maintained. Based on what we know about our resident group, it seems unlikely that chimpanzee tourism could succeed here. The animals are too few, too mobile and often too far away from where tourists are able to go in short time.

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997



Section 10
Appendix II.
IUCN Policy Guidelines

IUCN GUIDELINES FOR THE PLACEMENT OF CONFISCATED LIVE ANIMALS[1]

Statement of Principle:

When live animals are confiscated by government authorities, these authorities have a responsibility to dispose of them appropriately. Within the confines of national and international law, the ultimate on disposition of confiscated animals must achieve three goals: 1) to maximise conservation value of the specimens without in any way endangering the health, behavioral repertoire, genetic characteristics, or conservation status of wild or captive populations of the species[1]; 2) to discourage further illegal or irregular[2] trade in the species; and 3) to provide a humane solution, whether this involves maintaining the animals in captivity, returning them to the wild, or employing euthanasia to destroy them.

Statement of Need:

Increased regulation of trade in wild plants and animals and enforcement of these regulations has resulted in an increase in the number of wildlife shipments intercepted by government authorities as a result of non-compliance with these regulations. In some instances, the interception is a result of patently illegal trade; in others, it is in response to other irregularities. While in some cases the number of animals in a confiscated shipment is small, in many others the number is in the hundreds. Although in many countries confiscated animals have usually been donated to zoos and aquaria, this option is proving less viable with large numbers of animals and, increasingly, for common species. The international zoo community has recognized that placing animals of low conservation priority in limited cage space may benefit those individuals but may also detract from conservation efforts as a whole. They are, therefore, setting conservation priorities for cage space (IUDZG/CBSG 1993).

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.

In light of these trends, there is an increasing demand - and urgent need - for information and advice to guide confiscating authorities in the disposition of live animals. Although specific guidelines have been formulated for certain groups of organisms, such as parrots (Birdlife International in prep.) and primates (Harcourt 1987), no general guidelines exist.

[1] Although this document refers to species, in the case of species with well-defined subspecies and races, the issues addressed will apply to lower taxonomic units.

When disposing of confiscated animals, authorities must adhere to both national and international law. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) requires that confiscated individuals of species listed on the treaty's Appendices be returned to the "state of export . . . or to a rescue centre or such other place as the Management Authority deems appropriate and consistent with the purpose of the Convention." (Article VIII). However the treaty does not elaborate on this requirement, and CITES Management Authorities must act according to their own interpretation, not only with respect to repatriation but also as regards what constitutes disposition that is "appropriate and consistent" with the treaty. Although the present guidelines are intended to assist CITES Management Authorities in making this assessment, they are designed to be of general applicability to all confiscated live animals.

The lack of specific guidelines has resulted in confiscated animals being disposed of in a variety of ways. 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, IUCN 1995). In other cases, such releases have not been well planned and have been inconsistent with general conservation objectives and humane considerations, such as releasing animals in inappropriate habitat, dooming these individuals to starvation or certain death from other causes against which the animals are not equipped or adapted. Such releases may also have strong negative conservation value by threatening existing wild populations as a result of: 1) diseases and parasites acquired by the released animals while in captivity spreading into existing wild populations; 2) individuals released into existing populations, or in areas near to existing populations, not being of the same race or sub-species as those in the wild population, resulting in mixing of distinct genetic lineages; 3) animals held in captivity, particularly juveniles and immatures, acquiring an inappropriate behavioral repertoire from individuals of other species, and/or either losing certain behaviors, or not developing the full behavioral repertoire, necessary for survival in the wild. Also, it is possible that release of these animals could result in inter-specific hybridisation.

Disposition of confiscated animals is not a simple process. Only on rare occasions will the optimum course to take be clear-cut or result in an action of conservation value. Options for the disposition of confiscated animals have thus far been influenced by the public's perception that returning animals to the wild is the optimal solution in terms of both animals welfare and conservation. A growing body of scientific study of re-introduction of captive animals suggests that such actions may be among the least appropriate options for many reasons. This recognition requires that the options available to confiscating authorities for disposition be carefully reviewed.

Management Options:

In deciding on 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 fall into three

principal categories: 1) maintenance of the individual(s) in captivity; 2) returning the individual(s) in question to the wild; and 3) euthanasia.
Within a conservation perspective, by far the most important consideration in reviewing the options for disposition is the conservation status of the species concerned. Where the confiscated animals represent an endangered or threatened species, particular effort should be directed towards evaluating whether and how these animals might contribute to a conservation programme for the species. The decision as to which option to employ in the disposition of confiscated animals will depend on various legal, social, economic and biological factors. The "Decision Tree"[1] provided in the present guidelines is intended to facilitate consideration of these options. The tree has been written so that it may be used for both threatened and common species. However, it recognizes that the conservation status of the species will be the primary consideration affecting the options available for placement, particularly as the expense and difficulty of returning animals to the wild (see below) will often only be justified for threatened species. International networks of experts, such as the IUCN-Species Survival Commission Specialist Groups, should be able to assist confiscating authorities, and CITES Scientific and Management Authorities, in their deliberations as to the appropriate disposition of confiscated specimens.

Sending animals back automatically to the country from which they were shipped, the country in which they originated (if different), or another country m which the species exists, does not solve any problems. Repatriation to avoid addressing the question of disposition of confiscated animals is irresponsible as the authorities in these countries will face the same issues concerning placement as the authorities in the original confiscating country.

OPTION 1-- **CAPTIVITY**

Confiscated animals are already in captivity; there are numerous options for maintaining them in captivity. Depending on the circumstances, animals can be donated, loaned, or sold. Placement may be in zoos or other facilities, or with private individuals. Finally, placement may be 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. If animals are maintained in captivity, in preference to either being returned to the wild or euthanized, they must be afforded humane conditions and ensured proper care for their natural lives.

Zoos and aquaria are the captive facilities most commonly considered for disposition of animals, but a variety of captive situations exist where the primary aim of the institution or individuals involved is not the propagation and resale of wildlife. These include:

> **Rescue centres**, established specifically to treat injured or confiscated animals, are sponsored by a number of humane organisations in many countries.
>
> **Life-time care facilities** devoted to the care of confiscated animals have been built in a few countries.

Specialist societies or clubs devoted to the study and care of single taxa or species(e.g., reptiles, amphibians, birds) have, in some instances, provided an avenue for the disposition of confiscated animals without involving sale through intermediaries. Placement may be made directly to these organisations or to individuals who are members.

Humane Societies may be willing to ensure placement of confiscated specimens with private individuals who can provide humane life-time care.

Research laboratories (either commercial or non-commercial, e.g. universities) maintain collections of exotic animals for many kinds of research (e.g. behavioural, ecological, physiological, psychological, medical). Attitudes towards vivisection, or even towards the non-invasive use of animals in research laboratories as captive study populations, vary widely from country to country. Whether transfer of confiscated animals to research institutions is appropriate will therefore engender some debate. However, it should be noted that transfer to facilities involved in research conducted under humane conditions may offer an alternative -- and one which may eventually contribute information relevant to the species' conservation. In many cases, the lack of known provenance and the risk that the animal in question has been exposed to unknown pathogens will make transfer to a research institution an option that will be rarely exercised or desired.

CAPTIVITY - Sale, Loan or Donation

Animals can be placed with an institution or individual in a number of ways. It is critical, however. that two issues be separated: the ownership of the animals and/or their progeny, and the payment of a fee by the institution/individual receiving the animals. Paying the confiscating authority, or the country of origin, does not necessarily give the person or institution making the payment any rights (these may rest with the confiscating authority). Similarly, ownership of an animal can be transferred without payment. Confiscating authorities and individuals or organizations participating in the placement of confiscated specimens must clarify ownership. both of the specimens being transferred and their progeny. Laws dictating right of ownership of wildlife differ between nations, in some countries ownership remains with the government, in others the owner of the land inhabited by the wildlife has automatic rights over the animals.

When drawing up the terms of transfer many items must be considered, including:

-- ownership of both the animals involved and their offspring (dictated by national law) must be specified as one of the terms and conditions of the transfer (it may be necessary to insist there is no breeding for particular species, e.g. primates). Either the country of origin or the country of confiscation may wish to retain ownership of the animals and/or their progeny. Unless specific legal provisions apply, it is impossible to assure the welfare of the animals following a sale which includes a transfer of ownership.

-- sale or payment of a fee to obtain certain rights (e.g. ownership of offspring) can provide a means of placement that helps offset the costs of confiscation.

--sale and transfer of ownership should only be considered in certain circumstances, such as where the animals in question are not threatened and not subject to a legal proscription on trade (e.g., CITES Appendix I) and there is no risk of stimulating further illegal or irregular trade.

--sale to commercial captive breeders may contribute to reducing the demand for wild-caught individuals.

--sale may risk creating a public perception of the confiscating State perpetuating or benefitting from illegal or irregular trade.

--if ownership is transferred to an organization to achieve a welfare or conservation goal, the confiscating authority should stipulate what will happen to the specimens should the organization wish to sell/transfer the specimens to another organization or individual.

--confiscating authorities should be prepared to make public the conditions under which confiscated animals have been transferred and, where applicable, the basis for any payments involved.

CAPTIVITY-- **Benefits**

The benefits of placing confiscated animals in a facility that will provide life-time care under humane conditions include;

a) educational value;
b) potential for captive breeding for eventual re-introduction;
c) possibility for the confiscating authority to recoup from sale costs of confiscation;
d) potential for captive bred individuals to replace wild-caught animals as a source for trade.

CAPTIVITY- **Concerns**

The concerns raised by placing animals in captivity include:

A) **Disease.** Confiscated animals may serve as vectors for disease. The potential consequences of the introduction of alien disease to a captive facility are more serious than those of introducing disease to wild populations (see discussion page 9); captive conditions might encourage disease spread to not only conspecifics. As many diseases can not be screened for, even the strictest quarantine and most extensive screening for disease can not ensure that an animal is disease free. Where quarantine cannot adequately ensure that an individual is disease free, isolation for an indefinite period, or euthanasia, must be carried out.

B) **Escape**. Captive animals maintained outside their range can escape from captivity and become pests. Accidental introduction of exotic species can cause tremendous damage and in certain cases, such as the escape of mink from fur farms in the United

Kingdom, the introduction of exotics can result from importation of animals for captive rearing.

C) **Cost of Placement.** While any payment wi11 place a value on an animal, there is little evidence that trade would be encouraged if the institution receiving a donation of confiscated animals were to reimburse the confiscating authority for costs of care and transportation. However, payments should be explicitly for reimbursement of costs of confiscation and care, and, where possible, the facility receiving the animals should bear all such costs directly.

D) **Potential to Encourage Undesired Trade**. Some (e.g., Harcourt 1987) have maintained that any transfer - whether commercial or non-commercial - of confiscated animals risks promoting a market for these species aud creating a perception of the confiscating state being involved in illegal or irregular trade.

Birdlife International (in prep.) suggests that in certain circumstances sale of confiscated animals does not necessarily promote undesired trade. They offer the following requirements that must be met for permissible sale by the confiscating authority: I) the species to be sold is already available for sale legally in the confiscating country in commercial quantities; and 2) wildlife traders under indictment for; or convicted of, crimes related to import of wildlife are prevented from purchasing the animals in question. However, experience in selling confiscated animals in the USA suggests that it is virtually impossible to ensure that commercial dealers suspected or implicated in illegal or irregular trade are excluded, directly or indirectly, in purchasing confiscated animals.

In certain circumstances sale or loan to commercial captive breeders may have a clearer potential for the conservation of the species, or welfare of the individuals, than non-commercial disposition or euthanasia. However, such breeding programmes must be carefully assessed as it may be difficult to determine the effects of these programmes on wild populations.

OPTION 2-- RETURN **TO THE WILD**

These guidelines suggest that return to the wild would be a desirable option in only a very small number of instances and under very specific circumstances. The rationale behind many of the decision options iii this section are discussed in greater detail in the IUCN Re-introduction Guidelines (IUCN/SSC RSG 1995) which, it is important to note, make a clear distinction between the different options for returning animals to the wild. These are elaborated below.

I) **Re-introduction**: an attempt to establish a population in an area that was once part of the range of the species but from which it has become extirpated.
Some of the best known re-introductions have been of species that had become extinct in the wild. Examples include: Pere David's deer (*Elaphurus davidanus*) and the Arabian

oryx (*Oryx leucoryx*.). Other re-introduction programmes have involved species that exist in some parts of their historical range but have been eliminated from other areas; the aim of these programmes is to re-establish a population in all area, or region, from which the species has disappeared. An example of this type of r~introduction is the recent re-introduction of the swift fox (*Vulpes velox*) in Canada.

2) **Reinforcement of an Existing Population**: the addition of individuals to all existing population of the same taxon.

Reinforcement can be a powerful conservation tool when natural populations are diminished by a process which, at least in theory, can be reversed. An example of a successful reinforcement project is the golden lion tamarin *(Leontopithecus rosalia*) project in Brazil. Habitat loss, coupled with capture of live animals for pets, resulted in a rapid decline of the golden lion tamarin. when reserves were expanded, and capture for the pet trade curbed, captive-bred golden lion tamarins were then used to supplement depleted wild populations.

Reinforcement has been most commonly pursued when individual animals injured by human activity have been provided with veterinary care and released. Such activities are common in many western countries, and specific programmes exist for species as diverse as hedgehogs and birds of prey. However common an activity, reinforcement carries with it the very grave risk that individuals held in captivity, even temporarily, are potential vectors for the introduction of disease into wild populations.

Because of inherent disease risks and potential behavioural abnormalities, reinforcement should only be employed in instances where there is a direct and measurable conservation benefit (demographically and/or genetically, and/or to enhance conservation in the public's eye), for example when reinforcement will significantly add to the viability of the wild population into which an individual is being placed.

3) **Conservation Introductions:** (also referred to as Beneficial or Benign Introductions - IUCN 1995): an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within a suitable habitat in which a population can be established without predicted detriment to native species.

Extensive use of conservation introductions has been made in New Zealand, where endangered birds have been transferred to off-shore islands that were adjacent to, but not part of the animals' original range. Conservation introductions can also be a component of a larger programme of re-introduction, an example being the breeding of red wolves on islands outside their natural range and subsequent transfer to mainland range areas (Smith
1990).

RETURN To THE WILD - CONCERNS

Before return to the wild of confiscated animals is considered, several issues of concern must be considered in general terms; welfare, conservation value, cost, and disease.

a) **Welfare**. While some consider return to the wild to be humane, ill-conceived projects may return animals to the wild which then die from starvation or suffer an inability to adapt to an unfamiliar or inappropriate environment. This is not humane. Humane considerations require that each effort to return confiscated animals to the wild be thoroughly researched and carefully planned. Such returns also require long-term commitment in terms of monitoring the fate of released individuals. Some (e.g., International Academy of Animal Welfare Sciences 1992) have advocated that the survival prospects for released animals must at least approximate those of wild animals of the same sex and age class in order for return to the wild to be seriously considered. While such demographic data on wild populations are, unfortunately, rarely available, the spirit of this suggestion should be respected -- there must be humane treatment of confiscated animals when attempting to return them to the wild.

b) **Conservation Value And Cost**. In cases where returning confiscated animals to the wild appears to be the most humane option, such action can only be undertaken if it does not threaten existing populations of conspecifics or populations of other interacting species, or the ecological integrity of the area in which they live. The conservation of the species as a whole, and of other animals already living free, must take precedent over the welfare of individual animals that are already in captivity.

Before animals are used in programmes in which existing populations are reinforced, or new populations are established, it must be determined that returning these individuals to the wild will make a significant contribution to the conservation of the species, or populations of other interacting species. Based solely on demographic considerations, large populations are less likely to go extinct, and therefore reinforcing existing very small wild populations may reduce the probability of extinction. In very small populations a lack of males or females may result in reduced population growth or population decline and, therefore, reinforcing a very small population lacking animals of a particular sex may also improve prospects for survival of that population. However, genetic and behavioural considerations, as well as the possibility of disease introduction, also play a fundamental role in determining the long term survival of a population.

The cost of returning animals to the wild in an appropriate manner can be prohibitive for all but the most endangered species (Stanley Price 1989; Seal et al. 1989). The species for which the conservation benefits clearly outweigh these costs represent a tiny proportion of the species which might, potentially, be confiscated In the majority of cases, the costs of appropriate, responsible (re)introduction will preclude return to the wild. Poorly planned or executed (re)introduction programmes are no better than dumping animals in the wild and should be vigorously opposed on both conservation and humane grounds.

c) **Founders And Numbers Required**. Most re-introductions require large numbers of founders, usually released in smaller groups over a period of time. Hence, small groups of confiscated animals may be inappropriate for re-introduction programmes, and even larger groups will require careful management if they are to have any conservation value for re-introduction programmes. In reality, confiscated specimens will most often only be of potential value for reinforcing an existing population, despite the many potential problems this will entail.

c) **Source of Individuals**. If the precise provenance of the animals is not known (they may be from several different provenances), or if there is any question of the source of animals, supplementation may lead to inadvertent pollution of distinct genetic races or sub~species. If particular local races or sub-species show specific adaptation to their local environments mixing in individuals from other races or sub-species may be damaging to the local population. Introducing an individual or individuals into the wrong habitat type may also doom that individual to death.

a) **Disease**. Animals held in captivity and/or transported, even for a very short time, 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. Even if there is a very small risk that confiscated animals have been infected by exotic pathogens, the potential effects of introduced diseases on wild populations are so great that this will often prevent returning confiscated animals to the wild (Woodford and Rossiter 1993, papers in *J Zoo and Wildlife Medicine* 24(3), 1993).

Release of any animal into the wild which has been held in captivity is risky. Animals held in captivity are more likely to acquire diseases and parasites. While some of these diseases can be tested for, tests do not exist for many animal diseases. Furthermore, animals held in captivity are frequently exposed to diseases not usually encountered in their natural habitat. Veterinarians and quarantine officers, taking that the species in question is only susceptible to certain diseases, may not test for the diseases picked up in captivity. It should be assumed that all diseases are potentially contagious.

Given that any release incurs some risk, the following “precautionary principle" must be adopted: *if there is no conservation value in releasing confiscated specimens, the possibility of accidentally introducing a disease, or behavioural and genetic aberrations into the environment which are not already present, however unlikely, may rule out returning confiscated specimens to the wild as a placement option.*

RETURN To THE WILD: BENEFITS

There are several benefits of returning animals to the wild, either through re-introduction for the establishment of a new population or reinforcement of an existing population.

a) **Threatened Populations**: In situations where the existing population is severely threatened, such an action might improve the long-term conservation potential of the species as a whole, or of a local population of the species (e.g., golden lion tamarins).

b) **Public Statement**: Returning animals to the wild makes a strong political/educational statement concerning the fate of animals (e.g., orangutans (*Pongo pygmaeus*) and chimpanzees *(Pan troglodytes*) - Aveling & Mitchell 1982, but see Rijksen & Rijksen-Graatsma 1979) and may serve to promote local conservation values. However, as part of any education or public awareness programmes, the costs and difficulties associated with the return to the wild must be emphasized.

OPTION 3- EUTHANASIA

Euthanasia: the killing of animals carried out according to humane guidelines -- is unlikely to be a popular option amongst confiscating authorities for disposition of confiscated animals. However, it cannot be over-stressed that euthanasia may frequently be the most feasible option available for economic, conservation and humane reasons. hi many cases, authorities confiscating live animals will encounter the following situations:

a) Return to the wild in some manner is either unnecessary (e.g., in the case of a very common species), impossible, or prohibitively expensive as a result of the need to conform to biological (IUCN/SSC RSG ~995) and animal welfare guidelines (International Academy of We1fare Sciences 1992).

b) Placement in a captive facility is impossible, or there are serious concerns that sale will be problematic or controversial.

c) During transport, or while held in captivity, the animals have contracted a chronic disease that is incurable and, therefore, are a risk to any captive or wild population. hi such situations, there may be no practical alternative to euthanasia.

EUTHANASIA -ADVANTAGES:

a) From the point of view of conservation of the species involved, and of protection of existing captive and wild populations of animals, euthanasia carries far fewer risks (e.g. loss of any unique behavioural/genetic/ecological variations within an individual representing variation within the species) when compared to returning animals to the wild.

b) Euthanasia will also act to discourage the activities that gave rise to confiscation, be it smuggling or other patently illegal trade, incomplete or irregular paperwork, poor packing, or other problems, as the animals in question are removed entirely from trade.

c) Euthanasia may be in the best interest of the welfare of the confiscated animals. Release to the wild will carry enormous risks for existing wild populations and may pose severe challenges to the survival prospects of the individual animals, who may, as a result, die of starvation, disease or predation.

d) Cost: euthanasia is cheap compared to other options. There is potential for diverting resources which might have been used for re-introduction or lifetime care to conservation of the species in the wild.

When animals are euthanized, or when they die a natural death while in captivity, the dead specimen should be placed in the collection of a natural history museum, or another reference collection in a university or research institute. Such reference collections are of great importance to studies of biodiversity. if such placement is impossible, carcasses should be incinerated to avoid illegal trade in animal parts or derivatives.

EUTHANASIA- RISKS

a) There is a risk of losing unique behavioural, genetic and ecological material within an individual or group of individuals that represents variation within a species.

DECISION TREE ANALYSIS

For decision trees dealing with “Return to the Wild” and “Captive Options” the confiscating party must first ask the question:

Question 1: Will “Return to the Wild” make a significant contribution to the conservation of the species?

The most important consideration in deciding on placement of confiscated specimens is the conservation of the species in question. Conservation interests are best served by ensuring the survival of as many individuals as possible. The release of confiscated animals therefore must improve the prospects for survival of the existing wild population. Returning an individual to the wild that has benn held in captivity will always involve some level of risk to existing populations of the same or other species in the ecosystem to which the animal is returned because there can never be absolute certainty that a confiscated animal is disease- and parasite-free. In most instances, the benefits of return to the wild will be outweighed by the costs and risks of such an action. If returning animals to the wild is not of conservation value, captive options pose fewer risks and may offer more humane alternatives.

Q1 Answer: No: Investigate “Captive Options”
Yes: Investigate “Return to the Wild Options”

DECISION TREE ANALYSIS: CAPTIVITY

The decision to maintain confiscated animals in captivity involves a simpler set of considerations than that involving attempts to return confiscated animals to the wild.

Question 2: Have animals been subjected to a comprehensive veterinary screening and quarantine?

Animals that may be transferred to captive facilities must have a clean bill of health because of the risk of introducing disease to captive populations.

Theses animals must be placed in quarantine to determine if they are disease-free before being transferred to a captive-breeding facility.

Q2 Answer: Yes: Proceed to Question 3.
No: Quarantine and screen and move to Question 3.

Question 3: Have animals been found to be disease-free by comprehensive veterinary screening and quarantine or can they be treated for any infection discovered?

If; during quarantine animals are found to harbour diseases that cannot reasonably be cured, they must be euthanized to prevent infection of other animals. If the animals are suspected to have come into contact with diseases for which screening is impossible, extended quarantine, donation to a research facility, or euthanasia must be considered.

Q3 Answer: Yes: Proceed to Question 4
No: If chronic and incurable infection, first offer animals to research institutions. impossible to place in such institutions, euthanize.

Question 4: Are there grounds for concern that sale will stimulate further illegal or irregular trade?

Commercial sale of Appendix I species is not permitted under the Convention as it is undesirable to stimulate trade in these species. Species not listed in any CITES appendix, but which are nonetheless seriously threatened with extinction, should be afforded the same caution.

Sale of confiscated animals, where legally permitted, is a difficult option to consider. while the benefits of sale -- income and quick disposition -- are clear, there are many problems that may arise as a result of further commercial transactions of the specimens involved. Equally, it should be noted that there may be circumstances where such problems arise as a result of a non-commercial transaction or that, conversely, sale to commercial captive breeders may contribute to production of young offsetting the capture from the wild.

More often than not, sale of threatened species should not take place. Such sales or trade in threatened species may be legally proscribed in some countries, or by CITES. There may be rare cases where a commercial captive breeding operation may purchase or receive individuals for breeding, which may reduce pressure on wild populations subject to trade. In all circumstances, the confiscating authority should be satisfied that:

1) those involved in the illegal or irregular transaction that gave rise to confiscation cannot obtain the animals;
2) the sale does not compromise the objective of confiscation; and, finally,
3) the sale will not increase illegal, irregular or otherwise undesired trade in the species.

Previous experience with sale in some countries (e.g., the USA) has indicated that selling confiscated animals is beset by both logistic and political problems and that, in addition to being controversial, it may also be counter-productive to conservation objectives.

Q4 Answer: Yes: Proceed to Question 5a.
No: Proceed to Question 5b.

Question 5a: **Is space available in a non-commercial captive facility (e.g., life-time care facility, zoo, rescue centre, specialist society, their members or private individuals)?**

Question 5b: **Is space available in a non-commercial captive facility (e.g., life-time care facility, zoo, rescue centre, specialist society, their members or private individuals) or is there a commercial facility breeding this species, and is the facility interested in the animals?**

Transfer of animals to non-commercial captive-breeding facilities, if sale may stimulate further illegal or irregular trade, or commercial captive breeding facilities, an option only if sale will not stimulate further illegal or irregular trade, should generally provide a safe and acceptable means of disposition of confiscated animals. when a choice must be made between several such institutions, the paramount consideration should be which facility can:

1) offer the opportunity for the animals to participate in a captive breeding programme;
2) provide the most consistent care; and
3) ensure the welfare of the animals.

The terms and conditions of the transfer should be agreed between the confiscating authority and the recipient institution. Terms and conditions for such agreements should include:

I) a clear commitment to ensure life-time care or, in the event that this becomes impossible, transfer to another facility that can ensure life-time care, or euthanasia;
2) clear specification of ownership of the specimens concerned (as determined by national law) and, where breeding may occur, the offspring. Depending on the circumstances, ownership may be vested with the confiscating authority, the country of origin or export, or with the recipient facility.
3) clear specification of conditions under which the animal(s) or their progeny may be sold.

In the majority of instances, there will be no facilities or zoo or aquarium space available in the country in which animals are confiscated. Where this is the case other captive options should be investigated. This could include transfer to a captive facility outside the country of confiscation particularly in the country of origin, or, if transfer will not stimulate further illegal trade, placement in a commercial captive breeding facility. However, these breeding programmes must be carefully assessed and approached with caution. It may be difficult to monitor these programmes and such programmes may unintentionally, or intentionally, stimulate trade in wild animals. The conservation potential of this transfer, or breeding loan, must be carefully weighed against even the smallest risk of stimulating trade which would further endanger the wild population of the species.

In many countries, there are active specialist societies or clubs of individuals with considerable expertise in the husbandry and breeding of individual Species or groups of Species. Such societies can assist in finding homes for confiscated animals without involving sale through intermediaries. In this case, individuals receiving confiscated animals must have demonstrated expertise in the husbandry of the species concerned and must be provided with adequate information and advice by the club or society concerned. Transfer to specialist societies or individual members must be made according to terms and conditions agreed with the confiscating authority. Such agreements may be the same or similar to those executed with Lifetime Care facilities or zoos. Placement with these societies or members is an option if sale of the confiscated animals may or may not stimulate trade.

Q5 Answer: Yes: Execute agreement and Sell
No: Proceed to Question 6.

Question 6: Are institutions interested in animals for research under humane conditions?

Many research laboratories maintain collections of exotic animals for research conducted under humane conditions. If these animals are kept in conditions that ensure their welfare, transfer to such institutions may provide an acceptable alterative to other options, such as sale or euthanasia. As in the preceding instances, such transfer should be subject to terms and conditions agreed with the confiscating authority; in addition to those already suggested, it may be advisable to include terms that stipulate the types of research the confiscating authority considers permissible. If no placement is possible, the animals should be euthanized.

Q6 Answer: Yes: Execute Agreement and Transfer.
No: Euthanize.

DECISION TREE ANALYSIS -- RETURN TO THE WILD

Question 2: Have animals been subjected to a comprehensive veterinary screening and quarantine?

Because of the risk of introducing disease to wild populations, animals that may be released must have a clean bill of health. These animals must be placed in quarantine to determine if they are disease free before being considered for released.

Q2 Answer: Yes: Proceed to Question 3.
No: Quarantine and screen and move to Question 3

Question 3: Have animals been found to be disease free by comprehensive veterinary screening and quarantine or can they be treated for any infection discovered?

1. If during quarantine, the animals are found to harbour diseases that cannot reasonably be cured, unless any institutions are interested in the animals for research under humane conditions, they must be euthanized to prevent infection of other animals. If the animals are suspected to have come into contact with diseases for which screening is impossible, extended quarantine, donation to a research facility, or euthanasia must be considered.

Q3 Answer: Yes: Proceed to Question 4

No: if chronic and incurable infection, first offer animals to research institutions. if impossible to place in such institutions, euthanize.

Question 4: Can country of origin and site of capture be confirmed?

The geographical location from which confiscated individuals have been removed from the wild must be determined if these individuals are to be re-introduced or used to supplement existing populations. In most cases, animals should only be returned to the population from which they were taken, or from populations which are known to have natural exchange of individuals with this population.

If provenance of the animals is not known, release for reinforcement may lead to inadvertent hybridisation of distinct genetic races or sub-species. Related species of animals that may live in sympatry in the wild and never hybridise have been known to hybridise when held in captivity or shipped in multi-Species groups. This type of generalisation of species recognition under abnormal conditions can result in behavioural problems compromising the success of any future release and can also pose a threat to wild populations by artificially destroying reproductive isolation that is behaviourally mediated.

Q4 Answer: Yes: Proceed to Question 5.
No: Pursue 'Captive Options'.

Question 5: Do the animals exhibit behavioural abnormalities which might make them unsuitable for return to the wild?

Behavioural abnormalities as a result of captivity can result in animals which are not suitable for release into the wild. A wide variety of behavioural traits and specific behavioural skills are necessary for survival, in the short-term for the individual, and in the long-term for the population. Skills for hunting, avoiding predators, food selectivity etc. are necessary to ensure survival.

Q5 Answer: Yes: Pursue 'Captive Options'.
No; Proceed to Question 6.

Question 6:Can individuals be returned expeditiously to origin (specific location), and will benefits to conservation of the species outweigh any risks of such action?

Repatriation of the individual and reinforcement of the population will only be options under certain conditions and following the IUCN/RSG 1995 guidelines:

1) Appropriate habitat for such an operation still exists in the specific location that the individual was
removed from; and
2) sufficient funds are available, or can be made available.

Q6 Answer: Yes: Repatriate and reinforce at origin (specific location) following IUCN guidelines.
No: Proceed to Question 7.

Question 7: For the species in question, does a generally recognized programme exist whose aim is conservation of the species and eventual return to the wild of confiscated individuals and or their progeny? Contact IUCN/SSC, IUDZG, Studbook Keeper, or Breeding Programme Coordinator.

In the case of Species for which active captive breeding and or re-introduction programmes exist, and for which further breeding stock/founders are required, confiscated animals should be transferred to such programmes after consultation with the appropriate scientific authorities. If the Species in question is part of a captive breeding programme, but the taxon (sub-species or race) is not part of this programme (e.g. Maguire & Lacy 1990), other methods of disposition must be considered. Particular attention should be paid to genetic screening to avoid jeopardizing captive breeding programmes through inadvertent hybridisation.

Q7 Answer: Yes: Executer agreement and transfer to existing programme.
No: Proceed to Question 8.

Question 8: Is there a need and is it feasible to establish a new r~introduction programme following IUCN Guidelines?

In cases where individuals cannot be transferred to existing r~introduction programmes, return to the wild, following appropriate guidelines, will only be possible under the following circumstances:
1) appropriate habitat exists for such an operation; 2) sufficient funds are available, or can be made available, to support a programme over the many years that (re)introduction will require; and 3) either sufficient numbers of animals are available so that re-introduction efforts are potentially viable, or only reinforcement of existing populations is considered. In the majority of cases, at least one, if not all, of these requirements will fail to be met. In this instance, either conservation introductions outside the historical range of the Species or other options for disposition of the animals must be considered.

It should be emphasized that if a particular species or taxon is confiscated with some frequency, consideration should be made as to whether to establish a re-introduction, reinforcement, or introduction programme. Animals should not be held by the confiscating authority indefinitely while such programmes are planned, but should be transferred to a holding facility after consultation with the organization which is establishing the new programme.

Q8 Answer: Yes: Execute agreement and transfer to holding facility or new programme.
No: Pursue 'Captive Options'.

References

Aveling, R. & Mitchell A.H. (1982). Is rehabilitating orang utans worthwhile? Oryx 16: 263-271.

BirdLife International (in prep). Parrots: An Action Plan for their Conservation. (BirdLife International, Cambridge: England).

Harcourt, A. H. (1987). *Options for unwanted or confiscated primates*. Primate Conservation 8:111-113.

International Academy of Animal Welfare Sciences (1992). *Welfare guidelines for the re-introduction of captive-bred mammals to the wild*. (Universities Federation for Animal Welfare, Potters Bar: United Kingdom).

IUCN (1987). *The IUCN position statement on translocation of living organisms: introductions, re-introductions and restocking*. (IUCN, Gland: Switzerland).

IUCN/SSC RSG (1995). *Draft guidelines for re-introductions*. Species Survival Commission Re-introduction Specialist Group, IUCN - The World Conservation Union.

IUDZG/CBSG (IUCN/SSC) 1993. *The World Zoo Conservation Strategy. The Role of Zoos and Aquaria of the World in Global Conservation*. IUDZG - the World Zoo Organization.

Maguire, L.A. and Lacy, W. C. (1990). Allocating scarce resources for conservation of endangered sub-Species: partitioning zoo space for tigers. Conservation Biology 4, 156-157.

Rijksen, H. D. & Rijksen-Graatsma, A. (1979). Rehabilitation, a new approach is needed. Tigerpaper 6:16-18.

Seal, U.S. & Foose, T. (1992). Captive Animal Management Program (CAMP) Summary Report. (IUCN-CBSG, Apple Valley, Minnesota: USA).

Smith, R. (1990). Island Update. Red Wolf Newsletter 2(1): 2-3.

Stanley Price, M. W. (1989) *Animal re-introduction: the Arabian oryx in Oman*. Cambridge studies in applied ecology and resource management. (Cambridge University Press, Cambridge).

IUCN 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.

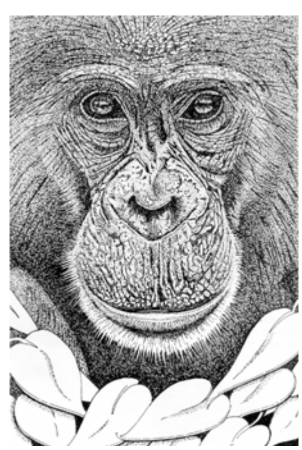
! Continuing public relations activities, including education and mass media coverage.

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

! Regular publications in scientific and popular literature.

POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE CHIMPANZEES OF UGANDA (*Pan troglodytes schweinfurthii*)

Entebbe, Uganda
6 - 9 January 1997



Section 11
Appendix III.
VORTEX Technical Reference

Wildl. Res., 1993, **20**, 45-65

VORTEX: A Computer Simulation Model for Population Viability Analysis

Robert C. Lacy

Department of Conservation Biology, Chicago Zoological Society,
Brookfield, Illinois 60513, U.S.A.

Abstract

Population Viability Analysis (PVA) is the estimation of extinction probabilities by analyses that incorporate identifiable threats to population survival into models of the extinction process. Extrinsic forces, such as habitat loss, over-harvesting, and competition or predation by introduced species, often lead to population decline. Although the traditional methods of wildlife ecology can reveal such deterministic trends, random fluctuations that increase as populations become smaller can lead to extinction even of populations that have, on average, positive population growth when below carrying capacity. Computer simulation modelling provides a tool for exploring the viability of populations subjected to many complex, interacting deterministic and random processes. One such simulation model, VORTEX, has been used extensively by the Captive Breeding Specialist Group (Species Survival Commission, IUCN), by wildlife agencies, and by university classes. The algorithms, structure, assumptions and applications of VORTEX are described in this paper.

VORTEX models population processes as discrete, sequential events, with probabilistic outcomes. VORTEX simulates birth and death processes and the transmission of genes through the generations by generating random numbers to determine whether each animal lives or dies, to determine the number of progeny produced by each female each year, and to determine which of the two alleles at a genetic locus are transmitted from each parent to each offspring. Fecundity is assumed to be independent of age after an animal reaches reproductive age. Mortality rates are specified for each pre-reproductive age–sex class and for reproductive-age animals. Inbreeding depression is modelled as a decrease in viability in inbred animals.

The user has the option of modelling density dependence in reproductive rates. As a simple model of density dependence in survival, a carrying capacity is imposed by a probabilistic truncation of each age class if the population size exceeds the specified carrying capacity. VORTEX can model linear trends in the carrying capacity. VORTEX models environmental variation by sampling birth rates, death rates, and the carrying capacity from binomial or normal distributions. Catastrophes are modelled as sporadic random events that reduce survival and reproduction for one year. VORTEX also allows the user to supplement or harvest the population, and multiple subpopulations can be tracked, with user-specified migration among the units.

VORTEX outputs summary statistics on population growth rates, the probability of population extinction, the time to extinction, and the mean size and genetic variation in extant populations.

VORTEX necessarily makes many assumptions. The model it incorporates is most applicable to species with low fecundity and long lifespans, such as mammals, birds and reptiles. It integrates the interacting effects of many of the deterministic and stochastic processes that have an impact on the viability of small populations, providing opportunity for more complete analysis than is possible by other techniques. PVA by simulation modelling is an important tool for identifying populations at risk of extinction, determining the urgency of action, and evaluating options for management.

Introduction

Many wildlife populations that were once widespread, numerous, and occupying contiguous habitat, have been reduced to one or more small, isolated populations. The causes of the original decline are often obvious, deterministic forces, such as over-harvesting,

1035-3712/93/010045$10.00

habitat destruction, and competition or predation from invasive introduced species. Even if the original causes of decline are removed, a small isolated population is vulnerable to additional forces, intrinsic to the dynamics of small populations, which may drive the population to extinction (Shaffer 1981; Soulé 1987; Clark and Seebeck 1990). Of particular impact on small populations are stochastic processes. With the exception of aging, virtually all events in the life of an organism are stochastic. Mating, reproduction, gene transmission between generations, migration, disease and predation can be described by probability distributions, with individual occurrences being sampled from these distributions. Small samples display high variance around the mean, so the fates of small wildlife populations are often determined more by random chance than by the mean birth and death rates that reflect adaptations to their environment.

Although many processes affecting small populations are intrinsically indeterminate, the average long-term fate of a population and the variance around the expectation can be studied with computer simulation models. The use of simulation modelling, often in conjunction with other techniques, to explore the dynamics of small populations has been termed Population Viability Analysis (PVA). PVA has been increasingly used to help guide management of threatened species. The Resource Assessment Commission of Australia (1991) recently recommended that 'estimates of the size of viable populations and the risks of extinction under multiple-use forestry practices be an essential part of conservation planning'. Lindenmayer *et al.* (1993) describe the use of computer modelling for PVA, and discuss the strengths and weaknesses of the approach as a tool for wildlife management.

In this paper, I present the PVA program VORTEX and describe its structure, assumptions and capabilities. VORTEX is perhaps the most widely used PVA simulation program, and there are numerous examples of its application in Australia, the United States of America and elsewhere.

The Dynamics of Small Populations

The stochastic processes that have an impact on populations have been usefully categorised into demographic stochasticity, environmental variation, catastrophic events and genetic drift (Shaffer 1981). Demographic stochasticity is the random fluctuation in the observed birth rate, death rate and sex ratio of a population even if the probabilities of birth and death remain constant. On the assumption that births and deaths and sex determination are stochastic sampling processes, the annual variations in numbers that are born, die, and are of each sex can be specified from statistical theory and would follow binomial distributions. Such demographic stochasticity will be important to population viability only in populations that are smaller than a few tens of animals (Goodman 1987), in which cases the annual frequencies of birth and death events and the sex ratios can deviate far from the means. The distribution of annual adult survival rates observed in the remnant population of whooping cranes (*Grus americana*) (Mirande *et al.* 1993) is shown in Fig. 1. The innermost curve approximates the binomial distribution that describes the demographic stochasticity expected when the probability of survival is 92·7% (mean of 45 non-outlier years).

Environmental variation is the fluctuation in the probabilities of birth and death that results from fluctuations in the environment. Weather, the prevalence of enzootic disease, the abundances of prey and predators, and the availability of nest sites or other required microhabitats can all vary, randomly or cyclically, over time. The second narrowest curve on Fig. 1 shows a normal distribution that statistically fits the observed frequency histogram of crane survival in non-outlier years. The difference between this curve and the narrower distribution describing demographic variation must be accounted for by environmental variation in the probability of adult survival.

Catastrophic variation is the extreme of environmental variation, but for both methodological and conceptual reasons rare catastrophic events are analysed separately from the more typical annual or seasonal fluctuations. Catastrophes such as epidemic disease,

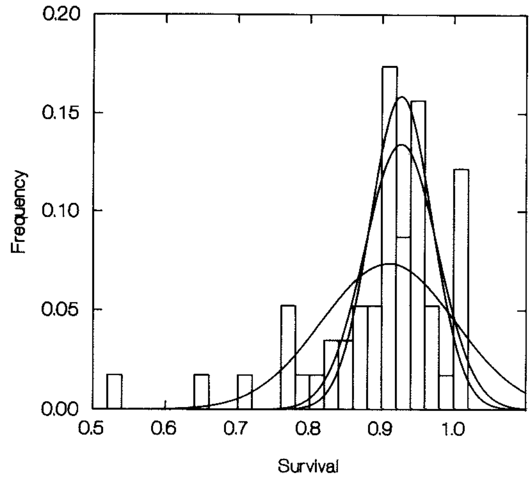


Fig. 1. Frequency histogram of the proportion of whooping cranes surviving each year, 1938–90. The broadest curve is the normal distribution that most closely fits the overall histogram. Statistically, this curve fits the data poorly. The second highest and second broadest curve is the normal distribution that most closely fits the histogram, excluding the five leftmost bars (7 outlier 'catastrophe' years). The narrowest and tallest curve is the normal approximation to the binomial distribution expected from demographic stochasticity. The difference between the tallest and second tallest curves is the variation in annual survival due to environmental variation.

hurricanes, large-scale fires, and floods are outliers in the distribution of environmental variation (e.g. five leftmost bars on Fig. 1). As a result, they have quantitatively and sometimes qualitatively different impacts on wildlife populations. (A forest fire is not just a very hot day.) Such events often precipitate the final decline to extinction (Simberloff 1986, 1988). For example, one of two populations of whooping crane was decimated by a hurricane in 1940 and soon after went extinct (Doughty 1989). The only remaining population of the black-footed ferret (*Mustela nigripes*) was being eliminated by an outbreak of distemper when the last 18 ferrets were captured (Clark 1989).

Genetic drift is the cumulative and non-adaptive fluctuation in allele frequencies resulting from the random sampling of genes in each generation. This can impede the recovery or accelerate the decline of wildlife populations for several reasons (Lacy 1993). Inbreeding, not strictly a component of genetic drift but correlated with it in small populations, has been documented to cause loss of fitness in a wide variety of species, including virtually all sexually reproducing animals in which the effects of inbreeding have been carefully studied (Wright 1977; Falconer 1981; O'Brien and Evermann 1988; Ralls *et al.* 1988; Lacy *et al.* 1993). Even if the immediate loss of fitness of inbred individuals is not large, the loss of genetic variation that results from genetic drift may reduce the ability of a population to adapt to future changes in the environment (Fisher 1958; Robertson 1960; Selander 1983).

Thus, the effects of genetic drift and consequent loss of genetic variation in individuals and populations have a negative impact on demographic rates and increase susceptibility to environmental perturbations and catastrophes. Reduced population growth and greater fluctuations in numbers in turn accelerate genetic drift (Crow and Kimura 1970). These synergistic destabilising effects of stochastic process on small populations of wildlife have been described as an 'extinction vortex' (Gilpin and Soulé 1986). The size below which a population is likely to be drawn into an extinction vortex can be considered a 'minimum viable population' (MVP) (Seal and Lacy 1989), although Shaffer (1981) first defined a MVP more stringently as a population that has a 99% probability of persistence for 1000 years. The estimation of MVPs or, more generally, the investigation of the probability of extinction constitutes PVA (Gilpin and Soulé 1986; Gilpin 1989; Shaffer 1990).

Methods for Analysing Population Viability

An understanding of the multiple, interacting forces that contribute to extinction vortices is a prerequisite for the study of extinction–recolonisation dynamics in natural populations inhabiting patchy environments (Gilpin 1987), the management of small populations (Clark and Seebeck 1990), and the conservation of threatened wildlife (Shaffer 1981, 1990; Soulé 1987; Mace and Lande 1991). Because demographic and genetic processes in small populations are inherently unpredictable, the expected fates of wildlife populations can be described in terms of probability distributions of population size, time to extinction, and genetic variation. These distributions can be obtained in any of three ways: from analytical models, from empirical observation of the fates of populations of varying size, or from simulation models.

As the processes determining the dynamics of populations are multiple and complex, there are few analytical formulae for describing the probability distributions (e.g. Goodman 1987; Lande 1988; Burgmann and Gerard 1990). These models have incorporated only few of the threatening processes. No analytical model exists, for example, to describe the combined effect of demographic stochasticity and loss of genetic variation on the probability of population persistence.

A few studies of wildlife populations have provided empirical data on the relationship between population size and probability of extinction (e.g. Belovsky 1987; Berger 1990; Thomas 1990), but presently only order-of-magnitude estimates can be provided for MVPs of vertebrates (Shaffer 1987). Threatened species are, by their rarity, unavailable and inappropriate for the experimental manipulation of population sizes and long-term monitoring of undisturbed fates that would be necessary for precise empirical measurement of MVPs. Retrospective analyses will be possible in some cases, but the function relating extinction probability to population size will differ among species, localities and times (Lindenmayer *et al.* 1993).

Modelling the Dynamics of Small Populations

Because of the lack of adequate empirical data or theoretical and analytical models to allow prediction of the dynamics of populations of threatened species, various biologists have turned to Monte Carlo computer simulation techniques for PVA. By randomly sampling from defined probability distributions, computer programs can simulate the multiple, interacting events that occur during the lives of organisms and that cumulatively determine the fates of populations. The focus is on detailed and explicit modelling of the forces impinging on a given population, place, and time of interest, rather than on delineation of rules (which may not exist) that apply generally to most wildlife populations. Computer programs available to PVA include SPGPC (Grier 1980*a*, 1980*b*), GAPPS (Harris *et al.* 1986), RAMAS (Ferson and Akçakaya 1989; Akçakaya and Ferson 1990; Ferson 1990), FORPOP (Possingham *et al.* 1991), ALEX (Possingham *et al.* 1992), and SIMPOP (Lacy *et al.* 1989; Lacy and Clark 1990) and its descendant VORTEX.

SIMPOP was developed in 1989 by converting the algorithms of the program SPGPC (written by James W. Grier of North Dakota State University) from BASIC to the C programming language. SIMPOP was used first in a PVA workshop organised by the Species Survival Commission's Captive Breeding Specialist Group (IUCN), the United States Fish and Wildlife Service, and the Puerto Rico Department of Natural Resources to assist in planning and assessing recovery efforts for the Puerto Rican crested toad (*Peltophryne lemur*). SIMPOP was subsequently used in PVA modelling of other species threatened with extinction, undergoing modification with each application to allow incorporation of additional threatening processes. The simulation program was renamed VORTEX (in reference to the extinction vortex) when the capability of modelling genetic processes was implemented in 1989. In 1990, a version allowing modelling of multiple populations was briefly named VORTICES. The only version still supported, with all capabilities of each previous version, is VORTEX Version 5.1.

VORTEX has been used in PVA to help guide conservation and management of many species, including the Puerto Rican parrot (*Amazona vittata*) (Lacy *et al.* 1989), the Javan rhinoceros (*Rhinoceros sondaicus*) (Seal and Foose 1989), the Florida panther (*Felis concolor coryi*) (Seal and Lacy 1989), the eastern barred bandicoot (*Perameles gunnii*) (Lacy and Clark 1990; Maguire *et al.* 1990), the lion tamarins (*Leontopithecus rosalia* ssp.) (Seal *et al.* 1990), the brush-tailed rock-wallaby (*Petrogale penicillata penicillata*) (Hill 1991), the mountain pygmy-possum (*Burramys parvus*), Leadbeater's possum (*Gymnobelideus leadbeateri*), the long-footed potoroo (*Potorous longipes*), the orange-bellied parrot (*Neophema chrysogaster*) and the helmeted honeyeater (*Lichenostomus melanops cassidix*) (Clark *et al.* 1991), the whooping crane (*Grus americana*) (Mirande *et al.* 1993), the Tana River crested mangabey (*Cercocebus galeritus galeritus*) and the Tana River red colobus (*Colobus badius rufomitratus*) (Seal *et al.* 1991), and the black rhinoceros (*Diceros bicornis*) (Foose *et al.* 1992). In some of these PVAs, modelling with VORTEX has made clear the insufficiency of past management plans to secure the future of the species, and alternative strategies were proposed, assessed and implemented. For example, the multiple threats to the Florida panther in its existing habitat were recognised as probably insurmountable, and a captive breeding effort has been initiated for the purpose of securing the gene pool and providing animals for release in areas of former habitat. PVA modelling with VORTEX has often identified a single threat to which a species is particularly vulnerable. The small but growing population of Puerto Rican parrots was assessed to be secure, except for the risk of population decimation by hurricane. Recommendations were made to make available secure shelter for captive parrots and to move some of the birds to a site distant from the wild flock, in order to minimise the damage that could occur in a catastrophic storm. These recommended actions were only partly implemented when, in late 1989, a hurricane killed many of the wild parrots. The remaining population of about 350 Tana River red colobus were determined by PVA to be so fragmented that demographic and genetic processes within the 10 subpopulations destabilised population dynamics. Creation of habitat corridors may be necessary to prevent extinction of the taxon. In some cases, PVA modelling has been reassuring to managers: analysis of black rhinos in Kenya indicated that many of the populations within sanctuaries were recovering steadily. Some could soon be used to provide animals for re-establishment or supplementation of populations previously eliminated by poaching. For some species, available data were insufficient to allow definitive PVA with VORTEX. In such cases, the attempt at PVA modelling has made apparent the need for more data on population trends and processes, thereby helping to justify and guide research efforts.

Description of VORTEX

Overview

The VORTEX computer simulation model is a Monte Carlo simulation of the effects of deterministic forces, as well as demographic, environmental and genetic stochastic events, on wildlife populations. VORTEX models population dynamics as discrete, sequential events that occur according to probabilities that are random variables, following user-specified distributions. The input parameters used by VORTEX are summarised in the first part of the sample output given in the Appendix.

VORTEX simulates a population by stepping through a series of events that describe an annual cycle of a typical sexually reproducing, diploid organism: mate selection, reproduction, mortality, increment of age by one year, migration among populations, removals, supplementation, and then truncation (if necessary) to the carrying capacity. The program was designed to model long-lived species with low fecundity, such as mammals, birds and reptiles. Although it could and has been used in modelling highly fecund vertebrates and invertebrates, it is awkward to use in such cases as it requires complete specification of the percentage of females producing each possible clutch size. Moreover, computer memory limitations often hamper such analyses. Although VORTEX iterates life events on an annual cycle, a user could model 'years' that are other than 12 months' duration. The simulation of the population is itself iterated to reveal the distribution of fates that the population might experience.

Demographic Stochasticity

VORTEX models demographic stochasticity by determining the occurrence of probabilistic events such as reproduction, litter size, sex determination and death with a pseudo-random number generator. The probabilities of mortality and reproduction are sex-specific and pre-determined for each age class up to the age of breeding. It is assumed that reproduction and survival probabilities remain constant from the age of first breeding until a specified upper limit to age is reached. Sex ratio at birth is modelled with a user-specified constant probability of an offspring being male. For each life event, if the random value sampled from the uniform 0–1 distribution falls below the probability for that year, the event is deemed to have occurred, thereby simulating a binomial process.

The source code used to generate random numbers uniformly distributed between 0 and 1 was obtained from Maier (1991), according to the algorithm of Kirkpatrick and Stoll (1981). Random deviates from binomial distributions, with mean p and standard deviation s, are obtained by first determining the integral number of binomial trials, N, that would produce the value of s closest to the specified value, according to

$$N = p(1-p)/s^2 .$$

N binomial trials are then simulated by sampling from the uniform 0–1 distribution to obtain the desired result, the frequency or proportion of successes. If the value of N determined for a desired binomial distribution is larger than 25, a normal approximation is used in place of the binomial distribution. This normal approximation must be truncated at 0 and at 1 to allow use in defining probabilities, although, with such large values of N, s is small relative to p and the truncation would be invoked only rarely. To avoid introducing bias with this truncation, the normal approximation to the binomial (when used) is truncated symmetrically around the mean. The algorithm for generating random numbers from a unit normal distribution follows Latour (1986).

VORTEX can model monogamous or polygamous mating systems. In a monogamous system, a relative scarcity of breeding males may limit reproduction by females. In polygamous or monogamous models, the user can specify the proportion of the adult males in the breeding pool. Males are randomly reassigned to the breeding pool each year of the simulation, and all males in the breeding pool have an equal chance of siring offspring.

The 'carrying capacity', or the upper limit for population size within a habitat, must be specified by the user. VORTEX imposes the carrying capacity via a probabilistic truncation whenever the population exceeds the carrying capacity. Each animal in the population has an equal probability of being removed by this truncation.

Environmental Variation

VORTEX can model annual fluctuations in birth and death rates and in carrying capacity as might result from environmental variation. To model environmental variation, each demographic parameter is assigned a distribution with a mean and standard deviation that is specified by the user. Annual fluctuations in probabilities of reproduction and mortality are modelled as binomial distributions. Environmental variation in carrying capacity is modelled as a normal distribution. The variance across years in the frequencies of births and deaths resulting from the simulation model (and in real populations) will have two components: the demographic variation resulting from a binomial sampling around the mean for each year, and additional fluctuations due to environmental variation and catastrophes (see Fig. 1 and section on The Dynamics of Small Populations, above).

Data on annual variations in birth and death rates are important in determining the probability of extinction, as they influence population stability (Goodman 1987). Unfortunately, such field information is rarely available (but see Fig. 1). Sensitivity testing, the examination of a range of values when the precise value of a parameter is unknown, can help to identify whether the unknown parameter is important in the dynamics of a population.

Catastrophes

Catastrophes are modelled in VORTEX as random events that occur with specified probabilities. Any number of types of catastrophes can be modelled. A catastrophe will occur if a randomly generated number between zero and one is less than the probability of occurrence. Following a catastrophic event, the chances of survival and successful breeding for that simulated year are multiplied by severity factors. For example, forest fires might occur once in 50 years, on average, killing 25% of animals, and reducing breeding by survivors by 50% for the year. Such a catastrophe would be modelled as a random event with 0·02 probability of occurrence each year, and severity factors of 0·75 for survival and 0·50 for reproduction.

Genetic Processes

Genetic drift is modelled in VORTEX by simulation of the transmission of alleles at a hypothetical locus. At the beginning of the simulation, each animal is assigned two unique alleles. Each offspring is randomly assigned one of the alleles from each parent. Inbreeding depression is modelled as a loss of viability during the first year of inbred animals. The impacts of inbreeding are determined by using one of two models available within VORTEX: a Recessive Lethals model or a Heterosis model.

In the Recessive Lethals model, each founder starts with one unique recessive lethal allele and a unique, dominant non-lethal allele. This model approximates the effect of inbreeding if each individual in the starting population had one recessive lethal allele in its genome. The fact that the simulation program assumes that all the lethal alleles are at the same locus has a very minor impact on the probability that an individual will die because of homozygosity for one of the lethal alleles. In the model, homozygosity for different lethal alleles are mutually exclusive events, whereas in a multilocus model an individual could be homozygous for several lethal alleles simultaneously. By virtue of the death of individuals that are homozygous for lethal alleles, such alleles would be removed slowly by natural selection during the generations of a simulation. This reduces the genetic variation present in the population relative to the case with no inbreeding depression, but also diminishes the subsequent probability that inbred individuals will be homozygous for a lethal allele. This model gives an optimistic reflection of the impacts of inbreeding on many species, as the median number of lethal equivalents per diploid genome observed for mammalian populations is about three (Ralls *et al.* 1988).

The expression of fully recessive deleterious alleles in inbred organisms is not the only genetic mechanism that has been proposed as a cause of inbreeding depression. Some or most of the effects of inbreeding may be a consequence of superior fitness of heterozygotes (heterozygote advantage or 'heterosis'). In the Heterosis model, all homozygotes have reduced fitness compared with heterozygotes. Juvenile survival is modelled according to the logarithmic model developed by Morton *et al.* (1956):

$$\ln S = A - BF$$

in which S is survival, F is the inbreeding coefficient, A is the logarithm of survival in the absence of inbreeding, and B is a measure of the rate at which survival decreases with inbreeding. B is termed the number of 'lethal equivalents' per haploid genome. The number of lethal equivalents per diploid genome, $2B$, estimates the number of lethal alleles per individual in the population if all deleterious effects of inbreeding were due to recessive lethal alleles. A population in which inbreeding depression is one lethal equivalent per diploid genome may have one recessive lethal allele per individual (as in the Recessive Lethals model, above), it may have two recessive alleles per individual, each of which confer a 50% decrease in survival, or it may have some other combination of recessive deleterious alleles that equate in effect with one lethal allele per individual. Unlike the situation with fully recessive deleterious alleles, natural selection does not remove deleterious alleles at heterotic loci because all alleles are deleterious when homozygous and beneficial when present in heterozygous combination with other alleles. Thus, under the Heterosis model, the impact of inbreeding on survival does not diminish during repeated generations of inbreeding.

Unfortunately, for relatively few species are data available to allow estimation of the effects of inbreeding, and the magnitude of these effects varies considerably among species (Falconer 1981; Ralls *et al.* 1988; Lacy *et al.* 1993). Moreover, whether a Recessive Lethals model or a Heterosis model better describes the underlying mechanism of inbreeding depression and therefore the response to repeated generations of inbreeding is not well-known (Brewer *et al.* 1990), and could be determined empirically only from breeding studies that span many generations. Even without detailed pedigree data from which to estimate the number of lethal equivalents in a population and the underlying nature of the genetic load (recessive alleles or heterosis), applications of PVA must make assumptions about the effects of inbreeding on the population being studied. In some cases, it might be considered appropriate to assume that an inadequately studied species would respond to inbreeding in accord with the median (3·14 lethal equivalents per diploid) reported in the survey by Ralls *et al.* (1988). In other cases, there might be reason to make more optimistic assumptions (perhaps the lower quartile, 0·90 lethal equivalents), or more pessimistic assumptions (perhaps the upper quartile, 5·62 lethal equivalents).

Deterministic Processes

VORTEX can incorporate several deterministic processes. Reproduction can be specified to be density-dependent. The function relating the proportion of adult females breeding each year to the total population size is modelled as a fourth-order polynomial, which can provide a close fit to most plausible density-dependence curves. Thus, either positive population responses to low-density or negative responses (e.g. Allee effects), or more complex relationships, can be modelled.

Populations can be supplemented or harvested for any number of years in each simulation. Harvest may be culling or removal of animals for translocation to another (unmodelled) population. The numbers of additions and removals are specified according to the age and sex of animals. Trends in the carrying capacity can also be modelled in VORTEX, specified as an annual percentage change. These changes are modelled as linear, rather than geometric, increases or decreases.

Migration among Populations

VORTEX can model up to 20 populations, with possibly distinct population parameters. Each pairwise migration rate is specified as the probability of an individual moving from one population to another. This probability is independent of the age and sex. Because of between-population migration and managed supplementation, populations can be recolonised. VORTEX tracks the dynamics of local extinctions and recolonisations through the simulation.

Output

VORTEX outputs (1) probability of extinction at specified intervals (e.g., every 10 years during a 100-year simulation), (2) median time to extinction if the population went extinct in at least 50% of the simulations, (3) mean time to extinction of those simulated populations that became extinct, and (4) mean size of, and genetic variation within, extant populations (see Appendix and Lindenmayer *et al.* 1993).

Standard deviations across simulations and standard errors of the mean are reported for population size and the measures of genetic variation. Under the assumption that extinction of independently replicated populations is a binomial process, the standard error of the probability of extinction (*SE*) is reported by VORTEX as

$$SE(p) = \sqrt{[p \times (1-p)/n]}\,,$$

in which the frequency of extinction was p over n simulated populations. Demographic and genetic statistics are calculated and reported for each subpopulation and for the metapopulation.

Availability of the VORTEX Simulation Program

VORTEX Version 5.1 is written in the C programming language and compiled with the Lattice 80286C Development System (Lattice Inc.) for use on microcomputers using the MS-DOS (Microsoft Corp.) operating system. Copies of the compiled program and a manual for its use are available for nominal distribution costs from the Captive Breeding Specialist Group (Species Survival Commission, IUCN), 12101 Johnny Cake Ridge Road, Apple Valley, Minnesota 55124, U.S.A. The program has been tested by many workers, but cannot be guaranteed to be error-free. Each user retains responsibility for ensuring that the program does what is intended for each analysis.

Sequence of Program Flow

(1) The seed for the random number generator is initialised with the number of seconds elapsed since the beginning of the 20th century.

(2) The user is prompted for input and output devices, population parameters, duration of simulation, and number of interations.

(3) The maximum allowable population size (necessary for preventing memory overflow) is calculated as

$$N_{max} = (K + 3s) \times (1 + L)$$

in which K is the maximum carrying capacity (carrying capacity can be specified to change linearly for a number of years in a simulation, so the maximum carrying capacity can be greater than the initial carrying capacity), s is the annual environmental variation in the carrying capacity expressed as a standard deviation, and L is the specified maximum litter size. It is theoretically possible, but very unlikely, that a simulated population will exceed the calculated N_{max}. If this occurs then the program will give an error message and abort.

(4) Memory is allocated for data arrays. If insufficient memory is available for data arrays then N_{max} is adjusted downward to the size that can be accommodated within the available memory and a warning message is given. In this case it is possible that the analysis may have to be terminated because the simulated population exceeds N_{max}. Because N_{max} is often several-fold greater than the likely maximum population size in a simulation, a warning it has been adjusted downward because of limiting memory often will not hamper the analyses. Except for limitations imposed by the size of the computer memory (VORTEX can use extended memory, if available), the only limit to the size of the analysis is that no more than 20 populations exchanging migrants can be simulated.

(5) The expected mean growth rate of the population is calculated from mean birth and death rates that have been entered. Algorithms follow cohort life-table analyses (Ricklefs 1979). Generation time and the expected stable age distribution are also estimated. Life-table estimations assume no limitation by carrying capacity, no limitation of mates, and no loss of fitness due to inbreeding depression, and the estimated intrinsic growth rate assumes that the population is at the stable age distribution. The effects of catastrophes are incorporated into the life-table analysis by using birth and death rates that are weighted averages of the values in years with and without catastrophes, weighted by the probability of a catastrophe occurring or not occurring.

(6) Iterative simulation of the population proceeds via steps 7–26 below. For exploratory modelling, 100 iterations are usually sufficient to reveal gross trends among sets of simulations with different input parameters. For more precise examination of population behaviour under various scenarios, 1000 or more simulations should be used to minimise standard errors around mean results.

(7) The starting population is assigned an age and sex structure. The user can specify the exact age–sex structure of the starting population, or can specify an initial population size and request that the population be distributed according to the stable age distribution calculated from the life table. Individuals in the starting population are assumed to be unrelated. Thus, inbreeding can occur only in second and later generations.

(8) Two unique alleles at a hypothetical genetic locus are assigned to each individual in the starting population and to each individual supplemented to the population during the simulation. VORTEX therefore uses an infinite alleles model of genetic variation. The subsequent fate of genetic variation is tracked by reporting the number of extant alleles each year, the expected heterozygosity or gene diversity, and the observed heterozygosity. The expected heterozygosity, derived from the Hardy–Weinberg equilibrium, is given by

$$H_e = 1 - \Sigma(p_i^2),$$

in which p_i is the frequency of allele i in the population. The observed heterozygosity is simply the proportion of the individuals in the simulated population that are heterozygous. Because of the starting assumption of two unique alleles per founder, the initial population has an observed heterozygosity of 1·0 at the hypothetical locus and only inbred animals can become homozygous. Proportional loss of heterozygosity by means of random genetic drift is independent of the initial heterozygosity and allele frequencies of a population (assuming that the initial value was not zero) (Crow and Kimura 1970), so the expected heterozygosity remaining in a simulated population is a useful metric of genetic decay for comparison across scenarios and populations. The mean observed heterozygosity reported by VORTEX is the mean inbreeding coefficient of the population.

(9) The user specifies one of three options for modelling the effect of inbreeding: (a) no effect of inbreeding on fitness, that is, all alleles are selectively neutral, (b) each founder individual has one unique lethal and one unique non-lethal allele (Recessive Lethals option), or (c) first-year survival of each individual is exponentially related to its inbreeding coefficient (Heterosis option). The first case is clearly an optimistic one, as almost all diploid

populations studied intensively have shown deleterious effects of inbreeding on a variety of fitness components (Wright 1977; Falconer 1981). Each of the two models of inbreeding depression may also be optimistic, in that inbreeding is assumed to have an impact only on first-year survival. The Heterosis option allows, however, for the user to specify the severity of inbreeding depression on juvenile survival.

(10) Years are iterated via steps 11–25 below.

(11) The probabilities of females producing each possible litter size are adjusted to account for density dependence of reproduction (if any).

(12) Birth rate, survival rates and carrying capacity for the year are adjusted to model environmental variation. Environmental variation is assumed to follow binomial distributions for birth and death rates and a normal distribution for carrying capacity, with mean rates and standard deviations specified by the user. At the outset of each year a random number is drawn from the specified binomial distribution to determine the percentage of females producing litters. The distribution of litter sizes among those females that do breed is maintained constant. Another random number is drawn from a specified binomial distribution to model the environmental variation in mortality rates. If environmental variations in reproduction and mortality are chosen to be correlated, the random number used to specify mortality rates for the year is chosen to be the same percentile of its binomial distribution as was the number used to specify reproductive rate. Otherwise, a new random number is drawn to specify the deviation of age- and sex-specific mortality rates for their means. Environmental variation across years in mortality rates is always forced to be correlated among age and sex classes.

The carrying capacity (K) of the year is determined by first increasing or decreasing the carrying capacity at year 1 by an amount specified by the user to account for linear changes over time. Environmental variation in K is then imposed by drawing a random number from a normal distribution with the specified values for mean and standard deviation.

(13) Birth rates and survival rates for the year are adjusted to model any catastrophes determined to have occurred in that year.

(14) Breeding males are selected for the year. A male of breeding age is placed into the pool of potential breeders for that year if a random number drawn for that male is less than the proportion of breeding-age males specified to be breeding.

(15) For each female of breeding age, a mate is drawn at random from the pool of breeding males for that year. The size of the litter produced by that pair is determined by comparing the probabilities of each potential litter size (including litter size of 0, no breeding) to a randomly drawn number. The offspring are produced and assigned a sex by comparison of a random number to the specified sex ratio at birth. Offspring are assigned, at random, one allele at the hypothetical genetic locus from each parent.

(16) If the Heterosis option is chosen for modelling inbreeding depression, the genetic kinship of each new offspring to each other living animal in the population is determined. The kinship between a new animal, A, and another existing animal, B is

$$f_{AB}=0{\cdot}5\times(f_{MB}+f_{PB})$$

in which f_{ij} is the kinship between animals i and j, M is the mother of A, and P is the father of A. The inbreeding coefficient of each animal is equal to the kinship between its parents, $F=f_{MP}$, and the kinship of an animal to itself is $f_{AA}=0{\cdot}5\times(1+F)$. [See Ballou (1983) for a detailed description of this method for calculating inbreeding coefficients.]

(17) The survival of each animal is determined by comparing a random number to the survival probability for that animal. In the absence of inbreeding depression, the survival probability is given by the age and sex-specific survival rate for that year. If the Heterosis model of inbreeding depression is used and an individual is inbred, the survival probability is multiplied by e^{-bF} in which b is the number of lethal equivalents per haploid genome.

If the Recessive Lethals model is used, all offspring that are homozygous for a lethal allele are killed.

(18) The age of each animal is incremented by 1, and any animal exceeding the maximum age is killed.

(19) If more than one population is being modelled, migration among populations occurs stochastically with specified probabilities.

(20) If population harvest is to occur that year, the number of harvested individuals of each age and sex class are chosen at random from those available and removed. If the number to be removed do not exist for an age–sex class, VORTEX continues but reports that harvest was incomplete.

(21) Dead animals are removed from the computer memory to make space for future generations.

(22) If population supplementation is to occur in a particular year, new individuals of the specified age class are created. Each immigrant is assigned two unique alleles, one of which will be a recessive lethal in the Recessive Lethals model of inbreeding depression. Each immigrant is assumed to be genetically unrelated to all other individuals in the population.

(23) The population growth rate is calculated as the ratio of the population size in the current year to the previous year.

(24) If the population size (N) exceeds the carrying capacity (K) for that year, additional mortality is imposed across all age and sex classes. The probability of each animal dying during this carrying capacity truncation is set to $(N-K)/N$, so that the expected population size after the additional mortality is K.

(25) Summary statistics on population size and genetic variation are tallied and reported. A simulated population is determined to be extinct if one of the sexes has no representatives.

(26) Final population size and genetic variation are determined for the simulation.

(27) Summary statistics on population size, genetic variation, probability of extinction, and mean population growth rate, are calculated across iterations and printed out.

Assumptions Underpinning VORTEX

It is impossible to simulate the complete range of complex processes that can have an impact on wild populations. As a result there are necessarily a range of mathematical and biological assumptions that underpin any PVA program. Some of the more important assumptions in VORTEX include the following.

(1) Survival probabilities are density independent when population size is less than carrying capacity. Additional mortality imposed when the population exceeds K affects all age and sex classes equally.

(2) The relationship between changes in population size and genetic variability are examined for only one locus. Thus, potentially complex interactions between genes located on the same chromosome (linkage disequilibrium) are ignored. Such interactions are typically associated with genetic drift in very small populations, but it is unknown if, or how, they would affect population viability.

(3) All animals of reproductive age have an equal probability of breeding. This ignores the likelihood that some animals within a population may have a greater probability of breeding successfully, and breeding more often, than other individuals. If breeding is not at random among those in the breeding pool, then decay of genetic variation and inbreeding will occur more rapidly than in the model.

(4) The life-history attributes of a population (birth, death, migration, harvesting, supplementation) are modelled as a sequence of discrete and therefore seasonal events. However, such events are often continuous through time and the model ignores the possibility that they may be aseasonal or only partly seasonal.

(5) The genetic effects of inbreeding on a population are determined in VORTEX by using one of two possible models: the Recessive Lethals model and the Heterosis model. Both models have attributes likely to be typical of some populations, but these may vary within and between species (Brewer *et al.* 1990). Given this, it is probable that the impacts of inbreeding will fall between the effects of these two models. Inbreeding is assumed to depress only one component of fitness: first-year survival. Effects on reproduction could be incorporated into this component, but longer-term impacts such as increased disease susceptibility or decreased ability to adapt to environmental change are not modelled.

(6) The probabilities of reproduction and mortality are constant from the age of first breeding until an animal reaches the maximum longevity. This assumes that animals continue to breed until they die.

(7) A simulated catastrophe will have an effect on a population only in the year that the event occurs.

(8) Migration rates among populations are independent of age and sex.

(9) Complex, interspecies interactions are not modelled, except in that such community dynamics might contribute to random environmental variation in demographic parameters. For example, cyclical fluctuations caused by predator–prey interactions cannot be modelled by VORTEX.

Discussion

Uses and Abuses of Simulation Modelling for PVA

Computer simulation modelling is a tool that can allow crude estimation of the probability of population extinction, and the mean population size and amount of genetic diversity, from data on diverse interacting processes. These processes are too complex to be integrated intuitively and no analytic solutions presently, or are likely to soon, exist. PVA modelling focuses on the specifics of a population, considering the particular habitat, threats, trends, and time frame of interest, and can only be as good as the data and the assumptions input to the model (Lindenmayer *et al.* 1993). Some aspects of population dynamics are not modelled by VORTEX nor by any other program now available. In particular, models of single-species dynamics, such as VORTEX, are inappropriate for use on species whose fates are strongly determined by interactions with other species that are in turn undergoing complex (and perhaps synergistic) population dynamics. Moreover, VORTEX does not model many conceivable and perhaps important interactions among variables. For example, loss of habitat might cause secondary changes in reproduction, mortality, and migration rates, but ongoing trends in these parameters cannot be simulated with VORTEX. It is important to stress that PVA does not predict in general what will happen to a population; PVA forecasts the likely effects only of those factors incorporated into the model.

Yet, the use of even simplified computer models for PVA can provide more accurate predictions about population dynamics than the even more crude techniques available previously, such as calculation of expected population growth rates from life tables. For the purpose of estimating extinction probabilities, methods that assess only deterministic factors are almost certain to be inappropriate, because populations near extinction will commonly be so small that random processes dominate deterministic ones. The suggestion by Mace and Lande (1991) that population viability be assessed by the application of simple rules (e.g., a taxon be considered Endangered if the total effective population size is below 50 or the total census size below 250) should be followed only if knowledge is insufficient to allow more accurate quantitative analysis. Moreover, such preliminary judgments, while often important in stimulating appropriate corrective measures, should signal, not obviate, the need for more extensive investigation and analysis of population processes, trends and threats.

Several good population simulation models are available for PVA. They differ in capabilities, assumptions and ease of application. The ease of application is related to the number of simplifying assumptions and inversely related to the flexibility and power of the model. It is unlikely that a single or even a few simulation models will be appropriate for all PVAs. The VORTEX program has some capabilities not found in many other population simulation programs, but is not as flexible as are some others (e.g., GAPPS; Harris *et al.* 1986). VORTEX is user-friendly and can be used by those with relatively little understanding of population biology and extinction processes, which is both an advantage and a disadvantage.

Testing Simulation Models

Because many population processes are stochastic, a PVA can never specify what will happen to a population. Rather, PVA can provide estimates of probability distributions describing possible fates of a population. The fate of a given population may happen to fall at the extreme tail of such a distribution even if the processes and probabilities are assessed precisely. Therefore, it will often be impossible to test empirically the accuracy of PVA results by monitoring of one or a few threatened populations of interest. Presumably, if a population followed a course that was well outside of the range of possibilities predicted by a model, that model could be rejected as inadequate. Often, however, the range of plausible fates generated by PVA is quite broad.

Simulation programs can be checked for internal consistency. For example, in the absence of inbreeding depression and other confounding effects, does the simulation model predict an average long-term growth rate similar to that determined from a life-table calculation? Beyond this, some confidence in the accuracy of a simulation model can be obtained by comparing observed fluctuations in population numbers to those generated by the model, thereby comparing a data set consisting of tens to hundreds of data points to the results of the model. For example, from 1938 to 1991, the wild population of whooping cranes had grown at a mean exponential rate, r, of 0·040, with annual fluctuations in the growth rate, SD (r), of 0·141 (Mirande *et al.* 1993). Life-table analysis predicted an r of 0·052. Simulations using VORTEX predicted an r of 0·046 into the future, with a SD (r) of 0·081. The lower growth rate projected by the stochastic model reflects the effects of inbreeding and perhaps imbalanced sex ratios among breeders in the simulation, factors that are not considered in deterministic life-table calculations. Moreover, life-table analyses use mean birth and death rates to calculate a single estimate of the population growth rate. When birth and death rates are fluctuating, it is more appropriate to average the population growth rates calculated separately from birth and death rates for each year. This mean growth rate would be lower than the growth rate estimated from mean life-table values.

When the simulation model was started with the 18 cranes present in 1938, it projected a population size in 1991 ($N \pm \mathrm{SD} = 151 \pm 123$) almost exactly the same as that observed ($N = 146$). The large variation in population size across simulations, however, indicates that very different fates (including extinction) were almost equally likely. The model slightly underestimated the annual fluctuations in population growth [model SD $(r) = 0{\cdot}112$ *v.* actual SD $(r) = 0{\cdot}141$]. This may reflect a lack of full incorporation of all aspects of stochasticity into the model, or it may simply reflect the sampling error inherent in stochastic phenomena. Because the data input to the model necessarily derive from analysis of past trends, such retrospective analysis should be viewed as a check of consistency, not as proof that the model correctly describes current population dynamics. Providing another confirmation of consistency, both deterministic calculations and the simulation model project an over-wintering population of whooping cranes consisting of 12% juveniles (less than 1 year of age), while the observed frequency of juveniles at the wintering grounds in Texas has averaged 13%.

Convincing evidence of the accuracy, precision and usefulness of PVA simulation models would require comparison of model predictions to the distribution of fates of many replicate populations. Such a test probably cannot be conducted on any endangered species, but could and should be examined in experimental non-endangered populations. Once simulation models are determined to be sufficiently descriptive of population processes, they can guide management of threatened and endangered species (see above and Lindenmayer *et al.* 1993). The use of PVA modelling as a tool in an adaptive management framework (Clark *et al.* 1990) can lead to increasingly effective species recovery efforts as better data and better models allow more thorough analyses.

Directions for Future Development of PVA Models

The PVA simulation programs presently available model life histories as a series of discrete (seasonal) events, yet many species breed and die throughout much of the year. Continuous-time models would be more realistic and could be developed by simulating the time between life-history events as a random variable. Whether continuous-time models would significantly improve the precision of population viability estimates is unknown. Even more realistic models might treat some life-history events (e.g., gestation, lactation) as stages of specified duration, rather than as instantaneous events.

Most PVA simulation programs were designed to model long-lived, low fecundity (K-selected) species such as mammals, birds and reptiles. Relatively little work has been devoted to developing models for short-lived, high-fecundity (r-selected) species such as many amphibians and insects. Yet, the viability of populations of r-selected species may be highly affected by stochastic phenomena, and r-selected species may have much greater minimum viable populations than do most K-selected species. Assuring viability of K-selected species in a community may also afford adequate protection for r-selected species, however, because of the often greater habitat-area requirements of large vertebrates. Populations of r-selected species are probably less affected by intrinsic demographic stochasticity because large numbers of progeny will minimise random fluctuations, but they are more affected by environmental variations across space and time. PVA models designed for r-selected species would probably model fecundity as a continuous distribution, rather than as a completely specified discrete distribution of litter or clutch sizes; they might be based on life-history stages rather than time-increment ages; and they would require more detailed and accurate description of environmental fluctuations than might be required for modelling K-selected species.

The range of PVA computer simulation models becoming available is important because the different assumptions of the models provide capabilities for modelling diverse life histories. Because PVA models always simplify the life history of a species, and because the assumptions of no model are likely to match exactly our best understanding of the dynamics of a population of interest, it will often be valuable to conduct PVA modelling with several simulation programs and to compare the results. Moreover, no computer program can be guaranteed to be free of errors. There is a need for researchers to compare results from different PVA models when applied to the same analysis, to determine how the different assumptions affect conclusions and to cross-validate algorithms and computer code.

Acknowledgments

James W. Grier made available his simulation program, SPGPC, which provided many of the algorithms on which the first version of VORTEX (SIMPOP) was based. I thank Ulysses S. Seal, Thomas J. Foose, Jon Ballou, Nathan R. Flesness, Tim W. Clark, Gary Backhouse, David Lindenmayer, Simon Bennett, and many of the staff of the Department of Conservation and Environment, Victoria, Australia, for many helpful comments on VORTEX and PVA. Tim W. Clark, David Lindenmayer and two anonymous reviewers provided valuable critiques of drafts of this paper.

References

Akçakaya, H. R., and Ferson, S. (1990). 'RAMAS/Space User Manual. Spatially Structured Population Models for Conservation Biology.' (Applied Biomathematics: Setauket, New York.)

Ballou, J. (1983). Calculating inbreeding coefficients from pedigrees. In 'Genetics and Conservation: A Reference for Managing Wild Animal and Plant Populations'. (Eds C. M. Schonewald-Cox, S. M. Chambers, B. MacBryde and W. L. Thomas.) pp. 509–20. (Benjamin/Cummings: Menlo Park, California.)

Belovsky, G. E. (1987). Extinction models and mammalian persistence. In 'Viable Populations for Conservation'. (Ed. M. E. Soulé.) pp. 35–57. (Cambridge University Press: Cambridge.)

Berger, J. (1990). Persistence of different-sized populations: an empirical assessment of rapid extinctions in bighorn sheep. *Conservation Biology* **4**, 91–8.

Brewer, B. A., Lacy, R. C., Foster, M. L., and Alaks, G. (1990). Inbreeding depression in insular and central populations of *Peromyscus* mice. *Journal of Heredity* **81**, 257–66.

Burgmann, M. A., and Gerard, V. A. (1990). A stage-structured, stochastic model for giant kelp *Macrocystis pyrifera*. *Marine Biology* **105**, 15–23.

Clark, T. W. (1989). 'Conservation Biology of the Black-footed Ferret. Special Scientific Report.' (Wildlife Preservation Trust International: Philadelphia.)

Clark, T. W., and Seebeck, J. H. (Eds) (1990). 'Management and Conservation of Small Populations.' (Chicago Zoological Society: Brookfield, Illinois.)

Clark, T. W., Warneke, R. M., and George, G. G. (1990). Management and conservation of small populations. In 'Management and Conservation of Small Populations'. (Eds T. W. Clark and J. H. Seebeck.) pp. 1–18. (Chicago Zoological Society: Brookfield, Illinois.)

Clark, T. W., Backhouse, G. N., and Lacy, R. C. (1991). Report of a workshop on population viability assessment as a tool for threatened species management and conservation. *Australian Zoologist* **27**, 28–35.

Crow, J. F., and Kimura, M. (1970). 'Introduction to Population Genetics Theory.' (Harper and Row: New York.)

Doughty, R. W. (1989). 'Return of the Whooping Crane.' (University of Texas Press: Austin.)

Falconer, D. S. (1981). 'Introduction to Quantitative Genetics.' 2nd Edn. (Longman: New York.)

Ferson, S. (1990). 'RAMAS/Stage. Generalized Stage-based Modeling for Population Dynamics.' (Applied Biomathematics: Setauket, New York.)

Ferson, S., and Akçakaya, H. R. (1989). 'RAMAS/Age User Manual. Modeling Fluctuations in Age-structured Populations.' (Applied Biomathematics: Setauket, New York.)

Fisher, R. A. (1958). 'The Genetical Theory of Natural Selection.' 2nd Edn. (Dover: New York.)

Foose, T. J., Lacy, R. C., Brett, R., and Seal, U. S. (1992). Kenya black rhinoceros population and habitat viability assessment. (Captive Breeding Specialist Group, SSC, IUCN: Apple Valley, Minnesota.)

Gilpin, M. E. (1987). Spatial structure and population vulnerability. In 'Viable Populations for Conservation'. (Ed. M. E. Soulé.) pp. 125–39. (Cambridge University Press: Cambridge.)

Gilpin, M. E. (1989). Population viability analysis. *Endangered Species Update* **6**, 15–18.

Gilpin, M. E., and Soulé, M. E. (1986). Minimum viable populations: processes of species extinction. In 'Conservation Biology: the Science of Scarcity and Diversity'. (Ed. M. E. Soulé.) pp. 19–34. (Sinauer: Sunderland, Massachusetts.)

Goodman, D. (1987). The demography of chance extinction. In 'Viable Populations for Conservation'. (Ed. M. E. Soulé.) pp. 11–34. (Cambridge University Press: Cambridge.)

Grier, J. W. (1980*a*). A simulation model for small populations of animals. *Creative Computing* **6**, 116–21.

Grier, J. W. (1980*b*). Modeling approaches for bald eagle population dynamics. *Wildlife Society Bulletin* **8**, 316–22.

Harris, R. B., Metzger, L. H., and Bevins, C. D. (1986). 'GAPPS. Version 3.0.' (Montana Cooperative Research Unit, University of Montana: Missoula.)

Hill, F. A. R. (1991). A research recovery plan for the brush-tailed rock wallaby *Petrogale pencillata* (Gray 1825). Report to Australian National Parks and Wildlife Service. (Department of Conservation and Environment: Melbourne.)

Kirkpatrick, S., and Stoll, E. (1981). A very fast shift-register sequence random number generator. *Journal of Computational Physics* **40**, 517.

Lacy, R. C. (1993). Impacts of inbreeding in natural and captive populations of vertebrates: implications for conservation. *Perspectives in Biology and Medicine.* (In press.)

Lacy, R. C., and Clark, T. W. (1990). Population viability assessment of eastern barred bandicoot. In 'The Management and Conservation of Small Populations'. (Eds T. W. Clark and J. H. Seebeck.) pp. 131–46. (Chicago Zoological Society: Brookfield, Illinois.)

Lacy, R. C., Flesness, N. R., and Seal, U. S. (1989). 'Puerto Rican Parrot Population Viability Analysis.' (Captive Breeding Specialist Group, SSC, IUCN: Apple Valley, Minnesota.)

Lacy, R. C., Petric, A. M., and Warneke, M. (1993). Inbreeding and outbreeding depression in captive populations of wild species. In 'The Natural History of Inbreeding and Outbreeding'. (Ed. N. W. Thornhill.) (University of Chicago Press: Chicago.) (In press.)

Lande, R. (1988). Demographic models of the northern spotted owl (*Strix occidentalis caurina*). *Oecologia* **75**, 601–7.

Latour, A. (1986). Polar normal distribution. *Byte* August 1986, 131–2.

Lindenmayer, D. B., Clark, T. W., Lacy, R. C., and Thomas, V. C. (1993). Population viability analysis as a tool in wildlife management: a review with reference to Australia. *Environmental Management*. (In press.)

Mace, G. M., and Lande, R. (1991). Assessing extinction threats: toward a reevaluation of IUCN threatened species categories. *Conservation Biology* **5**, 148–57.

Maguire, L. A., Lacy, R. C., Begg, R. J., and Clark, T. W. (1990). An analysis of alternative strategies for recovering the eastern barred bandicoot. In 'The Management and Conservation of Small Populations'. (Eds T. W. Clark and J. H. Seebeck.) pp. 147–64. (Chicago Zoological Society: Brookfield, Illinois.)

Maier, W. L. (1991). A fast pseudo random number generator. *Dr. Dobb's Journal* May 1991, 152–7.

Mirande, C., Lacy, R. C., and Seal, U. S. (1993). Whooping crane conservation viability assessment workshop. (Captive Breeding Specialist Group, SSC, IUCN: Apple Valley, Minnesota.)

Morton, N. E., Crow, J. F., and Muller, H. J. (1956). An estimate of the mutational damage in man from data on consanguineous marriages. *Proceedings of the National Academy of Sciences, U.S.A.* **42**, 855–63.

O'Brien, S. J., and Evermann, J. F. (1988). Interactive influence of infectious diseases and genetic diversity in natural populations. *Trends in Ecology and Evolution* **3**, 254–9.

Possingham, H., Davies, I., and Noble, I. R. (1991). 'An Evaluation of Population Viability Analysis for Assessing the Risk of Extinction.' (Resource Assessment Commission: Canberra.)

Possingham, H. P., Davies, I., Noble, I. R., and Norton, T. W. (1992). A metapopulation simulation model for assessing the likelihood of plant and animal extinctions. *Mathematics and Computers in Simulation* **33**, 367–72.

Ralls, K., Ballou, J. D., and Templeton, A. R. (1988). Estimates of lethal equivalents and the cost of inbreeding in mammals. *Conservation Biology* **2**, 185–93.

Resource Assessment Commission (1991). Forest and timber inquiry. Draft report. Vol. 2. July 1991. (Australian Government Publishing Service: Canberra.)

Ricklefs, R. E. (1979). 'Ecology.' 2nd Edn. (Chiron: New York.)

Robertson, A. (1960). A theory of limits in artificial selection. *Proceedings of the Royal Society of London* **153B**, 234–49.

Seal, U. S., and Foose, T. J. (1989). Javan rhinoceros population viability analysis and recommendations. (Captive Breeding Specialist Group, SSC, IUCN: Apple Valley, Minnesota.)

Seal, U. S., and Lacy, R. C. (1989). Florida panther population viability analysis. (Captive Breeding Specialist Group, SSC, IUCN: Apple Valley, Minnesota.)

Seal, U. S., Ballou, J. D., and Padua, C. V. (1990). *Leontopithecus* population viability analysis workshop report. (Captive Breeding Specialist Group, SSC, IUCN: Apple Valley, Minnesota.)

Seal, U. S., Lacy, R. C., Medley, K., Seal, R., and Foose, T. J. (1991). Tana River Primate Reserve Conservation Assessment Workshop. (Captive Breeding Specialist Group, SSC, IUCN: Apple Valley, Minnesota.)

Selander, R. K. (1983). Evolutionary consequences of inbreeding. In 'Genetics and Conservation: A Reference for Managing Wild Animal and Plant Populations'. (Eds C. M. Schonewald-Cox, S. M. Chambers, B. MacBryde and W. L. Thomas.) pp. 201-15. (Benjamin/Cummings: Menlo Park, California.)

Shaffer, M. L. (1981). Minimum population sizes for species conservation. *BioScience* **31**, 131-4.

Shaffer, M. L. (1987). Minimum viable populations: coping with uncertainty. In 'Viable Populations for Conservation'. (Ed. M. E. Soulé.) pp. 69-86. (Cambridge University Press: Cambridge.)

Shaffer, M. L. (1990). Population viability analysis. *Conservation Biology* **4**, 39-40.

Simberloff, D. A. (1986). The proximate causes of extinction. In 'Patterns and Processes in the History of Life'. (Eds D. M. Raup and D. Jablonski.) pp. 259-76. (Springer-Verlag: Berlin.)

Simberloff, D. A. (1988). The contribution of population and community biology to conservation science. *Annual Review of Ecology and Systematics* **19**, 473-511.

Soulé, M. E. (Ed.) (1987). 'Viable Populations for Conservation.' (Cambridge University Press: Cambridge.)

Thomas, C. D. (1990). What do real population dynamics tell us about minimum population sizes? *Conservation Biology* **4**, 324-7.

Wright, S. (1977). 'Evolution and the Genetics of Populations. Vol. 3. Experimental Results and Evolutionary Deductions.' (University of Chicago Press: Chicago.)

Appendix. Sample Output from VORTEX

Explanatory comments are added in italics

VORTEX—simulation of genetic and demographic stochasticity

TEST *Simulation label and output file name*

Fri Dec 20 09:21:18 1991

2 population(s) simulated for 100 years, 100 runs

VORTEX first lists the input parameters used in the simulation:

HETEROSIS model of inbreeding depression
with 3·14 lethal equivalents per diploid genome

Migration matrix:

	1	2
1	0·9900	0·0100
2	0·0100	0·9900

i.e. 1% probability of migration from Population 1 to 2, and from Population 2 to 1

First age of reproduction for females: 2 for males: 2
Age of senescence (death): 10
Sex ratio at birth (proportion males): 0·5000

Population 1:

Polygynous mating; 50·00 per cent of adult males in the breeding pool.
Reproduction is assumed to be density independent.
50·00 (EV = 12·50 SD) per cent of adult females produce litters of size 0
25·00 per cent of adult females produce litters of size 1
25·00 per cent of adult females produce litters of size 2
EV is environmental variation
50·00 (EV = 20·41 SD) per cent mortality of females between ages 0 and 1
10·00 (EV = 3·00 SD) per cent mortality of females between ages 1 and 2
10·00 (EV = 3·00 SD) per cent annual mortality of adult females (2<=age<=10)
50·00 (EV = 20·41 SD) per cent mortality of males between ages 0 and 1
10·00 (EV = 3·00 SD) per cent mortality of males between ages 1 and 2
10·00 (EV = 3·00 SD) per cent annual mortality of adult males (2<=age<=10)

EVs have been adjusted to closest values possible for binomial distribution.
EV in reproduction and mortality will be correlated.
Frequency of type 1 catastrophes: 1·000 per cent
with 0·500 multiplicative effect on reproduction
and 0·750 multiplicative effect on survival
Frequency of type 2 catastrophes: 1·000 per cent
with 0·500 multiplicative effect on reproduction
and 0·750 multiplicative effect on survival

Initial size of Population 1: (set to reflect stable age distribution)

Age	1	2	3	4	5	6	7	8	9	10	Total	
	1	0	1	1	0	1	0	0	1	0	5	Males
	1	0	1	1	0	1	0	0	1	0	5	Females

Carrying capacity = 50 (EV = 0·00 SD)
with a 10·000 per cent decrease for 5 years.

Animals harvested from population 1, year 1 to year 10 at 2 year intervals:
1 females 1 years old
1 female adults (2 <= age <= 10)
1 males 1 years old
1 male adults (2 <= age <= 10)

Animals added to population 1, year 10 through year 50 at 4 year intervals:
1 females 1 years old
1 females 2 years old
1 males 1 years old
1 males 2 years old

Input values are summarised above, results follow.

VORTEX now reports life-table calculations of expected population growth rate.

Deterministic population growth rate (based on females, with assumptions of no limitation of mates and no inbreeding depression):
r = −0·001 lambda = 0·999 RO = 0·997
Generation time for: females = 5·28 males = 5·28

Note that the deterministic life-table calculations project approximately zero population growth for this population.

Stable age distribution:

Age class	females	males
0	0·119	0·119
1	0·059	0·059
2	0·053	0·053
3	0·048	0·048
4	0·043	0·043
5	0·038	0·038
6	0·034	0·034
7	0·031	0·031
8	0·028	0·028
9	0·025	0·025
10	0·022	0·022

Ratio of adult (>= 2) males to adult (>= 2) females: 1·000

Population 2:

Input parameters for Population 2 were identical to those for Population 1.
Output would repeat this information from above.

Simulation results follow.

Population1

Year 10

N[Extinct] = 0, P[E] = 0·000
N[Surviving] = 100, P[S] = 1·000
Population size = 4·36 (0·10 SE, 1·01 SD)
Expected heterozygosity = 0·880 (0·001 SE, 0·012 SD)
Observed heterozygosity = 1·000 (0·000 SE, 0·000 SD)
Number of extant alleles = 8·57 (0·15 SE, 1·50 SD)

Population summaries given, as requested by user, at 10-year intervals.

Year 100

N[Extinct] = 86, P[E] = 0·860
N[Surviving] = 14, P[S] = 0·140
Population size = 8·14 (1·27 SE, 4·74 SD)
Expected heterozygosity = 0·577 (0·035 SE, 0·130 SD)
Observed heterozygosity = 0·753 (0·071 SE, 0·266 SD)
Number of extant alleles = 3·14 (0·35 SE, 1·29 SD)

In 100 simulations of 100 years of Population1:
86 went extinct and 14 survived.
This gives a probability of extinction of 0·8600 (0·0347 SE),
or a probability of success of 0·1400 (0·0347 SE).
99 simulations went extinct at least once.
Median time to first extinction was 5 years.
Of those going extinct,
mean time to first extinction was 7·84 years (1·36 SE, 13·52 SD).
123 recolonisations occurred.
Mean time to recolonisation was 4·22 years (0·23 SE, 2·55 SD).
110 re-extinctions occurred.
Mean time to re-extinction was 54·05 years (2·81 SE, 29·52 SD).

Mean final population for successful cases was 8·14 (1·27 SE, 4·74 SD)

Age 1	Adults	Total	
0·14	3·86	4·00	Males
0·36	3·79	4·14	Females

During years of harvest and/or supplementation
mean growth rate (r) was 0·0889 (0·0121 SE, 0·4352 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was −0·0267 (0·0026 SE, 0·2130 SD)

Population growth in the simulation ($r = -0\cdot0267$) was depressed relative to the projected growth rate calculated from the life table ($r = -0\cdot001$) because of inbreeding depression and occasional lack of available mates.

Note: 497 of 1000 harvests of males and 530 of 1000 harvests of females could not be completed because of insufficient animals.

Final expected heterozygosity was	0·5768 (0·0349 SE, 0·1305 SD)
Final observed heterozygosity was	0·7529 (0·0712 SE, 0·2664 SD)
Final number of alleles was	3·14 (0·35 SE, 1·29 SD)

Population2

Similar results for Population 2, omitted from this Appendix, would follow.

******** Metapopulation Summary ********

Year 10

N[Extinct] = 0, P[E] = 0·000
N[Surviving] = 100, P[S] = 1·000
Population size = 8·65 (0·16 SE, 1·59 SD)
Expected heterozygosity = 0·939 (0·000 SE, 0·004 SD)
Observed heterozygosity = 1·000 (0·000 SE, 0·000 SD)
Number of extant alleles = 16·92 (0·20 SE, 1·96 SD)

Metapopulation summaries are given at 10-year intervals.

Year 100

N[Extinct] = 79, P[E] = 0·790
N[Surviving] = 21, P[S] = 0·210
Population size = 10·38 (1·37 SE, 6·28 SD)
Expected heterozygosity = 0·600 (0·025 SE, 0·115 SD)
Observed heterozygosity = 0·701 (0·050 SE, 0·229 SD)
Number of extant alleles = 3·57 (0·30 SE, 1·36 SD)

In 100 simulations of 100 years of Metapopulation:
79 went extinct and 21 survived.
This gives a probability of extinction of 0·7900 (0·0407 SE),
or a probability of success of 0·2100 (0·0407 SE).
97 simulations went extinct at least once.
Median time to first extinction was 7 years.
Of those going extinct,
mean time to first extinction was 11·40 years (2·05 SE, 20·23 SD).
91 recolonisations occurred.
Mean time to recolonisation was 3·75 years (0·15 SE, 1·45 SD).
73 re-extinctions occurred.
Mean time to re-extinction was 76·15 years (1·06 SE, 9·05 SD).

Mean final population for successful cases was 10·38 (1·37 SE, 6·28 SD)

Age 1	Adults	Total	
0·48	4·71	5·19	Males
0·48	4·71	5·19	Females

During years of harvest and/or supplementation
mean growth rate (r) was 0·0545 (0·0128 SE, 0·4711 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was −0·0314 (0·0021 SE, 0·1743 SD)

Final expected heterozygosity was 0·5997 (0·0251 SE, 0·1151 SD)
Final observed heterozygosity was 0·7009 (0·0499 SE, 0·2288 SD)
Final number of alleles was 3·57 (0·30 SE, 1·36 SD)

Manuscript received 4 March 1992; revised and accepted 13 August 1992