

CBSG ARIDLAND ANTELOPE WORKSHOP

San Antonio, Texas, U.S.A.
13-15 September, 1989

**Captive Breeding Specialist Group,
Species Survival Commission,
International Union for the Conservation of
Nature and Natural Resources**

Prepared by

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1 February 1990

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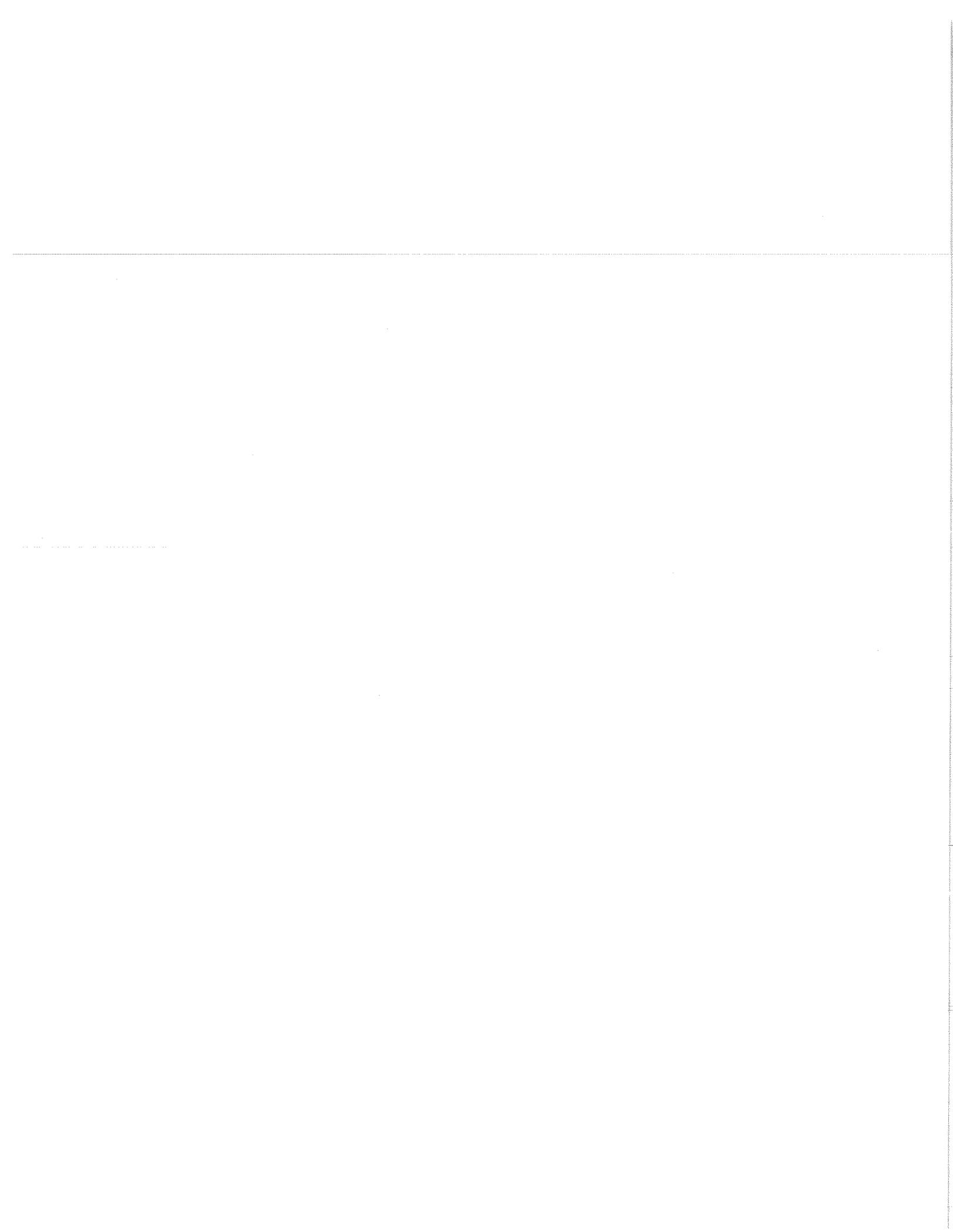
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OVERVIEWS

1 February 1990



SURVEY OF ARTIODACTYLA IN CAPTIVITY

Karen Sausman

September 13, 1989

A survey of the order Artiodactyla in captivity was undertaken using data from the following sources: the International Species Information System (ISIS), data as of December 31, 1988; the International Zoo Yearbook (IZY), data for 1985/86; Australia and New Zealand (AZDANZ) data as of June 1989; Texas Department of Fish and Game Texas Ranch Survey data as of March, 1989; Antelope Specialist Group (ASG) surveys published in 1988 and 1989, and various other sources.

The survey covered 527 forms (species and subspecies). The total captive population of artiodactyla is over 34,600 individuals ranging in size from dik-dik to giraffe and ranging in habitat from aquatic pygmy hippos to desert antelope.

Table 1 provides a summary of the captive population by families. Of the 527 forms, 154 are listed in either the IUCN Red Data Book, or CITES, or the USDI endangered species list at some level, and 115 of those are in captivity.

Table 2 provides reviews of the threatened/protected captive population and the total captive population based on the physical size of the species, and on those species requiring "mountain" habitat. It has been compiled for use in reviewing current and potential captive habitat for future breeding programs.

The final portion of this report, Table 3, is a list of 126 species and/or subspecies which are listed in the Red Data Book as endangered, or are CITES 1, or are considered at risk by the Antelope Specialist Group of the IUCN. These include 2 hogs, 1 peccary, 2 muntjac, 31 deer, 13 wild cattle, 6 duikers, 44 antelope and gazelles, and 25 goats, goat-antelope or sheep.

Of the 126 forms on the list, only 13 have captive populations that are greater than 100:

Cervus duvauceli

Cervus eldi thamin

Cervus nippon taiquanus

Bos guarus

Kobus leche leche

Oryx dammah

Oryx leucoryx

Addax nasomaculatus

Gazella dama

Gazella dama mhor

Gazella dama ruficollis

Gazella leptoceros

Hemitraqus jayakari

Following the name of each species is its status in the wild and then its current captive population as reported by ISIS, IZY and, if existing, the international studbook. Also included are IZY population figures for 1976 which can be used as a quick, rough reference on whether the captive population is increasing, decreasing, etc. The information given on recorded births and captive populations by continent might also help provide a more complete picture of each species' captive status. Under the heading "Some Captive Locations" can be found the locations of some of the larger captive collections, the Texas ranch figures (TXRAN), and current AZDANZ populations (AZD). The last section of this report is a review of status in captivity of all forms of artiodactyla.

Many individuals provided information for this survey, among them Nate Flesness, Tom Foose, Jim Dolan, Larry Killmar, Peter Olney, Bruce Read and Paul Garland.

TABLE 1
STATUS IN CAPTIVITY
SUMMARY OF
ALL ARTIODACTYLS

COMMON NAME GENUS. SPECIES	TOTAL NO. FORMS IN REPORT	NO. OF RDB/PROT FORMS IN REPORT	NO. OF CAPTIVE RDB/PROT FORMS	RDB/PROT POP	EST CAPT. POP	EST. TOTAL
				ISIS88 IZY85 STBK	NON RDB/PROT ISIS88 IZY86 (**=EST)	CAPT. POP ISIS88 IZY85/6 (**=EST)
ALL PIGS & PECCARIES	39	7	4	ISIS-47 IZY-76*	313 1187*	360 1263*
ALL HIPPOS	5	2	2	ISIS-96 IZY-191	113 120*	209 311*
ALL CAMELS & LLAMAS	9	4	3	ISIS-185 IZY-597*	881 1620*	1066 2217*
ALL MUNTJACS MUNTIACUS	11	2	2	ISIS-2 IZY-5	357 720*	359 725*
ALL MOUSE DEER	5	1	0	ISIS-0 IZY-0	67 83	67 83
ALL MUSK DEER	3	3	2	ISIS-4 IZY-31	0 0	4 31
ALL DEER IN THE GENUS CERVUS	69	26	16	ISIS-706 IZY-2296	1067 5681*	1773 7977*
ALL OTHER DEER, MOOSE & CARIBOU	51	15	6	ISIS-135 IZY-165	632 1701*	767 1866*
ALL GIRAFFES & OKAPI	10	0	0	ISIS-0 IZY-0	507 441	507 441
ALL PRONGHORN	6	3	0	ISIS-0 IZY-0	135 68	135 68
ALL CATTLE	29	19	11	ISIS-473 IZY-784*	648 950*	1121 1734*
ALL DUICKERS CEPHALOPHUS	24	12	9	ISIS-92 IZY-130*	54 53*	146 183*
ALL ANTELOPES & GAZELLES	174	36	36	ISIS-1808 IZY-3034	3621 8658	5429 11692
ALL GOATS, GOAT-ANTELOPE & SHEEP	92	24	24	ISIS-710 IZY-4121	1533 1907	2243 6028
ALL ARTIODACTYLS	527	154	115	ISIS-4258 IZY-11430*	9928 23189	14186 34619*

ACTION PLAN FOR ARTIODACTYLA

September 15, 1989

A survey of 527 taxa of artiodactyla shows a captive population of over 34,600 individuals ranging in size from dik-dik to giraffe and ranging in habitat from aquatic pygmy hippos to desert antelope.

Of these 527 taxa, 154 are listed in the IUCN Red Data Book, CITES or the USDI endangered species list. One hundred and twenty-six of those are either Red Data Book Endangered or CITES 1 or have been identified by the IUCN Antelope Specialist Group as being at risk or in need of captive propagation. These include 2 hogs, 1 peccary, 2 muntjac, 31 deer, 13 wild cattle, 6 duikers, 44 antelopes and gazelles, and 25 goats, goat-antelope or sheep.

Of the 126 taxa that are seriously threatened, about half (69) have some known captive population and 19 of these are part of a captive program (studbook, SSP, EEP, etc). Only 13 taxa have captive populations of over 100, while 32 have captive populations which number less than 25 individuals.

PRIORITY LIST CRITERIA FOR SPECIES SELECTION FOR CAPTIVE BREEDING

1. Degree of endangerment and reasons, ie. immediate loss of habitat.
2. Taxonomic uniqueness, ie. monotypic forms.
3. Geographical, ecological or adaptive uniqueness.
4. Existence of a captive population or possibility of acquiring new founder stock.

5. Suitability to captivity, ie. management protocols.
 - a. suitability for artificial insemination.
 - b. suitability for embryo transfer.
 - c. storage of genetic material regionally.
-

6. Regional carrying capacities.

LIST OF PRIORITY SPECIES AND SPECIFIC PROGRAM RECOMMENDATIONS

A - top priority; species which require immediate captive programs be developed or current captive programs be expanded.

B - species which do not exist in captivity or have small captive populations and require close monitoring.

C - species which are difficult or impossible to obtain or species which already have captive populations and adequate programs.

GENERAL RECOMMENDATIONS

1. Document founder stock for all captive species, especially threatened forms.
2. Develop and use methods of permanent, individual specimen identification.
3. Develop studbooks or, at least, registries for all threatened species that currently have captive populations.
4. Keep only specimens that can be identified fully taxonomically for breeding purposes and manage the others for display only. If replacement stock of known origin is reasonably available, then the unknown stock should be managed to extinction.

5. Develop a format for interchange of information and expertise between the captive breeding community and the various IUCN specialist groups.
6. Encourage research in the field and in captivity on the taxonomic status of several species and subspecies including giraffes, dama gazelles, the genus *Gazella*, and the genus *Ovis*.
7. Encourage the development of knowledge about the reproductive physiology of the various species.
8. Develop information about what is held in private collections.
9. Encourage the development of working groups based on taxonomic relatedness or on a regional basis, ie. North African antelopes and gazelles, duikers, and deer.
10. Develop a list of institution's special interests and encourage institutions to specialize.
11. Encourage in situ breeding programs in the country or region of origin for threatened species.
12. Encourage the interchange of technology, resources, and personnel between in situ and ex situ breeding programs.
13. Encourage multiple use of existing field facilities, ie. kouprey facilities for other Asian species.
14. Encourage a review of the status of South American artiodactyla.
15. Develop a resource list of people, institutions, etc., with expertise and financial resources.

<u>GENUS</u>	<u>SPECIES</u>	<u>COMMON</u>	<u>PRIORITY</u>
SUS	SALVANIUS	HOG, PYGMY	A
CATAGONUS	WAGNERI	PECCARY, CHACOAN	A
CERVUS	ALFREDI	DEER, VISAYAN SPOTTED	A
CERVUS	DAMA MESOPOTAMICA	DEER,PERSIAN FALLOW	A
CERVUS	ELDI ELDI	DEER, MANIPUR BROW-ANTLERED	A
CERVUS	ELDI SIAMENSIS	DEER, SIAMESE BROW-ANTLERED	A
CERVUS	KUHLI	DEER, BAWEAN (KUHL'S)	A
BLASTOCEROS	DICHOTOMUS	DEER, MARSH	A
HIPPOCAMELUS	ANTISENSIS	HUEMUL, NORTH ANDEAN	A
HIPPOCAMELUS	BISCULCUS	HUEMUL, SOUTH ANDEAN	A
PUDU	PUDU	PUDU, CHILIAN	A
BISON	BISON ATHABASCAE	BISON, WOOD	A
BOS	MUTUS	YAK, WILD	A
BOS (NOVIBOS)	SAUVELI	KOUPREY	A
BUBALUS	ARNEE	BUFFALO, ASIATIC WATER	A
BUBALUS	DEPRESSICORNIS	ANOA, LOWLAND	A
BUBALUS	DEPRESSICORNIS QUARLESI	ANOA, MOUNTAIN	A
BUBALUS	MINDORENSIS	TAMARAW	A
CEPHALOPHUS	ADERSI	DUIKER, ADER'S	A
CEPHALOPHUS	JENTINKI	DUIKER, JENTINK'S	A
CEPHALOPHUS	SPADIX	DUIKER, ABBOTT'S	A
CEPHALOPHUS	ZEBRA	DUIKER, ZEBRA	A
TRAGELAPHUS	BUXTONI	NYALA, MOUNTAIN	A
KOBUS	LECHE SMITHEMANI	LECHWE, BLACK	A
KOBUS	MEGACEROS	LECHWE, NILE	A
ALCELAPHUS	BUSELAPHUS SWAYNEI	HARTEBEEST, SWAYNE'S	A
ALCELAPHUS	BUSELAPHUS TORA	HARTEBEEST, TORA	A
DAMALISCUS	HUNTERI	ANTELOPE, HUNTER'S OR HIROLA	A
DAMALISCUS	LUNATUS KORRIGUM	KORRIGUM	A
HIPPOTRAGUS	NIGER VARIANI	ANTELOPE, GIANT SABLE	A
GAZELLA	DAMA DAMA	GAZELLE, SENEGAL DAMA	A
GAZELLA	DAMA MHORR	GAZELLE, MHORR	A
GAZELLA	LEPTOCEROS	GAZELLE, SLENDER-HORNED	A
GAZELLA	SOEMERRINGI BERBERANA	GAZELLE, SOMALI SOMMERING'S	A
GAZELLA	SOEMERRINGI SOEMMERRI	GAZELLE, NUBIAN SOMMERING'S	A
GAZELLA	SPEKEI	GAZELLE, SPEKE'S	A
NEOTRAGUS	MOSCHATUS MOSCHATUS	SUNI, ZANZIBAR	A
CAPRICORNIS	SUMATRAENSIS ANNECTENS	SEROW, SIAMESE	A
CAPRICORNIS	SUMATRAENSIS MILNEEDWARDSI	SEROW, BURMESE	A
CAPRICORNIS	SUMATRAENSIS RUBIDUS	SEROW, ARAKAN	A
CAPRICORNIS	SUMATRAENSIS SUMATRAENSIS	SEROW, SUMATRAN	A
CAPRICORNIS	SUMATRAENSIS SWETTENHAMI	SEROW, MALAYAN	A

<u>GENUS</u>	<u>SPECIES</u>	<u>COMMON</u>	<u>PRIORITY</u>
NEMORHAEDUS	GORAL ARNOUXIANUS	GORAL, CENTRAL CHINESE	A
NEMORHAEDUS	GORAL CAUDATUS	GORAL, KOREAN	A
AMMOTRAGUS	LERVIA SAHARIENSIS	AOUDAD, SAHARAN	A
CAPRA	IBEX WALIE	IBEX, WALIA	A
CAPRA	PYRENAICA PYRENAICA	IBEX, PYRENEAN	A
HEMITRAGUS	JAYAKARI	TAHR, ARABIAN	A
OVIS	AMMON HODGSONI	ARGALI, TIBETAN	A
OVIS	ORIENTALIS OPHION	MOUFLON, CYPRUS (RED SHEEP)	A

<u>GENUS</u>	<u>SPECIES</u>	<u>COMMON</u>	<u>PRIORITY</u>
BABYROUSA	BABYROUSA	BABIRUSA	B
CERVUS	CALAMIANENSIS	DEER, CALAMAIN	B
CERVUS	ELAPHUS HANGLU	DEER, KASHMIR RED (HANGUL)	B
CERVUS	ELDI THAMIN	DEER, BURMESE BROW-ANTLERED	B
CERVUS	NIPPON MANDARINUS	SIKA, NORTH CHINA	B
CERVUS	PORCINUS ANNAMITICUS	DEER, SIAMESE HOG	B
BLASTOCEROS	CAMPESTRIS LEUCOGASTER	DEER, CHACO PAMPAS	B
ANTILOCAPRA	AMERICANA PENINSULARIS	PRONGHORN, LOWER CALIFORNIA	B
ANTILOCAPRA	AMERICANA SONORIENSIS	PRONGHORN, SONORAN	B
TRAGELAPHUS	DERBIANUS GIGAS	ELAND, EASTERN GIANT	B
DAMALISCUS	DORCAS DORCAS	BONTEBOK	B
AEPYCEROS	MELAMPUS PETERSI	IMPALA, BLACK-FACED	B
GAZELLA	CUVIERI	GAZELLE, CUVIER'S	B
GAZELLA	DAMA RUFICOLLIS	GAZELLE, ADDRA	B
GAZELLA	DORCAS PELZEINI	GAZELLE, PELZELN'S	B
GAZELLA	THOMSONI ALBONOTATAGAZELLE,	MONGALLA	B
NEMORHAEDUS	GORAL CRANBROOKI	GORAL, RED	B
CAPRA	FALCONERI HEPNTERI	MARKHOR, TURKESTAN	B

<u>GENUS</u>	<u>SPECIES</u>	<u>COMMON</u>	<u>PRIORITY</u>
MUNTIACUS	CRINIFRONS	MUNTJAC, BLACK	C
MUNTIACUS	FEAE	MUNTJAC, FEA'S	C
MOSCHUS	MOSCHIFERUS	DEER, SIBERIAN MUSK	C
CERVUS	DUVAUCELI	DEER, SWAMP (BARASINGHA)	C
CERVUS	DUVAUCELI BRANDERI	DEER, C. INDIAN SWAMP (BARASINGHA)	C
CERVUS	DUVAUCELI DUVAUCELI	DEER, N. INDIAN SWAMP (BARASINGHA)	C
CERVUS	ELAPHUS BACTRIANUS	DEER, BACTRAIAN RED	C
CERVUS	NIPPON TAIUANUS	SIKA, FORMOSAN	C
BOS	GAURUS GAURUS	GUAR, INDIAN	C
BOS	GAURUS HUBBACKI	GUAR, MALAYAN	C
BOS	GAURUS READI	GUAR, SIAMESE/BURMESE	C
CEPHALOPHUS	OGILBYI	DUIKER, OGILBY'S	C
CEPHALOPHUS	RUBIDUS	DUIKER, RUWENZORI RED	C
KOBUS	LECHE KAFUENSIS	LECHWE, KAFUE	C
KOBUS	LECHE LECHE	LECHWE, RED	C
DAMALISCUS	LUNATUS TOPI	ANTELOPE, TOPI	C
ADDAX	NASOMACULATUS	ADDAX	C
ORYX	DAMMAH	ORYX, SCIMITAR-HORNED	C
ORYX	LEUCORYX	ORYX, ARABIAN	C
AMMODORCAS	CLARKEI	DIBATAG	C
DORCATRAGUS	MEGALOTIS	ANTELOPE, BEIRA	C
GAZELLA	RUFIFRONS	GAZELLE, RED FRONTED	C
GAZELLA	RUFIFRONS TILONURA	GAZELLE, HEUGLIN'S	C
GAZELLA	SUBGUTTUROSA MARICA	GAZELLE, ARABIAN GOITERED (SAND)	C
MADOQUA	PIACENTINII	DIK-DIK, PIACENTINI'S	C
OREOTRAGUS	OREOTRAGUS PORTEOUSI	KLIPSPRINGER, WESTERN	C
OUREBIA	OUREBI HAGGARDI	ORIBI, HAGGARD'S	C
NEMORHAEDUS	GORAL BAILEYI	GORAL, TIBETAN	C
NEMORHAEDUS	GORAL GORAL	GORAL, KASHMIR GRAY	C
NEMORHAEDUS	GORAL GRISEUS	GORAL, BURMESE GRAY	C
PANTHOLOPS	HODGSONI	ANTELOPE, TIBETAN	C
RUPICAPRA	RUPICAPRA CARTUSIANACHAMOIS	CHARTREUSE	C
RUPICAPRA	RUPICPRA ORNATA	CHAMOIS, APENNIAN	C

VIABLE CONSERVATION STRATEGIES FOR ARID-LAND ANTELOPES

11

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Arid-land antelopes will exist as small populations (several hundreds to perhaps a few thousand) for the next few decades or even centuries. Such small populations are vulnerable to stochastic problems that can endanger survival just as much as habitat degradation and direct extermination can. These stochastic problems can be environmental, demographic, or genetic in nature. Environmental fluctuations conditions can impair survival and fertility of individuals to detrimental even catastrophic levels. Catastrophes (droughts, floods, epidemics) are becoming increasingly recognized as severe threats to small populations. Demographically even in the absence of deleterious fluctuations in the environmental, small populations may develop biased sex ratios, unstable age distributions, or random failures in survival and fertility that can fatally disrupt propagation and persistence. Genetically, small populations can rapidly lose diversity that is necessary for fitness under existing environmental conditions and adaptation to changed environments in the future..

The smaller the population and the more limited it is in distribution, the greater these stochastic risks and problems will be. Hence, conservation strategies need to be based on development of viable populations, i.e. populations large and well distributed enough to survive the stochastic problems.

There is no single magic number that represents a minimum viable population for all taxa. Indeed there is no single number that represents a minimum viable population for any one taxa all the time. Rather viable population size depends on several sets of factors:

- (1) Genetic and demographic objectives of the program;
 - (a) The probability of survival of the population;
 - (b) The kinds and amounts of genetic diversity to be preserved;
 - (c) The period of time over which this genetic diversity and survival probability are to be preserved.
- (2) Biological characteristics of the population;
 - (a) The generation time (average age during life at which animals produce their offspring) in the population.
 - (b) Growth rate of the population;
 - (c) Number of founders;
 - (d) Ratio of genetically effective size N_e to the total size N .
- (3) The kinds and levels of stochasticity operating.

Viable conservation will require development of metapopulations (Figure 1) to achieve populations that are large and widely distributed enough to survive the stochastic risks. A metapopulation is a collection of disjunct subpopulations. Metapopulation strategies entail interactively managing the subpopulations to maximize the survival of the species.

These strategies (survival plans) must then recommend the number, sizes, and distribution of the subpopulations and the level of interchange among them to achieve the goal. For example, the conservation strategies for each of the 3 species of Asian rhinos recommend:

- (1) An Effective Population Size (N_e) \geq 500
- (2) A Total Population Size \geq 2000
- (3) The Number of Subpopulations \geq 10
- (4) The Size of Each Subpopulation \geq 100

Determining guidelines for the numbers, sizes, distribution, nature (i.e., captive/wild) and interaction of the metapopulation components should be formulated through Population Viability Analyses and Survival Plans (VASPS).

The metapopulations will often, perhaps usually, contain captive as well as wild populations, at least for some period of time. The IUCN recommends that captive propagation be invoked for any taxon whose wild population declines below 1000 individuals. Captive populations have certainly been and will continue to be vital for survival of arid-land antelopes, especially the three largest forms: the Arabian oryx, the scimitar-horned oryx, and the addax. Based on available evidence, it appears that: the Arabian oryx became extinct in the wild sometime in the late 1960's or early 1970's; the scimitar-horned oryx has recently vanished from the wild; and the addax survives at most in very small and fragmented populations (Table 1). Reintroduction of Arabian oryx in the last decade has commenced the restoration of this species to its natural habitat. Some scimitar-horned oryx and addax have already been reintroduced in Tunisia. Plans to reintroduce scimitar-horned oryx and addax on a larger scale in Niger are progressing.

Captive populations of all 3 species are large (Table 2), although many of the animals are not part of formally organized and pedigree managed programs. Moreover, the founder base of the captive populations is limited, especially in the case of the addax (Tables 2 & 3). Normally, for species with generation times of the order of these antelope, 20 to 30 effective founders (founder genomes surviving or founder genome equivalents) are advisable for a high probability of long-term viability.

Captive and wild populations will need to be interactively managed for mutual support and survival (Figure 2). Reproductive technology (A.I. & E.T.) potentially will facilitate transfer of material between captivity and the wild, as well as among disjunct natural populations. Reproductive technology may also greatly facilitate the "readaptation" process.

The ultimate goal of captive propagation is to reinforce survival of taxa in natural environments: by reestablishing species that have been exterminated; by reinvigorating taxa that have been debilitated genetically or demographically; or by recreating a semblance of the natural environment in a new area (e.g., horses in Canada; condors in the Grand Canyon).

The objectives, therefore, of formally organized programs like the SSP, EEP, and SMP are to propagate and manage ex situ populations of highly endangered taxa with prescribed levels of demographic stability and genetic diversity for defined periods of time to prevent extinction of the taxa.

These programs operate through masterplans that perform sophisticated genetic and demographic analyses to formulate animal-by-animal recommendations for the entire managed captive population. Such masterplans have been formulated for: the Arabian oryx, scimitar-horned oryx, and the addax in North America and the United Kingdom and for the scimitar-horned oryx in Australia/New Zealand.

Captive propagation programs like the SSP, EEP, and SMP all attempt to propagate and manage the captive populations to maximize the preservation of genetic diversity. In other words, to minimize the amount of change that may occur during the time in captivity.

Nevertheless, it will be important to retain or to restore some populations to the wild as soon as possible with the goal of again subjecting the population to natural selection and hence to evolution. This criteria will impose minimum size constraints on the wild populations reintroduced, i.e. normally > 100 . Optimally, reintroductions should be part of a masterplan for restoration of the taxa in the wild. Where reintroductions have to be opportunistic, they should nevertheless be developed within a strategic framework, e.g. will the area be able to support a population > 100 ?

Selection of animals for reintroduction to the wild from captivity should be based on genetic and demographic considerations to insure that the founders for the reintroduction are as representative as possible of the gene pool available in captivity as is occurring with the Arabian oryx reintroductions. It is probably important to continue to reintroduce the full spectrum of genetic material for extended periods of time and not arrive prematurely at conclusions about selective superiority of various lineages.

As long as populations remain small and managed, the highest priority should be placed on the most secure part of system and gene pool, which normally will be the captive population. Consequently, reintroductions should not impair, and indeed interactions with wild populations should where possible enhance, the security of captive population genetically and demographically. This kind of strategy has been applied with success to the Arabian oryx. Reciprocally, there should be every attempt to ensure that reintroduction really enhances overall survival of the taxa, e.g. the Amur leopard case, where a reintroduction has been proposed to reinforce a small remnant wild population of about 30 animals from a captive population that descends mostly from 2 founders (75% of captive gene pool), one of which may not be a verifiable representative of the subspecies. In other words, the paramount attention should be on viability of the entire metapopulation and its gene pool.

The interaction between captive and wild populations is particularly complex for the addax. The captive population derives from a small, potentially non-viable, number of effective founders. The proposed reintroduction in Niger would occur in an area possibly still inhabited by a remnant wild population. The remnant wild population could provide additional founder material to significantly enhance the viability of the one secure population of this species, the captive one. There is still a very appreciable probability of total extinction in the wild even if the reintroductions proceed. Even if the reinforced wild population prospers initially, there should be relative evaluation of long-term objectives versus short-term benefits. For most megavertebrates, the next couple of centuries will be unstable times. There will be ebbs and flows of the captive ark. It is imprudent to believe that a single

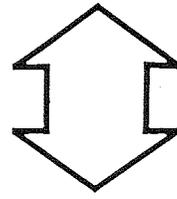
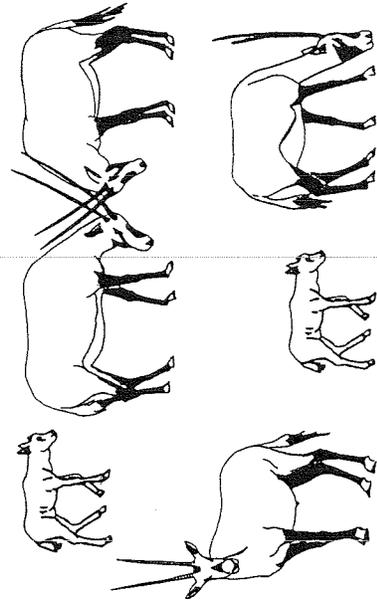
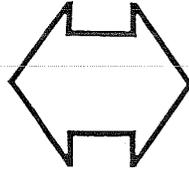
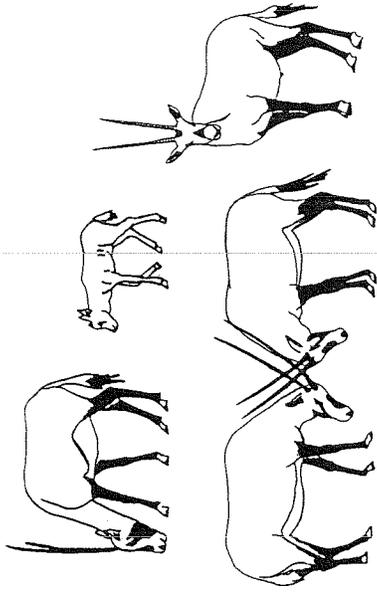
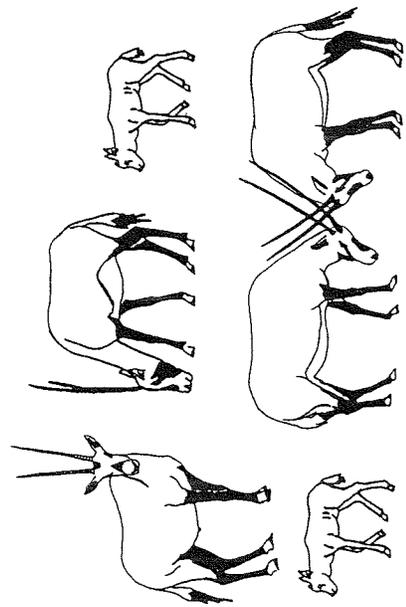
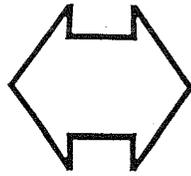
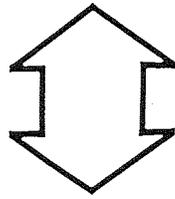
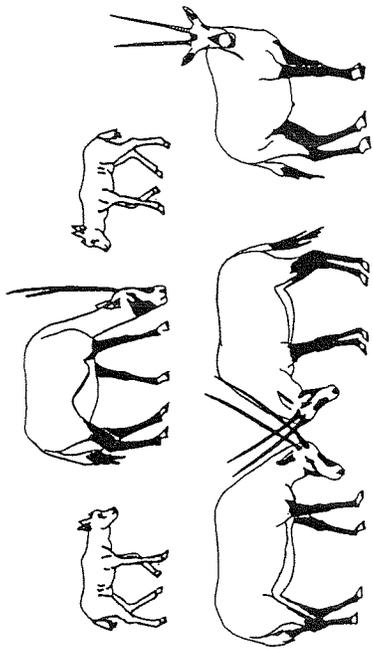
or few reintroductions in near future, even if very successful, will ensure long-term survival of species. Conservation strategies need to be prepared for (1) multiple inoculations to subsidize failures of the reestablishment/readaptation process and (2) repetition of the entire cycle of extinction in wild and reintroduction from captivity.

Consequently, there is merit in considering collection of additional founder material from the remnant wild population before animals are released from captivity into the same area, potentially confusing the founder bases of the current captive and remnant wild populations.

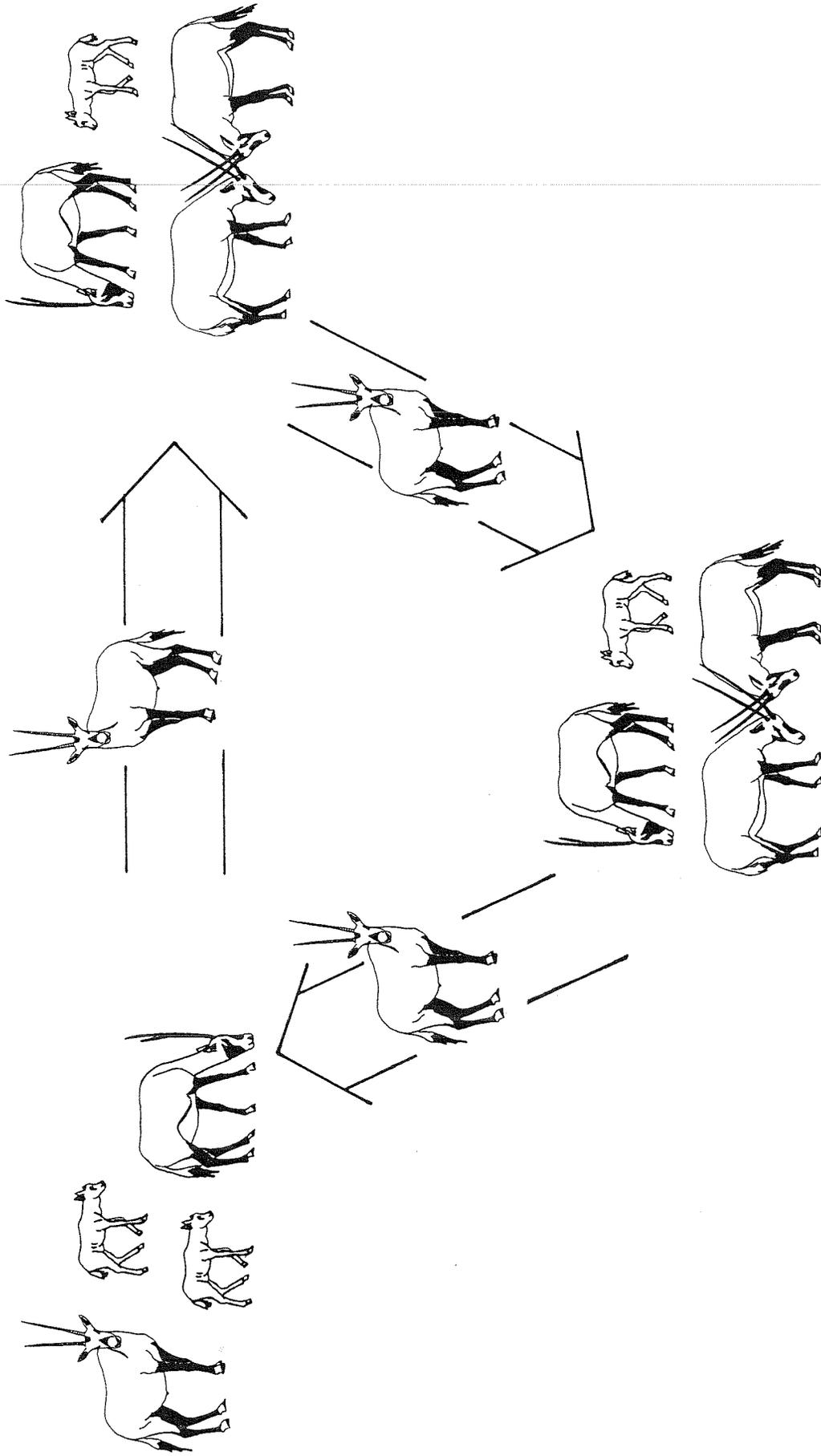
Like the captive, the wild populations will need to be managed. At its simplest, metapopulation management will entail managed migration among wild subpopulations as well as between captivity and the wild (Figure 3). However, more intensive management may also be needed and possible within small wild populations, e.g. artificially changing reproductive dominance or monopolization. Natural sanctuaries are becoming megazoos. Such intensive management will require more detailed data compilation on wild populations, including the possibility of "studbooks" for selected taxa like the black rhino.

Ideally, there should be management plans formulated and management groups organized to supervise and implement the strategies combining captive and wild populations. The Red Wolf AAZPA SSP Masterplan and U.S. Fish & Wildlife Service Recovery Plan is an eminent example. Analogous plans are under development for Puerto Rican Crested toads and Parrots, black-footed ferret, Javan and Sumatran rhino. Such a masterplan for metapopulation management of the captive and reintroduced populations of Arabian oryx is already underway. It is recommended that this approach be expanded to all the larger arid-land antelopes and specifically that a coordinating committee be formed to develop conservation strategies for all these species. Such a committee could be an extension of the Advisory Board that has been established for Arabian oryx.

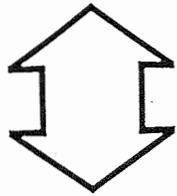
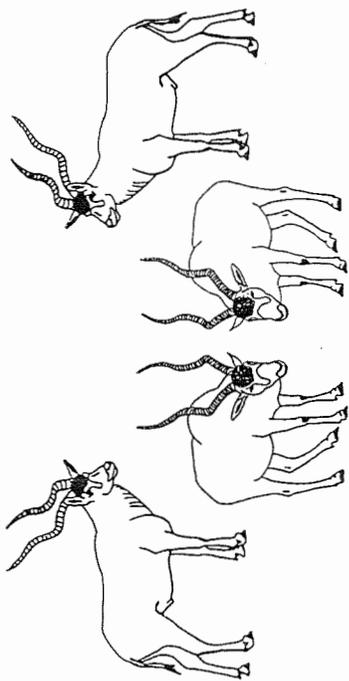
METAPOPOPULATION



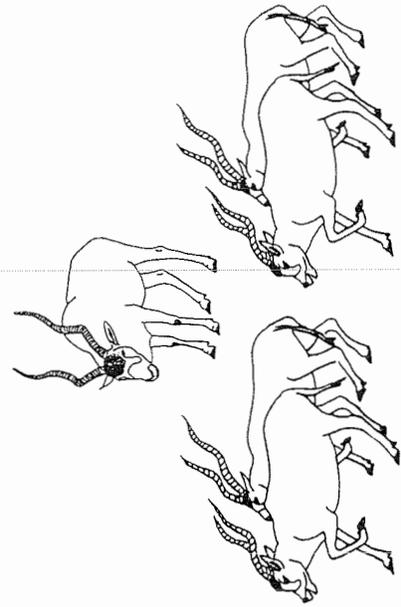
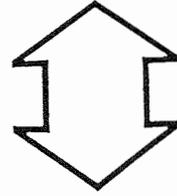
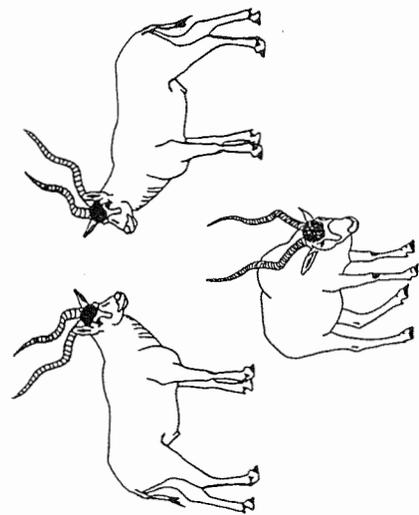
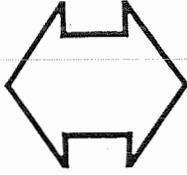
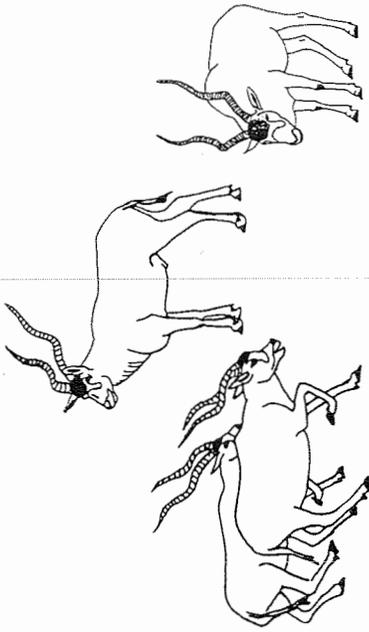
MANAGED MIGRATION AMONG POPULATIONS OF ARABIAN ORYX



**CAPTIVE
POPULATIONS**



**WILD
POPULATIONS**



**STATUS
OF
LARGER ARID-LAND ANTELOPES
IN THE WILD AND CAPTIVITY**

SEPTEMBER 1989

**NUMBERS OF ARID-LAND ANTELOPES
IN WILD AND REINTRODUCED POPULATIONS**

	ADDAX	ARABIAN ORYX	SCIMITAR HORNED ORYX
MAURITANIA	?	---	?
ALGERIA	?	---	---
MALI	< 50	---	?
BURKINA FASO	?	---	?
NIGER	50 - 200	---	?
TUNISIA	12	---	?
CHAD	200 ?	---	?
SUDAN	?	---	?
EGYPT	?	---	---
ISRAEL	---	---	---
JORDAN	---	95	---
SAUDI ARABIA	---	16	---
OMAN	---	74	---
ELSEWHERE	---	?	?

**NUMBERS OF ARID-LAND ANTELOPES IN
WILD AND REINTRODUCED POPULATIONS**

	<u>MALI</u>	<u>NIGER</u>	<u>CHAD</u>	<u>TUNISIA</u>	<u>ISRAEL</u>	<u>JORDAN</u>	<u>SAUDI ARABIA</u>	<u>OMAN</u>	<u>ELSEWHERE</u>
ADDAX	< 50	50-200	200+	12	?	?	?	?	?
ARABIAN ORYX	?	?	?	?	?	95	?	74	?
SCIMITAR HORNED ORYX	?	?	?	14	?	?	?	?	?

NUMBERS OF ARID-LAND ANTELOPES IN CAPTIVITY

	NORTH AMERICA		UNITED KINGDOM	EUROPE		MIDDLE EAST	AUSTRALIA	OTHER	WORLD		
	SSP	NON-SSP		PED.	NON				PED.	NON	ALL
ADDAX	191 (55/136)	400+	14 (5/9)	40 (15/25)	64 (23/41)	125+ (40 Israel) (25 Saudi)	3	16 (5/11)	245	608+	853+
SCIMITAR-HORNED ORYX	297 (103/194)	700+	64 (24/40)	?	150	150? (50 Israel)	60 (P) (29/31)	125?	421	1125+	1546+
ARABIAN ORYX	211 (84/127)	92 (70/22)	9 (6/3)	51 (30/21)	?	170 (P) 350 (NP)	0	22 (P) (15 Africa) (7 Asia)	463	442	905+

FOUNDER GENOMES SURVIVING

	ADDAX		SCIMITAR-HORNED ORYX		ARABIAN ORYX	
	ACTUAL	ORIGINAL	ACTUAL	ORIGINAL	ACTUAL	ORIGINAL
NORTH AMERICA	9.6	14	22	30	8.7	10
UNITED KINGDOM	?	?	8.25	12	?	?
EUROPE	5.75	14	?	?	6.8	10
MIDDLE EAST	2	2	2	2	17	19
AUSTRALIA/ NEW ZEALAND	?	?	?	?	?	?
WORLD	12	16	24	41	17	19

FOUNDER GENOME EQUIVALENTS = "EFFECTIVE FOUNDERS"

	ADDAX		SCIMITAR-HORNED ORYX		ARABIAN ORYX	
	EXISTING	POTENTIAL	EXISTING	POTENTIAL	EXISTING	POTENTIAL
NORTH AMERICA	4.0	9.6	17.9	23.2	7.9	8.7
UNITED KINGDOM	?	?	3.8	8.25	?	?
EUROPE	3.6	5.75	?	?	5.7	6.8
MIDDLE EAST	2	2	2	2	8.2	17.2
AUSTRALIA/ NEW ZEALAND	?	?	?	?	?	?
WORLD	6.7	12.2+	21.7	27+	8.2+	17.2+

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

Effective Size and Carrying Capacity Necessary for Maintaining the
Specified Amount of Genetic Diveristy for the Specified Amount of Time

Number of Years per Generation:	9.0	# Generations during 200 Years:	22
Yearly Growth Rate (lambda):	1.100	Exponential Growth Rate (r):	0.095
Effective Number of Founders:	10	Growth rate per Generation:	2.358
Estimated Ne/N Ratio:	0.50	Exponential Growth/Gener:	0.858
Desired % Hetero. Retain:	90.0		
Length of Time Period (Years):	200		

Effective Size Required to Maintain 90.0% of the
Original Founder's Heterozygosity for 200 Years: 468

Actual Carrying Capacity Required (Based on Ne/N Ratio): 936

=09/13/89===== j.ballou Mar'89 ===

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

ACTUAL CARRYING CAPACITIES Required to Maintain 90.0% of the Original
Heterozygosity for Various Time Periods Given Various Founder Numbers

		LENGTH OF PROGRAM (YEARS)					
		50	100	150	200	500	
No.	10	92	354	608	936	2804	Table
Effective	15	56	158	254	372	1050	Parameters
Founders	20	50	130	202	294	810	-----
	25	48	118	184	262	714	Lambda: 1.100
	30	48	114	172	246	664	Gen. Length: 9.0
							Ne/N Ratio: 0.50

== 09/13/89 ===== j.ballou-NZP Mar 89 ==

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

ACTUAL CARRYING CAPACITIES Required to Maintain Various Levels of
Heterozygosity for 200 Years with Various Numbers of Founders

		PERCENT HETEROZYGOSITY RETAINED													
		70.0	75.0	80.0	85.0	90.0									
No.	10	70	94	134	236	936	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: left;">Table Parameters</th> </tr> </thead> <tbody> <tr> <td style="text-align: right;">Lambda:</td> <td style="text-align: right;">1.100</td> </tr> <tr> <td style="text-align: right;">Gen. Length:</td> <td style="text-align: right;">9.0</td> </tr> <tr> <td style="text-align: right;">Ne/N Ratio:</td> <td style="text-align: right;">0.50</td> </tr> </tbody> </table>	Table Parameters		Lambda:	1.100	Gen. Length:	9.0	Ne/N Ratio:	0.50
Table Parameters															
Lambda:	1.100														
Gen. Length:	9.0														
Ne/N Ratio:	0.50														
Effective	15	66	84	114	176	372									
Founders	20	64	80	108	158	294									
	25	62	80	104	150	262									
	30	62	78	102	144	246									

== 09/13/89 ===== j.ballou-NZP Mar 89 ==

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

ACTUAL CARRYING CAPACITIES Required to Maintain Various Levels of
Heterozygosity for Various Time Periods Given 10 Effective Founders

		LENGTH OF PROGRAM (YEARS)					
		50	100	150	200	500	
	70.0	14	34	50	70	190	Table
Percent	75.0	18	42	66	94	254	Parameters
Heter.	80.0	24	60	94	134	372	-----
Retained	85.0	36	100	162	236	664	Lambda: 1.100
	90.0	92	354	608	936	2804	Gen. Length: 9.0
							Ne/N Ratio: 0.50

== 09/13/89 ===== j.ballou-NZP Mar 89 ==

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

Effective Size and Carrying Capacity Necessary for Maintaining the
Specified Amount of Genetic Diveristy for the Specified Amount of Time

Number of Years per Generation:	9.0	# Generations during 200 Years:	22
Yearly Growth Rate (λ):	1.100	Exponential Growth Rate (r):	0.095
Effective Number of Founders:	10	Growth rate per Generation:	2.358
Estimated N_e/N Ratio:	0.30	Exponential Growth/Gener:	0.858
Desired % Hetero. Retain:	90.0		
Length of Time Period (Years):	200		

Effective Size Required to Maintain 90.0% of the
Original Founder's Heterozygosity for 200 Years: 468

Actual Carrying Capacity Required (Based on N_e/N Ratio): 1560

=09/13/89===== j.ballou Mar'89 ===

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

ACTUAL CARRYING CAPACITIES Required to Maintain 90.0% of the Original
Heterozygosity for Various Time Periods Given Various Founder Numbers

		LENGTH OF PROGRAM (YEARS)					
		50	100	150	200	500	
No.	10	153	590	1013	1560	4673	Table
Effective	15	93	263	423	620	1750	Parameters
Founders	20	83	217	337	490	1350	-----
	25	80	197	307	437	1190	Lambda: 1.100
	30	80	190	287	410	1107	Gen. Length: 9.0
							Ne/N Ratio: 0.30

== 09/13/89 ===== j.ballou-NZP Mar 89 ==

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

ACTUAL CARRYING CAPACITIES Required to Maintain Various Levels of
Heterozygosity for 200 Years with Various Numbers of Founders

		PERCENT HETEROZYGOSITY RETAINED					
		70.0	75.0	80.0	85.0	90.0	
No.	10	117	157	223	393	1560	
Effective	15	110	140	190	293	620	
Founders	20	107	133	180	263	490	
	25	103	133	173	250	437	
	30	103	130	170	240	410	

							Table Parameters

							Lambda: 1.100
							Gen. Length: 9.0
							Ne/N Ratio: 0.30

== 09/13/89 ===== j.ballou-NZP Mar 89 ==

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

ACTUAL CARRYING CAPACITIES Required to Maintain Various Levels of
Heterozygosity for Various Time Periods Given 10 Effective Founders

		LENGTH OF PROGRAM (YEARS)					
		50	100	150	200	500	
	70.0	23	57	83	117	317	Table
Percent	75.0	30	70	110	157	423	Parameters
Heter.	80.0	40	100	157	223	620	-----
Retained	85.0	60	167	270	393	1107	Lambda: 1.100
	90.0	153	590	1013	1560	4673	Gen. Length: 9.0
							Ne/N Ratio: 0.30

== 09/13/89 ===== j.ballou-NZP Mar 89 ==

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

Actual Carrying Capacity Required to Maintain 90.0% of the Original
Heterozygosity for Various Time Periods Under Various Ne/N Ratios

		LENGTH OF PROGRAM (YEARS)					
		50	100	150	200	500	
	0.30	153	590	1013	1560	4673	Table
Ne/N	0.40	115	443	760	1170	3505	Parameters
Ratio	0.50	92	354	608	936	2804	-----
	0.60	77	295	507	780	2337	Lambda: 1.100
	0.70	66	253	434	669	2003	Gen. Length: 9.0
							No. Fndrs: 10

== 09/13/89 ===== j.ballou-NZP Feb 89 ==

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

Actual Carrying Capacity Required to Maintain 90.0% of the Original
Heterozygosity for Different Founder #s Under Various Ne/N Ratios

		No. EFFECTIVE FOUNDERS						
		10	15	20	25	30		
Ne/N Ratio	0.30	1560	620	490	437	410	Table Parameters <hr style="width: 100%;"/> Lambda: 1.100 Gen. Length: 9.0 Time Period: 200	
	0.40	1170	465	368	328	308		
	0.50	936	372	294	262	246		
	0.60	780	310	245	218	205		
	0.70	669	266	210	187	176		

== 09/13/89 ===== j.ballou-NZP Mar 89 ==

**ARID-LAND ANTELOPE
CALCULATIONS FOR CARRYING CAPACITY**

Capacity 2.11

=====

Actual Carrying Capacities Required to Maintain Various Levels of
Heterozygosity for Various Ne/N Ratios for 200 Years

		PERCENT HETEROZYGOSITY TO RETAIN						
		70.0	75.0	80.0	85.0	90.0		
	0.30	117	157	223	393	1560	Table Parameters <hr style="width: 100%;"/> Lambda: 1.100 Gen. Length: 9.0 No. Fndrs: 10	
Ne/N	0.40	88	118	168	295	1170		
Ratio	0.50	70	94	134	236	936		
	0.60	58	78	112	197	780		
	0.70	50	67	96	169	669		

== 09/13/89 ===== j.ballou-NZP Mar 89 ==

R_0 Net reproductive rate. The rate of change per generation.

If $R_0 < 1$ Population is declining

$R_0 = 1$ Population is stationary
(Does not change in number)

$R_0 > 1$ Population is increasing

G Generation Time.

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

GENETICS GLOSSARY

DNA

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

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

LOCUS

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

ALLELE

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

ALLELE OR GENE FREQUENCY

The proportion of all copies of a gene in the population that represent a particular allele.

GENOTYPE

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

GENOTYPIC FREQUENCY

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

HETEROZYGOSITY

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

HARDY-WEINBERG EQUILIBRIUM

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

**EXPECTED HETEROZYGOSITY = FOUNDER ALLELE DIVERSITY
= GENE DIVERSITY**

The heterozygosity expected in a population if the population were in Hardy-Weinberg equilibrium. Expected heterozygosity is calculated from allele frequencies, and is the heterozygosity expected in progeny produced by random mating. $1 - \sum p_i^2$, where p_i = the frequency of allele i .

GENE DIVERSITY

Same as expected heterozygosity.

GENOME

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

GENETIC DRIFT

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

BOTTLENECK

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

FOUNDER

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

FOUNDER REPRESENTATION

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

EXISTING REPRESENTATION

The existing percentage representation of founders in the population.

TARGET REPRESENTATION

The desired or target percentage representation of founders. These target figures are proportional to the fraction of each founder genome that survived in the population. Achieving these target representation values will maximize preservation of genetic diversity.

ORIGINAL FOUNDER ALLELES

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

ORIGINAL FOUNDER GENOMES

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

FOUNDER ALLELES SURVIVING

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

FOUNDER GENOMES SURVIVING

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

FOUNDER GENOME EQUIVALENTS

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

FOUNDER EQUIVALENTS

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

EFFECTIVE POPULATION SIZE

A concept developed to reflect the fact that not all individuals in a population will contribute equally or at all to the transmission of genetic material to the next generation. Effective population size is usually denoted by N_e and is defined as the size of an ideal population that would have the same rate of genetic drift and of inbreeding as is observed in the real population under consideration. An ideal population is defined by: sexual reproduction; random mating; equal sex ratio; Poisson distribution of family sizes, i.e. total lifetime production of offspring; stable age distribution and constant size, i.e. demographically stationary.

LIST OF THREATENED ANTELOPES IN SUB-SAHARAN AFRICA IDENTIFIED
BY THE IUCN/SSC ANTELOPE SPECIALIST GROUP'S ANTELOPE SURVEY

1. ANTELOPES UNDER IMMEDIATE THREAT (Antelopes currently in danger of extinction, or likely to become in danger of extinction in the near future)

(a) Species:

Aders' duiker (Cephalophus adersi)
 Abbott's duiker (Cephalophus spadix)
 Jentink's duiker (Cephalophus jentinki)
 scimitar-horned oryx (Oryx dammah)
 addax (Addax nasomaculatus)
 beira (Dorcatragus megalotis)
 dibatag (Ammodorcas clarkei)
 slender-horned gazelle (Gazella leptoceros)
 dama gazelle (Gazella dama)

(b) Subspecies (note: the ASG's surveys include only those subspecies which are highly distinctive morphologically, behaviourally and/or geographically, and are usually recognised as distinctive by wildlife managers in the field):

Ruwenzori black-fronted duiker (Cephalophus nigrifrons rubidus)
 western mountain reedbuck (Redunca fulvorufula adamauae)
 giant sable (Hippotragus niger variani)
 tora hartebeest (Alcelaphus buselaphus tora)
 western klipspringer (Oreotragus oreotragus porteousi)
 Heuglin's gazelle (Gazella rufifrons tilonura)

2. ANTELOPES POTENTIALLY AT RISK (Antelopes whose survival is not under immediate threat, but have a very restricted distribution and/or are not well represented in protected areas)

(a) Species:

mountain nyala (Tragelaphus angasii)
 giant eland (Tragelaphus derbianus)

Ogilby's duiker (Cephalophus ogilbyi)
zebra duiker (Cephalophus zebra)
Nile lechwe (Kobus megaceros)
hirola (Damaliscus hunteri)
Piacentini's dikdik (Madoqua piacentinii)
Speke's gazelle (Gazella spekei)
red-fronted gazelle (Gazella rufifrons)
Soemmerring's gazelle (Gazella soemmerringii)

(b) Subspecies:

western giant eland (Tragelaphus derbianus derbianus)
eastern giant eland (Tragelaphus derbianus gigas)
white-eared kob (Kobus kob leucotis)
red lechwe (Kobus leche leche)
Kafue lechwe (Kobus leche kafuensis)
black lechwe (Kobus leche smithemani)
Swayne's hartebeest (Alcelaphus buselaphus swaynei)
Kenya hartebeest (Alcelaphus buselaphus cokei x lelwel)
bontebok (Damaliscus dorcas dorcas)
korriqum (Damaliscus lunatus korriqum)
coastal topi (Damaliscus lunatus topi)
Haggard's oribi (Ourebia ourebi haggardi)
black-faced impala (Aepyceros melampus petersi)
Pelzein's gazelle (Gazella dorcas pelzelni)
Mongalla gazelle (Gazella thomsonii albonotata)

SUMMARY OF STATUS OF ANTELOPES

Lowland Nyala (Tragelaphus angasii)

No. of Countries: Occurs naturally in five countries (see below). In addition, this species has recently entered the extreme east of Botswana, through animals spreading from the adjacent northern Transvaal.

Population: Total numbers are at least in the tens of thousands. Its numbers are increasing in some parts of its range, e.g., South Africa, Swaziland.

Occurrence in Protected Areas: Occurs in more than 20 protected areas, with major populations* in areas such as Lengwe National Park (Malawi), Gorongosa National Park (Mozambique), Gonarezhou National Park (Zimbabwe), and several areas in South Africa such as Umfolozi/Hluhluwe, Mkuzi and Ndumu Game Reserves, and Kruger National Park. (*major populations refer to populations of 1000 or more individuals).

Overall Status: Satisfactory (Not threatened).

Country by Country Assessments of the Nyala's Status:

<u>Country</u>	<u>Status*</u>	<u>Country</u>	<u>Status</u>
Malawi	S	South Africa	S
Mozambique	S	Swaziland	S
Zimbabwe	R		

*R = rare; S = satisfactory (not threatened).

Addax (Addax nasomaculatus)

No. of Countries: Still occurs in at least four of the five countries on the southern side of the Sahara where it occurred historically (see below).

Population: Eliminated from most of its range by uncontrolled hunting and competition with livestock for limited forage. It survives in remote desert areas in scattered remnant populations which may comprise no more than a few hundred individuals in total, or perhaps in the low thousands at the most. The main surviving populations are in Niger (probably less than 250 animals) and Chad (no recent estimates available, but at least several hundred were present before the 1978-87 war with Libyan forces in northern Chad, where some addax still occur).

Occurrence in Protected Areas: A few addax survive in the recently established Air and Tenere National Nature Reserve in Niger. This vast reserve (more than 77 000 sq km) includes a special reserve for addax and there are plans to release captive-bred animals to supplement the wild population. This species also survives in the northern part of the Ouadi Rime-Ouadi Achim reserve in Chad.

Overall Status: Endangered.

Country by Country Assessments of the Addax's Status:

<u>Country</u>	<u>Status*</u>	<u>Country</u>	<u>Status</u>
Mauritania	En	Chad	probably En
Mali	En	Sudan	probably Ex
Niger	En		

*Ex = extinct; En = endangered.

Scimitar-horned Oryx (Oryx dammah)

No. of Countries: Eliminated from most of its range on the southern fringe of the Sahara, where it formerly occurred in eight countries (see below). Very small numbers may survive in Mali, Burkina Faso and/or Niger, but the only viable population in the wild is probably that of the Ouadi Rime-Ouadi Achim reserve in Chad. This reserve supported several thousand oryx prior to the 1978-87 war. The species still occurs in this part of Chad, and surveys are urgently required to assess its current status as a first step towards the re-establishment of protection. The current population is unknown, but may comprise a few hundred animals.

Occurrence in Protected Areas: The Ouadi Rime-Ouadi Achim reserve in Chad is the only legally protected area in sub-Saharan Africa which is known to contain scimitar-horned oryx at present. Rehabilitation of this reserve is of vital importance to the future of the species.

Overall Status: Endangered.

Country by Country Assessments of the Scimitar-horned Oryx's Status:

<u>Country</u>	<u>Status*</u>	<u>Country</u>	<u>Status</u>
Mauritania	Ex	Niger	En/Ex
Senegal	Ex	Nigeria	Ex
Mali	En/Ex	Chad	probably En
Burkina Faso	En/Ex	Sudan	probably Ex

*Ex = extinct; En = endangered.

Dama Gazelle (Gazella dama)

No. of Countries: Eliminated from much of its range on the southern fringe of the Sahara by uncontrolled hunting, competition with domestic livestock for forage, and the effects of persistent drought. Small numbers survive in most of the eight countries of sub-Saharan Africa within its historical range (see below). In Senegal, it is extinct in the wild but survives in captivity with individuals being bred for release into protected areas.

Population: Its numbers are unknown, but are unlikely to be less than a few hundred or more than a few thousand.

Occurrence in Protected Areas: Occurs in no more than six protected areas. These include the Gueumbeul Faunal Reserve in Senegal which contains a captive breeding population of 10-15 animals, the Ansongo-Menaka and Elephant reserves in Mali which are unprotected but may still support a few dama gazelles, the Sahel reserve in Burkina Faso which has been severely overgrazed by domestic livestock and is unlikely to support a viable population of dama gazelle if any do survive there, the Air and Tenere National Nature Reserve in Niger which has a population of about 200 dama gazelles, and the Ouadi Rime-Ouadi Achim Faunal Reserve in Chad which supported the bulk of the world population of this species (about 6-8000 animals) in the mid to late 1970s. The Ouadi Rime-Ouadi Achim reserve was unprotected during the war in northern Chad from 1978 to 1987. Dama gazelle still occur in this area and the population should recover if protection of this reserve is re-established.

Overall Status: Threatened/Endangered.

Country by Country Assessments of the Dama Gazelle's Status:

<u>Country</u>	<u>Status*</u>	<u>Country</u>	<u>Status</u>
Mauritania	Ex	Niger	En
Senegal	R	Nigeria	probably Ex
Mali	En	Chad	V/En
Burkina Faso	En	Sudan	probably En

*Ex = extinct; En = endangered; R = rare; V = vulnerable.

STATUS OF DESERT ANTELOPES IN CAPTIVITY

Karen A. Sausman

September 14, 1989

There are approximately 66 forms of desert or semi-desert antelope ranging from the semi-arid ranging Grant's gazelle and gerenuk to true desert forms such as addax and Arabian oryx.

Of these 66 forms, 5 species have no known captive populations: mountain nyala, dibatag, Piacentini's dik-dik, Salt's dik-dik, and Swayne's dik-dik. Four species only have captive populations in the Middle East: Yemen's gazelle, beira antelope, Philip's dik-dik and red-fronted gazelle. In addition, 11 sub-species have no captive populations except in the Middle East: *Gazella arabica cora* (7), *Gazella dama dama*, *Gazella dorcas dorcas*, *Gazella dorcas pelzeini*, *Gazella dorcas littoralis*, *Gazella dorcas saudiya*, *Gazella rufifrons laevipes*, *Gazella rufifrons hasleri*, *Gazella soemmeringi berberana*, *Gazella soemmeringi soemmeringi*, and *Gazella subgutturosa siestanica*.

There are currently at least 22 forms of desert and semi-desert antelope that are listed as CITES 1, IUCN endangered or are considered at great risk by the Antelope Specialist Group. Three of these have no known captive population: mountain nyala, dibatag and Piacentini's dik-dik. Four of these most threatened forms have captive populations only in the Middle East: beira antelope, *Gazella dama dama*, *Gazella dorcas pelzeini* and the red-fronted gazelles.

Of these 22 forms, four have total worldwide captive populations of less than 25: black-faced impala, beira antelope, Pelzin's gazelle and red-fronted gazelle.

Only 6 species have studbooks: Scimitar-horned oryx, Arabian oryx, addax, slender-horn gazelle, Cuvier's gazelle and Speke's gazelle. Of these, only the first three are part of management programs.

The Antelope Specialist Group has suggested the development of captive breeding programs for the beira, dibatag, and Heuglin's gazelle and has also identified mountain nyala, black-faced impala, Pelzen's gazelle, red-fronted gazelle, Soemmering's gazelle, and Piacentini's dik-dik as needing special protection.

I would recommend that studbook information be gathered for all the species of *Gazella dama*, *Gazella dorcas*, *Gazella soemmeringi*, *Gazella arabica*, *Gazella subgutturosa*, gerenuk, and *Madoqua kirki*. It would be appropriate to gather this type of data now while most of these species have small captive populations and data as to the origin of the founders and current breeding records may still be available. There is also a need to clarify the taxonomy of many of these species and their various forms through genetic studies on the captive populations and in coordination with the surveys being carried out by the Antelope Specialist Group.

Survey of Desert and Semi-desert Antelopes in Captivity
by Karen A. Sausman
September 13, 1989

INTRODUCTION

A survey of the desert and semi-desert antelopes in captivity was undertaken using data from the following sources: the International Species Information System (ISIS), data as of December 31, 1988; the International Zoo Yearbook (IZY), data for 1985/86; Australia and New Zealand (AZDANZ) data as of June 1989; Texas Department of Fish and Game Texas Ranch Survey data as of March, 1989; Antelope Specialist Group (ASG) surveys published in 1988 and 1989, and various other sources.

The survey covered 66 forms (species and subspecies). The total captive population of desert and semi-desert antelopes is over 3900 individuals ranging in size from dik-dik to addax.

Also included in the survey were 35 other desert hoofed mammals, 23 of which are listed in either the IUCN Red Data Book, or CITES, or the USDI endangered species list.

Section 1 (S1) provides a summary of the 66 forms by species. Of these, 33 are listed in either the IUCN Red Data Book, or CITES, or the USDI endangered species list at some level, and 25 of those are in captivity.

A review of the threatened/protected captive population and the total captive population based on the physical size of the species has also been included. It has been compiled for use in reviewing current and potential captive habitat for future breeding programs. A similar review is provided for other desert hoofed mammals.

The final portion of this report, Table 1 (T1), is a list of 22 species and/or subspecies which are listed in the Red Data Book as endangered, or are CITES 1, or are considered at risk by the Antelope Specialist Group of the IUCN.

Of the 22 forms on the list, only 7 have captive populations that are greater than 100:

Oryx dammah
Oryx leucoryx
Addax nasomaculatus
Gazella dama
Gazella dama mhorr
Gazella dama ruficollis
Gazella leptoceros

Following the name of each species is its status in the wild and then its current captive population as reported by ISIS, IZY and, if existing, the

international studbook. Also included are IZY population figures for 1976 which can be used as a quick, rough reference on whether the captive population is increasing, decreasing, etc. The information given on recorded births and captive populations by continent might also help provide a more complete picture of each species' captive status. Under the heading "Some Captive Locations" can be found the locations of some of the larger captive collections, the Texas ranch figures (TXRAN), and current AZDANZ populations (AZD).

The last section of this report is a review of status in captivity of all forms of desert and semi-desert antelope and also of other desert hoofed mammals.

Many individuals provided information for this survey, among them Nate Fleness, Tom Foose, Jim Dolan, Larry Killmar, Peter Olney, Bruce Read and Paul Garland.

STATUS IN CAPTIVITY
SUMMARY OF
ALL DESERT & SEMI-DESERT ANTELOPES

COMMON NAME GENUS, SPECIES	TOTAL NO. FORMS IN REPORT	NO. OF RDB/PROT FORMS IN REPORT	NO. OF CAPTIVE RDB/PROT FORMS	RDB/PROT POP	EST CAPT. POP	EST. TOTAL CAPT
				ISIS88 IZY85 STBK	NON RDB/PROT ISIS88 IZY86 (*=EST)	CAPT. POP ISIS88 IZY85/6 (*=EST)
NYALA, MOUNTAIN TRAGELAPHUS BUXTONI	1	1	0	ISIS-0 IZY-0	0 0	0 0
KUDU, LESSER TRAGELAPHUS IMBERBIS	2	0	0	ISIS-0 IZY-0	33 60*	33 60*
DRYX, SCIMITAR-HORNED DRYX DAMMAH	1	1	1	ISIS-445 IZY-544 SB-1000	0 0	445 544
DRYX DRYX GAZELLA	4	0	0	ISIS-0 IZY-0	222 520*	222 520*
DRYX, ARABIAN DRYX LEUCORYX	1	1	1	ISIS-273 IZY-248 SB-900	0 0	273 248
ADDAX ADDAX NASOMACULATUS	1	1	1	ISIS-229 IZY-409 SB-600?	0 0	229 409
DIBATAG AMMODORCAS CLARKEI	1	1	0	ISIS-0 IZY-0	0 0	0 0
SPRINGBOK ANTIDORCAS MARSUPIALIS	3	0	0	ISIS-0 IZY-0	162 510*	162 510*
ANTELOPE, BEIRA DORCATRABUS MEGALOTIS	1	1	1	ISIS-0 IZY-17	0 0	0 17
GAZELLE, ARABIAN GAZELLA ARABICA	2	0	0	ISIS-0 IZY-0	25 91	25 91
GAZELLE, BENNETT'S OR CHINKARA GAZELLA BENNETTI	1	0	0	ISIS-0 IZY-0	0 60*	0 60*
GAZELLE, YEMAN GAZELLA BILKIS	1	0	0	ISIS-0 IZY-0	0 0	0 0
GAZELLE, CUVIER'S GAZELLA CUVIERI	1	1	1	ISIS-22 IZY-75 SB-76	0 0	22 75
GAZELLE, DAMA GAZELLA DAMA	5	5	4	ISIS-282 IZY-351	0 0	282 351

*Black-Faced
Impresso*

STATUS IN CAPTIVITY
SUMMARY OF
ALL DESERT & SEMI-DESERT ANTELOPES

COMMON NAME GENUS, SPECIES	TOTAL NO. FORMS IN REPORT	NO. OF RDB/PROT FORMS IN REPORT	NO. OF CAPTIVE RDB/PROT FORMS	RDB/PROT POP		EST. TOTAL CAPT	
				ISIS88 1ZY85 STBK	NON RDB/PROT 1S1S88 1ZY86 (**=EST)	1S1S88 1S1S88 1ZY85/6 (**=EST)	EST. TOTAL CAPT POP
GAZELLE, DORCAS GAZELLA DORCAS	7	7	5	ISIS-54 1ZY-220*	0 0	54 220*	
GAZELLE, MOUNTAIN GAZELLA GAZELLA	2	2	2	ISIS-9 1ZY-45*	0 0	9 45*	
GAZELLE, GRANT'S GAZELLA GRANTI	2	0	0	ISIS-0 1ZY-0	75 300*	75 300*	
GAZELLE, SLENDER-HORNED GAZELLA LEPTOCEROS	2	2	2	ISIS-92 1ZY-65 SB-102	0 0	92 65	
GAZELLE, RED-FRONTED GAZELLA RUFIFRONS	4	4	1	ISIS-0 1ZY-14	0 0	0 14	
GAZELLE, SOMMERING'S GAZELLA SOMMERINGI	4	4	4	ISIS-0 1ZY-30*	0 0	0 30*	
GAZELLE, SPEKE'S GAZELLA SPEKEI	1	1	1	ISIS-21 1ZY-80 SB-25	0 0	21 80	
GAZELLE, GOITERED GAZELLA SUBEUTTUROSA	5	1	1	ISIS-36 1ZY-56	62 150*	98 206	
BERENUK LITOCRANIUS WALLERI	2	0	0	ISIS-0 1ZY-0	37 24	37 24	
DIK-DIK, GUNTHERS MADOQUA GUNTHERI	2	0	0	ISIS-0 1ZY-0	27 6*	27 6*	
DIK-DIK, KIRK'S MADOQUA KIRKI	6	0	0	ISIS-0 1ZY-0	68 45*	68 45*	
DIK-DIK, PHILLIPS MADOQUA PHILLIPSI	1	0	0	ISIS-0 1ZY-0	0 0	0 0	
DIK-DIK, PIACENTINI'S MADOQUA PIACENTINII	1	0	0	ISIS-0 1ZY-0	0 0	0 0	
DIK-DIK, SALT'S MADOQUA SALTIANA	1	0	0	ISIS-0 1ZY-0	0 0	0 0	
DIK-DIK, SWAYNES MADOQUA SWAYNEI	1	0	0	ISIS-0 1ZY-0	0 0	0 0	

CAPTIVE SPACES
FOR
ALL DESERT & SEMI-DESERT
ANTELOPES

GENUS. SPECIES	SIZE	RDB/PROT		TOTAL	
		FORMS		FORMS CAPT	
		ISIS 88	IZY 85/86	ISIS 88	IZY 85/86
MADOQUA GUENTHERI	VS	0	0	27	6
MADOQUA KIRKI	VS	0	0	68	45
MADOQUA PHILLIPSI	VS	0	0	0	0
MADOQUA PIACENTINII	VS	0	0	0	0
MADOQUA SALTIANA	VS	0	0	0	0
MADOQUA SWAYNEI	VS	0	0	0	0
DORCATRABUS MEGALOTIS	S	0	17	0	17
GAZELLA ARABICA	S	0	0	25	91
GAZELLA BENNETTI	S	0	0	0	60
GAZELLA BILKIS	S	0	0	0	0
GAZELLA CUVIERI	S	22	75	22	75
GAZELLA DORCAS	S	54	220	54	220
GAZELLA LEPTOCEROS	S	92	102	92	65
GAZELLA RUFIFRONS	S	0	14	0	14
GAZELLA SPEKEI	S	21	80	21	80
GAZELLA SUBGUTTUROSA	S	36	56	98	206
ANTIDORCAS MARSUPIALIS	MS	0	0	162	510
GAZELLA GAZELLA	MS	9	45	9	45
TRAGELAPHUS BUXTONI	M	0	0	0	0
TRAGELAPHUS IMBERBIS	M	0	0	33	60
AMMODORCAS CLARKEI	M	0	0	0	0
GAZELLA DAMA	M	282	351	282	351
GAZELLA GRANTI	M	0	0	75	300
GAZELLA SOEMMERINGI	M	0	30	0	30
LITOCRANIUS WALLERI	M	0	0	37	24
ORYX GAZELLA	ML	0	0	222	520
ORYX LEUCORYX	ML	273	248	273	248
ADDAX NASOMACULATUS	ML	229	409	229	409
ORYX DAMMAH	L	445	544	445	544
*** Total ***		1463	2191	2174	3920

FINAL VERSION: Compiled by R. East

CHAPTER 5: NIGER

J.F. Grettenberger and J.E. Newby

INTRODUCTION

The Republic of Niger extends from the Sahara Desert in the north to the region of the Niger River in the southwest. The topography is largely flat, but is broken by upland plateaux and mountain massifs such as the Air and Termit Massifs, and the Djado Plateau on the Libya border in the north. Desert, subdesert and sahel steppe cover most of the country (Fig. 1). Mean annual rainfall varies from >600 mm in the extreme southwest to <50 mm in the north. Natural vegetation zones follow the north-south rainfall gradient, from the sparsely vegetated deserts of the north through semi-desert grassland with scattered trees to Sudan wooded savanna in the south (Fig. 1).

Niger is one of the world's poorest nations and is beset with a host of problems. These range from the recurrent droughts and desertification which have recently affected all sahelian countries, to a drop in the world prices of uranium, Niger's major export commodity.

Not surprisingly in view of the massive problems faced by Niger, protection of wildlife has not been given high priority. Nevertheless, support has been given to wildlife conservation (Grettenberger 1984), as evidenced by the continued provision of funds for maintaining Niger's only national park, Parc National du W, and the establishment of the Air and Tenere National Nature Reserve.

CURRENT STATUS OF ANTELOPES

Over the last two decades the wildlife of Niger, especially medium-sized to large mammals, has suffered a catastrophic reduction. This has resulted from increasing competition with domestic livestock for forage, habitat destruction through overgrazing by domestic stock and tree-felling by pastoralists and cultivators, and extensive illegal hunting (Jones 1973; Newby 1980). The great sahel drought of 1968-73 affected wildlife as severely as man and domestic livestock and greatly increased pressures on the remaining wildlife habitats (Jones 1973). The situation has worsened with the droughts of the 1980s. While good rains fell in 1985 and 1986 in much of the

savanna, sahel and subdesert zones of Niger, the Air/Tenere and other regions of the northern deserts remained dry, severely reducing the food supply available for addax and other desert herbivores. However, the good wet seasons enjoyed by Niger in 1987 and 1988, especially the latter, extended northwards to regions such as Air/Tenere.

The surviving remnants of Niger's antelopes and other large mammals are now concentrated mainly in isolated or mountainous and hilly tracts in the saharan and sahel zones, notably in the regions of the Air and Termit Massifs, and in the W National Park and the contiguous Tamou Faunal Reserve in the southwest. Fifteen of the 17 antelope species which occurred in Niger in historical times are now classified as extinct, endangered, rare or vulnerable (Table 1).

(Table 1 about here)

CONSERVATION MEASURES TAKEN

All hunting is illegal in Niger, but enforcement is generally lax in protected areas and non-existent elsewhere. Protected areas comprise the W National Park, Tamou and Gadabedji Faunal Reserves, and the Air and Tenere National Nature Reserve (Fig. 1).

The W National Park is shared by Niger, Burkina Faso and Benin and is the largest national park (total area 10 230 sq km) in West Africa. This national park, Benin's Pendjari National Park, Burkina Faso's Arli reserve and extensive surrounding hunting zones and game reserves form a continuous area of >26 000 sq km which is one of the most important remaining wildlife habitats in West Africa. Combretum shrub savanna is the most widespread vegetation type in the W National Park, occurring on shallow infertile soils, with Combretum wooded savanna on deeper, more porous soil. Riparian forest is found along watercourses. The Niger section of the W National Park contains depleted but still viable populations of nine species of antelopes which were formerly widespread within suitable habitat in the savanna zone of southwestern Niger, viz., bushbuck, red-flanked duiker, grey duiker, waterbuck, kob, bohor reedbuck, roan, hartebeest and oribi. The W National Park also contains small remnant populations of korrigum and red-fronted gazelle. This national park and the contiguous Tamou reserve are under increasingly severe pressure from human encroachment, illegal grazing and hunting, uncontrolled bushfires, and exploration for phosphate mining. There is insufficient finance and staff to combat these threats (Poche 1973; Grettenberger 1984).

The Air and Tenere National Nature Reserve was officially established on 22 January 1988. This followed eight years of development work and support from the Niger Government, WWF and IUCN to establish the reserve. It comprises a vast area (77 360 sq km) of the Air Massif and Tenere Desert, making it the largest protected area under active management in Africa. Within its boundaries, a strict nature reserve of 12 806 sq km has been established specifically for addax conservation. The western part of the reserve is dominated by the Air Mountains, which consist of granitic massifs and outcroppings bisected by temporary watercourses or wadis. The eastern part is a mixture of ergs (sand dunes) and regs (gravel plains). The reserve is sparsely vegetated. Most of the vegetation is concentrated along wadis, which support perennial grass and forb communities (primarily Panicum turgidum and Aerva javanica with an overstory dominated by Acacia spp. and Balanites aegyptiaca). Extensive areas in the eastern part of the reserve are devoid of vegetation except in years of good rainfall. This reserve is of major international importance for the conservation of saharo-sahelian wildlife, affording protection to dorcas and dama gazelles, addax, and other species such as barbary sheep (Ammotragus lervia), cheetah (Acinonyx jubatus), striped hyaena (Hyaena hyaena) and ostrich (Struthio camelus). The slender-horned gazelle also occurs but the area is slightly too arid for scimitar-horned oryx. The management plan for the Air and Tenere National Nature Reserve attempts to strike a balance between the requirements of conservation of the fauna and flora, rational exploitation of the reserve's natural resources by the local nomadic people, and the development of tourism (Grettenberger & Newby 1984).

The Gadabedji reserve, which is unprotected at present, is situated in an area of northern sahelian wooded steppe and grassland. Temporary pools hold water during the wet season, but there is no permanent surface water within the reserve. Substantial areas of this reserve have been degraded by flocks of sheep, goats and camels, and there is considerable human occupation. There are no wells within the Gadabedji reserve, but waterpoints around the reserve's borders enable livestock to be grazed readily within the reserve. Despite these pressures, considerable areas of the reserve still support natural habitat in good condition.

CONSERVATION MEASURES PROPOSED

The surviving remnants of the antelopes and other wildlife of Niger represent important national and international wildlife

assets. The continued survival of Niger's antelopes depends on immediate international assistance for the protection and development of its national park and reserves (Grettenberger 1984). High priority should be given to increasing law enforcement in the W National Park to control the heavy pressures of illegal hunting and grazing. This would require increasing the number of guards, equipment and infrastructure as well as obtaining cooperation between Niger, Benin and Burkina Faso to facilitate law enforcement for all of the W National Park.

A survey of the Sirba River region in southwestern Niger is needed to determine the possibility of establishing a protected area for wildlife.

International support for the protection and development of the Air and Tenere National Nature Reserve is also a high priority. In addition, a reserve is required in the Termit area for Niger's arid zone species. The area surrounding the Termit Massif, which is much smaller than the Air Massif, supported relatively high densities of dama and dorcas gazelles, and addax in the early 1980s (Dragesco 1983) and remains a high priority for conservation action (Newby 1988). The Termit area is unprotected from illegal hunting, which has almost certainly eliminated the scimitar-horned oryx there. Nevertheless, the Termit Massif and its surrounds is one of the last and best remaining areas, both within Niger and internationally, for saharo-sahelian wildlife, including barbary sheep, cheetah and patas monkey (Eythrocebus patas) as well as antelopes.

In addition to protection for the surviving populations of the Air-Tenere and Termit regions, international assistance for the establishment in Niger of captive breeding groups for reintroduction to the wild may be vital for the long-term survival of endangered saharo-sahelian antelopes and other wildlife. A joint Zoological Society of London/IUCN/WWF project is currently planning to establish a regional centre for the reintroduction of saharo-sahelian wildlife. This centre will be based at Niger's Gadabedji Faunal Reserve. Reintroduction will be based on captive-bred animals from North America and/or Europe, plus animals relocated from wild populations where appropriate. The most likely candidates for reintroduction are scimitar-horned oryx, addax, dorcas and dama gazelles, and sahelian ostrich. Other species such as slender-horned gazelle, giraffe (Giraffa camelopardalis) and bustards may also be included. Broad support for the project has been obtained from the Nigerien Government and local

-5-

nomads. The local people have shown great interest in the reappearance of wildlife species which form an important part of their culture. The project will aim to establish viable wild populations of aridland wildlife species as part of a wider strategy for the long-term management of sahelian natural resources through habitat rehabilitation and the development of sustainable land-use practices.

Scimitar-horned Oryx (*Oryx dammah*)

Distribution & Population: Formerly widespread in Niger's sahelian zone, by the 1970s the scimitar-horned oryx was largely confined to an area on the southern fringe of the Sahara Desert from east of Agadez to the Termit Massif (Fig. 2). The total population was reduced to probably <200 by the early 1980s. The oryx's decline has continued to the point where there have been no reliable reports of this species in Niger since a herd of four was seen between the Air Mountains and Termit in 1983.

Habitat, Food & Reproduction: The scimitar-horned oryx is an animal of rolling dunes, grassy steppes and wooded interdunal depressions in the arid grassy zone between the desert and sahel vegetation zones. It is almost entirely a grazer, and is highly gregarious and mobile. Herds move over large ranges in response to seasonal and spatial variations in rainfall and pasturage. Births may occur throughout the year but with peaks occurring during the late cold/early hot season (February-April) and the late rainy/early cold season (September-November).

Status: Very probably extinct. By the early 1980s, this species had been reduced to precariously low levels by illegal hunting, competition with livestock for sparse food supplies, and exclusion from prime habitat by the increasing extension of deep permanent-water bore holes for livestock into areas which were formerly hot season feeding grounds for oryx (Newby 1978, 1980, 1988). During the early-mid 1980s, drought probably forced the few surviving oryx to move from between the Air and Termit Massifs to marginally better pastures further south. Here they would have been exposed to increased hunting, which they would be unlikely to survive. There is a slight possibility that oryx may still exist in the Termit area, but an expedition mounted in 1986 found no sign (Newby 1988).

Conservation Measures Taken: Small numbers of scimitar-horned oryx were observed as vagrants in the Air and Tenere National Nature Reserve up until 1982 (Grettenberger & Newby 1984; Newby 1988). This area is slightly too arid for permanent occupation by this species.

Conservation Measures Proposed: Proposals for saving the

scimitar-horned oryx from extinction in the wild and its subsequent rehabilitation were outlined by Newby (1988). Those which relate specifically to Niger include a survey of the Termit region to determine if any oryx survive there, establishment of a protected area centred on the Termit Massif, and establishment of a regional centre for captive breeding and reintroduction of saharo-sahelian wildlife into appropriate protected areas. Large numbers of captive-bred scimitar-horned oryx are held in zoos in Europe, North America and elsewhere. The availability of animals for reintroduction, together with this species' status of endangered or extinct throughout its natural geographical range which includes 13 countries (Newby 1988), make it a prime candidate for the planned regional centre for the reintroduction of saharo-sahelian wildlife at Niger's Gadabedji Faunal Reserve. The Gadabedji reserve lies within the natural range of the scimitar-horned oryx. Considerable long-term international financial and technical assistance and the full cooperation and support of the Nigerien Government will be essential if these proposals are to succeed.

Additional Remarks: The oryx is a large, fast-growing, efficient protein producer which is superbly adapted to the harsh climate and sparse vegetation of the subdesert steppe. These attributes give the oryx major potential as a food resource in much of the sahelian region. With its additional values for tourism and legal sport-hunting, this antelope is an economically valuable resource which could play a significant role in the successful development of the impoverished sahel (Newby 1978, 1980). Attempts to rehabilitate the scimitar-horned oryx and other saharo-sahelian wildlife species will not succeed unless they are integrated with broader land-use strategies aimed at developing sustainable utilisation of natural resources (Newby 1988).

Addax (*Addax nasomaculatus*)

Distribution & Population: Formerly widespread in the saharan zone, the addax has now been eliminated from much of its former range in Niger. It survives mainly in dune areas which are inaccessible to motorised hunting parties (Fig. 2), as in the east and northwest of the Termit region (Dragesco 1983), the Tenere Desert, and in the northwest near the Algeria border, where Jones (1973) observed two live and six dead addax in 1972 and found considerable evidence of hunting from vehicles. Probably <200 addax remain in Niger and numbers continue to decline. A few (<50) probably survive in the western Tenere Desert within the Air and Tenere National Nature Reserve. The addax population in the area around the

-11-

Termit Massif is difficult to estimate precisely. Although it occupies a relatively small area compared to the Air and Tenere National Nature Reserve, the population density may be considerably greater in the Termit area (Dragesco 1983).

Habitat, Food & Reproduction: The addax is a true desert animal, occupying waterless areas of the Sahara, particularly the vast dune regions (ergs) but also stony plains (regs). It occurs singly or in groups of up to 4 (formerly in herds of up to 20, excluding wet season or migratory agglomerations). It is highly mobile, searching out patches of desert vegetation which have grown in response to localised rainfall. Addax are primarily grazers, although they will browse on the green shoots of Acacia trees. During the droughts of the mid-1980s in the Air-Tenere area, addax persisted largely on the perennial tussock-grass Stipagrostis vulnerans, which is normally only a dry season food. Other foods include the forbs Schouwia thebaica, Aerva javanica, and Chrozophora brocchiana. In ephemeral pastures which are produced by rainfall, addax consume Stipagrostis plumosa, Tribulus sp., Cyperus conglomertus, and a variety of annual legumes (Tephrosia/Indigofera). Birth (normally one calf after a gestation period of 8-10 months) usually takes place in the period following the rainy season and before the cold (September-January).

Status: Endangered. Because of its less accessible habitat the addax has not suffered quite as severe a decline as the scimitar-horned oryx (Newby 1980). The addax has nevertheless been reduced to the verge of extinction in Niger by illegal hunting. The remnant population has also suffered from the effects of recurrent drought and harassment by desert travellers, mining exploration, and in some areas tourists (Grettenberger et al. 1984).

Conservation Measures Taken: The Air and Tenere National Nature Reserve protects a sufficiently large area of good addax habitat to play a vital role in ensuring this species' long-term survival in the wild, both in Niger and in Africa as a whole. The 12 806 sq km strict nature reserve ("La Sanctuaire des Addax") within the Air and Tenere National Nature Reserve is clearly delineated and protected by patrols. No tourist circulation or other human activity is permitted within the strict nature reserve, which incorporates all habitat types believed to be necessary for the survival of addax. Most of the area is open, sandy desert. Several seasonal watercourses drain into the strict nature reserve from the Air Mountains, providing ephemeral water supplies. The vegetation consists of scattered desert pasture, growing in response to rare and localised rainfall and runoff from the wadis. Typical plants include grasses of the genera

Stipagrostis and Panicum, Fagonia scrub, and along the wadis, Acacia trees and succulents such as the wild melon Citrullus. The good rainfalls of 1987 and 1988 in this area regenerated good quality addax pasture. Addax have been present in the area for centuries but numbers are now very low.

Conservation Measures Proposed: It is proposed to reintroduce addax into the strict nature reserve within the Air and Tenere National Nature Reserve, using captive-bred animals. There are now over 2000 addax held in captivity in the United States, Europe and the Middle East, including a number of healthy animals available for release programmes. The reintroduction project will be undertaken jointly by WWF/IUCN and the Nigerien Wildlife Service within the framework of the Air and Tenere Natural Resource Conservation Project. The Zoological Society of London is responsible for the external coordination of the reintroduction project. The objective is to release 50-75 addax into the wild over a 3-year period commencing in 1989/90, to repopulate areas suitable for addax and provide a genetic and social boost to any existing groups. Creation of a protected area in the Termit region in the near future would also be of major value for this species.

Additional Remarks: Its unique adaptation to desert habitats would make the addax a valuable natural resource if its populations were permitted to recover. Controlled exploitation of addax for meat, hides, traditional medicinal products, and legal sport-hunting has major potential economic value.

Dorcas Gazelle (Gazella dorcas)

Distribution & Population: Formerly found throughout the desert, subdesert, and the northern half of the sahel zone in Niger, in suitable habitat, south to about latitude 14 degrees North. The dorcas gazelle is still widespread in Niger and is the only surviving antelope species in many regions of the desert and subdesert zones (Fig. 2). Although numbers are much reduced, it is still locally common in a few areas, such as the Air and Tenere National Nature Reserve, where the total population of this species (1983/84 estimate) probably comprises several thousand animals. It does not occur in the

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upper elevations of the larger massifs or in the hyper-arid eastern half of the reserve (Grettenberger 1987). Within the 30-40% of the reserve which comprises suitable habitat, the average population density is approximately one gazelle per 5 sq km. This suggests a population of 4800-6400 within the reserve. In localised areas of high quality habitat, such as the large wadis on the eastern side of the Air Mountains, densities may reach 4 to 5 per sq km. Densities are probably well below one per 5 sq km in parts of the reserve where nomads and their livestock are present or the quality of the grazing is poor. The dorcas gazelle occurs at a relatively high density in the Termit region, where Dragesco (1983) estimated a population of a few thousand in an area of several thousand sq km in 1980-82. Numbers elsewhere are unknown but probably declining.

Habitat, Food & Reproduction: A very adaptable gazelle which browses and grazes on a wide range of desert shrubs and grasses, browsing more under dry conditions and grazing when pasture is available, e.g., after rainfall. The trees Acacia tortilis and Balanites aegyptiaca and the forb Chrozophora brocchiana formed the bulk of this gazelle's diet under drought conditions in the Air and Tenere National Nature Reserve in 1983-84; leaves of the tree Maerua crassifolia and the shrub Leptadenia pyrotechnica were the most highly preferred foods (Grettenberger 1987). Average group size observed in the Air region in 1983-84 was 2.5 (range 1 to 13). It is highly mobile, wandering long distances in search of food. In the Air region during the hottest season of the year, this species concentrates in habitats associated with temporary watercourses and riverbeds, where trees and shrubs provide shade and forage. It disperses widely into less wooded habitats following rain and in cooler seasons. Births have been observed from September to February in the Air and Tenere National Nature Reserve, with a peak in November.

Status: Not yet threatened, since it still occurs widely and is locally common, but numbers have declined markedly over the last two decades because of uncontrolled hunting, habitat degradation and competition for food and shade with domestic livestock. The recent droughts in northern Niger forced large numbers of dorcas gazelles to quit their usual ranges for the marginally better pastures further south, with a corresponding increase in illegal hunting. Up to 1-200 gazelles were taken at a time in some zones.

Conservation Measures Taken: Well represented in the Air and Tenere National Nature Reserve. A small population (perhaps 100) occurs in the Gadabedji Faunal Reserve. Human occupation of parts of the Gadabedji reserve, particularly depressions where shade and wood are available, has had negative

consequences for the surviving gazelles which utilise these areas during the hot season.

Conservation Measures Proposed: Establishment of a protected area in the Termit region, together with effective protection and management of the Air and Tenere National Nature Reserve, would probably ensure the long-term survival of this species in Niger.

Slender-horned Gazelle (Gazella leptoceros)

Distribution & Population: This species is a very rare inhabitant of desert country. It has been seen occasionally in desert bordering the Air Massif (Jones 1973; Newby, personal observations). Although not yet recorded elsewhere in Niger (Fig. 2), it may be present in other parts of the desert zone. In the field it is easily confused with the more abundant dorcas gazelle. Numbers are unknown but there are probably <1000 in Niger.

Habitat, Food & Reproduction: The most desert-loving of the gazelles, it occupies both sandy and stony deserts (Newby 1980). It is particularly well adapted to sandy dunes and lives in small herds (up to 5). It is strongly nomadic (Dorst & Dandelot 1970).

Status: Probably endangered. Although it is protected from illegal hunting to some extent by its inhospitable habitat (Newby 1980), like the addax it has probably been affected severely by recurrent droughts in the desert zone.

Conservation Measures Taken: Occurs sporadically in the Air and Tenere National Nature Reserve, where it may be more common than expected.

Conservation Measures Proposed: Effective management of the Air and Tenere National Nature Reserve will enhance the survival prospects of this gazelle. Surveys of the desert regions of this reserve and the Termit area are required to assess its status more accurately. Discovery of a viable population of this species in the Termit area, for example, would enhance the value of establishing a protected area there. Establishment of a captive breeding population of this species in Niger should be a high priority, to provide animals for reintroduction into protected areas.

Red-fronted Gazelle (Gazella rufifrons)

Distribution & Population: This gazelle still occurs widely at low densities within Niger's sahel and savanna zones (Fig. 2). It is occasionally seen further north than the distribution indicated in Fig. 2, e.g., in the southwest of the Termit region (Dragesco 1983) and as far north as 16 degrees 30'N in the region south of Agadez (Grettenberger, personal observations). The total population is unknown but is possibly

-16-

of the order 3-5000.

Habitat, Food & Reproduction: A species of the wooded savanna. It occurs singly or in small herds (up to 5), and feeds by both grazing and browsing.

Status: Vulnerable. It is still quite common in a few localities, but its overall population is declining. Its habitat is severely threatened by clearance for agriculture, although it can reoccupy fallow land if enough cover is available. It is protected to some extent by its skulking habits.

Conservation Measures Taken: Occurs in small numbers in the W National Park, Tamou Faunal Reserve, and Gadabedji Faunal Reserve. It seems to be a seasonal visitor to Gadabedji, mainly during the wet season.

Conservation Measures Proposed: Effective protection and management of the conservation areas in which it occurs, enlargement of the Gadabedji Faunal Reserve to provide year-round habitat, and better enforcement of the anti-hunting laws are necessary to counteract this species' gradual decline. It would also benefit from the establishment of a reserve in the Sirba River region.

Dama Gazelle (Gazella dama)

Distribution & Population: Formerly widespread in the sahelian, subdesert and southern saharan zones in Niger, the dama gazelle is now reduced to scattered remnant populations within its former distribution, notably in the Termit and Air regions (Fig. 2). Numbers in the Air and Tenere National Nature Reserve were estimated to be approximately 150-250 in 1983-84 (Grettenberger & Newby 1986). The largest surviving population of dama gazelle in Niger is in the Termit region, where surveys carried out in 1980 and 1982 revealed a population of approximately 2-400 in an area of several thousand sq km (Dragesco 1983). Its total population in Niger is probably <1000 and is certainly declining.

Habitat, Food & Reproduction: It occurs mainly in the arid grassy zone between the true desert and true sahel country, with a marked preference for stony or rocky terrain, often around the edges of hills. During dry conditions in the Air and Tenere National Nature Reserve, it is observed most often in temporary watercourses which provide green forage and shade. It is a browser, feeding mainly on trees such as acacias and desert date (Balanites aegyptiaca) and the shrub Leptadenia pyrotechnica (Grettenberger & Newby 1986). It occurs singly or in small herds; average group size was 1.9 (range 1-5) in observations in the Air region in 1979-84. Wide seasonal movements are undertaken in response to the availability of food. Births probably occur at the end of the

wet season, if similar to the pattern in Chad.

Status: Endangered. The continuing decline of this gazelle caused by illegal hunting, habitat destruction and drought is rapidly worsening its status. Recent droughts forced considerable numbers of dama gazelles to move south of their usual range in search of browse, bringing them into greater contact with man with a corresponding increase in hunting.

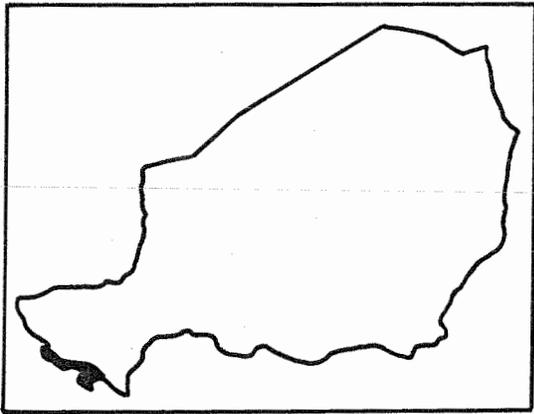
Conservation Measures Taken: The only protected population of dama gazelle in Niger is that in the Air and Tenere National Nature Reserve.

Conservation Measures Proposed: Implementation of an effective management plan for the Air and Tenere National Nature Reserve (Grettenberger & Newby 1984) is essential for the long-term survival of the dama gazelle. Establishment of a protected area in the Termit region in the near future is also vitally important for this species' survival. Establishment of a captive breeding group in Niger and reintroduction of dama gazelle to protected areas may be necessary to ensure the recovery of populations once effective reserves have been created.

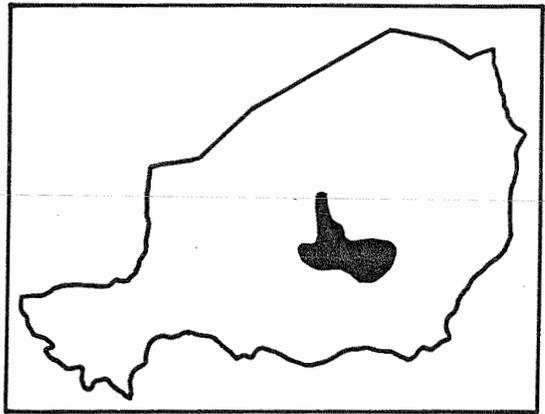
Table 1. Current Status of Antelopes in Niger.

<u>Species</u>	<u>Status*</u>	<u>Species</u>	<u>Status</u>
Bushbuck	V	Addax	En
Sitatunga	Ex	Western Hartebeest	V
Red-flanked Duiker	En	Korrigum	En
Grey Duiker	S	Dorcas Gazelle	S
Bohor Reedbuck	R	Slender-horned Gazelle	En
Waterbuck	V	Red-fronted Gazelle	V
Kob	V	Dama Gazelle	En
Roan	R	Oribi	R
Scimitar-horned Oryx	En/Ex		

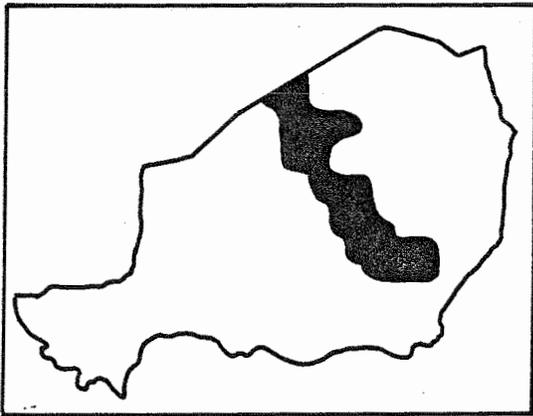
*Ex = extinct; En = endangered; V = vulnerable; R = rare; S = satisfactory (not threatened). See chapter 1 for definition of status categories.



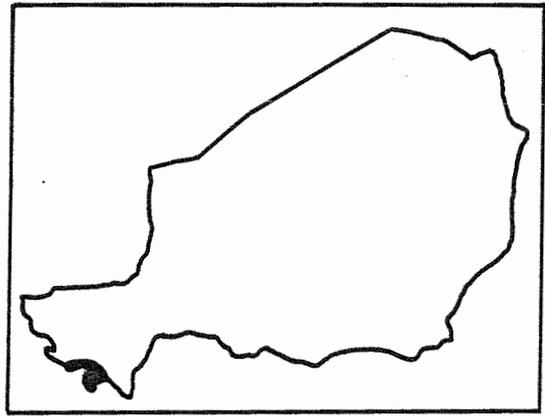
Roan



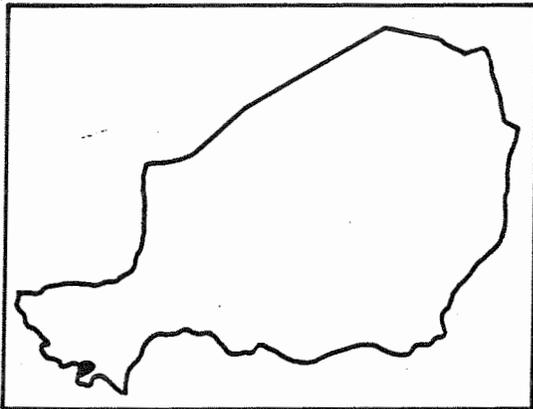
Scimitar-horned Oryx



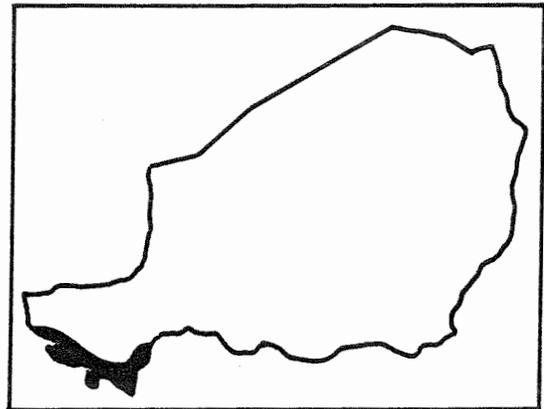
Addax



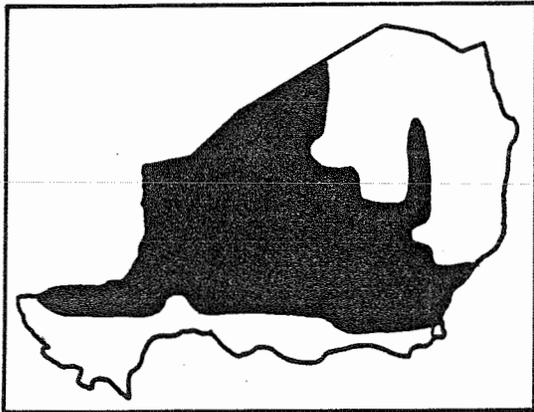
Hartebeest



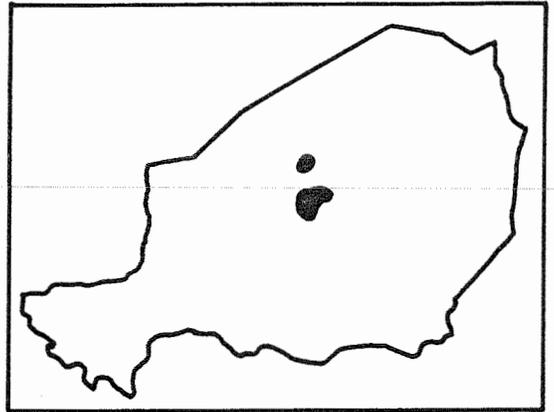
Korrigum



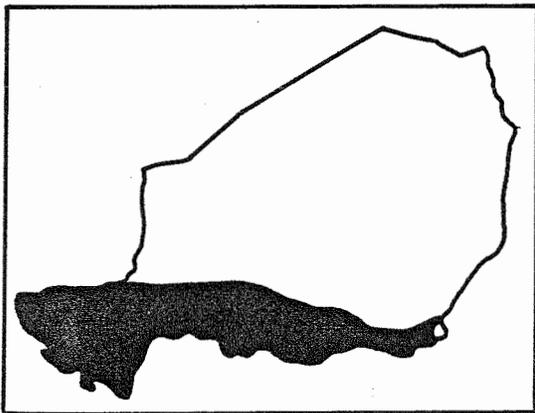
Oribi



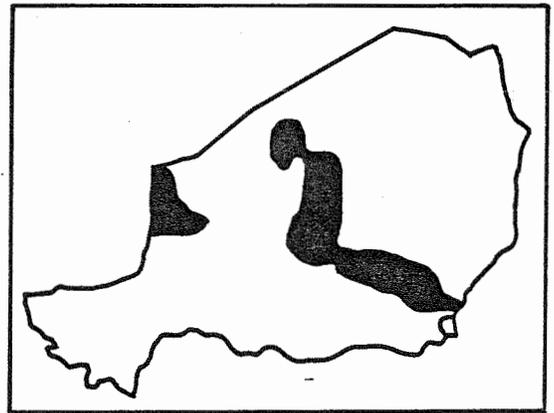
Dorcas Gazelle



Slender-horned Gazelle



Red-fronted Gazelle



Dama Gazelle

FINAL VERSION: Compiled by R. East

CHAPTER 14: BURKINA FASO

A.C. Heringa, U. Belemsobgo, C.A. Spinage and G.W. Frame

INTRODUCTION

Burkina Faso (formerly Upper Volta) is situated within the northern part of the belt of savanna woodland which extends across West Africa. Physically, the country comprises a series of broad, flat plateaux, broken in places by hills and sandstone massifs. The plateaux are dissected by broad river valleys, such as those of the Mouhoun (Volta Noire), Nazinon (Volta Rouge) and Nakambe (Volta Blanche). Altitude ranges from about 200 m to 750 m, with an average of about 300 m. Mean annual rainfall varies from <400 mm in the extreme north to >1000 mm in the southwest. The natural vegetation consists mainly of savanna woodland, with sahelian Acacia deciduous bushland and wooded grassland in the drier northern region (Fig. 1). In the central parts of the country, the vegetation is typical Sudan savanna woodland. In the more humid southern and southwestern regions there are extensive patches of more closely wooded Sudan-Guinea savanna vegetation with abundant Isoberlinia spp., e.g., within depressions.

The population of Burkina Faso is predominantly rural, with about 90% of the people living as small farmers or pastoralists. Bushmeat, including antelopes, is an important source of protein in the less densely populated areas. Population density is highest in the central regions, where agriculture and livestock grazing have greatly modified and even completely eliminated the natural vegetation over vast areas and most wildlife has disappeared. In these regions and in the sahel, recent droughts have aggravated the degradation of natural habitats caused by man's activities. The sahel zone has been affected especially severely by overgrazing, excessive tree-felling, and increasing aridity. This contrasts with some regions in the south of the country, where endemic diseases such as onchocerciasis and trypanosomiasis have discouraged settlement, e.g., in the major river valleys, the southwest and the southeast. These regions are sparsely

settled and retain extensive areas of relatively unmodified natural vegetation which provides important wildlife habitats. Since 1979, surveys conducted with the technical and financial assistance of UNDP/FAO have quantified the country's major wildlife resources and produced management recommendations for conservation areas and wildlife populations (e.g., Bousquet 1982; FAO 1983; Spinage & Souleymane 1984). This has focussed attention on the economic, scientific and cultural value of Burkina Faso's remaining wildlife resources, and the development of a national strategy for wildlife conservation (Service de la Conservation de la Faune 1987).

CURRENT STATUS OF ANTELOPES

Sixteen antelope species have been recorded within Burkina Faso in historical times. The antelopes of the sahel zone (scimitar-horned oryx, korrigum and three species of gazelles) have been affected severely by overhunting, competition for food with domestic livestock, and habitat destruction resulting from overgrazing and excessive tree-felling. Most of these species are now endangered or extinct within Burkina Faso (Table 1). The red-fronted gazelle occurs in parts of the savanna zone as well as in the sahel, while the korrigum survives only in the southeastern savannas. Nine species, viz., bushbuck, red-flanked and grey duikers, bohor reedbuck, waterbuck, kob, roan, hartebeest and oribi, were formerly widespread in suitable habitat within the savanna zone. Apart from the reedbuck, which generally occurs at low densities, and two species of Cephalophus duikers which are restricted to the southwest, savanna antelopes remain locally common in those parts of the southern savannas with sparse human populations. Despite the effects of widespread illegal hunting, increasing aridity, and the encroachment of agriculture, livestock and wood-gathering into game areas, most savanna species are not yet threatened (Table 1). However, the survival of these species will become increasingly insecure if effective protection and management of their populations are not implemented in the near future.

(Table 1 about here)

CONSERVATION MEASURES TAKEN

At present, Burkina Faso has two national parks, four total faunal reserves, and six partial faunal reserves (Fig. 2). In addition, wildlife receives legal protection in several classified forests (only the larger ones are indicated in Fig. 2) and the Nazinga Game Ranch. There is little effective difference in legislative protection between the different

Status: Not threatened.

Conservation Measures Taken: It is common in most of the protected areas, e.g., W National Park (population 800), the Arli complex (4500), Kabore Tambi National Park (about 800), Nazinga Game Ranch (>2000), Deux Bale (700), the southwest census zone (1800), and Dida Classified Forest. Small numbers occur in the Bontioli reserves.

Scimitar-horned Oryx (Oryx dammah)

Distribution & Population: This species formerly occurred in the sahel zone of northern Burkina Faso (de Coutouly 1925). It was believed to have been exterminated by uncontrolled hunting in the 1950s (Roure 1968). A German aid worker (M. Grof, personal communication to A.C. Heringa, March 1989) reported seeing two oryx within close range at Laga Koundiri, a waterpoint in the Burkina Faso-Mali border area within the sahel zone (Fig. 1), in the 1986 wet season.

Status: If this species is in fact not yet extinct in Burkina Faso, it is undoubtedly endangered.

Conservation Measures Proposed: The scimitar-horned oryx is on the brink of extinction in the wild (Newby 1988). Surveys are urgently required of the Burkina Faso-Mali border area where oryx have been reported, to confirm the species' continued presence in this area and investigate possible protective measures.

Western Hartebeest (Alcelaphus buselaphus major)

Distribution & Population: A characteristic species of the savanna woodland zone. It has probably been eliminated from extensive areas of the northern and central parts of its range (Fig. 3), but it remains locally common in the southern savannas. Total population >10 000.

Status: Not threatened.

Conservation Measures Taken: Well represented in most of the protected areas, e.g., W National Park (population 800), the Arli complex (>3500), Kabore Tambi National Park (about 400), Nazinga Game Ranch (800-1000), Deux Bale (180), the southwest census zone (5500), and Dida Classified Forest.

Korrigum (Damaliscus lunatus korrigum)

Distribution & Population: Before the 1920s, this antelope probably occurred throughout the country apart from the southwest (Sayer 1982), but it is now confined to the southeastern savanna woodland zone (Fig. 3). Sayer (1982) has documented its decline throughout West Africa, where it was formerly the most abundant large antelope. The last surviving

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Dorcas Gazelle (Gazella dorcas)

Distribution & Population: Confined to the northern sahel zone (Fig. 3), where it has been recorded in the past (e.g., de Coutouly 1925) and probably still occurs in very small numbers. It appears to be more frequent in adjacent parts of Mali than within Burkina Faso, where it may now be largely confined to the Seno-Mango region.

Status: Endangered. Threatened by poaching, and habitat destruction caused by the activities of man and his livestock.

Conservation Measures Taken: Occurs in the north of the Sahel reserve, within the area of the proposed Seno-Mango Biosphere Reserve.

Conservation Measures Proposed: This species is unlikely to survive in Burkina Faso unless the proposed Seno-Mango Biosphere Reserve is established and effectively protected.

Red-fronted Gazelle (Gazella rufifrons)

Distribution & Population: Occurs in the sahel zone and the northern and eastern savanna woodlands (Fig. 3). Its distribution may extend beyond the limits indicated in Fig. 3. Reports of dama gazelle in the Comoe area in the southwest of the country in the 1970s, for example, almost certainly refer to red-fronted gazelle, but it is now very rare in this area if it occurs at all. It is found mainly in small, scattered remnant populations but is locally common in a few areas, such as the census zones (see Fig. 2) of Sirba (population 500) and Ouest Forage Christine (population 720). Total numbers >1500.

Status: Vulnerable. Not in immediate danger, but its numbers are probably declining because of habitat degradation and overhunting.

Conservation Measures Taken: Well represented in the proposed Seno-Mango Biosphere Reserve within the Sahel reserve. A small population (perhaps 50) occurs in the W National Park. It is not known to occur in any other protected areas, although it has been reported in the past from immediately north of the Arli complex (Green 1979). It has bred successfully in captivity several times at the Nazinga Game Ranch, where a pair were still held in 1988. The red-fronted gazelle is a candidate for release into the wild at Nazinga, where the habitat appears to be suitable.

Dama Gazelle (Gazella dama)

Distribution & Population: Restricted to the sahel zone (Fig. 3). Its numbers have been reduced to very low levels in the sahel of Burkina Faso and Mali. The surviving animals are

observed more often on the Mali side of the border. It has probably been eliminated from most, if not all, of its range in Burkina Faso by overhunting and the expansion of livestock grazing, aggravated by drought. Suitable, relatively unmodified habitat is now restricted to the Seno-Mango area.

Status: Endangered. Threatened by the same factors as the dorcas gazelle. A proposal to re-open a well in the Seno-Mango area would, if implemented, lead to the destruction of the remaining area of habitat available to these gazelles.

Conservation Measures Taken: A few individuals may persist in the Seno-Mango area of the Sahel reserve.

Conservation Measures Proposed: The dama gazelle's survival in Burkina Faso is unlikely without immediate and effective protection of the proposed Seno-Mango Biosphere Reserve.

Oribi (Ourebia ourebi)

Distribution & Population: Found throughout the savanna woodland zone (Fig. 3). It has been eliminated from the more densely settled parts of its range, but it still occurs widely. It is locally common in some regions, including unprotected areas such as the Sirba census zone. It is probably the most numerous antelope species in Burkina Faso; total numbers exceed 40 000.

Status: Not threatened.

Conservation Measures Taken: Probably occurs in all of the conservation areas, apart from the Sahel reserve. It is common to abundant in many of these areas, e.g., W National Park (population 1400), the Arli complex (>7500), Kabore Tambi National Park (about 2500), Nazinga Game Ranch (1500-2000), Deux Bale (about 280), the southwest census zone (16 300), and Dida Classified Forest.

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Table 1. Current Status of Antelopes in Burkina Faso.

<u>Species</u>	<u>Status*</u>	<u>Species</u>	<u>Status</u>
Bushbuck	S	Roan	S
Maxwell's Duiker	I	Scimitar-horned Oryx	En/Ex
Red-flanked Duiker	S	Western Hartebeest	S
Yellow-backed Duiker	R	Korrigum	V
Grey Duiker	S	Dorcas Gazelle	En
Bohor Reedbuck	R	Red-fronted Gazelle	V
Waterbuck	S	Dama Gazelle	En
Buffon's Kob	S	Oribi	S

*Ex = extinct; En = endangered; R = rare; V = vulnerable; I = indeterminate (i.e., endangered, rare, or vulnerable); S = satisfactory (not threatened). See chapter 1 for definition of status categories.

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illegal activities by supplying increased levels of trained manpower, funding and equipment. The proposed Lame-Burra Game Reserve currently receives little or no protection but retains a significant Sudanian savanna antelope community, including the endangered western race of the klipspringer.

3.3.11 Mali: Boucle du Baoule National Park - Kongossambougou Faunal Reserve - Badinko Faunal Reserve - Fina Faunal Reserve
The Boucle du Baoule complex includes savanna woodland, semi-arid bushland, and dense riverine forest. It supports a depleted but internationally significant savanna antelope community. Over the last 10-15 years, illegal hunting, invasion by domestic livestock, and agricultural settlement have caused severe reductions in wildlife densities within the complex. These factors threaten to degrade the ecosystem completely if no management steps are taken. Species such as elephant, giraffe and giant eland have now largely or completely disappeared from the complex. Antelopes such as waterbuck and western hartebeest have been reduced to very low densities, but substantial populations of species such as bushbuck, red-flanked and grey duikers, bohor reedbuck, roan, oribi and warthog persist. The best prospects for the long-term survival of savanna antelopes in Mali lie with upgrading the protection of the Boucle du Baoule complex, in conjunction with the introduction of wildlife management systems which make a significant contribution to improving the living standards of local people. A cooperative research venture between the Mali and Netherlands Governments has produced a management plan for the complex which integrates protected areas with zones for agriculture, grazing of domestic livestock, and wildlife utilisation. Implementation of this plan is an important international priority in antelope conservation.

3.4 Sahel Regional Transition Zone and Sahara Regional Transition Zone

The Sahel zone, which lies mainly within West and Central Africa, has suffered severely from prolonged droughts, overgrazing by large herds of domestic livestock, and increasing desertification. Antelopes have been affected by uncontrolled hunting, competition with domestic livestock, and habitat degradation. Representative antelope communities of the Sahel unit are now largely restricted to a few protected areas. Some of these areas, e.g., the Air and Tenere and Ouadi Rime-Ouadi Achim reserves, extend northwards into the Sahara regional transition zone. Effective protection and management

of these key conservation areas is vital for the survival of saharo-sahelian antelopes.

3.4.1 Chad: Ouadi Rime-Ouadi Achim Faunal Reserve

The vast Ouadi Rime-Ouadi Achim Faunal Reserve (80 000 sq km) in north-central Chad is of outstanding international importance for the conservation of saharo-sahelian wildlife. It extends from wooded steppe in the south through subdesert steppe to desert in the north. Since its establishment in 1969, the reserve has suffered serious threats from illegal hunting and expansion of the range of domestic livestock into dry-season grazing grounds required by wild herbivores. Effective control of hunting allied with good rainfall years allowed the wildlife populations of Ouadi Rime-Ouadi Achim to increase substantially in the 1970s. Antelope populations in the mid-late 1970s included 4-6000 scimitar-horned oryx, about 800 addax, at least several thousand dorcas gazelle, and 6-8000 dama gazelle, with red-fronted gazelle present in the southern part of the reserve. The populations of scimitar-horned oryx and dama gazelle represented large proportions of the total world populations of these two species. Security problems disrupted the region in 1978 and forced the complete abandonment of conservation activities. The reserve was in the centre of a war zone until March 1987, when Libyan-backed rebel forces were driven back to Chad's northern border region. Viable remnants of the reserve's wildlife are believed to survive. There is an urgent need to conduct systematic surveys of Ouadi Rime-Ouadi Achim as soon as circumstances permit, as a first step towards the re-establishment of protection and management of the reserve and its integration with the economic development of the region. This action is a very high international priority in antelope conservation.

3.4.2 Niger: Air and Tenere National Nature Reserve, Termit Massif

Niger's Air and Tenere National Nature Reserve (77 360 sq km, including a 12 806 sq km Strict Nature Reserve specifically for addax conservation) was officially established in January 1988, after several years of developmental work. This vast area contains the granitic massifs of the Air Mountains in the west and part of the Tenere desert in the east. Vegetation is sparse and is concentrated along temporary watercourses. The fauna includes important populations of saharo-sahelian wildlife such as barbery sheep, cheetah, striped hyaena, ostrich, addax (<200), dorcas gazelle (5-6000), and dama

now <50?

N.B. This section on Niger will be expanded to include reference to the internationally important reintroduction programmes proposed for addax in the Air/Tenere reserve, and for saharo-sahelian wildlife species in the Gadabedji reserve.

gazelle (150-250). The slender-horned gazelle also occurs, but the area is slightly too arid for scimitar-horned oryx, which formerly occurred as a vagrant but is now locally extinct. A management plan has been prepared for the Air and Tenere reserve which attempts to strike a balance between the requirements of conservation of the fauna and flora, sustainable utilisation of the reserve's natural resources by the local people, and the development of tourism. International support for the implementation of this management plan is a very high priority in antelope conservation. The Termit Massif is also an important area for arid-zone antelopes, such as scimitar-horned oryx (formerly), addax, dorcas and dama gazelles, but is unprotected at present. Protection of the Termit area against uncontrolled hunting would be of major international significance to antelope conservation.

3.4.3 Mali: Ansongo-Menaka Faunal Reserve

On paper, the Ansongo-Menaka Faunal Reserve includes a large area (17 500 sq km) of sahelian habitats. In practice, the wildlife of this reserve receives little or no protection and it has suffered from illegal hunting and the expansion of pastoralism and settlement. Effective protection and management of the Ansongo-Menaka reserve would be of international significance to antelope conservation, but high land-use pressures throughout the Sahel zone of Mali preclude the establishment of a large, strictly protected conservation area. Effective control of hunting would allow antelopes such as dorcas and red-fronted gazelles to co-exist in small numbers with domestic livestock, but this will be difficult to implement.

3.4.4 Burkina Faso: Seno-Mango Biosphere Reserve

The proposed Seno-Mango Biosphere Reserve within the Sahel Partial Faunal Reserve is the last remaining area of relatively undisturbed sahelian bushland in northern Burkina Faso. The rest of the Sahel reserve is densely settled and has been severely overgrazed by domestic livestock. The proposed Seno-Mango reserve contains an important population of red-fronted gazelle. Dorcas and dama gazelles probably still occur in small numbers. This proposed biosphere reserve should be established and given effective protection as a matter of urgency.

3.5 Afromontane Archipelago-like Regional Centre of Endemism

Montane habitats are very restricted within West and Central

From Draft Summary of Regional Status in part 3 of
Antelope Survey and Action Plan

Table 2. Current Regional Status of Antelope Species in West and Central Africa (see chapter 2 for scientific names and determinators).

Species	Import- ance of Region	No. Coun- tries	Total Regional Popn. (3)	Popns. in Cons. Areas (4)	Status (5)
	(1)	(2)			
Bushbuck	W	22	widespread, common	A	<u>S</u>
Sitatunga	W	15 to 17	localised, common	A	<u>S</u>
Greater Kudu	M	3	localised, few	B	<u>En</u>
Common Eland	M	1	localised, few	B	<u>En</u>
Giant Eland	W	4 to 8	< or = 15 000	B	<u>T</u>
Bongo	W	12	widespread, mod.nos.	A	<u>S</u>
Maxwell's Duiker	C	12	widespread, common	A	<u>S</u>
Blue Duiker	W	7	widespread, common	A	<u>S</u>
Peters' Duiker	C	6	localised, common	A	<u>S</u>
Weyns' Duiker	W	1	localised, common	A	<u>S</u>
Black-fronted Duiker	W	6	localised, common	A	<u>S</u>
Red-flanked Duiker	W	18	widespread, common	A	<u>S</u>
Bay Duiker	C	13 or 14	widespread, common	A	<u>S</u>
White-bellied Duiker	C	6	localised, common	A	<u>S</u>
Ogilby's Duiker	C	8	localised, mod.nos.	B	<u>T</u>
Zebra Duiker	C	3	localised, mod.nos.	B	<u>T</u>

Table 2 (continued)

<u>Species</u>	Import- ance of Region (1)	No. of Coun- tries (2)	Total Regional Popn.(3)	Popns. in Cons. Areas (4)	Status (5)
Black Duiker	C	7 or 8	widespread, mod.nos.	A	<u>S</u>
Yellow-backed Duiker	W	18	widespread, mod.nos.	A	<u>S</u>
Jentink's Duiker	C	2 or 3	localised, few	B	<u>En</u>
Grey Duiker	W	17 or 18	widespread, common	A	<u>S</u>
Southern Reedbuck	W	1 to 3	localised, mod.nos.	A	<u>R</u>
Bohor Reedbuck	W	18	> 25 000	A	<u>S</u>
Mountain Reedbuck	M	2 or 3	localised, few	B	<u>En</u>
Waterbuck	W	18	> 30 000	A	<u>S</u>
Kob	W	16 or 17	> 240 000	A	<u>S</u>
Puku	M	1	localised, mod.nos.	B	<u>T</u>
Lechwe	M	1	localised, few	B	<u>En</u>
Roan	W	17 or 18	> 70 000	A	<u>S</u>
Sable	M	1	localised, few	B	<u>En</u>
Scimitar- horned Oryx	C	1 or 2	localised, few	B	<u>En</u>
Addax	C	4	localised, few	B	<u>En</u>

Table 2 (continued)

Species	Import- ance of Region	No. Coun- tries	Total Regional Popn.(3)	Popns.	Status
				in Cons. Areas (4)	
(1)	(2)	(3)	(4)	(5)	
Common Hartebeest	W	14 to 16	> 170 000	A	<u>S</u>
Lichtenstein's Hartebeest	M	1	localised, few	B	<u>En</u>
Korrigum/ Tiang/Topi	W	8	> 12 000	A	<u>S</u>
Impala	M	1	localised, few	B	<u>En</u>
Dorcas Gazelle	W	6 or 7	> 10 000	A	<u>S</u>
Slender-horned Gazelle	W	3 or 4	localised, few	B	<u>En</u>
Red-fronted Gazelle	W	10 to 13	widespread, mod.nos.	B	<u>T</u>
Dama Gazelle	C	5 or 6	< 10 000	B	<u>T</u>
Bates' Pigmy Antelope	C	6 or 7	widespread, mod.nos.	A	<u>S</u>
Royal Antelope	C	5 or 6	widespread, mod.nos.	A	<u>S</u>
Sharpe's Grysbok	M	1	localised, few	B	<u>En</u>
Oribi	W	17	> 100 000	A	<u>S</u>
Klipspringer	M	3	localised, mod.nos.	A	<u>R</u>

(1) C = largely/entirely confined to the region; W = occurs widely outside the region, but region contains internationally significant populations; M = occurs marginally in the region.

Table 2 (continued)

(2) No. countries within the region in which the species currently occurs.

(3) Extrapolated from population estimates obtained by aerial and/or ground censuses over substantial areas of the species' range in West and Central Africa (see individual country reports; estimates of total regional populations are conservative). For species whose numbers are unknown, qualitative assessments of distribution and abundance are given (see Table 1, footnote 2).

(4) See Table 1, footnote 3.

(5) Ex = extinct; En = endangered; R = rare; T = threatened; S = satisfactory/not threatened, as defined in Table 1.

Table 4. Threatened, Rare and Endangered Antelopes in West and Central Africa. Asterisks denote antelopes classed as regionally endangered or which may become endangered in the near future.

<u>Species/ Subspecies</u>	<u>Habitat</u>	<u>Major Areas of Present Occurrence within Region (important cons. areas in parentheses) (1)</u>
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Species Largely/Entirely Confined to the Region:

Ogilby's Duiker	Moist forest	Sierra Leone (Outamba-Kilimi NP), Liberia (Sapo NP, Krahn-Bassa NF), Ivory Coast (Tai NP), Ghana (Bomfobiri WS, Owabi WS), Nigeria (Okwangwo-Boshi FoRs, A & B FoR), Cameroon (Korup NP), Equatorial Guinea (proposed reserves on Bioko Island), western Gabon
*Zebra Duiker	Moist forest	Sierra Leone (Gola FoRs), Liberia (Sapo NP, Gola NF, Krahn-Bassa NF, Grebo NF), Ivory Coast (Tai NP)
*Jentink's Duiker	Moist forest	Liberia (Sapo NP, Krahn-Bassa NF), Ivory Coast (Tai NP)
*Scimitar-horned Oryx	Subdesert	north-central Chad (Ouadi Rime-Ouadi Achim FR)
*Addax	Desert	northern Niger (Air & Tenere National NR), northern Chad (Ouadi Rime-Ouadi Achim FR)
*Dama Gazelle	Subdesert	northern & central Niger (Air & Tenere National NR), north-central Chad (Ouadi Rime-Ouadi Achim FR)

Subspecies Confined to the Region:

Western Giant Eland	Savanna woodland	Senegal (Niokolo-Koba NP)
*Western Mountain Reedbuck	Montane grassland	Nigeria (Gashaka FoR), Cameroon

CBSG ARIDLAND ANTELOPE WORKSHOP

San Antonio, Texas, U.S.A.
13-15 September, 1989

ARABIAN ORYX

1 February 1990

ARABIAN ORYX PLAN

Introduction

The Arabian oryx disappeared from the wild sometime between 1972 and 1979; opinions vary. The future of the species depended upon captive propagation. A great deal of cooperation was necessary to ensure the success of the program. This included the professional and financial input of many individuals and organizations in the Middle East, Europe and North America. The goal of the captive effort was the ultimate re-introduction of the species back into its ancestral home in the Middle East.

Objectives of Program

1. Survival of the species, initially ensured by rescue of remnants from the wild and development of a captive population managed so as to provide the best genetic base of animals from which to repopulate or reinforce the wild.
2. Recovery of the species by re-introductions of animals to the wild and the development of a viable population or metapopulation (with a total number of at least 5000 distributed over subpopulations of at least 200 animals).

Summary of Re-introductions Projects

As a result of the breeding success of this antelope in captivity, the first reintroduction was possible in 1978 when 4 males were sent to Jordan from the World Herd. These were followed by 4 females from the same source in 1979. Additionally, animals were received from the Royal Herd in Qatar. At present, this herd consists of approximately 100 animals. Unfortunately, a large number of animals from the Qatari bloodline have been shipped from Jordan to other sites - Oman, Saudi Arabia, and Iraq. An agreement has now been reached between the Royal Society for the Conservation of Nature and the Studbook Keeper that no additional animals of this bloodline will be exported from Jordan. Additionally, it has also been agreed that the North American breeders will provide animals to the Jordanian herd in order to balance out the founder representation.

Shortly after the Jordanian shipment in 1978, Israel received 4 pairs from the Los Angeles Zoo. In addition, 3 males were received at Hai Bar from the World Herd in 1980. This group of animals now numbers approximately 60. Unfortunately, the Israeli animals have remained outside the mainstream of oryx breeding.

Of the utmost importance has been the re-introduction project undertaken in the Sultanate of Oman through the efforts of His Highness Sultan Qaboos. The first oryx from North America arrived in 1980. This group consisted of 4 males and 5 females. Since that time, an additional 20 animals (10 males and 10 females) have also be shipped from North America. In 1987 the Royal Society for the Conservation of Nature in Jordan presented 3 males and 3 females to the Omani Project. This shipment brought Qatari blood into the Omani herd. One of the females was retained in the Sultan's private collection at Muscat where she was joined by a male from Bahrain. The free-ranging herd at Yalooni consists of between 74 and 80 animals.

A further development has been the reintroduction program now under way in the Kingdom of Saudi Arabia. A re-introduction site was chosen at Mahazat al Sayd, 150 km east of Taif. On 30 November 1988, 5 males and 4 females were received from the

North American herd. These were then followed by 3 males and 3 females from Jordan on 20 March 1989. These animals introduced Qatari blood into the Saudi herd. This entire group of 16 (10 males; 6 females) animals is scheduled to be released in October 1989. An additional group of 3 males and 3 females will be shipped from North America in November 1989. Negotiations are in progress for additional animals direct from Qatar. The Reserve at Mahazat is entirely fenced and consists of a gravel plain of 265,000 hectares.

Status of Captive Populations

Based on information received as of 31 December 1988, the captive population is as follows:

538 - 269.269 of registered parentage
 350 - of unknown parentage principally in the Middle East
 Births in 1988: 120 = 62.58
 Deaths in 1988: 41=25.16

During 1988 the following herds were established in North America: Baton Rouge, Dallas, St. Louis, Cincinnati, Salt Lake City, Alberta, Ron Surrat and a male to Sacramento. The following herds were either established abroad or supplemented: Pretoria (new), Jakarta (supplemented), Saudi Arabia (supplemented), Oman (supplemented) and Yokohama.

In 1989 additional animals will go to Oman, Saudi Arabia, Jordan, Abu Dhabi and Dubai. A new herd will be established at Dvur Kralove, Czechoslovakia.

At least 10 other facilities are available in North American zoos for the expansion of the population and the ranches are still an untapped resource. Australia represents a further area for the expansion of the captive population.

Of importance is the potential acquisition of 2 males from Al Ain, Abu Dhabi. One will be left in Europe for use by the Arabian Oryx EEP and one will be brought to North America. This is only a first step as the number of founders needs to be increased. Other attempts are also being made to acquire at least 5.5 from Qatar, 4.4 from Bahrain, and an additional 4.4 from Abu Dhabi. Health restrictions for their importation are rather complicated but recent events seem to indicate that it is not insurmountable. Animals from North America should be provided to Qatar as that herd has had no new blood added since 1965 and animals should also be made available to the Al Ain Herd

Recommendations

1. Founder recruitment: It is to the benefit of the global population that exchange of founder material between all regions so that each region has a full representation of each. Need to be explicit. There are 8 or 9 founders represented in Middle East that are not represented in North America or Europe. The 3 most important in the Middle East are: 2 separate collections in Abu Dhabi (one Al Ain and a private collection) and Doha. Outside is male at Rabat from Al Ain. Also possibility of the female in Saudi.
2. Metapopulation strategy for reintroduced populations: Oman may need some more animals for genetic adjustment but probably not for

demographic enhancement. (See suggestions: After population at 50-60, no further introductions for demographic reasons.) Review of Saudi scenarios. Possible establishment of second Jordanian population. Exchange of animals between reintroduced populations.

3. Assessment of demographic impact on captive population of removal of animals for reintroduction.
4. Preparation of animals for release.
5. Summary of molecular genetic studies and needs.
6. Reproductive Technologies:
Artificial insemination with frozen semen should be given serious consideration for transmission of founder animal genetic influence from one population to another. Although additional research is needed, data available from scimitar-horned oryx and addax are likely to be applicable to the Arabian oryx with little or no modification. When the founder animal of interest is a female, embryo transfer technologies should also be considered. Here again, more research is required. However, the fact that embryo transfer procedures can be performed with only temporary removal of the valuable female from the conventional breeding program, with much less risk than by transport and introduction, makes such efforts worthy of serious consideration.
An additional advantage of these reproductive technologies is the reduction of risk of disease transmission while moving genetic material between locations. In some cases, it may be possible to move gametes or embryos across borders where animal movements are prohibitive.
7. Veterinary Considerations
Veterinary considerations are of great importance when considering an introduction or re-introduction of desert antelopes, and these should comprise one of the vital pre-translocation planning phases of any reintroduction operation. In fact, possible veterinary complications should be taken into account during the search for a suitable release site.

The veterinary hazards are predominantly twofold:

- 1) it must be ensured that the founder animals, which perforce, will probably originate in the U.S., do not suffer from any inapparent infection which will present a disease risk to wild or domestic stock in the reception area.
- 2) since the founders will probably have been raised in relative isolation and may lack immunity to endemic diseases present in the reception area, an appraisal of these risks must be made prior to release so that appropriate protection (usually vaccinations) can be assured.

Failure to take account of either of these disease hazards has resulted in unexpected and expensive failures of reintroduction projects in the past and could bring a very useful conservation technique into disrepute.

Subsequent to reintroduction, a program of health and disease monitoring should be implemented at the release site. To be effective

this program should include a training component for a local national veterinarian.

8. Reproductive Research

Additional research and development is needed for adapting gamete and embryo cryopreservation, artificial insemination, embryo transfer and related technologies for application to the Arabian oryx. These technologies will be important for translocation of genetic representation from founder animals between locations, enhancing genetic representation of under-represented breeding stock, and propagation of animals in small populations of SSP animals where genetically "surplus" animals are available. These technologies have been proven to be biologically feasible in this species, and although improvements in efficiency are needed, their cost/benefit ratios may be favorable at the present time under certain specific circumstances. Likewise, birth control measures, such as vasa-deferens plugging and tubal ligation should be considered for obtaining appropriate genetic balance within populations where carrying capacity is limited and breeding dynamics are enhanced by the presence of peripheral males or females.

9. Behavioral Research

Because very little work was done with this species in the wild prior to its rapid decline, little or no behavioral data were ever collected. In an effort to help us understand better the needs of these animals prior to release and to aid us in making the releases as smooth as possible, it is recommended that we complete a thorough study in as normal conditions as can be obtained.

Aridland Antelope Meeting, 13-15 September

September 19, 1989

ARABIAN ORYX - AUGUST, 1989

NEW HERDS IN NORTH AMERICA

Baton Rouge	1.2
Dallas	2.4
St. Louis	1.3
Cincinnati	1.2
Salt Lake	1.2
Ron Surratt	1.1
Alberta	1.1
Sacramento	now has breeding male

NEW HERDS - OTHER 1988

Pretoria	2.2
Jakarta	1.1 from Phoenix
Saudi	Mahazet Assed, 5.4 + 4.4 from Jordan
Oman	another 3.3 in 1-89
Yokomana	1.2

PLANNING FOR FUTURE

Oman	3.3
Saudi	3.3
Qatar	4.0
Jordan	2.0
Czechoslovakia	2.2
Abu Dhabe	2.0
Dubal	1.2
Herds in U. S. -30	=295 animals (73 IAE, 19 TASAJILLO)
Herds in Europe -11	= 51 animals
Herds in Asia - 2	= 7 animals
Herds in Middle East -4	=170 animals
Herds - other (Pretoria - 5, Rabat - 10)	= 15 animals
Total in studbook	269.269 =538
Births in 1988	62.58 =120
Deaths in 1988	25.16 = 41
Total app. in registry	350
Total having animals 31 December 1988	app. 900

INTRODUCTION

The Arabian oryx Oryx leucoryx was first described by the Russian naturalist Pallas in 1777, although he provided little information other than it occurred in Arabia and possibly Libya. The latter, of course, was erroneous. However, as far as the written word is concerned, the oryx has been known for thousands of years and in Deuteronomy 33:17 a reference to the Arabian oryx is masked under the name unicorn: 'His glory is like the firstling of his bullock and his horns are like the horns of unicorns: with them we shall push the people together to the ends of the earth.' Of more contemporary date, is its description by the English naturalist Pennant in History of Quadrupeds (1781) based on drawings, now in the British Museum, made in 1712 from living specimens belonging to the Shah of Persia and kept in a park outside the city of Esfahan. Pennant called the animal Leucoryx and it is unfortunate that a great deal of confusion developed over the use of the name which somehow became applied to the Scimitar-horned oryx Oryx dammah, so that in the vernacular the latter was called the 'Leucoryx' in older literature and Pallas' scientific name was likewise transferred to the oryx of the Sahara.

In 1857, a living specimen of the Arabian oryx arrived, oddly enough via Bombay, at the Zoological Gardens in London. It was initially believed to be an immature South African oryx or gemsbok Oryx g. gazella, but later, J. E. Gray of the British Museum recognized it as a species unknown to him. Gray apparently did not suspect the animal was the Leucoryx of Pallas and Pennant and as a result proposed the name Oryx beatrix in honour of HRH Princess Beatrix.

The antelope seems to have ranged originally throughout most of the Near East, i.e., the Arabian Peninsula north to the Syrian Desert and Mesopotamia. About 1880 it was still to be found in virtually all of the Arabian peninsula, the Sinai, Lower Palestine, Transjordan and much of Iraq. In older literature reference is also found to its occurrence in Persia but there is some doubt as to where older authors drew the boundary between Persia and Arabia. Talbot (1960) indicated that only a single reference (Murray, 1866) suggested that the oryx ever ranged east of the Euphrates and as a result he eliminated Persia from the distribution.

Towards the middle of the 19th century, the oryx began to disappear from the northern portions of its range. In 1864, the last known refuge in the north of Arabia was at Tubaiq. By 1914, the situation was already grave and few seem to have survived outside Saudi Arabia. With the occupation of Arabia by Turkey, the increase of human activity in the desert and the availability of modern firearms as a result of the First World War, most of the remaining oryx in the northern population were destroyed.

Among the Arabic people it is believed that by eating the meat of an oryx a bullet can be expelled from the body and it is a sign of manhood to kill an oryx - an animal of great strength and endurance. Furthermore, great value is placed on the hide and other portions of the body are used for medicinal purposes. Nevertheless, Arabic culture did little to endanger the oryx in prevehicular days when hunting with spears or long rifles was done from horse or camel back. It was the advent of the automobile and automatic weapons that sounded the death

knell for the oryx.

In 1935, Carruthers in an interesting resume of its history, reported that the Arabian oryx was divided into two populations which kept to their respective sandy refuges, approximately 1100 km apart: the Northern Nafud and the southern wilderness of the Rub al Khali. While these two groups had formerly linked up along the Dahna sand belts, it was extremely doubtful whether any still existed there or indeed in any of the other sand belts in middle Arabia. Carruthers concluded that the southern wilderness of sand from Najran to Oman was the oryx's main and probably last stronghold.

These remaining populations were doomed by the late 1930's when the developing oil industry brought increased wealth to the Arabian princes and many foreign workers into the country. A few animals seem to have survived in Jordan until about 1930 but they were rapidly exterminated. In the early 1950s, the pressure had increased to the point where as many as 300 vehicles were used in a single hunting foray. Obviously, it was only a matter of time before the Nafud population was totally eliminated and the last tracks were seen in the area in 1954. The oryx was then confined to the extreme south of the Rub al Khali. By 1960, Talbot considered that perhaps 100 to 200 animals were all that remained and saw little hope for the continued survival of the species as the remaining animals were under considerable hunting pressure. His fears were well-founded and although under legal protection, enforcement was extremely difficult. The IUCN Red Data Book entry of 1972 gives the range as Oman in a quadrilateral c. 400x160km. There were also occasional reports of individuals or small herds outside this area, principally in the Duru and Wahiba country to the east of the Rub al Khali but this dates from 1962/3. Whereas the Red Data Book gave a glimmer of hope for the continued existence of a small population in the wild, a report by Henderson (1974) of a photographic safari to Oman in October 1972 shatters it. Over a period of several days, he and his companions traced some six to seven animals in the area but later found evidence that at least this number had been killed or captured. Despite an extensive search, they found no further trace and concluded that '...the oryx killed and captured could well have been the last wild Arabian oryx. Even if a handful remain what we found undoubtedly ranks as a major wildlife disaster.'

As a result of the Talbot report (1960), the Fauna Preservation Society in co-operation with the Survival Service Commission of IUCN initiated a plan for the capture of Arabian oryx to place them in a suitable captive environment. In 1962 an expedition to Aden captured two males and a female in the desert near San'a. In co-operation with the World Wildlife Fund, the Shikar-Safari Club, the Arizona Zoological Society and the Zoological Society of London, these animals were quarantined in Kenya and then in Europe from where they were shipped to the Phoenix Zoological Garden. An excellent documentation of what has come to be known as 'Operation Oryx' can be found in Shepherd (1966). Transport and the construction of the breeding compound in Phoenix was underwritten by the Shikar-Safari Club of Los Angeles, whose then president, Maurice Machris, has made the preservation of the Arabian oryx a personal crusade. The 'World Herd' breeding nucleus at Phoenix was made up of the three wild-caught animals, a female from the London

Zoo, a female acquired in September 1963 from sheikh Jabir Abdulla Al-Sabah, ruler of Kuwait, and two pairs presented by the ruler of Saudi Arabia.

Some excellent contemporary work has been published on the captive management, reproduction and behaviour of the Arabian oryx (Thorp, 1964; Turkowski and Mohny, 1971) but information on captive and reproductive history prior to 1963 is sketchy. Captive breeding can be established only for Dresden (I), Paris (I), Cairo (2), Washington (I), Bronx (4 or 5) and Philadelphia (3). Although it is probably safe to assume that other captive births which can no longer be verified have taken place, the number would still remain unimpressively low. Hybridisation between Oryx leucoryx has occurred on several occasions. At Bristol Zoo, the female received in 1932 produced a hybrid calf by casearian section in 1936 sired by a Scimitar-horned oryx. The female hybrid was mated to her sire and produced a calf in 1939 which died before reaching maturity. In the private collection of Sheikh Jabir Abdullah Al-Sabah, ruler of Kuwait, a female Arabian oryx mated with a Beisa oryx Oryx gazella beisa produced a healthy male hybrid and hybrids are known to have been kept in the collection at Cairo Zoo.

In addition, hybrids between Arabian and Scimitar-horned oryx have been bred at the King Khalid Farm, Thumama, Saudi Arabia. A single female is still living at Thumama but is slated for euthanasia.

In a previous paper (Dolan, 1976), I attempted to document the captive history of this animal prior to the establishment of the "World Herd," however, I could only find records for 13 births between 1848 and 1946. In addition, the prewar longevities for captive oryx were poor, averaging about five years. One could easily get the wrong impression from this historical data were it not for the impressive record achieved in modern oryx management. The Arabian oryx studbook, established by the Flora and Fauna Preservation Society was transferred to me in 1976. The document shows the remarkable progress of this animal over a period extending from October 29, 1963, when the first calf, a male, was born in the "World Herd," until December 31, 1985 when the last studbook was published.

In 1976 a second group of oryx, which were not part of the "World Herd," was established at the Los Angeles Zoo from direct imports from Saudi Arabia. This group, which produced its first calf in 1968, has also been extremely successful.

All oryx presently living in North American and European collections are the descendents of 10 founder animals. One of these founders cannot be accurately identified. He is the sire of a calf born in the Naples quarantine, which eventually arrived at the Los Angeles Zoo. In addition, animals of the North American breeding have been sent to Oman, Israel, Morocco, Jordan, Taiwan and Saudi Arabia.

Between 1963 and 1972, all oryx breeding in North America was concentrated in Los Angeles and Phoenix. On November 15, 1972, four males and two females were transferred to the San Diego Wild Animal Park. These were followed by four males and four females on October 21, 1976. The first birth at the San Diego Wild Animal Park occurred

on June 2, 1973. The mother of this animal arrived pregnant from the Phoenix Zoo, where she had been bred to one of the wild caught males from Aden. From 1973 until December 31, 1985, 145 oryx were born at the San Diego Wild Animal Park. From 1963 until the end of 1985, 163 animals were born in Phoenix, and from 1968 until the conclusion of 1985, 91 oryx were produced at the Los Angeles Zoo. The rapid increase in numbers at the San Diego Wild Animal Park can be explained by virtue of the fact that due to available space, it has been possible to maintain a larger number of breeding females than is possible for most institutions. In the early days at Phoenix, term females were removed from the herd just before parturition and were not returned to the males for some time. As a result, there was a fairly extended period between births for individual females. It is understandable that at the onset of the oryx project, when there were so few animals, every precaution was taken to ensure the survival of the calves. This management method was abandoned, as it was unnecessary after a few years; this resulted in a more rapid increase in the Phoenix population.

On November 1, 1976, a trio of oryx was sent from the Phoenix Zoo to the Gladys Porter Zoo in Brownsville, Texas. His group has produced 32 calves up until the end of December, 1985. In addition, groups have been established in the United States at Chicago; Knoxville, Tennessee; St. Catherine's Island, Georgia; Holiday Island, Arkansas; Tasajillo Ranch, Texas; Sacramento, California; San Diego Zoo, California; Palm Desert, California; Atascadero, California; Bronx Zoo, New York; Oklahoma City; and San Antonio, Texas.

The first oryx were sent from the United States to Europe in 1979, to the collections at Berlin, German Democratic Republic; Zurich, Switzerland and Rotterdam, Holland. Unfortunately, the experience in Europe has only been marginal. The Rotterdam group is now extinct; in Berlin a very high percentage of male calves have been born, one of which was sent to Hanover in the Federal Republic of Germany. At Zurich, 21 calves have been born, eight of which were females. Two of these females were sent to Hanover, where they have begun breeding with the Berlin male. Both the Zurich and Berlin groups have been supplemented with females from the San Diego Wild Animal Park.

A most unfortunate experience occurred in England. Two females which London received from the continent, one born in Berlin, the other in Rotterdam, did not survive.

At present there are four males and one female from Zurich in England, but it is hoped that two additional females born in Hanover will be sent to London in the near future. There is no doubt that a very close watch must be maintained on the European animals. On February 4 of this year, three young female oryx were sent to Berlin from the San Diego Wild Animal Park to help bolster the European population. This population needs very close monitoring.

Of extreme importance was the shipment of four males, born at the San Diego Wild Animal Park, to the Shaumari Reserve, Jordan on March 17, 1978. These were the first captive bred oryx to be returned to the Middle East. The four males were followed by four females on August 24, 1979. Three of the females were born at the Phoenix Zoo and one at

the San Diego Wild Animal Park. To this group were added additional animals from private herds on the Arabian Peninsula. The Shaumari herd was so successful that in October, 1983, the entire group, consisting of 31 individuals was released by HM King Hussein, into a fenced and protected area of 22 sq. km. Although it may not be possible to release oryx into the open desert in Jordan, the Shaumari oryx are, for all intense purposes, living under natural conditions. The history of the Oman project will be fully covered in a book by Mark Stanley Price, who has overseen the release of the oryx into the desert at Jiddat al Harassis. This project was begun with eight male and nine female oryx sent from the San Diego Wild Animal Park.

In 1980, the "World Herd" was disbanded. All Arabian oryx became the property of the institutions holding them.

A most recent and extremely exciting undertaking has been the establishment of the National Wildlife Research Center at Taif, Saudi Arabia, under the direction of Dr. Abuzinada, Secretary General of the National Commission for Wildlife Conservation and Development.

In 1982, 35 Arabian oryx were exported from the United States to the Middle East. Once the animals left North America, it was virtually impossible to trace them. At the time it was believed that the entire group was purchased for His late Majesty King Khalid and taken to his farm at Thumama. It is now known that one male and five females were sold to Abu Dhabi and that the remaining 17 males and 12 females went to Saudi Arabia. Whether all of the animals found their way to Thumama still remains an unanswered question. In 1978 one pair of oryx had also reached Thumama from Bharain. I have no knowledge of what existed at Thumama prior to 1978. Under the circumstances, we would have to assume that the known Saudi oryx are closely related to those of North America.

After the death of His Majesty, Thumama fell into disuse, although the collection remained. It was, therefore, decided that the major portion of the oryx herd would be moved to the new facility at Taif. This was undertaken in April of 1986. A documentation of the procedure can be found in the reports issued by the Taif Center. On April 29, 57 oryx were relocated to Taif, five of which subsequently died. These deaths can be attributed to the manner in which the animals were moved. Subsequently, tuberculosis was discovered in the herd and there were additional losses. To date the situation in Taif has been brought under control and the future of this herd looks very promising.

At Thumama, a clean up operation has been put in full swing to provide for better care and management of the remaining oryx and other species. This project has been given the full support of His Royal Highness Prince Saud Al Faisal. It is hoped that a second breeding center can be established at Thumama for the Arabian oryx and the native Saudi gazelles. Should this come to pass, it would be desirable to add animals from the various herds already established in the Middle East. The amount of interest and dedication that has been shown by all of the individuals involved in this project, both native Saudis and foreigners, speak for a very bright future for the Arabian oryx in the kingdom from which it received its name.

As studbook keeper, I am very pleased with the turn of events in Saudi Arabia. This will now enable me to enter the oryx kept at Taif and Thumama. Some years back, I included in the main studbook, all animals about which I had received any information. This very rapidly became a problem, as the animals all received studbook numbers, but the year after their entry, no further information was received. Most of the problem animals were to be found in private hands in the Middle East and the information had come to me via a second party. This then resulted in unnatural fluctuations in the number of oryx appearing in the studbook from year to year. In order to prevent this from happening in the future, a full studbook will only be maintained for those animals for which there is parental data and a separate registry will be maintained for all other oryx, listing their location and numbers. An example of the latter is the large herd owned by the Ministry of Agriculture in Qatar and the oryx kept in Israel. The latest studbook, for the year 1986, has this registry as an addenda. It is certainly inaccurate, as many of the animals are probably long since dead. I will do my very best to clean this up in the 1987 edition. As of December 31, 1985, a total of 297 males, 286 females and one unsexed animal were listed, but of these only 176 males and 155 females are in the main body of the studbook. The figures for Saudi Arabia are incorrect in the registry, but I will be able to provide the correct numbers in 1987.

**ARABIAN ORYX
NORTH AMERICAN POPULATION
FOUNDER ALLELE REPRESENTATION**

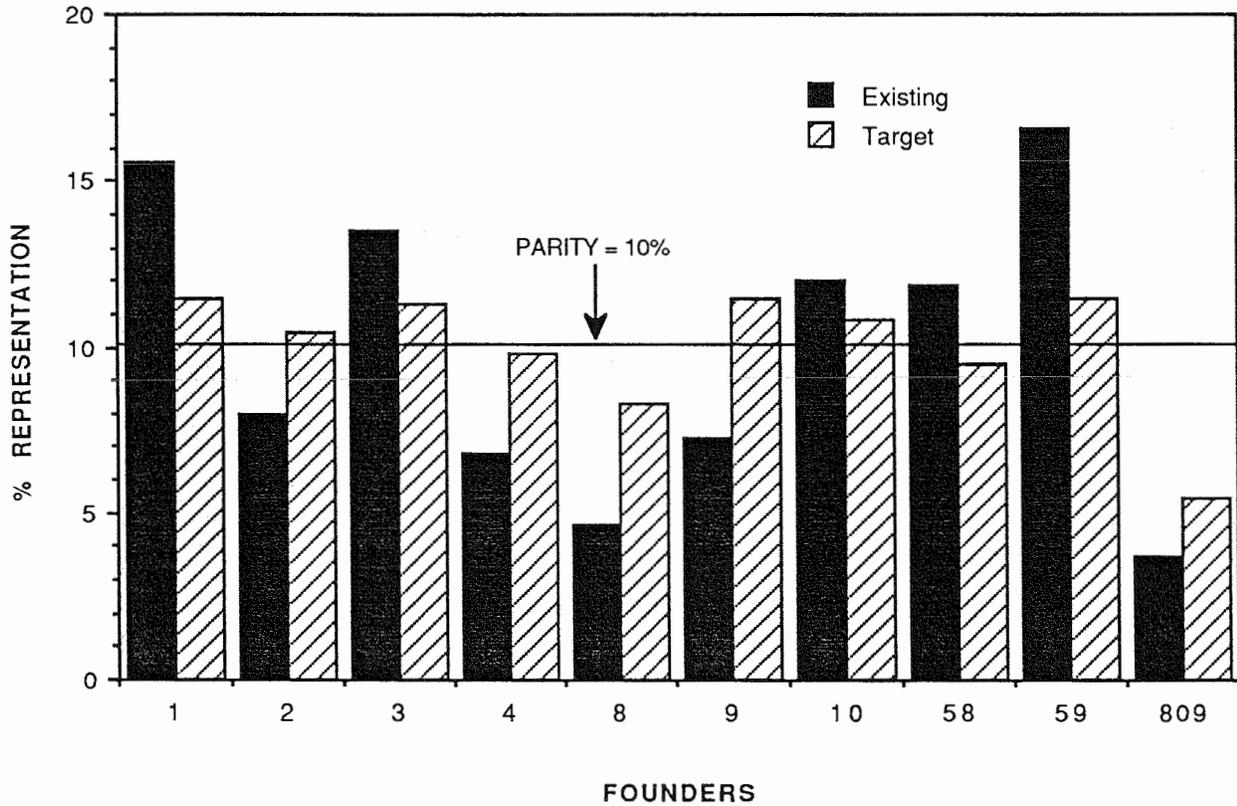
09 September 1989

FOUNDER	RETENTION	PERCENT REPRESENTATION	TARGET REPRESENTATION	DIFFERENCE
1F	0.999	15.541	11.479	-4.062
2M	0.910	8.005	10.462	2.457
3M	0.985	13.499	11.318	-2.181
4F	0.853	6.836	9.806	2.970
8F	0.720	4.660	8.277	3.617
9FL	0.936	7.284	11.496	4.212
10M	0.939	12.002	10.795	-1.207
58F	0.822	11.896	9.450	-2.446
59M	0.997	16.599	11.456	-5.143
809M	0.475	3.677	5.461	1.783

GENETIC SUMMARY

	LIVING DESCENDANT POPULATION	POTENTIAL POPULATION
Number of founders:	10	10
Parity (%):	10.000	10.000
Mean retention:	0.863	0.870
Founder Genomes Surviving:	8.634	8.698
Founder Equivalents:	8.446	9.680
Founder Genome Equivalents:	7.877	8.698
Fraction of wild heterozygosity retained:	0.911	0.943
Fraction of wild heterozygosity lost:	0.089	0.057
Mean inbreeding coefficient realized:	0.087	

NORTH AMERICAN ARABIAN ORYX POPULATION FOUNDER REPRESENTATION



**ARABIAN ORYX
POPULATION OUTSIDE OF NORTH AMERICA
FOUNDER ALLELE REPRESENTATION**

09 September 1989

FOUNDER	% REPRESENTATION	TARGET REPRESENTATION	DIFFERENCE
1F	25.735	5.810	-19.925
2M	5.468	5.717	0.250
3M	11.525	5.793	-5.732
4F	5.145	5.584	0.439
8F	5.810	4.361	-1.449
9FL	3.302	5.810	2.508
10M	10.490	5.665	-4.825
58F	6.141	5.389	-0.752
59M	8.601	5.810	-2.791
140ML	2.098	5.810	3.712
141FL	1.786	5.810	4.024
189FL	1.086	5.810	4.724
190F	0.283	2.240	1.956
327ML	5.884	5.810	-0.074
328F	3.059	5.738	2.679
339F	0.630	4.314	3.684
383FL	0.649	5.810	5.162
384FL	0.713	5.810	5.097
809M	1.594	2.905	1.311

GENETIC SUMMARY

LIVING DESCENDANT POPULATION POTENTIAL

Number of founders:	19	19
Parity (%):	5.263	5.263
Mean retention:	0.893	0.906
Founder Genomes Surviving:	16.964	17.210
Founder Equivalentents:	8.514	18.301
Founder Genome Equivalentents:	8.353	17.211
Fraction of wild heterozygosity retained:	0.930	0.971
Fraction of wild heterozygosity lost:	0.070	0.029
Mean inbreeding coefficient realized:	0.095	

**ARABIAN ORYX
EUROPEAN POPULATION**

FOUNDER ALLELE REPRESENTATION

09 September 1989

FOUNDER	RETENTION	PERCENT REPRESENTATION	TARGET REPRESENTATION	DIFFERENCE
1F	0.957	22.345	14.013	-8.333
2M	0.852	11.603	12.468	0.865
3M	0.920	21.223	13.478	-7.744
4F	0.628	3.603	9.195	5.592
8F	0.635	8.516	9.298	0.782
9F	0.505	2.174	7.394	5.221
10M	0.895	16.972	13.105	-3.867
58F	0.506	4.792	7.409	2.617
59M	0.671	6.623	9.832	3.210
809M	0.260	2.149	3.807	1.658

GENETIC SUMMARY

	LIVING DESCENDANT POPULATION	POTENTIAL POPULATION
Number of founders:	10	10
Parity (%):	10.000	10.000
Mean retention:	0.683	0.683
Founder Genomes Surviving:	6.829	6.829
Founder Equivalentents:	6.519	9.116
Founder Genome Equivalentents:	5.670	6.829
Fraction of wild heterozygosity retained:	0.877	0.927
Fraction of wild heterozygosity lost:	0.123	0.073
Mean inbreeding coefficient realized:	0.095	

ARABIAN ORYX

FOUNDERS NOT REPRESENTED IN
NORTH AMERICA OR EUROPE

STUDBOOK	SIRE	DAM	CURRENT LOCATION	BIRTHDATE
140	WILD	WILD	AL AREEN	EST. 1972
141	WILD	WILD	SAUDI ARABIA	EST. 1972
189	WILD	WILD	BAGDAD	EST. 1975
190	WILD	WILD	SHAUMARI	EST. 1975
327	WILD	WILD	AL AIN	EST. 1971
328	WILD	WILD	AL AIN	EST. 1975
339	WILD	WILD	AL AIN	EST. 1975
383	WILD	WILD	AL AREEN	21 NOV 1976
384	WILD	WILD	AL AREEN	21 NOV 1976

**ARABIAN ORYX
MIDDLE EAST POPULATION**

FOUNDER ALLELE REPRESENTATION

09 September 1989

FOUNDER	RETENTION	PERCENT REPRESENTATION	TARGET REPRESENTATION	DIFFERENCE
1F	1.000	26.997	5.826	-21.171
2M	0.982	4.850	5.721	0.871
3M	0.994	9.835	5.788	-4.047
4F	0.961	5.465	5.596	0.131
8F	0.753	5.545	4.390	-1.155
9FL	0.848	2.882	5.826	2.944
10M	0.945	9.603	5.506	-4.097
58F	0.929	5.915	5.413	-0.502
59M	1.000	8.204	5.826	-2.377
140ML	0.999	2.522	5.826	3.304
141FL	0.924	2.128	5.826	3.698
189FL	0.934	1.281	5.826	4.545
190F	0.375	0.323	2.185	1.862
327ML	1.000	7.016	5.826	-1.190
328F	0.985	3.676	5.736	2.060
339F	0.742	0.747	4.323	3.576
383FL	0.941	0.773	5.826	5.054
384FL	0.962	0.853	5.826	4.973
809M	0.498	1.385	2.904	1.519

GENETIC SUMMARY

	LIVING DESCENDANT POPULATION	POTENTIAL POPULATION
Number of founders:	19	19
Parity (%):	5.263	5.263
Mean retention:	0.883	0.903
Founder Genomes Surviving:	16.772	17.163
Founder Equivalentents:	8.392	18.290
Founder Genome Equivalentents:	8.219	17.163
Fraction of wild heterozygosity retained:	0.929	0.971
Fraction of wild heterozygosity lost:	0.071	0.029
Mean inbreeding coefficient realized:	0.097	

GENETIC STATUS OF ARABIAN ORYX RE-INTRODUCED INTO OMAN

Georgina Mace, Institute of Zoology
ZSL, London
September 1989

Table 1 shows a summary of the status of the re-introduced population as at October 1988. There have been additional animals sent since this time, but I do not think they will make a substantial difference to the overall picture as they are basically from the same genetic background. The most effective way to improve the status of the population genetically will be to add from founder stocks that are not already present, especially from other herds of known background in the Middle East.

In spite of there being up to 8 generations of captive breeding from just 13 founders the population has fared well in preserving heterozygosity. Figures 1 and 2 examine the estimated probability of preserving alleles that were present in the ancestral wild population, using a gene drop analysis but with gene frequencies set at different values.

Figure 1 shows the survival rate of alleles that were rare in the ancestral wild population. About 17% of alleles that were present at a frequency of 0.10 will have been lost, 40% of those at a frequency of 0.05 and over 82% of those at a frequency of 0.01. In general, we expect to have preserved over 90% of alleles that were initially present at a frequency of ≥ 0.20 .

Figure 2 shows the expected level of allelic diversity preserved, and heterozygosity existing in the living wild population according to the number of equally frequent alleles at a locus there were in the ancestral wild population. The measure of allelic diversity preserved is A (from allendorf, 1986 Zoo Biology 5:181-190), where:

$$A = (n' - 1) / (n - 1)$$

And n' is the number of alleles retained of n equally frequent alleles in the starting population. The value of A is 1.0 when all alleles survive, and 0 when only one is left. From Figure 2 it seems that allelic diversity is well preserved. At least 95% is retained for a starting diversity of 6 alleles per locus or less.

Figure 2 also shows the estimated level of heterozygosity per locus in the wild population, assuming that there were n , equally frequent alleles at that locus in the ancestral wild population. Note that this is different from the measure of founder heterozygosity preserved given in Table 1 because in this case the starting heterozygosity is not 1.0, but is the Hardy-Weinberg equilibrium value given the appropriate gene frequencies. The absolute level of heterozygosity will be greater the more alleles that were present, and it drops quite steeply below 4 alleles; at 2 alleles, it is about 49%, i.e. close the starting frequency of 0.50.

Finally, I've included Table 2 which shows some data suggesting an effect of inbreeding on calf survival rates in the desert.

Table 1
ARABIAN ORYX (Oryx leucoryx)

Genetic status of reintroduced wild population at Yalooni, Oman:

Population size (October 1988)	=	59
Wild caught founders represented	=	13
Generations of captive breeding	=	2 - 7
Founder genome equivalents	=	7.07
Founder heterozygosity retained	=	97%

Figure 1.1 ESTIMATED PROBABILITY OF ALLELE LOSS
IN WILD ARABIAN ORYX

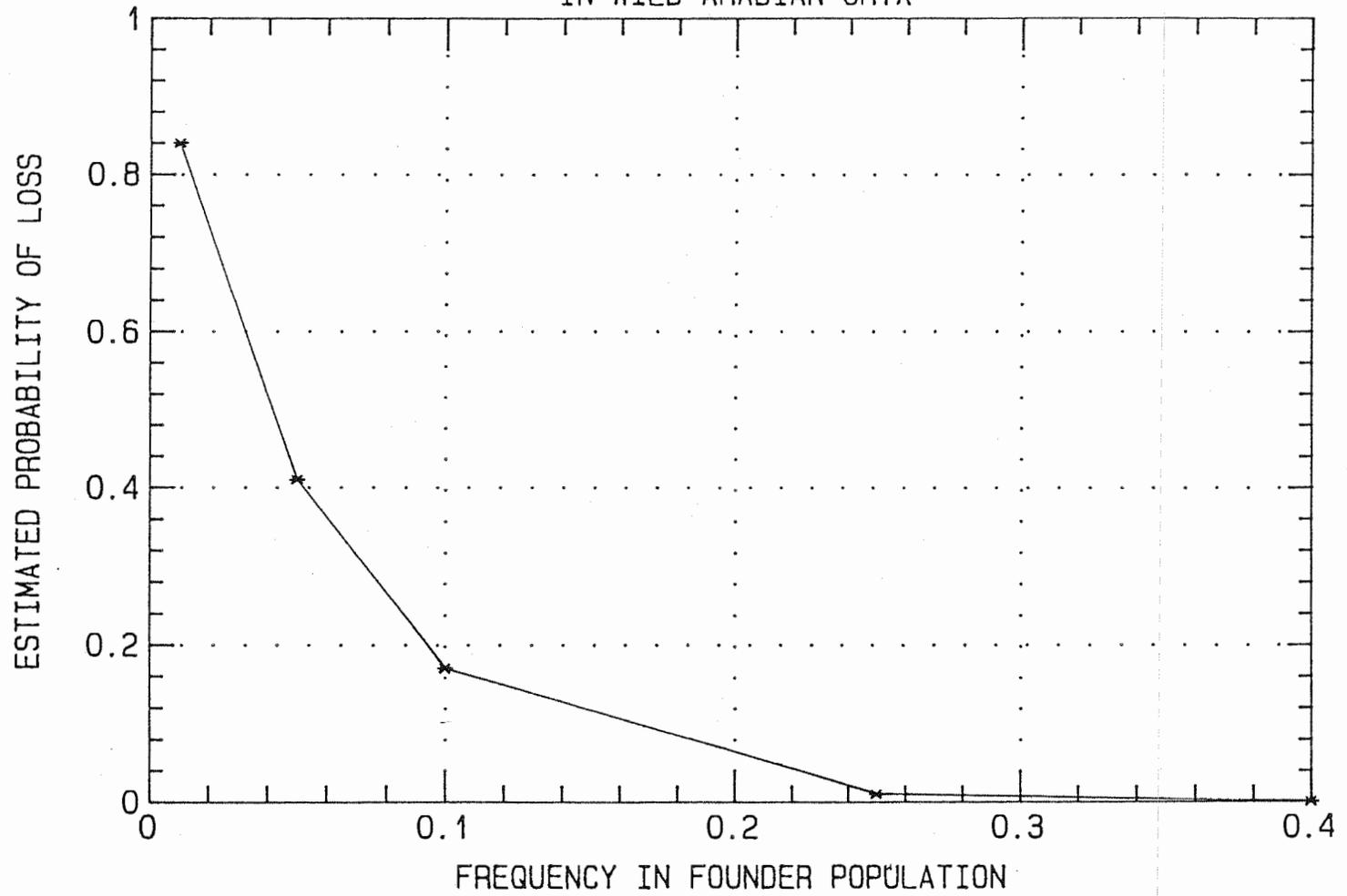


Figure 2. ARABIAN ORYX IN WILD

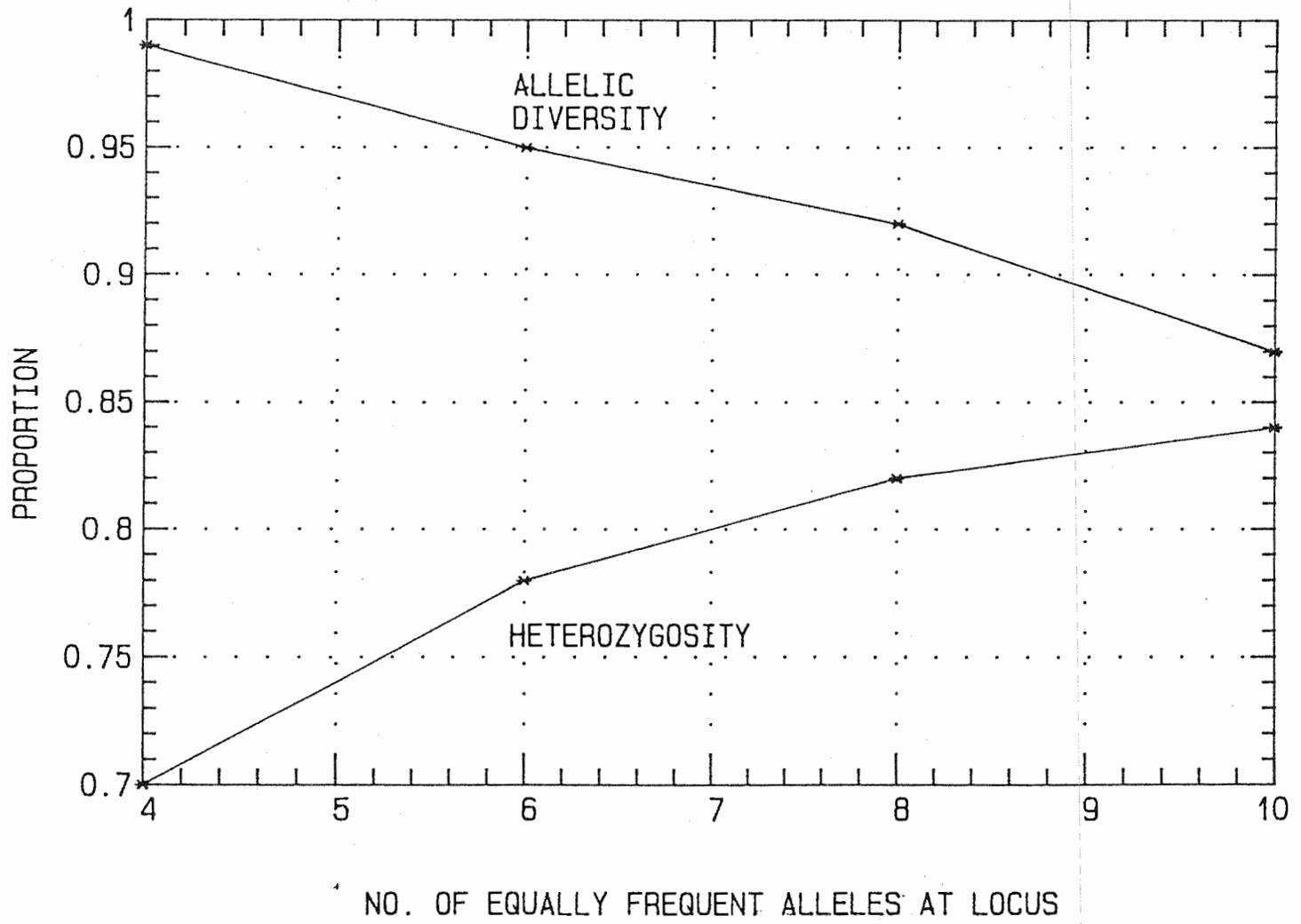


Table 2. ARABIAN ORYX (Oryx leucoryx)

Inbreeding in wild:

Calves survived < 1 month	f = .107	n = 12	s.d. = .076
Calves survived > 1 month	f = .047	n = 27	s.d. = .047

t = 2.52, 37 d.f., p < 0.02

ARABIAN ORYX CAPTIVE BREEDING AND REINTRODUCTION IN SAUDI ARABIA

Jean-François Asmodé and Abdul Rahman Khoja

Talk given at the Aridland Antelope Workshop,
San Antonio, Texas, U.S.A., 14-15 September 1989

INTRODUCTION

The National Wildlife Research Center, Taif was created in March 1986. One of its main tasks is to breed endangered species of Saudi Arabia, for overall reintroduction into the wild, notably the Arabian Oryx. The King Khaled Wildlife Research Center, created in 1987 in Thumamah near Riyadh on the farm of the late King Khaled, is a second such center. Together they are part of the conservation effort being undertaken in the Kingdom by the National Commission for Wildlife Conservation and Development.

The National Wildlife Research Center 30 km south of Taif is at an altitude of 1400 m, on the interior plateau of Arabia just east of the Hejaz mountains. It covers an area of 650 hectares of open acacia savannah and is completely fenced.

DISTRIBUTION IN SAUDI ARABIA

In the past the Arabian Oryx occurred throughout Saudi Arabia, with the exception of the western Sarawat mountains (Talbot, 1960 and Stewart, 1963). The northern population became extinct very early during the Forties. In the south Oryx survived much longer. Although official extinction of the Arabian Oryx was in 1972 in Oman, sightings occurred until 1979 along the western edge of the Rub-Al Khali (Abu Zinada et al., 1988). A N.C.W.C.D. expedition assisted by an helicopter of the Royal Saudi Air Force in November 1987 in the Al-Arid region where these last observations were made, failed to find any evidence of Oryx.

CAPTIVE BREEDING

A. Establishment of the Taif herd:

Saudi Arabia has long been involved with captive breeding of Arabian Oryx. Four of the founders of the World Herd came from collections of King Saud bin Abdulaziz (Dolan, 1976). An additional pair was acquired from Saudi Arabia by the Los Angeles Zoo.

His Majesty the late King Khaled established a herd of Arabian Oryx on his farm at Thumama near Riyadh from Oryx in American Zoos and from various Gulf countries. Thirty one were received in 1982 (Dolan, 1988). Unfortunately, after the King's death crowded conditions in the enclosure led to high calf mortality and numbers ceased to increase (Habibi, 1986).

It was decided to establish a captive breeding program based on scientific principles. This resulted in the creation of the Taif Center in 1986 (Abu Zinada et al., 1988). Of the 72 Oryx at Thumama, 57 (32 males and 25 females) were transported by air in communal crates to Taif in April 1986 by the Zoological Society of London. Following transportation, three animals died of trauma and one female aborted.

B. Tuberculosis outbreak:

Between June and October 1986 a severe outbreak of bovine tuberculosis manifested itself in Taif, with a total of 21 animals dying directly or indirectly from the disease.

The sudden appearance and acute nature of the disease in so many animals three months after capture is attributable to a number of factors (Flamand, 1988):

- the presence of tuberculosis in Thumama
- the stress during capture
- the methods of capture and transportation
- the climatic conditions at the time of and after translocation to Taif

C. Tuberculosis treatment:

To tackle the tuberculosis problem the following strategy (Flamand, 1988 and Flamand et al., 1989) has been followed:

- animals born before November 1987 are considered members of the "infected herd" and are isolated in individual pens where they receive a nine month antituberculosis treatment consisting of three antibiotics administered in their drinking water.

Tab.1: Strategy to deal with the tuberculosis problem in the Arabian Oryx herd in Taif and Thumama (Flamand, 1988).

INFECTED HERD + 37 + ▼	* ISOLATED IN INDIVIDUAL PENS * 9 MONTH TREATMENT * CALVES REMOVED AT BIRTH
FILTER HERD + 34 ▼	* HAND REARING * TB TEST * SMALL GROUPS * CALF PRODUCTION
CLEAN HERD	* BORN IN LARGE ENCLOSURES * REARED BY MOTHER * TB TEST ALL NEGATIVE * REINTRODUCTION IN MAHAZAT

- calves born in the infected herd since November 1987 are considered members of the "filter herd", having been systematically removed from their mothers immediately after birth. So far (August 1989), 34 calves have been recovered and successfully hand reared. They are kept in small groups of up to 4 animals so that should any animal have been infected, only members of its group will be at risk.

- the calves are tested for TB from the age of two and a half months, using skin tests, three different Elisa tests and a BTB test (Flamand et al., 1989).

- calves produced by the filter herd that prove to be clear of TB will be considered members of the "clean herd". When they reach the proper age, they will be reintroduced to the wild. At the moment, (August 1989) the oldest females of the "filter herd" are pregnant with possible "clean herd" calves. If everything goes well, the first calves will be ready for reintroduction in late spring 1991.

Two of the first handreared calves proved to be positive to the Elisa test and it is speculated that they were infected in utero or by the mother prior to their removal. Both mothers were highly positive and had not gone through treatment at the time of birth. These two animals were transferred to the infected herd and placed in treatment pens.

The oryx herd was thus reduced to 37 animals by October 1986. Births during the following winter allowed it to rise to 43 by April 1987, and until September 1987 births almost balanced deaths. No more deaths occurred for almost a year and the herd increased to 59 by September 1988, and to 71 by August 1989 (cf. Fig.1).

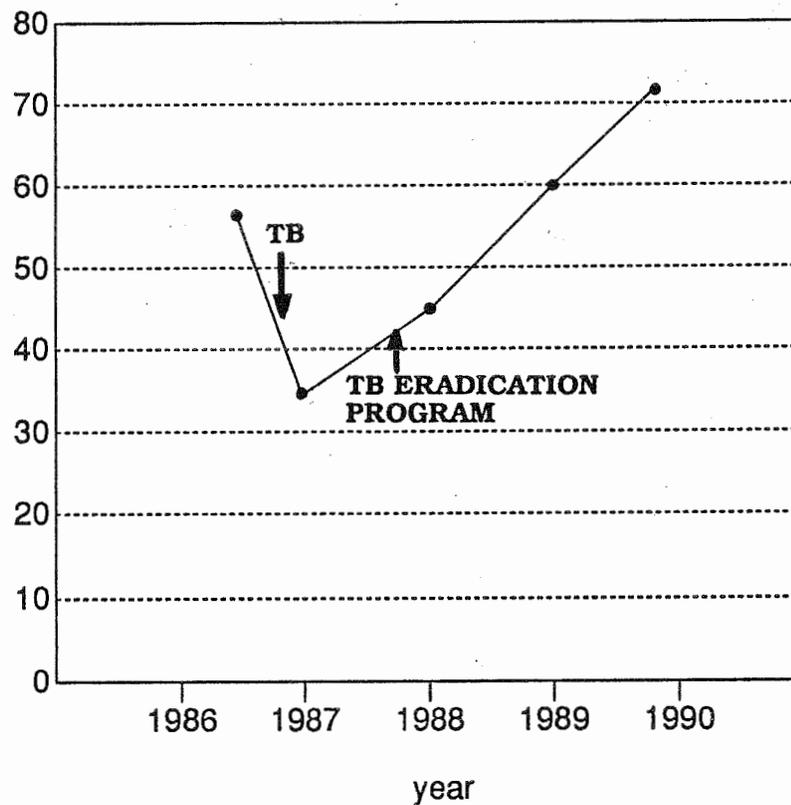


Fig. 1: Number of Arabian Oryx in N.W.R.C. Taif

As this program has been quite successful in Taif, it has been extended to the Oryx in Thumama, where five animals are under treatment. Four calves have been hand reared so far and one subadult male calf was received from the London Zoo in 1989.

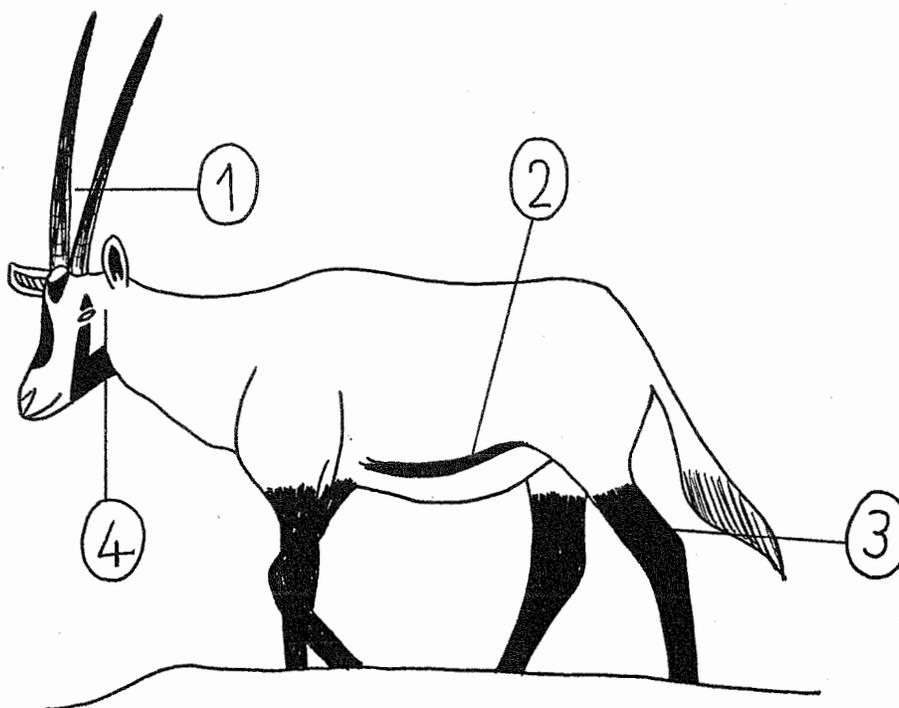
Four other Oryx groups exist in Saudi Arabia (Tab. 2), two of them being private. The total of Arabian Oryx present in the Kingdom at the time of writing (August 1989) is 102 with 97 being managed by the National Commission for Wildlife Conservation and Development.

Tab.2: Number of Oryx in the different collections in Saudi Arabia:

COLLECTION NAME	NUMBER OF ANIMALS	ORIGIN
NWRC - TAIF	71 = 30+41	THUMAMA
KKWRC - THUMAMA	10 = 05+05	USA - ARABIA - UK
MAHAZAT AL SAYD	16 = 10+06	USA - JORDAN
RIYADH ZOO	1 = 01+00	BAHREIN
AL JAMMAZ (PRIV.)	2 = 01+01	? - UK
ABDULLAH BIN KHALED (PRIVATE)	2 = 01+01	THUMAMA
TOTAL	102= 48+52	

D. Genetic management:

As all records of the animals while they were in Thumama prior to 1986 were lost, the management of the herd for breeding was extremely difficult. First, an identification card was developed for each animal utilizing their morphological and body variations (Fig.2), (Asmodé and Delhomme, 1988).

**Fig. 2:** Principal characters for the identification of the Arabian Oryx

- 1 Horn shape
- 2 Flank stripe existing or not
- 3 Back Knee color
- 4 Variation in face type

As these characters vary greatly from one animal to another, with a combination of characters we can obtain a formula that is unique to each individual. These characters are one of the criteria used for selection of the sire for each dam, having in mind that an Oryx very different phenotypically has less chance of being closely related to an individual of similar phenotype (Greth, in prep.).

To assess if this phenotypical variation can be traced genetically, we have just started to screen our oryx by enzymatic electrophoretic techniques. So far, four polymorphic loci have been found in our population.

Karyotyping has also just been started in order to detect hybrids from Scimitar-horned Oryx (*Oryx dammah*) as this species was also found in Thumama and three first generation hybrids were detected there in 1986.

E. Breeding success in the Taif herd:

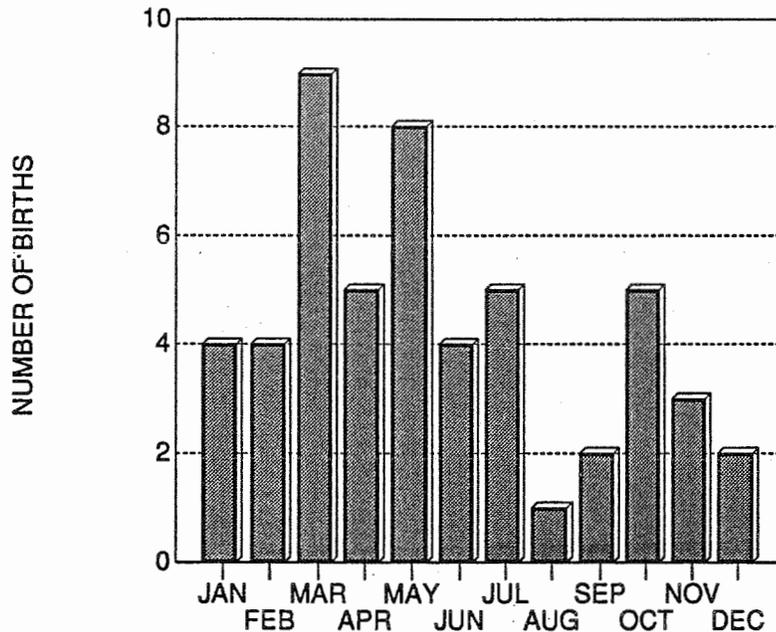
The increase of the number of Oryx to a level where the animals will be available for reintroduction has been the main objective of the captive breeding of the Arabian Oryx in Taif. One way to greatly increase herd size is to establish low perinatal mortality. This is particularly important as, since November 1987, all the calves are hand reared. Calf mortality was 31.8 % prior to TB treatment, almost exactly the level of mortality found in Whipsnade (Kirkwood et al., 1987) for free ranging ungulates. Perinatal mortality has decreased to 22.2 % (Tab.3) since TB treatment and hand rearing of calves.

Tab.3: Perinatal mortality in Taif, and comparison with free ranging Oryx in Oman (Stanley-Price, 1988) and free ranging ungulates in Whipsnade (Kirkwood et al., 1987).

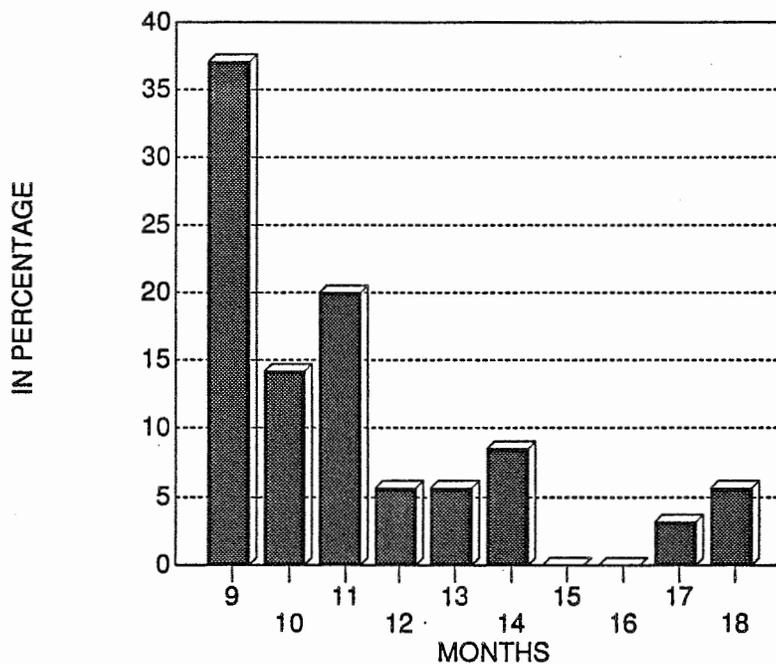
	Number born	Abortion stillbirth	Death at 1 month	Death at 1-6 month	Total Deaths	%
Taif prior TB treatment	22	4	2	1	7/22	32
Taif after TB treatment	27	4	0	2	6/27	22
Total Taif	49	8	2	3	13/49	26
Oryx Oman	32	3	5	1	9/32	28
Whipsnade Ungulate	1710	37	395	87	519/1710	30

Births occurred during all months of the year, with a peak in spring (March and May), and fewer during summer (August and September).

Fig. 3: Monthly distribution of Arabian Oryx births in N.W.R.C. Taif



The distribution of intervals between consecutive births, calculated for 16 females for which 35 intervals are known, is illustrated in **Fig. 4**. The mean birth interval is 324 days (range 270-520) with 37.1 % being nine months (270-275 days).



The gestation period was possible to calculate from data for four pregnancies of different females, the respective gestation times being: 262, 257, 265, and 262 days, averaging 261.5 days.

It would appear that conception frequently occurs within one to two weeks postpartum (37.1 %) and that the majority of conceptions occur within four months (77.1 %). These data are almost exactly the same as was found for Addax (*Addax nasomaculatus*) in captivity (Densmore & Kraemer, 1986)

REINTRODUCTION IN MAHAZAT AL SAYD PROTECTED AREA

Reintroduction of Arabian Oryx in the Kingdom has been one of the high priorities of the N.C.W.C.D. In 1987 a site called Mahazat Al Sayd was selected 150 km east of Taif. The size of this protected area is 2650 km², with a 220 km perimeter fence, 40 km of which borders the Taif-Riyadh highway.

A. Relief and vegetation:

Mahazat Al Sayd is primarily a flat plateau composed of gravel and sandy areas, and a few small jebels. In the recent past this area was known to have all 3 species of gazelles found in Saudi Arabia (Vesey-Fitzgerald, 1952). Unfortunately, due to the type of terrain, it was very easy to hunt with vehicles, and these species became extinct locally.

A vegetation study was undertaken with the aim of assessing if vegetation could again sustain those extinct species. Particular attention was given to the abundance and quality of known good fodder for Oryx and the gazelles. Due to the scarcity of published material (Stewart, 1963) on the diet of Arabian Oryx, information was also taken from published material on Scimitar horned Oryx and Addax (Gillet, 1965). Chemical analysis of the most important plants for the Arabian Oryx was done to determine if the vegetation was able to meet the nutritional requirement of the animals.

During this survey, 4 different types of habitat were found:

- the *Panicum turgidum* "grassland" with very few *Acacia tortilis* and *Maerua crassifolia*. This habitat is found mostly in the western part of the reserve and covers about one third of the reserve.

- the *Acacia tortilis* stands, which also cover about one third of the reserve especially the central part.

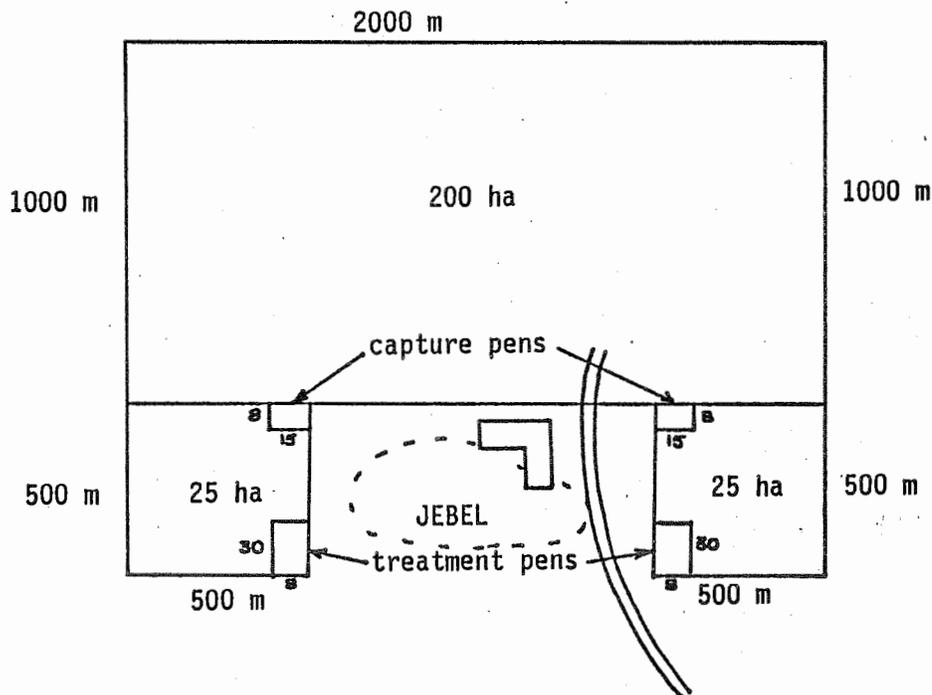
- the *Acacia ehrenbergiana* stands found in the waddis along the southern part of the reserve. This habitat has the thickest vegetation with up to 400 trees per hectare.

- the *Hammada elegans* association typical of salty soil, and one of the preferred habitats of the Houbara bustard. This habitat is found on the western and eastern end of the reserve.

Results of this study showed that grazing was still good, with a sizable presence of *Panicum turgidum* and *Eleusine compressa*, and seven other grasses known to be good fodder for the animals. In addition, the presence of a large number of trees provides shelter and food during the summer. The vegetation in Mahazat Al Sayd allows not only reintroduction of the Arabian Oryx but also reintroduction of the three species of gazelles, Ostrich and Houbara Bustard.

B. Prerelease site:

A prerelease site has been established in the western section of the protected area to acclimatize the animals to their new environment. There are three enclosures: two small ones of 25 hectares connected to a larger one of 200 hectares. This site was selected because of the variety of landscape present in this area which in case of fighting allows the dominated animals to hide from the dominant.



C. Oryx arrival in Mahazat Al Sayd:

Until the Taif herd produces tuberculosis-free Oryx, these animals cannot be utilized for reintroduction. Therefore, other sources of animals had to be found. The Arabian Oryx S.S.P. of the A.A.Z.P.A. offered 9 animals (5.4) and the Royal Society for Conservation of Nature-Jordan offered 8 animals (4.4) from Shaumari.

On November 30, 1988 the first group arrived from America. They had been selected and gathered by Dr. J. Dolan at the San Diego Wild Animal Park. They were put in one of the 25 hectare enclosures. The herd was composed of

- 4 adult females
- 4 adult males
- 1 juvenile male

The juvenile male arrived with a wound in the eye but was judged by the veterinary staff to be able to join the herd. This young male was dominated at water and feeding points by all the other individuals. His condition rapidly deteriorated and when he was finally separated from the herd, it was too late. The animal died two days later on December 28.

This loss was compensated by the birth of four calves (3.1) conceived in America. One young female calf showed signs of weakness quite early. She eventually died in April, which brought the number of animals in enclosure 1 to 11.

On March 20, 1989 Oryx coming from Shaumari Reserve arrived at Mahazat. Eight animals were shipped: one pair died during transportation, and another pair arrived with severe ankylosis. The male recovered quickly but the female was left a deformed neck. She died while being put into isolation with a male prior to the mixing of the two herds. All the Jordanian oryx were put into enclosure 2 after their arrival.

On May 30, 1989 the two herds were let out at the same time in the 200 hectare enclosure where grazing was in excellent condition after the heavy spring rains. Fights occurred between males for the first few days. They are now forming one herd of sixteen animals with dominance by the Jordanian male "Hail" (for the males), and by the American female "Mayu" (for the females).

The oryx became much more active in the 200 hectare enclosure than in the smaller enclosures. During the whole month of June they fed almost exclusively on natural vegetation and almost stopped feeding on alfalfa hay during that month. The American animals were slowly weaned off pellets.

In July during the hottest summer days, with vegetation drying and the weaning off pellets, the zoobred animals showed a deterioration in their condition and became slightly emaciated, while the Jordanian wild bred animals were in perfect condition. In view of that situation, the feeding point with alfalfa hay was extended to diminish competition between the animals and a permanent water system was installed.

In August the condition of the zoobred animals slowly improved and by the beginning of September the condition of all the animals, zoo bred and wild bred, was good and the animals again started to feed less on alfalfa hay.

Release is planned for the second part of October. Some animals will be equipped with radio transmitters with solar cells. Position of the animals will be registered everyday by the biologist and the reserve wardens.

Through the help of Dr. James Dolan the SSP of the AAZPA has already agreed to send a second herd of six Oryx (3.3) this year after the release of Herd 1.

D. Preparation of Oryx to be used for reintroduction:

According to the experiment with zoobred animals in Mahazat Al Sayd, animals fed with pellets and hay from a young age suffered when this diet was changed. Therefore, it was decided that animals captive bred by the N.W.R.C. Taif for reintroduction will be raised according to the following policy so that behavioural development will be as natural as possible:

1. The mother must be put in a large enclosure (4-25 ha) at least two months prior to the expected birth, if possible with other adults.
2. The calf must be reared by its mother.
3. The calf will be left with its mother until after weaning (at least nine months to a year).
4. Supplementary feeding in the enclosure will be mostly in the form of grass and alfalfa hay, with avoidance of pellets if possible, in order that digestive capability develops as closely as possible to that in the natural state.
5. The calf must be tested for TB at one year of age, following recommendations of the Specialist Group Report on TB, Taif, 21/2/89.
6. Oryx will be moved to Mahazat according to shipments coming from abroad, the condition of the reserve and the prerelease enclosures.

Tab.4: Composition of the Oryx herd in Mahazat Al Sayd

NAME	AGE	SEX	ORIGIN	RELATIONSHIP
MAYU	8Y 3M	F	USA	
FANNIYA	8Y 1M	F	USA	
SINDID	6Y 10M	M	USA	
MALLA	5Y 2M	F	USA	
GHADA	4Y 10M	F	JORDAN	
HAIL	4Y 2M	M	JORDAN	
JAFFAR	3Y 7M	M	JORDAN	
ASHIR	3Y 6M	F	USA	
ZAIN EL A.	2Y 11M	M	JORDAN	
SAFA	2Y 10M	F	JORDAN	
YAQUIZ	2Y 9M	M	USA	
AFAR	2Y 8M	M	USA	
MUBARRAK	2Y 3M	M	USA	
MERZOUG	9M	M	MAHAZAT	MAYU'S CALF
BADER	7M	M	MAHAZAT	ASHIR'S CALF
SAKER	6M	M	MAHAZAT	MALLA'S CALF

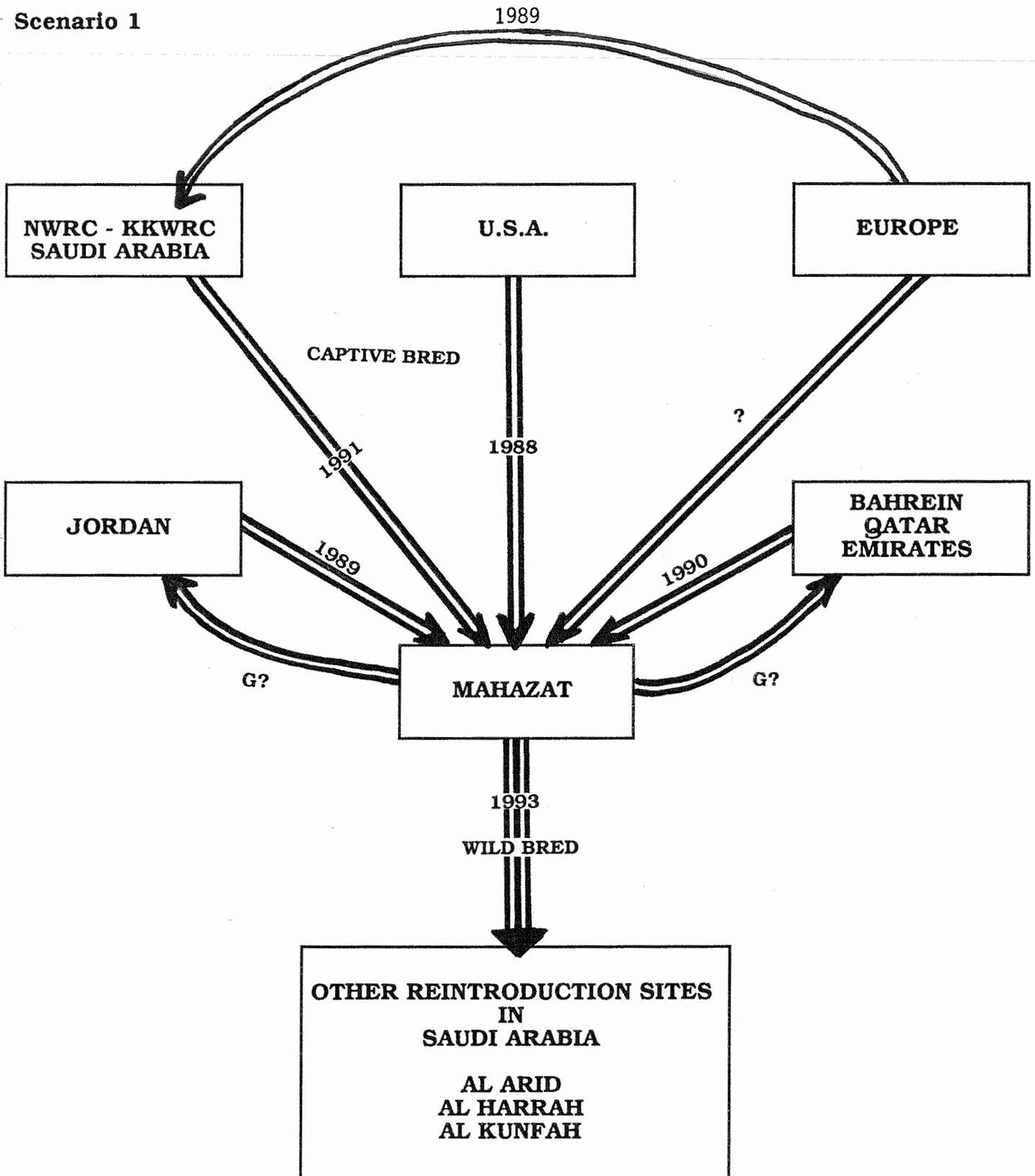
CONCLUSION

Another year will be necessary to determine if the TB eradication program of the Arabian Oryx in Taif is completely successful. In the meantime, with the help of Oryx bred outside the Kingdom, reintroduction of Arabian Oryx will continue in Mahazat Al Sayd. In the future additional reintroduction programs will be established in other protected areas throughout the Kingdom. Mahazat Al Sayd will then serve as a reservoir of wild animals for other reintroduction areas. Thus, the animals used for reintroduction will be wild and not captive bred. This procedure will shorten as much as possible the prerelease phase. The numbers of animals removed from Mahazat will be replaced by captive bred animals from the Kingdom and abroad. This will be one way of reducing the cost of the other reintroduction programs.

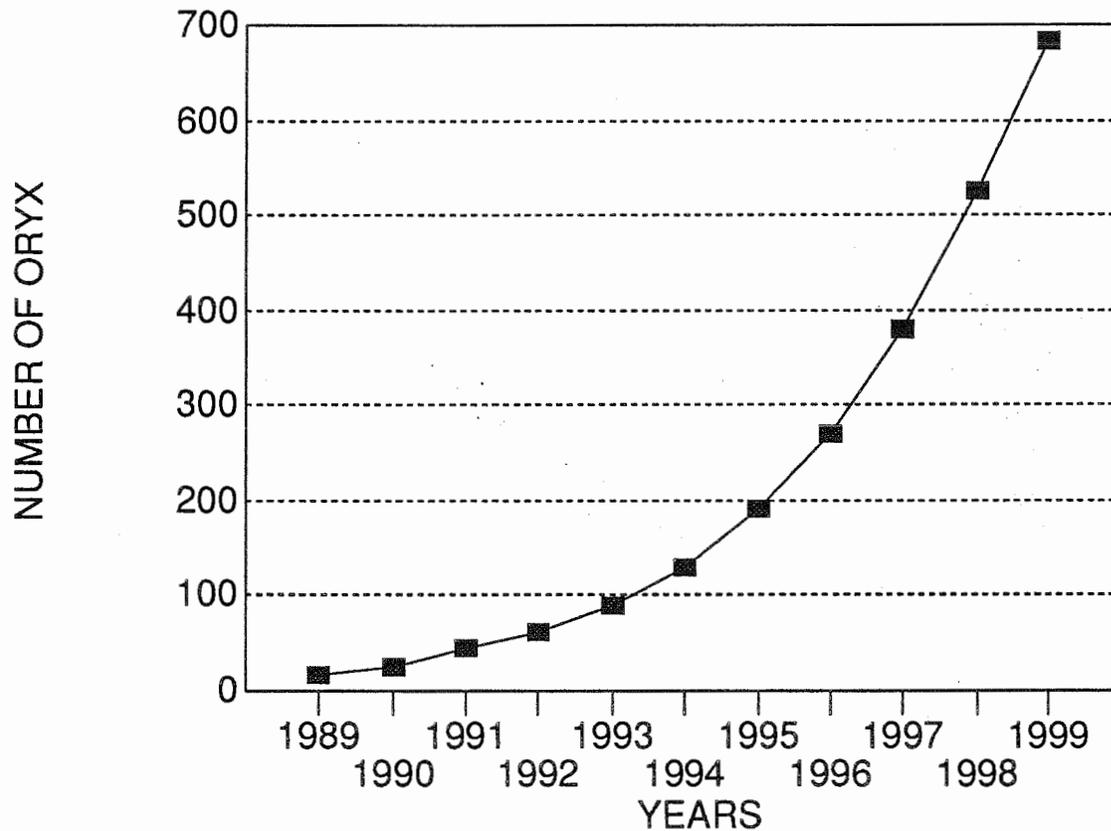
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Scenario 1

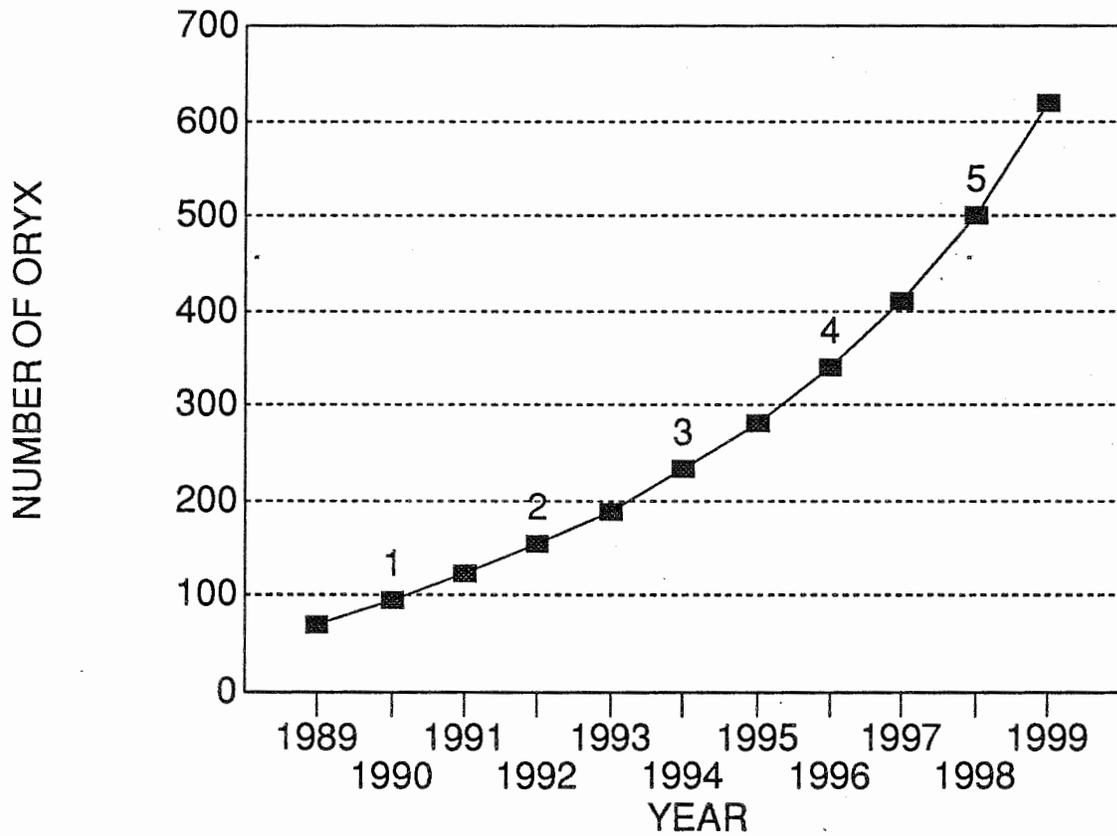


ORYX POPULATION PROJECTION FOR MAHAZET AL SAYD



- 33% of perinatal mortality
- 1 calf/year per female
- release of a herd of 8 animals per year from the U.S.A
- release of a Saudi bred herd of 8 animals per year from 1991 and on

ORYX POPULATION PROJECTION FOR N.W.R.C. TAIF



- | | |
|------------------|------------------------------------|
| Period 1 (89-90) | no take off |
| Period 2 (91-92) | 8 animals to Mahazat |
| Period 3 (93-94) | 8 animals to mahazat |
| | 8 animals to reintroduction site 2 |
| Period 4 (95-96) | 10 animals to Mahazat |
| | 10 animals to reintroduction 2 |
| | 10 animals to reintroduction 3 |
| Period 5 (97-99) | 10 animals to Mahazat |
| | 10 animals to reintroduction 2 |
| | 10 animals to reintroduction 3 |
| | 10 animals to reintroduction 4 |

CBSG ARIDLAND ANTELOPE WORKSHOP

San Antonio, Texas, U.S.A.
13-15 September, 1989

SCIMITAR-HORNED ORYX

1 February 1990

SCIMITAR-HORNED ORYX PLAN

This group has recognized that the scimitar-horned oryx, as an aridland antelope of the sahelian region of northern Africa, has experienced a rapid decline in wild populations and now faces imminent extinction. This decline has been induced partly by overhunting but primarily by loss of habitat due to desertification of the range bordering the Sahara desert. This loss of habitat has been brought on primarily by various human activities. The scimitar-horned oryx's precarious status deserves close and careful management.

THE MAIN OBJECTIVES

1. The survival of the species through the development of a captive population managed to provide the best genetic base of animals with which to repopulate or reinforce the wild.
2. Recovery of this species by reintroductions of animals to the wild and the development of a viable population or metapopulation with a total number of at least 5000 composed of subpopulations of at least 200 animals each.

STATUS AND DISTRIBUTION IN THE WILD AND IN CAPTIVITY

Having once ranged across most of northern Africa in the sahelian zones, the scimitar-horned oryx is now considered extinct with the possible exception of one very small surviving population in central Chad (Ouadi Rime - Ouadi Achim). The numbers and survival of this population is unknown.

Worldwide, in captivity, there are an estimated 1500 scimitar-horned oryx. The majority of this captive population is genealogically untraceable at this time. In the U. S. alone there are an estimated 1100 specimens most of which are in private ownership on ranches throughout Texas. To a lesser extent scimitar are thought to also exist on ranches and farms in Oklahoma, Arkansas, Missouri and Kansas. Currently, out of these 1100 animals, 297 are considered SSP specimens.

There have been at least 40 founders identified worldwide. The low number of founders are not as critical with this species as with the addax and Arabian oryx. We should attempt to ensure that a maximal founder base is distributed throughout the global population.

DEMOGRAPHICS

We recommend a survey of the numbers of scimitar-horned oryx maintained on private ranches in North America, those presently outside the managed captive population. Tissue and blood samples should be obtained from as many of these animals as possible to determine through various molecular techniques, e.g. mitochondrial DNA, how closely related these animals are to the managed population. Because of the limited number of wild scimitar-horned oryx available for added genetic variability, ranches will become an important potential source.

Little pedigree information is presently available on the European populations. The information that has been compiled suggests that the European population may have very limited founder representation, and the founders contributing to the U.S. and European, and Middle East populations are appreciably different. It is therefore important to determine to the extent possible, the pedigrees of the European and Middle East populations, and exchange animals between the regional populations to bolster the

genetic variability in each. The U.K. population has very limited founder contribution but extensive lineage and population demographics analysis has been done.

We recommend that the EEP assist in this overall effort by establishing a scimitar-horned oryx program of its own. To further these efforts, the North American regional studbook should be extended to the international level as soon as possible. Alan Rost, North American regional studbook keeper, is to communicate and coordinate closely with Georgina Mace of the UK in order to prevent duplication of effort and data.

It was recommended that the Australian and New Zealand population be reinforced with genetic material from the U. S. population and that the SSP group be asked to develop recommendations to meet this goal.

The potential founder component of the Pretoria and Cairo scimitars needs to be determined and recommendations made for their use.

We will continue to explore new management options for males as well as new locations for expanded breeding programs.

VETERINARY CONSIDERATIONS

Veterinary considerations are of great importance when planning an introduction or re-introduction of desert antelopes, and these should comprise one of the vital pre-translocation planning phases of any reintroduction operation. In fact, possible veterinary complications should be taken into account during the search for a suitable release site.

The veterinary hazards are predominantly twofold:

- 1) it must be ensured that the founder animals, which perforce, will probably originate in the U.S., do not suffer from any inapparent infection which will present a disease risk to wild or domestic stock in the reception area.
- 2) since the founders will probably have been raised in relative isolation and may lack immunity to endemic diseases present in the reception area, an appraisal of these risks must be made prior to release so that appropriate protection (usually vaccinations) can be assured.

Failure to take account of either of these disease hazards has resulted in unexpected and expensive failures of reintroduction projects in the past and could bring a very useful conservation technique into disrepute.

Subsequent to reintroduction, a program of health and disease monitoring should be implemented at the release site. To be effective this program should include a training component for a local national veterinarian.

REPRODUCTIVE RESEARCH

Additional research and development is needed for adapting gamete and embryo cryopreservation, artificial insemination, embryo transfer and related technologies for application to the scimitar-horned oryx. These technologies will be important for translocation of genetic representation from founder animals between locations, enhancing genetic representation of under-represented breeding stock, and propagation of animals in small populations of SSP animals where genetically "surplus" animals are available. These technologies have been proven to be biologically feasible in this species, and although improvements in efficiency are needed, their cost/benefit ratios may be favorable at the present time under certain

specific circumstances. Likewise, birth control measures, such as vasa-deferens plugging and tubal ligation should be considered for obtaining appropriate genetic balance within populations where carrying capacity is limited and breeding dynamics are enhanced by the presence of peripheral males or females.

BEHAVIORAL RESEARCH

Because very little work was done with this species in the wild prior to its rapid decline, little or no behavioral data were ever collected. In an effort to better understand the needs of these animals prior to release and to make the releases as uneventful as possible, a thorough study in as normal conditions as can be obtained is recommended.

The Bamberger ranch scimitar project will develop an on-site behavioral study project. It is felt that a more normal behavior pattern can be observed in this location due to its extensiveness and remoteness. We should allow up to two years for dependable results.

REINTRODUCTION EFFORTS

The following is a summary of the needs and status of reintroduction programs including the one in Tunisia which is in progress and the proposed project in Niger:

1. We recognize that reintroduction is a principle goal of the management of the captive population.
2. This project shows the major need for and commitment to the return of animals back to their original habitat.
3. The Niger project will draw attention and develop the necessary interest for the development of other reintroduction programs in this region of the world.
4. We recognize the need to establish in situ training programs and opportunities to facilitate future management of the project by Nigeriens.
5. The education process is considered essential. Programs directed at both adults and children should be developed as a priority and should maximize the use of oryx at the reintroduction center to heighten public awareness. We will seek and develop collaboration with AID agencies (Dutch), EEC, and other world agencies who use the presence of wildlife as an integrated part of multiple land use.
6. Appropriate attention to the pre-release veterinary protocol must be strictly adhered to in order to minimize disease transmission.
7. The Tunisian authorities should be persuaded of the need to import additional genetic material for the Bou-Hedma release project.

Re-introduction projects require considerable skills and commitment; none should be attempted without the approval of the IUCN.

CBSG Aridland Antelope Meeting
September 13 - 15, 1989

INTRODUCTION

The Scimitar-Horned Oryx Species Survival Plan (SSP), which will be referred to as the SHOSSP, was one of the original ten SSP species named in 1981. The early years of SHOSSP saw two focuses. The first focus was the development of the oryx ranch project at the Bamberger Ranch near Johnson City, Texas, which was on-line with the first oryx on location by the end of 1983. The second focus was the development of an adequate data base from which to begin examining demographic and genetic parameters. Although in the SSP world of 1989 the existence of a studbook would be a serious consideration in naming a species to SSP status, no studbook, on any level, had existed for the scimitar-horned oryx since Jim Dolan had discontinued his international studbook, for lack of participation, in the early 1970s. Development of a North American regional studbook to provide the needed data base began in 1984.

One of the main purposes of an SSP master plan is to present recommendations (concerning breeding, surplus, and movement of individuals within the SSP population) that will support the long-range genetic and demographic goals needed to keep a particular species viable in captivity. These recommendations, which can be found at the end of this document, are based on the results of demographic and genetic analysis using increasingly sophisticated methods for evaluating captive populations that have been developed into computer software over the past four years. Using this software, these recommendations have been developed in accordance with the guidelines presented in the document, "Development of an SSP Masterplan".

The primary goal of the SHOSSP is to establish as genetically diverse and demographically stable a self-sustaining captive population as possible, which can someday be used to either repopulate or reinforce threatened natural populations of this species. (This species is fortunate to already have one reintroduction program in Tunisia in operation, and another in Niger in the planning stage.) With the scimitar-horned oryx, the problem is one of quality, not quantity. This species has proven to be capable of reliably propagating in captivity in great numbers with relative ease.

However, there is, even with the studbook, a serious lack of genealogical or lineage information concerning the genetic heritage of most North American scimitar-horned oryx. One result of this problem was the necessity of developing several "hypothetical" specimens to cover certain given lineage possibilities. These hypothetical animals were created based on what was known about the history of their herds in terms of their genealogical origins and on worst case scenarios that used the most conservative assumptions and models of how the genetic diversity that went into these herds has been preserved. Without these hypotheticals, little of the genetic diversity in these herds or collections would have been salvaged for SSP type management.

Since the scimitar does propagate so readily, a second problem is to control the number of offspring while maintaining the maximum genetic diversity possible and balancing population structure for long-term survival, while not overpopulating available holding spaces and thereby jeopardizing the "Ark's" ability to handle one more ungulate species in need.

Our constantly fluctuating SSP population of scimitar-horned oryx in North America currently rests at about 400 specimens. As you will see later in this master plan, it appears that an age and sex-balanced population of 400 scimitar would provide a large enough effective population to sustain the maintenance of 90% of this species' genetic variability for about a 150-year period. With some small population adjustments it is possible that this can be extended to 200 years. This does take into consideration the developing release projects, and other captive populations worldwide, and the metapopulations in North America (mostly in Texas). Actually, it would appear that if you would factor in the well developed scimitar management programs in the British Isles and Australia/New Zealand alone, they would provide enough additional population to maintain the 90% genetic variability goal in the "world" captive population for a 200 year period even given current North American variables. (As you will find later in this master plan, although current SSP participating institutions currently hold about 400 scimitars, about 100 of these specimens have origins that are so unknown as to make hypotheticals entirely guesswork. We are recommending the surplus of these specimens from the population which lowers or current population numbers by 25%.) A management program for this species in Europe has also now begun.

The first priorities of our SHOSSP will be to try to enlarge our North American founder base, to increase our North American herd size back to about 400 specimens, and then to manage the scimitar population to produce a limited number of annual calves that will adjust each founder's genetic contribution in the population to a desired level, and yet balance the population's age structure and sexual demographics at the same time.

STATUS AND HISTORICAL PERSPECTIVE

The scimitar-horned oryx, *Oryx dammah* (Cretzschmar, 1826) is a medium-sized antelope standing approximately 40 inches at the shoulder. Formerly found throughout the Sahelian zones, both north and south of the Sahara, it at one time occurred in parts of most, if not all, the countries of North Africa. These countries probably included Egypt, Libya, Tunisia, Algeria, Morocco, Spanish Sahara, Senegal, Upper Volta, Mauritania, Mali, Niger, Sudan and Chad. Many of the original importations of scimitar to European zoos in the 1820s were from herds, now long extinct, in countries such as Egypt, Tunisia and Morocco. At one time, the scimitar was numerous enough in its range that it was referred to as "the game of the desert".

By the 1850s, the scimitar-horned oryx or "white antelope" began its gradual decline towards extinction. With the introduction of guns and motor vehicles to this area of Africa just prior and during World War II, the scimitar's decline greatly accelerated. By 1967, when the majority of wild-born founders who now

make up our international captive herds were captured and imported, there were only five countries left with any sizeable oryx population - Mauritania, Mali, Niger, Sudan and Chad. Shortly thereafter, the scimitar horned oryx disappeared from Mauritania, and by 1980, it was probably extinct in Sudan and Mali. John Newby, the WWF/IUCN representative in the Republic of Niger, reports that the scimitar should be considered extinct in Niger as of the end of 1983. At this point, for all practical purposes, the scimitar-horned oryx is probably extinct in the wild. There is a relatively recent report of an aerial sighting of a fairly large herd of galloping white antelope in an area of the foothills just above the capital of Chad. Unfortunately, this sighting is now believed to be of another species other than scimitars. In any event, the urgency of this species' situation in both the wild and captivity would demand confirmation before such a herd could or should be factored into any species survival planning programs. It should be noted here, that even if the above wild herd does exist, there is some chance that it may no longer be long-term genetically viable.

To suggest that the demise of this antelope is entirely traceable back to the introduction of guns and motor vehicles is, of course, an incorrect generalization. Even in areas where guns and vehicles remained rare, lifestyles were changing. Horses became common, and not a luxury. Now every nomad possessed at least one. It was not uncommon for even the oryx that escaped a chase to then die of exhaustion. This was especially true during periods of drought when weakened oryx were more prone to disease.

Man made desertification has also seriously affected the scimitar. Domestic livestock overgrazing has resulted in the loss of large tracts of rich pastures that this species used to migrate between. Destruction of tree cover has deprived ungulates of the shade they need to conserve their body fluids. Also, without these natural windbreaks along wadis, tongues of sand cut watercourses.

Another dangerous development were the many new permanent water boreholes dug in the areas which, although waterless, had rich pastures. Overuse by locals, combined with the erratic climate, destroyed many of these areas. In some of these locations, the recent droughts saw cattle dying in the thousands for lack of pasture, not water.

The early to mid-1980s have seen a particularly long and disastrous period of drought. The resulting stress has further drastically diminished already small herd numbers. Those scimitars that survived often began migrating into unfamiliar or untraditional areas looking for food or water. These "new" migrations often brought them into contact with man also trying to survive. John Newby has indicated that this is the probable fate of the last handful of scimitar-horned oryx in the Republic of Niger.

The status of the scimitar-horned oryx in the wild during the 1980s has been a very volatile, quick changing situation. As recently as the 1980-81 WORLD WILDLIFE FUND YEARBOOK, John Newby found that the total scimitar world wild population did not exceed 2000 head, and more realistically was probably about 1500. Ninety-nine percent of that total was found in just Niger and Chad. And eighty percent of those were in Chad, which was involved in an ongoing shooting war. Now the Niger population is extinct and the doubtful Chad scimitars in question are the only possible remaining wild population of this species.

The IUCN RED DATA BOOK lists the scimitar-horned oryx as vulnerable, but this is old material published in 1976 when Chad alone still held roughly 5500 head. The current change in the animal's status is reflected in CITES which, during 1983 at Niger's request, moved the oryx from Convention II to Convention I, its most highly regulated status. The scimitar-horned oryx is not currently listed on the U.S. ENDANGERED SPECIES ACT.

A survey of the INTERNATIONAL ZOO YEARBOOK's census of rare animals in captivity using decade intervals presents a moderately representative image of the explosion in reproduction of which this species is capable:

1965 census listed 13.10	or 23 scimitars in 11 collections
1975 census listed 108.158.3	or 269 scimitars in 36 collections
1985 census listed 185.316.2+	or 503+ scimitars in 58 collections
(most recent available)	
1986 census listed 191.349.4+	or 544+ scimitars in 54 collections

The above figures, of course, do not include any representation for the large number of oryx surplused each year from these reporting collections, or the large number of privately owned and held scimitars that are not reported to the INTERNATIONAL ZOO YEARBOOK and probably rivals the above reported numbers. (There were known to be well over 500 scimitars held on Texas ranches in 1988.)

SCIMITAR-HORNED ORYX
SPECIES SURVIVAL PLAN (SSP)
MASTER PLAN OBJECTIVES

1. Reinforce / reestablish wild populations. The ultimate objective of the SSP program for any species is to develop a genetic and demographic reserve in captivity that can contribute to survival of the species in the wild by:
 - A. reinforcing natural populations which may have been so reduced by human activities, natural catastrophe, or even epidemic diseases that they are no longer viable genetically or demographically.
 - B. providing animals for repopulation of original habitats when that proves practical.

As summarized earlier in this document, this objective is already underway. Only time will tell if reinforcement of any wild population of this species is going to be possible, but reintroduction projects are already underway (Tunisia) or in development (Niger). Although North American zoos are yet to participate actively in the scimitar-horned oryx part of these projects, discussions and planning are already in progress for future participation.

2. Develop a population of scimitar-horned oryx in North America capable of long-term genetic and demographic viability.
3. Try to maintain a minimum of 90% of this species' genetic variability for a period of at least 150 years by:
 - A. reaching and maintaining a balanced North American carrying capacity of 400 scimitar-horned oryx.
 - B. obtaining additional founder lines for the North American herd.
 - C. readjusting founder contributions from the existing to the target distribution.
 - D. conducting a continuing Population Viability Analysis of the North American scimitar-horned oryx herd as a basis of refining recommendations.

4. Increase population to carrying capacity of 400 as rapidly as possible, while still readjusting founder contributions.
 - A. There are 157 recommended breedings for 1988.
 - B. Once the population has leveled off at 400 specimens in the SSP program, there will only be a need for about 30 surviving calves per year to stabilize the North American scimitar-horned oryx population.

5. Designate individuals that are surplus to the population. Surplus in the SSP sense is an animal that:
 - A. Is from a totally unknown lineage.
 - B. Is from over-represented bloodlines or lineages.
 - C. Is too old to reproduce.
 - D. Has already produced its share of offspring and has attained the oldest age class necessary or allowable for a stable age distribution in the SSP population.

6. For non-surplus individuals determine who mates with whom to accomplish objectives 2 - 4 through offspring objectives for individual animals.
 - A. Offspring Objectives
 1. If individual is NOT from under-represented founders:
 - a. Individual is not F1, from known real founders:
 - Female 1.1 offspring that survive to reproduce.
 - Male 3.3 offspring that survive to reproduce.
 - Female 2.2 offspring if reproductive status is uncertain.
 - Male 6.6 offspring if reproductive status is uncertain.
 - b. Individual is a F1, from known real founders:
 - No limit on offspring AT THIS TIME.
 2. If individual is from under-represented founders:
 - No limit on offspring AT THIS TIME.

7. Instigate, promote, and support research on the scimitar-horned oryx that will facilitate objectives 1 and 2 by:
 - A. obtaining further pedigree clarification. Essentially, the development of an international studbook for this species.
 - B. surveying the North American scimitar-horned oryx population variation and structure. (With wild-caught founders in North America now deceased, Fls out of each of the different wild-caught founder lineages will have priority.)
 1. Conduct an electrophoresis survey.
 2. Conduct some DNA fingerprinting, to hopefully solve some of the North American population's more important lineage questions. This technique may be more limited for this species than some others because of the large number of closely related specimens with limited or no known genealogical background to act as a base for such a study.
8. Collect, compile, study and analyze North American scimitar-horned oryx mortality data and patterns.
 - A. By collecting all available North American scimitar-horned oryx necropsy reports.
9. Promote a more coordinated approach to the reproductive technology being currently developed by several disparate institutions working in isolation from each other.
10. Promote the timely and complete publication of research data or results by all parties performing research on this species in North America.
11. Conduct a survey and study of the North American scimitar-horned oryx "metapopulation" found in many private hands across the country, particularly on ranches in Texas.

**SCIMITAR HORNED ORYX
LIFE TABLE**

**NORTH AMERICAN POPULATION
(01 JUNE 1979 TO 01 JUNE 1989)**

MALES					FEMALES				
Age	Px	Lx	Mx		Age	Px	Lx	Mx	
0	0.745	1.000	0.000	r =	0	0.767	1.000	0.002	r =
1	0.942	0.745	0.010	0.0571	1	0.976	0.767	0.045	0.0796
2	0.989	0.702	0.135		2	0.975	0.749	0.188	
3	0.988	0.694	0.237	lambda =	3	0.984	0.730	0.207	lambda =
4	0.983	0.686	0.202	1.059	4	0.981	0.718	0.197	1.083
5	0.994	0.674	0.181		5	0.981	0.705	0.181	
6	0.990	0.670	0.219	Ro =	6	0.997	0.691	0.180	Ro =
7	0.982	0.663	0.217	1.592	7	0.996	0.689	0.200	2.013
8	0.987	0.651	0.218		8	0.967	0.686	0.225	
9	0.991	0.643	0.174	G =	9	0.975	0.664	0.182	G =
10	1.000	0.637	0.097	8.147	10	0.963	0.647	0.194	8.789
11	0.988	0.637	0.094		11	0.978	0.623	0.160	
12	0.986	0.629	0.135		12	0.948	0.609	0.222	
13	0.966	0.621	0.133		13	0.969	0.578	0.215	
14	1.000	0.600	0.062		14	0.925	0.560	0.212	
15	0.985	0.600	0.132		15	0.951	0.518	0.189	
16	0.919	0.591	0.071		16	0.959	0.492	0.146	
17	0.895	0.543	0.063		17	0.838	0.472	0.165	
18	1.000	0.486	0.022		18	0.816	0.396	0.069	
19	0.941	0.486	0.000		19	0.849	0.323	0.000	
20	1.000	0.457	0.062		20	1.000	0.274	0.000	
21	1.000	0.457	0.000		21	0.750	0.274	0.000	
22	1.000	0.457	0.000		22	0.333	0.206	0.000	
23	0.169	0.457	0.000		23	1.000	0.068	0.000	
24	0.000	0.077	0.000		24	0.000	0.068	0.000	
25	0.000	0.000	0.000		25	0.000	0.000	0.000	

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**SCIMITAR HORNED ORYX
AGE STRUCTURE OF SSP POPULATION**

01 SEPTEMBER 1989

AGE CLASS IN YEARS	MALES	FEMALES
0 - 1	38	22
1 - 2	31	33
2 - 3	27	36
3 - 4	13	26
4 - 5	9	15
5 - 6	6	19
6 - 7	10	19
7 - 8	4	9
8 - 9	3	10
9 - 10	0	5
10 - 11	2	17
11 - 12	1	4
12 - 13	0	6
13 - 14	1	4
14 - 15	0	3
15 - 16	0	4
16 - 17	1	5
17 - 18	0	6
18 - 19	0	4
19 - 20	0	1
20 - 21	0	0
21 - 22	0	1
22 - 23	0	0
23 - 24	0	0

AGE STRUCTURE SUMMARY

RANGE (IN YEARS)	MALES	FEMALES
0 - 5	118	132
5 - 10	23	62
10 - 15	4	34
15 - 20	1	20
20 +	0	1
TOTAL	146	249

**SCIMITAR HORNED ORYX
AGE STRUCTURE OF SSP POPULATION**

(AFTER REMOVAL OF ANIMALS WITH UNKNOWN ANCESTRY)

01 SEPTEMBER 1989

AGE CLASS IN YEARS	MALES	FEMALES
0 - 1	38	16
1 - 2	27	22
2 - 3	17	25
3 - 4	8	19
4 - 5	9	11
5 - 6	3	16
6 - 7	5	13
7 - 8	0	7
8 - 9	3	10
9 - 10	0	4
10 - 11	2	15
11 - 12	1	3
12 - 13	0	6
13 - 14	1	3
14 - 15	0	3
15 - 16	0	4
16 - 17	1	5
17 - 18	0	6
18 - 19	0	4
19 - 20	0	1
20 - 21	0	0
21 - 22	0	1
22 - 23	0	0
23 - 24	0	0

AGE STRUCTURE SUMMARY

RANGE (IN YEARS)	MALES	FEMALES
0 - 5	87	93
5 - 10	11	50
10 - 15	4	30
15 - 20	1	20
20 +	0	1
TOTAL	103	194

**SCIMITAR HORNED ORYX
AGE STRUCTURE OF SSP POPULATION**

(AFTER REMOVAL OF ANIMALS WITH UNKNOWN ANCESTRY AND THOSE MARKED "HOLD DEMOGRAPHY")

01 SEPTEMBER 1989

AGE CLASS IN YEARS	MALES	FEMALES
0 - 1	17	16
1 - 2	26	22
2 - 3	16	25
3 - 4	8	19
4 - 5	7	11
5 - 6	1	16
6 - 7	2	12
7 - 8	0	7
8 - 9	2	10
9 - 10	0	4
10 - 11	0	15
11 - 12	0	3
12 - 13	0	6
13 - 14	0	3
14 - 15	0	3
15 - 16	0	4
16 - 17	1	5
17 - 18	0	6
18 - 19	0	4
19 - 20	0	1
20 - 21	0	0
21 - 22	0	1
22 - 23	0	0
23 - 24	0	0

AGE STRUCTURE SUMMARY

RANGE (IN YEARS)	MALES	FEMALES
0 - 5	74	93
5 - 10	5	49
10 - 15	0	30
15 - 20	1	20
20 +	0	1
TOTAL	80	193

SCIMITAR HORNED ORYX
SSP POPULATION
FOUNDER ALLELE REPRESENTATION

01 SEPTEMBER 1989

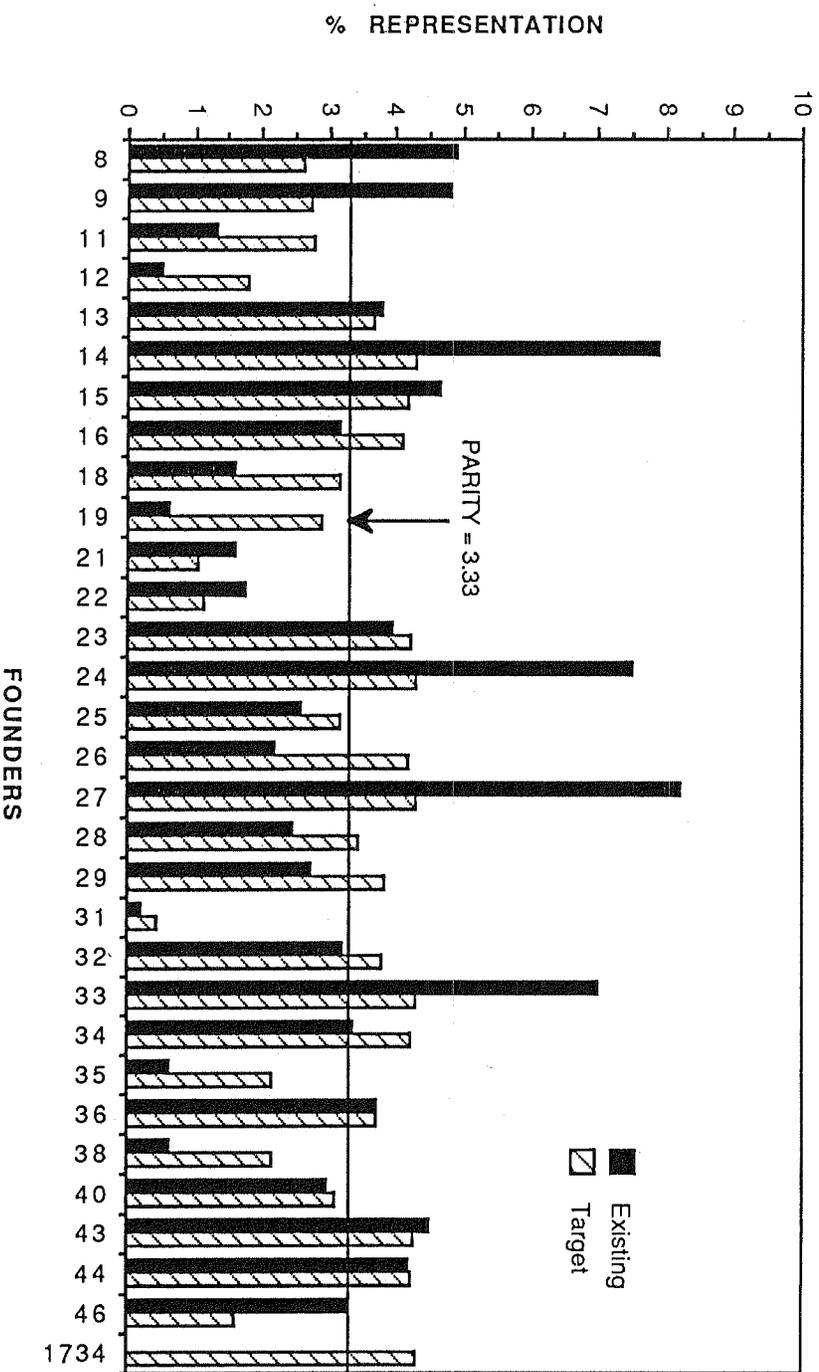
Founder	Retention	Percent Representation	Target	Difference
8F	0.611	4.986	2.623	-2.363
9M	0.634	4.805	2.724	-2.081
11F	0.646	1.342	2.778	1.436
12F	0.421	0.525	1.811	1.286
13F	0.854	3.791	3.667	-0.124
14M	0.999	7.906	4.292	-3.613
15F	0.977	4.664	4.196	-0.468
16F	0.959	3.152	4.118	0.966
18F	0.733	1.587	3.150	1.562
19F	0.670	0.612	2.881	2.269
21F	0.246	1.599	1.059	-0.540
22F	0.261	1.769	1.119	-0.650
23M	0.985	3.943	4.230	0.288
24M	0.998	7.497	4.288	-3.209
25F	0.740	2.560	3.177	0.617
26F	0.976	2.191	4.191	2.000
27M	0.998	8.190	4.286	-3.904
28F	0.795	2.446	3.418	0.972
29F	0.890	2.745	3.824	1.079
31F	0.099	0.205	0.423	0.218
32F	0.881	3.211	3.788	0.576
33M	1.000	7.010	4.297	-2.713
34F	0.981	3.376	4.215	0.839
35F	0.500	0.624	2.148	1.524
36M	0.868	3.713	3.727	0.015
38F	0.500	0.633	2.148	1.515
40F	0.718	2.952	3.083	0.131
43M	0.987	4.483	4.239	-0.244
44F	0.981	4.193	4.215	0.022
46M	0.369	3.289	1.585	-1.704
1734FL	0	0	4.297	4.297

GENETIC SUMMARY

	LIVING DESCENDANT POPULATION	POTENTIAL
Number of founders:	30	31
Parity (%):	3.333	3.226
Mean retention:	0.742	0.751
Founder Genomes Surviving:	22.273	23.274
Founder Equivalentents:	21.117	27.697
Founder Genome Equivalentents:	17.913	23.274
Fraction of wild heterozygosity retained:	0.963	0.979
Fraction of wild heterozygosity lost:	0.037	0.021
Mean inbreeding coefficient realized:	0.092	

SCIMITAR HORNED ORYX

SSP POPULATION



SCIMITAR-HORNED ORYX REINTRODUCED TO TUNISIA

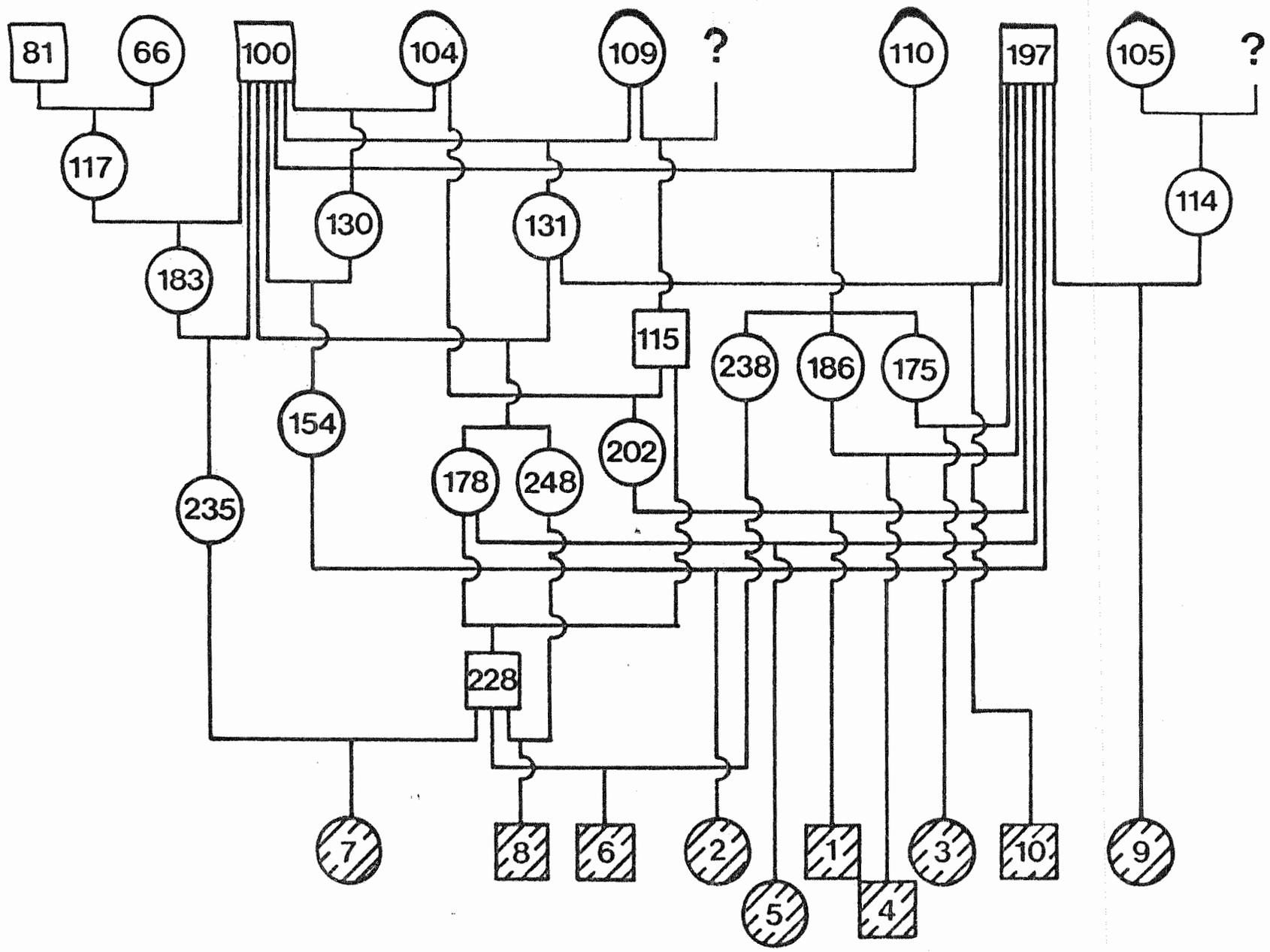
Georgina Mace, Institute of Zoology
ZSL, London

I have just reviewed the pedigree data on the scimitar-horned oryx reintroduced to Tunisia in 1985, and enclose (a) pedigree chart tracing the 10 reintroduced individuals (1-10) back to their ancestors (where unknown) and (b) a matrix of kinship coefficients (= inbreeding coefficients of offspring) from all possible pairs in the reintroduced herd.

I hope this will be useful in persuading the Tunisian authorities that there are several good reasons why new and unrelated genetic stock is needed:

1. The reintroduced herd are all quite closely related, seven were sired by one male (197) and three by another (228) and the maternal lines are also inter-related.
2. Inbreeding coefficients of calves born will be moderate in the first generation, but will soon increase. In general, we try to keep inbreeding coefficients below 0.125, and we chose the animals in Tunisia to keep to this as far as possible. The present breeding male is No. 1 (I believe) and I have included possible sons and daughters of his with each of the females in the matrix (Nos. 20-29); it is clear that once there is a second generation breeding, inbreeding levels are much too high.
3. All the reintroduced animals descend from 8 founders, some of which may themselves be related, and the herd is dominated genetically by founders 100 and 197. We can estimate that already over half the genetic variation carried by those founders has been lost, so the genetic diversity now present in the reintroduced herd is probably equivalent to, at most 3-4 unrelated founder animals.

(a)



(b) KINSHIP MATRIX (Kinship coefficients = unbreeding coefficient of offspring)

		MALES									
		6	1	8	4	10	20	21	22	23	24
FEMALES	7	.333	.035	.253	.070	.109	.303	.053	.070	.012	.036
	1	.086	.125	.070	.138	.166	.033	.313	.148	.125	.145
	2	.082	.141	.105	.172	.172	.123	.155	.320	.133	.163
	9	.000	.125	.000	.125	.125	.063	.125	.125	.313	.125
	5	.133	.133	.180	.172	.219	.145	.152	.164	.129	.316
	25	.137	.269	.168	.098	.125	.285	.183	.195	.165	.206
	26	.061	.313	.057	.155	.148	.183	.313	.234	.219	.232
	27	.059	.320	.074	.148	.156	.195	.234	.320	.223	.242
	28	.018	.313	.021	.125	.133	.165	.219	.223	.313	.221
	29	.084	.316	.111	.145	.190	.206	.232	.242	.221	.316

1-10 : reintroduced animals according to Wache's numbering system

20-29: calves sired by male No. 1 and each of the reintroduced females.

SCIMITAR-HORNED ORYX (Oryx tao)

Status in captive collections in North America (AAZPA) and Great Britain.

	<u>North America</u>	<u>Britain</u>	<u>Together</u>
Population size	296	64	360
Generations from wild-caught ancestors	2 - 10	1 - 6	1 - 10
Number of wild-caught founders	30	12	39
Founder genome equivalents	17.9	3.8	19.7

CBSG ARIDLAND ANTELOPE WORKSHOP

San Antonio, Texas, U.S.A.
13-15 September, 1989

ADDAX

1 February 1990

ADDAX PLAN

Introduction

The addax (Addax nasomaculatus) is one of the most desert-adapted of all large vertebrate species. Formerly ranging across the entire Sahara from Egypt to Senegambia, its numbers have been drastically reduced primarily through over-hunting and prolonged drought. Currently existing only in very small fragmented and isolated populations, it is at risk of imminent extinction. In light of its unique adaptations to one of the harshest environments on earth, the addax needs the immediate attention of the captive breeding community.

Objectives of Program

1. Survival of the species, ensured by development of a captive population managed in a way to provide the best genetic base of animals from which to repopulate or reinforce the wild.
2. Recovery of the species by re-introductions of animals to the wild, the protection of remnant, reinforced, and reintroduced populations in the wild, and the development of viable populations or a metapopulation (with a total number of at least 5000 distributed over subpopulations of at least 200 animals).

Status

The Addax antelope has perhaps as few as 300-450 individuals remaining in the wild in Mali, Niger, Algeria, Sudan, Chad and Tunisia. Because of the harsh environment it inhabits, it is difficult to obtain accurate population numbers throughout its range. Whether any individuals exist in any other country of its supposed range is questionable. Fortunately, the captive population has been productive. In the past year, the addax SSP has produced the first edition of its masterplan for the North American population. Continued work on the international studbook has identified more details of the overall captive population. The need to complete pedigrees for portions of the population still exists. The current captive population is as follows:

North America	SSP	191
	Non SSP	400+
United Kingdom		14
Europe		100
Middle East		150
Australia		3
Other		<u>16</u>
Total World		874

The primary objective is to maintain a viable captive herd for the next 200 years with 85% of founder genetic diversity and to provide individuals for re-introduction into its former range when possible. It is recognized that the captive population descends from a very limited genetic base, and some captive herds are probably already experiencing inbreeding depression. Every effort will be made to maximize effective founders through appropriate exchanges of individuals within the captive population and selective matings. Recommendations made which will improve the genetic variability and demographics of this species include the following:

1. Continue to further define the pedigrees in the captive population in an attempt to identify distinct founder lines that could be incorporated more effectively into the world herd.

- a. Encourage identification of individuals in the Middle East to assess their genetic value and maximize their use within the population.
 - i. We recommend that a North American male be made available to pair with the 0.2 females in Qatar. It is thought that these two females are unrelated to all other captive stock and this should be investigated further, including the use of molecular genetic techniques to establish the genetic proximity to existing stock. Efforts should be made to incorporate genetic material from these two females into the captive population outside of the Middle East.
 - ii. Explore the possibility that additional unrelated stock may be available from collections in Saudi Arabia.
 - b. Need to identify individuals currently held in private hands in North America to evaluate better their potential value to the population.
2. Continue development of embryo collection / cryopreservation techniques by Dr. Duane Kramer of Texas A & M University for the purpose of facilitating the transfer of genetic material.
 3. Support the use of molecular genetic techniques to assist in determining the relationships of individuals in the population. DNA fingerprinting analyses are being conducted in collaboration with Dr. John Patton of Washington University; mitochondrial DNA and MHC analyses will be undertaken by Ed Spevak of the University of Illinois/Fossil Rim Wildlife Trust; electrophoretic analyses of protein variation will be pursued by Dr. Robert Lacy at the Chicago Zoological Park. These varied analyses are complementary means to determine the relationships between herds and between individuals. Sample collection and distribution to all researchers will be coordinated by Dr. Evan Blumer of Fossil Rim Wildlife Trust. Sample collection and distribution protocols will help ensure that suitable material is obtained from all addax of importance to captive breeding programs.
 4. Successful reinforcement and reintroduction of wild populations, and appropriate management of captive stocks that are to provide animals to the wild, requires knowledge of the natural social structure of addax herds. We therefore encourage the field studies by Ed Spevak to assess the social behavior of addax in the semi-free ranging herds at the Fossil Rim Wildlife Park.
 5. Recommend that the Australian-New Zealand population be augmented demographically and genetically as quickly as possible.
 6. Endorse the move by the EEP to add this species to their program to enhance their active involvement in the conservation of addax.
 7. Recognize that because of small founder stock, this species would benefit from the addition of wild caught individuals if the possibility to acquire these occurred.
 8. Encourage and support a survey of the Ouadi Rime - Ouadi Achim region of Chad as proposed and agreed upon by WWF and the government of Chad to census the remnant population and, if present, to support its protection from further decline.

VETERINARY CONSIDERATIONS

Veterinary considerations are of great importance when planning an introduction or re-introduction of desert antelopes, and these should comprise one of the vital pre-translocation planning phases of any reintroduction operation. In fact, possible veterinary complications should be taken into account during the search for a suitable release site.

The veterinary hazards are predominantly twofold:

1) it must be ensured that the founder animals, which perforce, will probably originate in the U.S., do not suffer from any inapparent infection which will present a disease risk to wild or domestic stock in the reception area.

2) since the founders will probably have been raised in relative isolation and may lack immunity to endemic diseases present in the reception area, an appraisal of these risks must be made prior to release so that appropriate protection (usually vaccinations) can be assured.

Failure to take account of either of these disease hazards has resulted in unexpected and expensive failures of reintroduction projects in the past and could bring a very useful conservation technique into disrepute.

Subsequent to reintroduction, a program of health and disease monitoring should be implemented at the release site. To be effective this program should include a training component for a local national veterinarian.

REPRODUCTIVE RESEARCH

Additional research and development is needed for adapting gamete and embryo cryopreservation, artificial insemination, embryo transfer and related technologies for application to the addax. These technologies will be important for translocation of genetic representation from founder animals between locations, enhancing genetic representation of under-represented breeding stock, and propagation of animals in small populations of SSP animals where genetically "surplus" animals are available. These technologies have been proven to be biologically feasible in this species, and although improvements in efficiency are needed, their cost/benefit ratios may be favorable at the present time under certain specific circumstances. Likewise, birth control measures, such as vasa-deferens plugging and tubal ligation should be considered for obtaining appropriate genetic balance within populations where carrying capacity is limited and breeding dynamics are enhanced by the presence of peripheral males or females.

BEHAVIORAL RESEARCH

Because very little work was done with this species in the wild prior to its rapid decline, little or no behavioral data were ever collected. In an effort to help us understand better the needs of these animals prior to release and to aid us in making the releases as smooth as possible, it is recommended that we complete a thorough study in as normal conditions as can be obtained.

**ADDAX, Addax nasomaculatus,
HISTORICAL PERSPECTIVE AND STATUS**

Terrie Correll

The addax, Addax nasomaculatus (de Blainville, 1816) is the only species in its genus and there are no recognized subspecies. They are less dependent on moisture than oryx and can survive in very arid regions.

The original range of addax probably extended throughout most of the Sahara from the Rio de Oro and Algeria eastward to the Nile. Also, there may have been a small, isolated population in the Sudan, east of the Nile. Addax inhabit desert and semi-desert regions except for rocky slopes. Like most of the Saharan fauna, the addax has been decimated by indiscriminate hunting since the turn of the century. A combination of low numbers, prolonged drought and continued wars in the region where addax are found has pushed addax to the brink of extinction. There are more addax in captivity than remain in the wild.

In 1966, Dolan published an international studbook for addax. In 1965 he reported 47 addax living in North American facilities. Dolan continued to monitor the species for another 2 years and, in 1967 he calculated that a total of 72 addax were living in collections worldwide.

Since 1967 the number of captive addax has grown. The current ISIS SDRS for mammals (December 1988) reported 76,152 addax in captivity. Of these, 67,126 are in North American collections. The only census data is from the 1986 International Zoo Yearbook. The most recent census of rare animals in captivity indicated that there were 409+ individuals in collections worldwide with 225 individuals in North American collections. The international studbook (in progress) for addax currently estimates 800+ individuals worldwide. The estimates do not reflect all of the animals held in private ownership.

INTRODUCTION

The addax is a species which is virtually extinct in the wild, which has reproduced well in captivity but with individual (i.e., studbook-like) records frequently not available, and which now has the opportunity to be reintroduced into its natural range. Survival of this species now depends upon well managed captive propagation programs. Thus, the goal of the Addax Species Survival Plan (SSP) is to preserve a captive population and gene pool of this species for the ultimate purpose of providing animals for reinforcement of wild populations or reintroductions into their former range.

MVP analyses for Addax based on genetic considerations recommend a population of about 300 for the North American SSP. An MVP of this size should permit preservation of about 85% of the original heterozygosity that probably existed in the wild population for a period of 200 years. These objectives are slightly less than the 90% for 200 years that is frequently

adopted by SSP programs. However, with the loss of diversity that has already occurred and the limited number of founders for the North American population, the higher level of diversity may not be possible unless additional founders are located and/or cooperative global programs are developed.

Maximizing preservation of genetic diversity is best achieved by management of bloodlines or founder lineages.

Unfortunately, addax is a species which has been largely herd-managed with limited individual pedigree information maintained. Hence, there are many holes in the Addax pedigree. To compensate for the lack of normal pedigree records, the Addax SSP Masterplan working group used worst-case scenarios, process of elimination, and common-sense conclusions to "reconstruct" a plausible genealogy for the North American population.

There were 14 identifiable founders for addax and it has been possible to construct flow charts indicating inputs and outputs relative to founders or probable founders for each of the captive collections (refer to North American Addax chart). These 14 founders are traceable to wild caught animals from Chad and Hannover and Khartoum zoo stock. To formulate the demographic and genetic analysis for SSP individuals, certain animals were created and assumptions made in regard to pedigree. This was necessary as a starting point with some founders whose parentage traced back to Khartoum. Six additional founders were created for a total of 20 (refer to hypothetical pedigree). Some herds that had important founder representation lost individual identification over time. Determination of parentage for their offspring was based on the given possibilities within the herd. All hypothetical breedings were reconstructed using a worst case scenario.

Target representation is the desired representation of founders. Target figures are proportional to the fraction of each founder genome that has survived.

The SSP population of addax has 12 founders that have not met the target representation for founders. Six founders are over represented. Beyond producing animals for reintroduction, a 10% captive population growth will enable achievement of a more equal representation of founders to the addax SSP herd.

The large number of captive addax, spotty genealogy and the need for founder recruitment creates a management puzzle to be solved. The first draft of the Addax Masterplan outlines objectives, genetic and demographic analyses. Institutional and individual animal recommendations follow in an attempt to correct the problems within the captive herd.

The long term goal of an SSP group is the reintroduction of a species into its former range. A reintroduction program for addax is currently underway. The SSP will provide animals for this program based on the best genetic and demographic considerations for both the captive and wild populations.

ADDAX IN NIGER: DISTRIBUTION, STATUS AND CONSERVATION OPTIONS

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Niamey, Niger.

INTRODUCTION

This report summarizes the current distribution and status of the addax in Niger, and briefly reviews the major pros and cons involved in a potential reintroduction/capture and captive breeding program. It is complementary to the two previous ZSL/WWF/IUCN reports, which contain detailed descriptions of the proposed reintroduction project, the ecology of the addax, and the proposed captive breeding center at Gadabeji. The information presented here will hopefully enable the formulation of a coherent addax conservation strategy at the Desert Antelopes Workshop in San Antonio, to be implemented as soon as possible.

PRESENT DISTRIBUTION

The addax, Addax nasomaculatus, was formerly widespread and abundant in the Sahara. The species has disappeared from most of its original range and the remnant population found in the Air/Termit/Bilma region of north-eastern Niger may represent the last viable wild herd in existence (Map 1).

Addax live in extremely inhospitable, uninhabited, remote desert regions. Information on their distribution is received by the WWF/IUCN representation in Niger from two main sources: biologists working in the Air/Tenere National Nature Reserve on a WWF/IUCN Project, and sightings reported by tourists and their guides. The scientific census has never been carried out on the species in Niger because of the vast region that would have to be considered (hundreds of thousands of square kilometers) and consequent financial and logistical problems.

Known or presumed sightings of addax in the last 24 months extend in an arc along the northern and eastern flanks of the Air Mountains, south to the Arbre du Tenere and the massif of Termit, and east to Fachi, Bilma and Agadem (Map 2). Within the Reserve, Project personnel found the distinctive tracks of 2 adult addax at Ifinyane (19°21'N 09°14'E) in June 1989; tracks were reported by locals from Tezirzek (19°18'N 09°00'E) in September 1988; and approximately 6 sightings were made by tourists over the course of 1988/1989 in the region of Adrar Bous (20°18'N 08°57'E).

More sightings have been reported from outside the Reserve. Several addax were seen between Arbre du Tenere and Fachi (18°00'N 11°00'E) during the period June 1988 - March 1989. Tracks were reported in April 1989 near Azelik (17°00'N 09°03'E) crossing the Agadez-Bilma road. However, the major concentration of animals appears to be between the massif of Termit (16°00'N 11°20'E) and the oasis of Fachi (18°10'N 11°30'E). Continual reports are received of sightings of groups of up to 5 or 6 addax, together with one report of the tracks of 10-12 animals in one group. Lone addax and pairs have also been seen between Termit and the oasis of Agadem (16°50'N 13°10'E) this year.

Based on this admittedly scanty information, it is estimated that there can be no more than 200 addax in the whole of Niger, and numbers may be as low as 50.

The decline in the addax population over the last 9 years can be inferred from examination of the official Project records (Table 1) from the Air/Tenere Reserve. To summarize, the yearly totals of addax observations from 1980 to 1989 have been 10, 0, 2, 7, 13, 7, 5, 2, 0, 2 respectively. This decline has occurred despite three factors that - other things being equal - should have led to an increase in observations: an increase in the number of field trips made to addax habitat by the Project; the creation of a protected area for the addax of 12,800 km² free from tourist disturbance; and the presence of abundant high-quality pasture due to good rainfall.

ANALYSIS OF POPULATION THREATS

Over the last 50 years, the addax population of Niger has been greatly reduced by three factors: hunting, drought (and consequent desertification), and tourism. The relative importance of these in the decline of the species has obviously changed with time.

1. Hunting has declined in importance. Initially legal, it was banned throughout Niger in 1961. However, poaching (particularly by the Nigerian armed forces) has been widespread and the law has been little enforced. Addax - along with the rest of Niger's wildlife - have suffered extensively. The threat to the addax population from hunting should continue to decrease for the following reasons:
 - a) The rarity of the species
 - b) The inaccessibility and remoteness of its last strongholds
 - c) The recent creation of properly managed protected areas
 - d) Improved effectiveness and motivation of the Nigerian Service Faune (Wildlife Service) responsible for enforcing the law

e) Heightened public awareness and pressure (e.g. appreciation of wildlife's tourist potential)

2. Tourism has increased steadily since the 1970's. Tourists have been known to chase addax at high speeds using 4-wheel drive vehicles, often exhausting the animals to the point of death. Though undoubtedly a significant factor in the decline of the addax over the last 20 years, in the near future its negative impact should decrease because of:

a) The recent creation of properly managed protected areas

b) Sensitization and education of tourists has increased (e.g. publication of tourists brochures) and can be developed further

c) The vast majority of tourists come from Europe, where environmental and ecological concerns are rapidly permeating public awareness

d) Increased contact and cooperation between the Wildlife Service and the tourist industry centered in Agadez and Arlit (e.g. education of tour guides)

3. Drought/Desertification/Habitat Loss. After the severe droughts of the late 70's/early 80's, the rainfall in the past three years has been exceptionally good. Points to bear in mind are:

a) Long-term trends in rainfall are completely unpredictable

b) Good-quality addax habitat and pasture are currently available

c) In some areas and types of habitat the effects of the recent series of droughts are probably irreversible (e.g. loss of woody vegetation to sand encroachment in desert fringe areas)

The overall prospects for the surviving addax population and the proposed reintroduction scheme are therefore more favorable now than at any time in the past decade, and the situation will hopefully continue to improve.

CLIMATIC/VEGETATION SITUATION

Rainfall in the region averages 0 - 50 mm/year, with the possibility of several consecutive years of drought. For good pasture development, several consecutive years rainfall are required. Rainfall data for Agadez, Arlit, Bilma and Iferouane for

the past 20 years are presented in Table 2. Rainfall is extremely localized and unpredictable. The probability of receiving pasture-producing rainfall can be estimated as only once every 10 years.

The Air massifs are atypical of the region as a whole for several reasons. The high mountains (up to 2000 meters) stimulate orographic rainfall, and the bare rock surfaces lead to a high degree of run-off and water concentration. As a result of these two factors, habitats and vegetation types more typical of the Sahelian/Sudanian zone can be found. The Air therefore forms an ecological island in a desert sea, and for the reasons outlined in the first ZSL/WWF/IUCN report is the area considered for the addax reintroduction project.

Wet and dry season addax pasture is currently available throughout most of the addax's range in Niger. Desert pasture will persist in the absence of further rainfall for from 3 - 5 years, depending on the species composition and the amount of initial rainfall. Should the rains fail next year, pastures in the Air/Tenere Reserve will probably remain viable for another 2 - 3 years, giving a reintroduction project a high probability of success.

CONSERVATION OPTIONS

At the recent 5th International Theriological Conference in Rome, a group of interested experts discussed the addax reintroduction proposal. Concern was voiced at the idea of "reintroducing" an animal into an area where a remnant wild population still existed, and the possibility of launching a capture attempt (followed by a captive breeding program) was raised. Some of the pros and cons involved in these two options are briefly outlined below.

PROS AND CONS OF IMMEDIATE REINTRODUCTION AS PER PROPOSAL

1. Pros

- a) Conservation impact: generation of international publicity.
- b) Political impact: pressure on administration, knock-on effect of protection for other species, replicability.
- c) Reinforcement of small declining local population (genetic and social boost)
- d) Availability of good pasture, likely to persist for several years
- e) Reintroduction should lead to addax spreading into currently unpopulated areas, leading to a strengthening of the population

- f) Current interest from Wildlife Service and local population
- g) Recent increase in awareness of conservation in Niger (e.g. creation of Nigerian NGO's concerned with the protection of nature and natural resources)
- h) Favorable legislation
- i) Existence of managed specific Strict Nature Reserve for addax (12,800 km²) and of buffer zone (77,360 km²) in the Air
- j) Existing logistical support (Air/Tenere Project)
- k) Existing financial support
- l) Relative cheapness of operation: rapid release of large numbers of addax over a short time-span
- m) Existing local and national technical support (but note possible departure of John Newby within next two years)
- n) Interested external qualified technical support (ZSL)
- o) International institutional interest (ZSL, AAZPA, IUCN, WWF, etc.)
- p) Existence of large numbers of addax in captivity.

2. Possible Cons

- a) Genetic dilution of wild gene pool
- b) Introduction of disease/parasites, or poor resistance of introduced animals to local diseases/parasites
- c) Introduction of aberrant behavior leading to poor adaptation to local environment
- d) Reintroduced animals may be totally unable to adapt to the harsh local conditions
- e) Death of captive animals before or after release
- f) Financial cost?

- g) Logistic considerations - transport of animals to Niger and release site
- h) Possibility that loss of habitat through prolonged drought is the primary factor in the decline of the addax, which is therefore undergoing a natural extinction

PROS AND CONS OF ESTABLISHING A CAPTIVE BREEDING/CAPTURE PROGRAM

1. Pros

- a) Capture of animals from the wild would provide a genetic boost to the world captive population which is derived from relatively few founders and suffers inbreeding depression
- b) Nigerian genetic stock known to be adapted to local conditions would be secured, and could then be bred from to provide individuals for eventual reintroduction to the same area
- c) The wild population is possibly declining to extinction anyway, therefore it may be best to attempt to save a few individuals
- d) Favorable political situation and government support for the proposed captive breeding center at Gadabeji

2. Cons

- a) Extreme difficulty of locating the last few wild individuals
- b) Inaccessibility of the terrain will make capture and transport extremely difficult
- c) Establishment of logistic and technical support in a new area of Niger (potential capture site would most probably be in the region of Termit)
- d) Probability that only a very few individuals will be successfully captured (maximum likely to be 6)
- e) Financial considerations: high costs and obtaining funding
- f) High possibility of deaths during capture and consequent adverse publicity
- g) The attitude of the Nigerian government to a capture attempt is not known, since no approach has so far been made

- h) The proposed Gadabeji breeding center is in the Sahelian zone, far to the south of the addax's range, so the habitat and climate may not be ideal for addax
- i) Disruption (physical, social) to the addax population caused by capture activities may drive them to extinction in the wild
- j) Long-term nature of project

SUGGESTED SCENARIO

In the light of the considerations for both the reintroduction and captive breeding/capture programs outlined above, the WWF representative in Niger suggests the following action:

1. Go ahead with the proposed short-term release program for 1991
2. Simultaneously establish a capture program to reinforce captive genetic stock

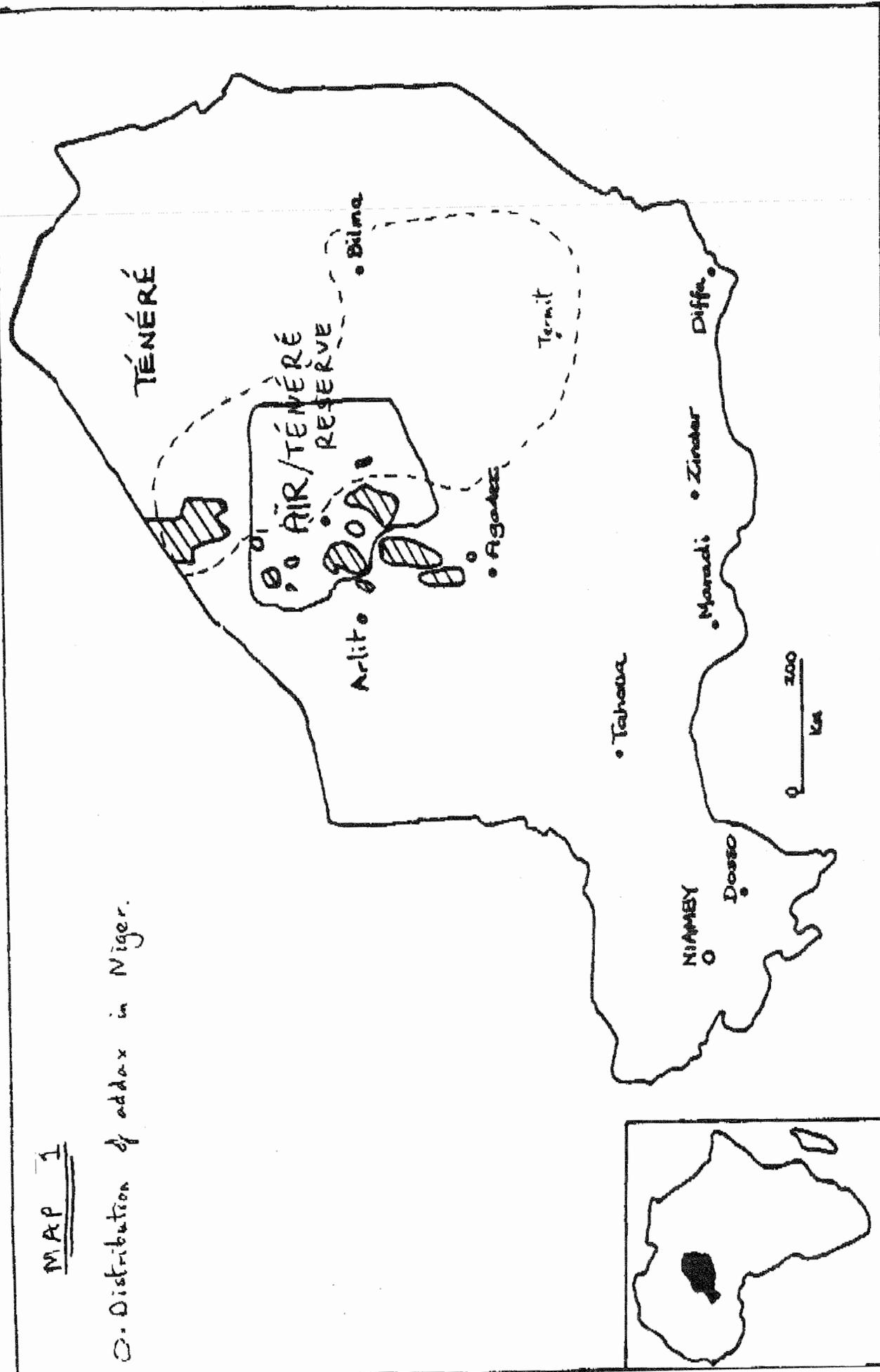
Two alternatives are possible for the subsequent captive breeding of wild-caught individuals: a) Keeping the animals in Niger, involving the establishment of a captive breeding capacity (e.g. Gadabeji proposal) and probable importation of additional zoo stock; b) Moving the animals to Europe or America and integrating them into the world herd.

The international zoo community is better placed to evaluate the relative merits of these two courses of action than ourselves (e.g. consideration of quarantine restrictions, possibility of using A.I. techniques and transporting gametes rather than animals, provision of adequate veterinary facilities, etc.).

In either case, the full cooperation of the Nigerian government must be sought at an early a stage as is practical, i.e. as soon as a consensus on what plan of action to take is reached.

MAP 1

0. Distribution of addax in Niger.

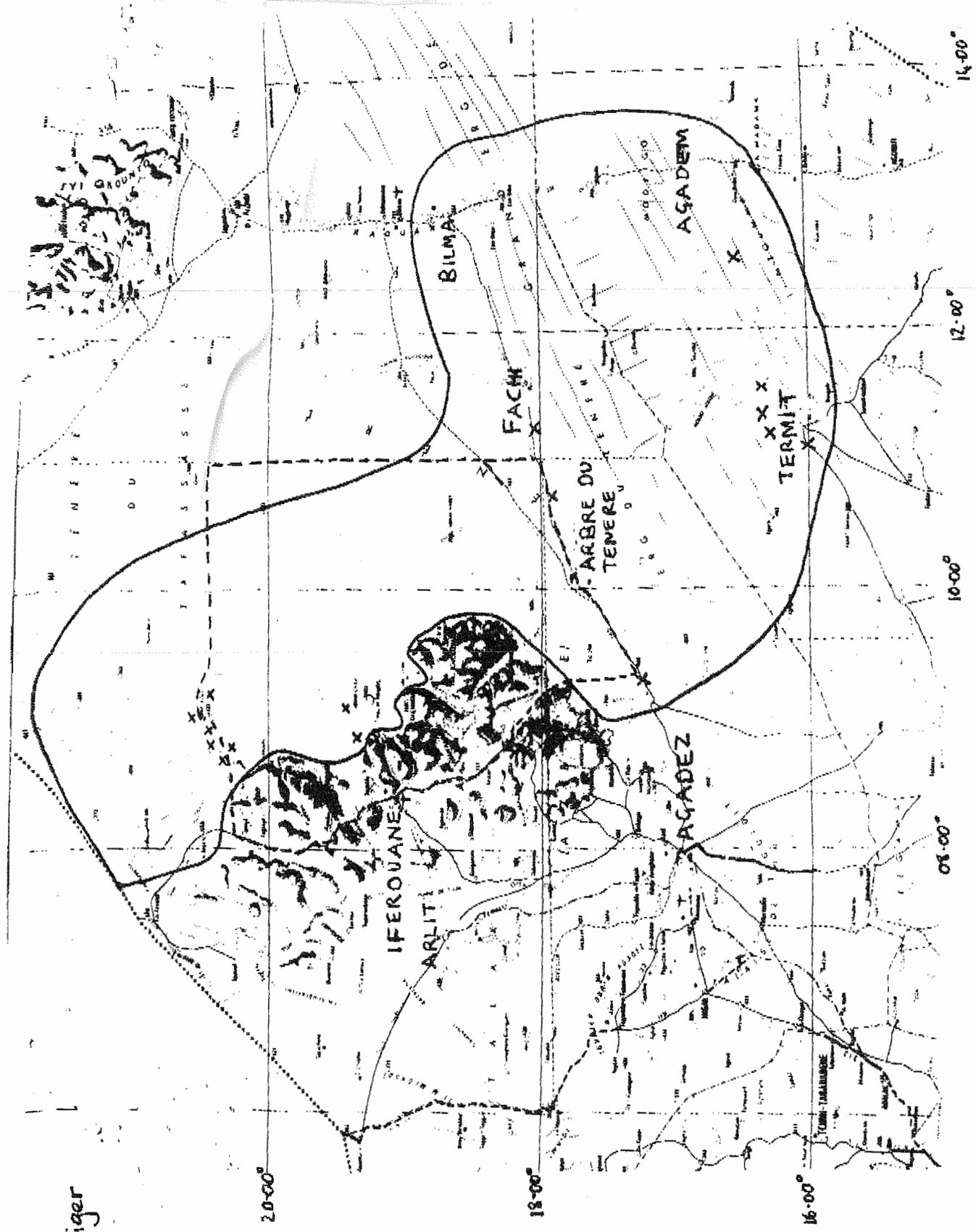


MAP 2

○ = Distribution of addax in Niger

□ = Air/Tenere Reserve

x = Sightings of addax in past 24 months



DATE	PLACE	TOT	MAL	FEM	UNC	IMM	JUV	LAT	LONG	HABITAT	TRACKS
05/27/80	Issaouan	1	0	0	1	0	0	19°05'N	09°22'E		.F.
05/27/80	Issaouan	8	0	0	8	0	0	19°05'N	09°22'E		.T.
05/28/80	Issaouan	9	1	0	8	0	0	19°09'N	09°27'E		.F.
05/28/80	Tezirzek	1	1	0	0	0	0	19°19'N	08°57'E		.F.
08/05/82	Izouzadene	2	0	0	2	0	0	19°33'N	09°13'E		.T.
06/15/83	Issaouan	1	0	0	1	0	0	19°09'N	09°30'E		.F.
07/02/83	Issaouan	1	0	1	0	0	0	19°07'N	09°27'E		.F.
08/07/83	Issaouan	2	1	1	0	0	0	19°07'N	09°27'E		.F.
08/20/83	Issaouan	3	0	0	3	0	0	19°07'N	09°27'E		.F.
03/22/84	Issaouan	1	1	0	0	0	0	19°07'N	09°27'E		.F.
06/21/84	Issaouan	5	1	3	0	1	0	19°05'N	09°25'E		.F.
06/24/84	Teywak	2	1	1	0	0	0	20°07'N	08°39'E		.F.
08/17/84	Issaouan	3	0	0	3	0	0	19°09'N	09°30'E		.F.
12/03/84	Arakao	1	0	0	1	0	0	19°04'N	09°41'E		.T.
02/08/85	Tezirzek	1	0	0	1	0	0	19°18'N	09°00'E		.T.
05/24/85	Temet	1	0	0	1	0	0	19°58'N	08°43'E		.T.
05/24/85	Emzeggar	1	0	0	1	0	0	19°39'N	08°51'E		.F.
05/24/85	Emzeggar	2	0	0	1	0	1	19°40'N	08°51'E		.T.
08/15/85	Issaouan	2	0	0	2	0	0	19°07'N	09°29'E		.F.
11/21/85	Issaouan	1	0	0	1	0	0	19°06'N	09°24'E		.T.
01/19/86	Emzeggar	1	0	0	1	0	0	19°43'N	08°48'E		.T.
03/02/86	Issaouan	1	0	1	0	0	0	19°07'N	09°27'E		.F.
03/03/86	In-Farane	1	0	1	0	0	0	19°20'N	09°22'E		.F.
06/18/86	Tchoumjoufjouf	2	0	0	2	0	0	19°51'N	08°44'E		.F.
06/20/87	Emzeggar	2	0	0	2	0	0	19°40'N	08°49'E		.T.
06/24/89	Ijinyane	2	0	0	2	0	0	19°21'N	09°14'E		T

TABLE 1

Addax observations in the Air from 1980-1989.

T = Tracks
F = Sighting

TABLE 2: ANNUAL RAINFALL 1968 - 1988
FOR 4 STATIONS IN THE DEPARTEMENT OF AGADEZ, NIGER

Data from Centre Informatique, Meteo Nationale, Niamey

YEAR	AGADEZ	ARLIT	BILMA	IFEROUANE
1968	165.1	-----	26.7	81.5
1969	81.6	-----	14.3	97.0
1970	39.7	-----	6.8	1.5
1971	92.6	-----	2.0	-----
1972	73.9	1.1	19.8	-----
1973	76.3	0.5	0.5	-----
1974	135.2	88.3	16.0	-----
1975	134.9	13.4	0.1	-----
1976	106.6	50.4	34.9	-----
1977	70.7	64.9	4.5	-----
1978	100.5	0.0	15.1	-----
1979	107.6	0.0	6.7	-----
1980	156.1	41.9	1.6	105.0
1981	127.0	57.1	12.3	85.9
1982	138.0	23.8	19.6	26.4
1983	94.2	9.5	0.3	20.7
1984	4.2	16.7	0.0	14.4
1985	60.8	42.9	21.5	14.0
1986	96.5	115.8	3.0	46.0
1987	51.5	20.9	1.0	30.1
1988	136.6	50.0	23.1	35.8

ADDAX - GENETIC ANALYSES

Georgina Mace, Institute of Zoology
ZSL, London
September 1989

1) Status Of The Captive Populations

The AAZPA SSP population, and the European animals of known origin were traced as far as possible back to wild caught founders. Conservation assumptions about unknown ancestors were as listed in the AAZPA master plan. These formed the basis for the following analysis.

Although there are large populations outside these two areas, little information was available concerning them or their origins. At present, there are over 500 animals in captivity, and there are urgent needs to investigate these other sources further.

Table 1 Summary status of the captive populations.

	<u>Europe</u>	<u>AAZPA SSP</u>	<u>Eur. ± SSP</u>
# Living	40	191	231
# Founders	16	19	22
# Effective Founders	14	19	19
# Unique Alleles	11.5 (8-16)	22.3 (17-27)	23.7 (19-28)
Founder Genome Equiv.	3.6	4.14.7	
Founder Heterozygosity	-	-	80

Estimated probability of having lost alleles rare in ancestral wild population (q = freq. of rare allele)

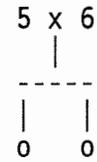
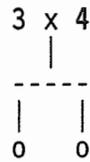
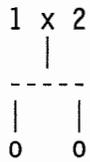
q = 0.05	-	-	0.285
q = 0.10	-	-	0.083
q = 0.3	-	-	0.000

The small founder population size, by whatever measure, is clearly a problem. Assuming that this group of animals is the basis for any serious conservation program for the species we can now look at the impact of adding additional wild caught animals.

2) Impact Of Additional Wild Caught Founders

I have assumed that 6 additional wild caught founders are added to the managed captive population, and have examined the extreme situations where the sex ratio is 3.3 and 1.5. All the 6 animals are assumed to breed to replace themselves numerically, and the analysis examines the effect on the population when they have died and their offspring survive. Their breeding is assumed to be as follows:

i) Sex Ratio 3.3.



ii) Sex Ratio 1.5.



The same statistics were then examined for the entire captive managed population plus the 6 offspring of these additional founders.

Table 2 Effect of 6 additional founders on the genetic status of the captive population.

	<u>SSP + Eur.</u>	<u>SSP + Eur.</u> <u>+ 3.3</u>	<u>SSP + Eur.</u> <u>+ 1.5</u>
# Living	231	237	237
# Eff. Founders	19	25	25
# Unique Alleles	23.7 (19-28)	32.7 (27-38)	31.3 (26-37)
Founder Genome Eq.	4.7	5.0	4.9
Founder Heteroz. Ret.	80%	80%	80%

Estimated probability of having lost alleles rare (freq. = q) in ancestral wild population.

q = 0.05	0.285	0.190	0.188
q = 0.10	0.083	0.025	0.039
q = 0.30	0.000	0.000	0.000

The six additional founders make an appreciable difference, especially to the scores reflecting allelic diversity, and the reduced loss of rare alleles is quite marked. Founder genome equivalents are not greatly affected. I think because the present founder representative levels are so far from ideal values.

We can now look at the genetic status of 20 reintroduced animals with and without 6 additional founders.

3) Genetic Status Of Reintroduced Population Of 20 Individuals

Time limitations precluded my looking at any sophisticated method of selecting animals for reintroduction. For the present purposes, I selected 20 animals which were the youngest 20 in the managed captive population which have different parents. I looked at various measures of the genetic status of these. I then assumed that these would be supplemented by 6 additional wild caught founders, in two different sex ratios (3.3 and 1.5) which bred as described above. The results are as follows.

Table 3 Impact of new wild caught founders on a population of 20 addax from the present captive population.

	<u>20 Animals</u>	<u>20 + 3.3</u>	<u>20 + 1.5</u>
# Living	20	26	26
# Eff. Founders	14	20	20
# Unique Alleles	11.3 (6-18)	20.2 (14-27)	18.6 (14-25)
Founder Genome Equiv.	3.18	5.12	4.84
Founder Heteroz. Pres.	69.3	78.3	74.1

Estimated prob. of losing alleles rare (freq. = q) in ancestral wild population.

q = 0.05	0.585	0.361	0.414
q = 0.10	0.315	0.122	0.136
q = 0.30	0.020	0.000	0.002

The benefits of additional founders to the allelic measures are quite marked, even when there is an unfavorable sex ratio (1.5). In genetic terms, the inclusion of the 6 wild caught founders in the reintroduced population would have a variety of benefits, and is certainly better than including many more individual animals from the captive population. Most scores under 20 + 3.3 compare very well with the same measures for the 231 captive animals. There are of course other factors to be considered.

**Effect of Immigration and Inbreeding
on Addax Populations**

Prepared by

G. Mace

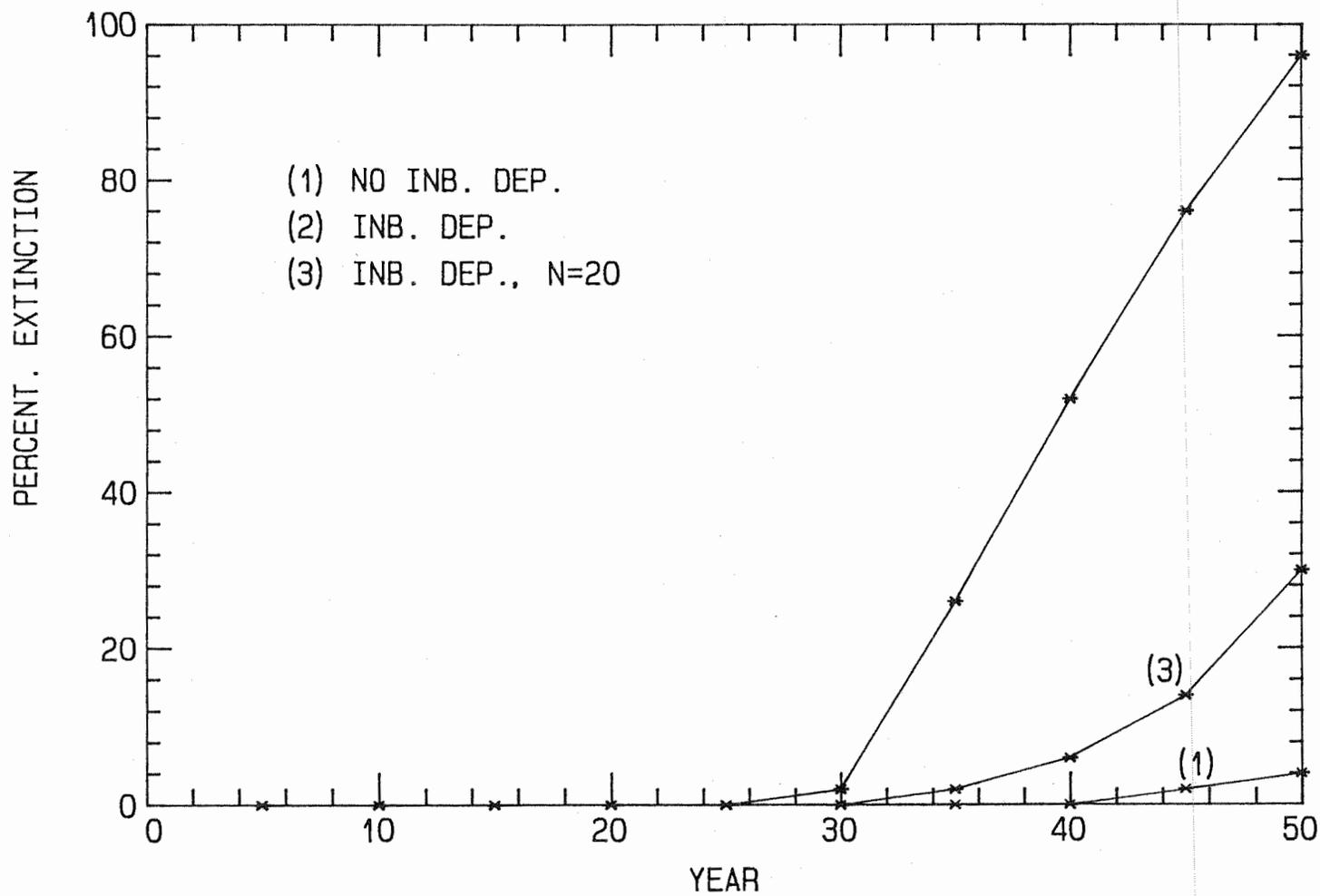
COMPONENTS OF ADDAX SIMULATION (50)

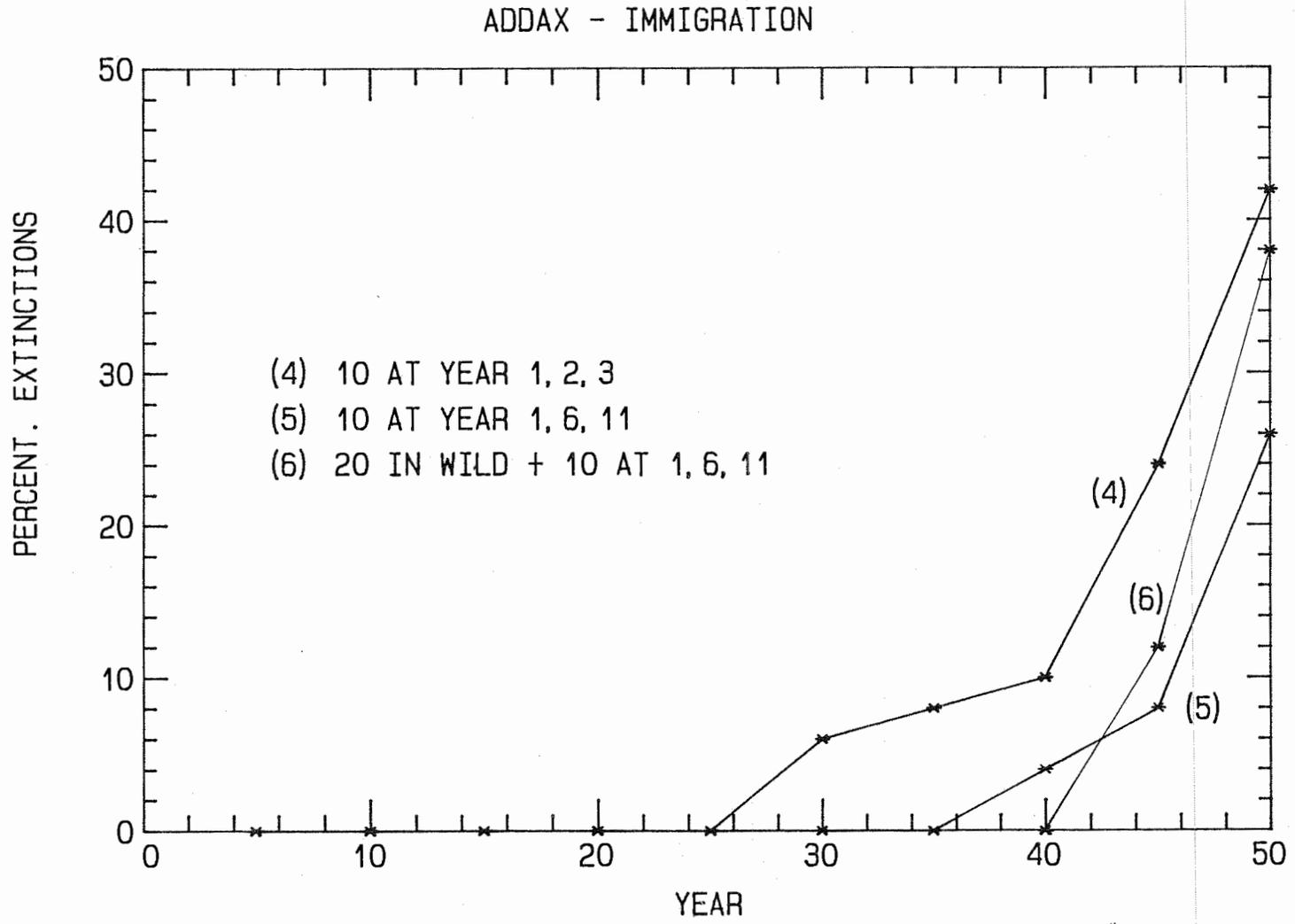
- 1 STARTING POPULATION
- 2 ALLOCATE GENETIC DIVERSITY
- each year for 50 years: -
- 3 MATING
- 4 MORTALITY
 (density dependence)
 (inbreeding depression)
- 5 IMMIGRATION
- 6 BREEDING
- 7 CENSUS

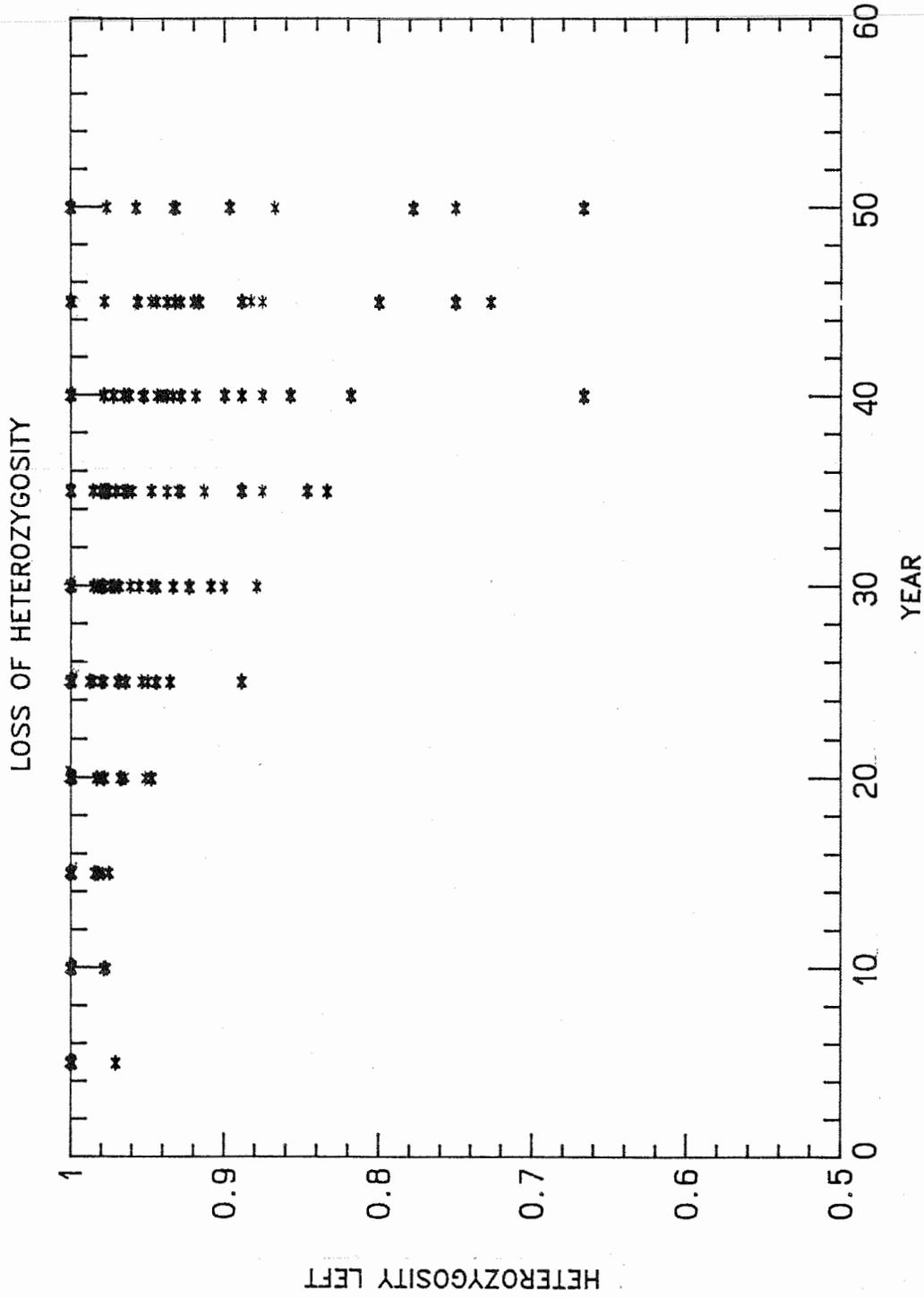
ADDAX SIMULATION

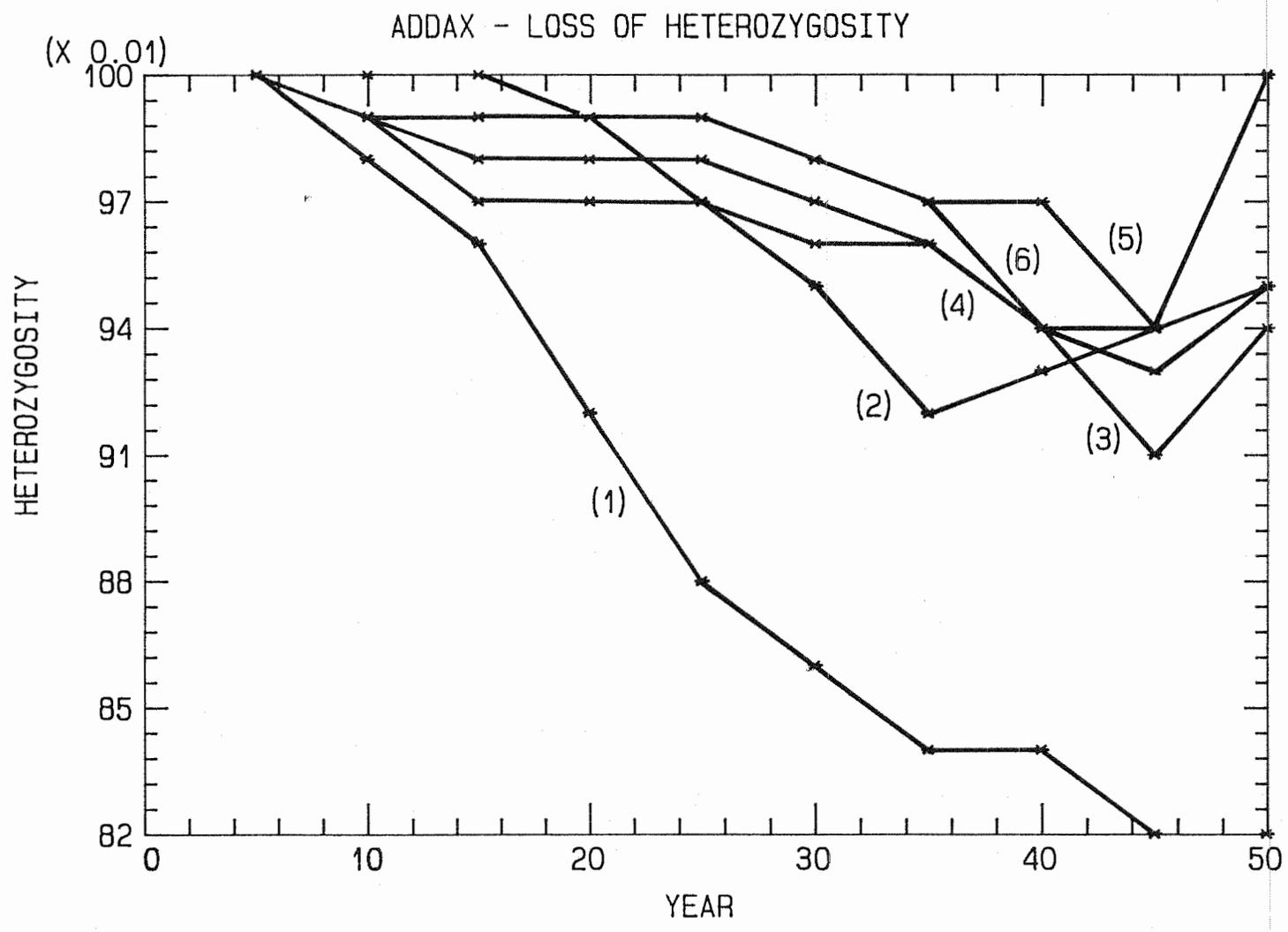
<u>NO</u>	<u>STARTING POP. SIZE</u>	<u>IMMIGRATION</u>	<u>INBREEDING DEPRESSION</u>
1	10	NONE	NONE
2	10	NONE	B = 3.0
3	20	NONE	B = 3.0
4	10	10 at 1, 2, 3	B = 3.0
5	10	10 at 1, 6, 11	B = 3.0
6	10 + 20 WILD	10 at 1, 6, 11	B = 3.0

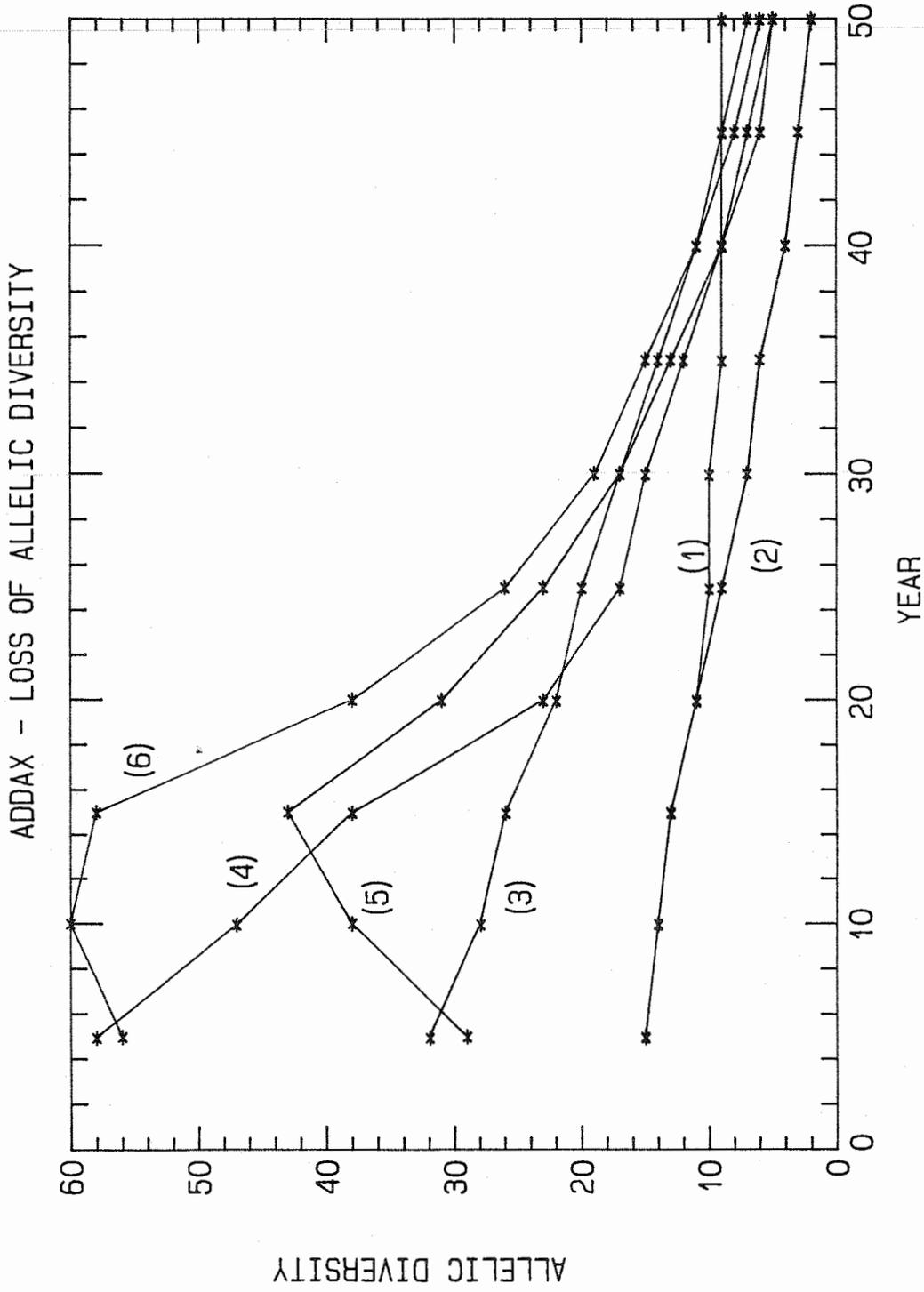
ADDAX - NO IMMIGRATION

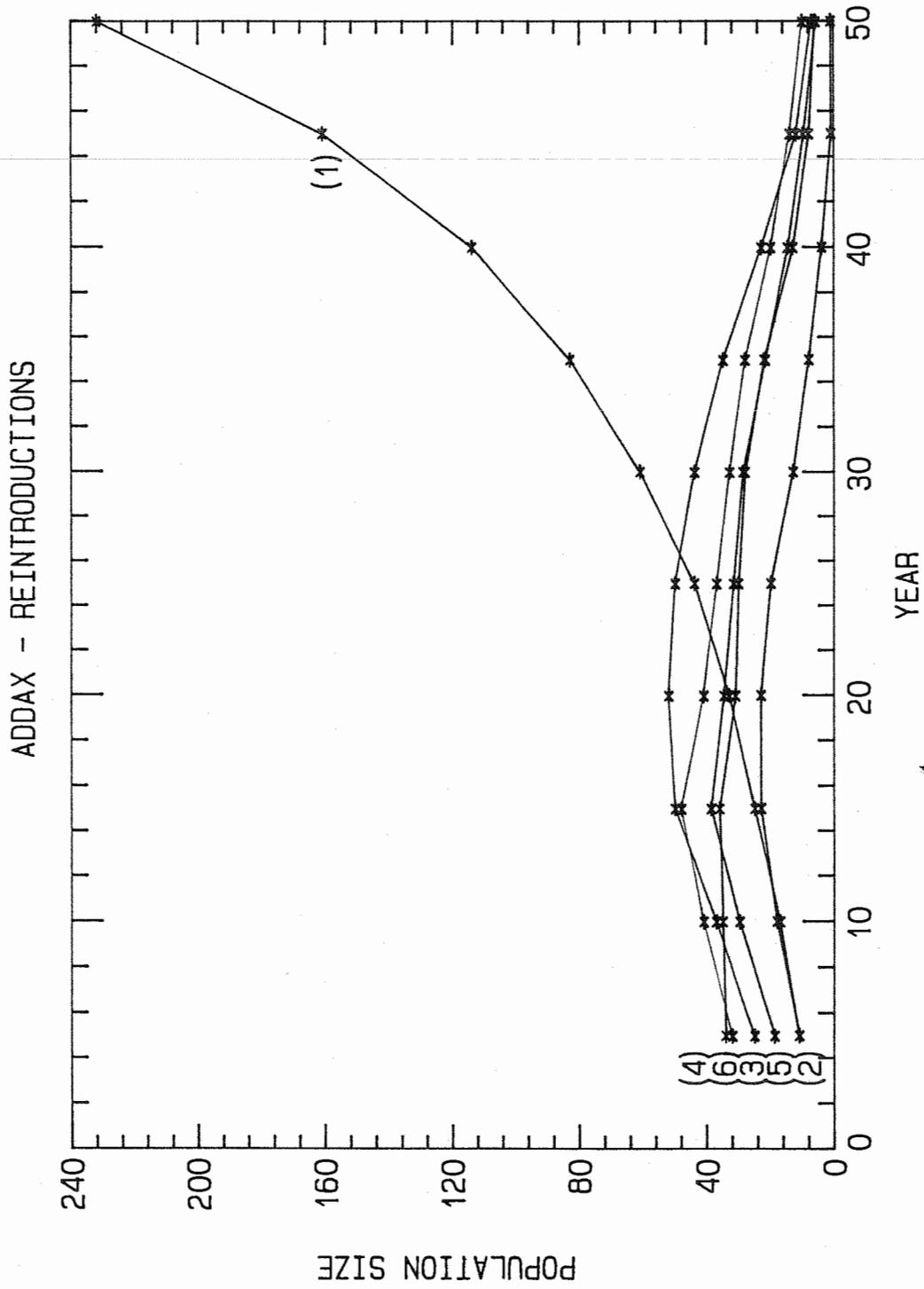




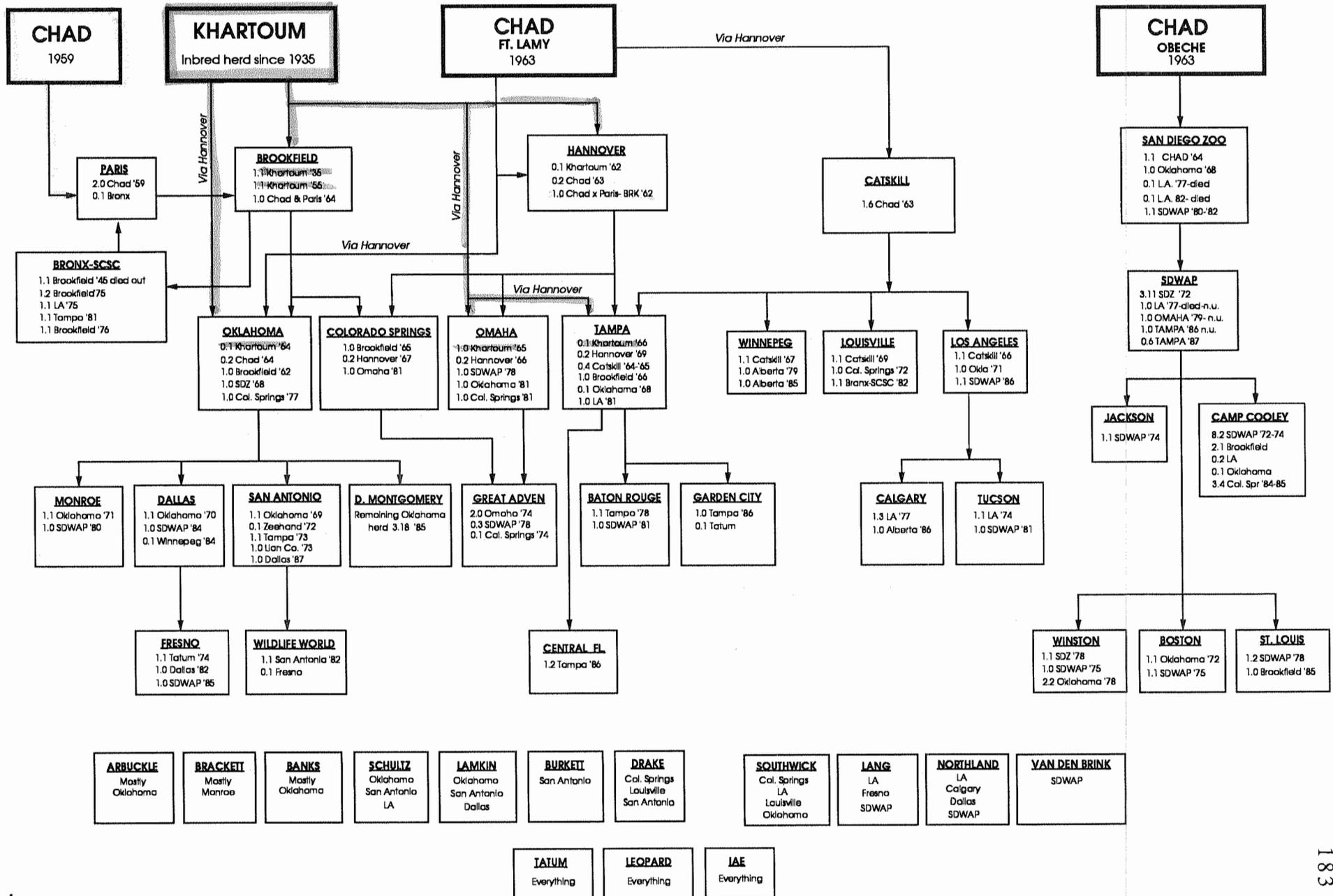








North American Addax



**ADDAX
SSP MASTERPLAN OBJECTIVES**

- 1 Assist with restoration and reinforcement of addax populations in natural habitats.
- 2 Attempt to preserve at least 85% of the genetic diversity for 200 years understanding that a higher percentage of diversity may be attainable if:
 - a) Greater number of founders are obtained.
 - b) Cooperative global program is developed.
- 3 Increase North American captive capacity to 300 spaces, allowing expansion of the population from 200 to 300 animals, over the next five years.
- 4 Provide 10 to 30 per year for projects dealing with reintroduction of the species.
- 5 Recruit 5 - 15 additional effective founders.

Potentially 5 more founders can be obtained through better management of the existing captive North American population.

An additional 5 - 10 through new acquisitions from wild and/or captive, unrelated population.
- 6 Develop breeding plans to move founder representation in population toward target distribution.
- 7 Regulate family sizes according to the offspring objectives.
- 8 10% per year, captive population growth, beyond the producing animals for reintroduction, which will require 45 matings in the next year.

**ADDAX
LIFETIME OFFSPRING OBJECTIVES**

(AVERAGE FIC = .51)

MALES

FIC VALUE =====	AT BIRTH =====	SURVIVE TO BREED =====
UNDER (FIC > .6)	12	7.2
OK (.445 < FIC < .6)	8	4.8
OVER (FIC < .445)	1	1.2
AVERAGE	7.3	2.5

=====

FEMALES

FIC VALUE =====	AT BIRTH =====	SURVIVE TO BREED =====
UNDER (FIC > .6)	6	3.8
OK (.445 < FIC < .6)	4	2.6
OVER (FIC < .445)	1	0.6
AVERAGE	3.6	2.3

=====

ADDAX
AGE STRUCTURE OF SSP POPULATION

01 JUNE 1989

AGE CLASS IN YEARS	MALES	FEMALES
0 - 1	1	2
1 - 2	12	17
2 - 3	10	13
3 - 4	5	18
4 - 5	4	15
5 - 6	8	8
6 - 7	3	10
7 - 8	0	7
8 - 9	2	5
9 - 10	4	8
10 - 11	2	2
11 - 12	0	3
12 - 13	0	4
13 - 14	0	2
14 - 15	1	3
15 - 16	1	5
16 - 17	0	2
17 - 18	0	2
18 - 19	0	1
19 - 20	0	1
20 - 21	0	2
21 - 22	0	2
22 - 23	0	0
23 - 24	0	1
24 - 25	0	1
25 - 26	2	1
26 - 27	0	0
27 - 28	0	1
28 - 29	0	0
29 - 30	0	0

**ADDAX
SSP POPULATION
AGE STRUCTURE SUMMARY**

RANGE (IN YEARS)	MALES	FEMALES
0 - 5	32	65
5 - 10	17	38
10 - 15	3	14
15 - 20	0	11
20 - 25	2	6
25 - 30	2	2
TOTAL	55	136

**ADDAX
LIFE TABLE**

SSP POPULATION
(01 JUNE 1979 TO 01 JUNE 1989)

MALES					FEMALES				
-----ACTUAL-----					-----ACTUAL-----				
Age	Px	Lx	Mx		Age	Px	Lx	Mx	
0	0.714	1.000	0.000	r =	0	0.744	1.000	0.000	r =
1	0.969	0.714	0.027	0.0459	1	0.972	0.744	0.007	0.0436
2	0.975	0.692	0.129		2	0.991	0.723	0.068	
3	0.978	0.675	0.147	lambda =	3	0.984	0.717	0.134	lambda =
4	0.989	0.660	0.211	1.047	4	0.997	0.705	0.135	1.045
5	0.988	0.652	0.213		5	0.986	0.703	0.150	
6	0.979	0.645	0.244	Ro =	6	0.980	0.693	0.152	Ro =
7	0.990	0.631	0.239	1.488	7	0.983	0.679	0.143	1.562
8	0.990	0.625	0.122		8	0.967	0.668	0.168	
9	0.982	0.619	0.085	G =	9	0.966	0.646	0.137	G =
10	1.000	0.607	0.093	8.647	10	0.938	0.624	0.174	10.213
11	0.992	0.607	0.039		11	0.962	0.585	0.133	
12	0.991	0.603	0.128		12	0.944	0.563	0.148	
13	0.990	0.597	0.087		13	0.954	0.531	0.136	
14	1.000	0.591	0.132		14	0.985	0.507	0.160	
15	0.969	0.591	0.171		15	0.962	0.499	0.212	
16	0.980	0.573	0.083		16	0.823	0.480	0.156	
17	0.976	0.561	0.149		17	0.878	0.395	0.113	
18	1.000	0.548	0.083		18	0.920	0.347	0.147	
19	0.955	0.548	0.000		19	0.950	0.319	0.117	
20	1.000	0.523	0.000		20	1.000	0.303	0.090	
21	1.000	0.523	0.000		21	1.000	0.303	0.142	
22	1.000	0.523	0.000		22	1.000	0.303	0.000	
23	1.000	0.523	0.000		23	1.000	0.303	0.000	
24	1.000	0.523	0.000		24	0.684	0.303	0.000	
25	1.000	0.523	0.000		25	1.000	0.208	0.000	
26	1.000	0.523	0.000		26	1.000	0.208	0.000	
27	1.000	0.523	0.000		27	1.000	0.208	0.000	
28	0.000	0.523	0.000		28	0.000	0.208	0.000	
29	0.000	0.000	0.000		29	0.000	0.000	0.000	
30	0.000	0.000	0.000		30	0.000	0.000	0.000	

**ADDAX
SSP POPULATION**

FOUNDER ALLELE REPRESENTATION

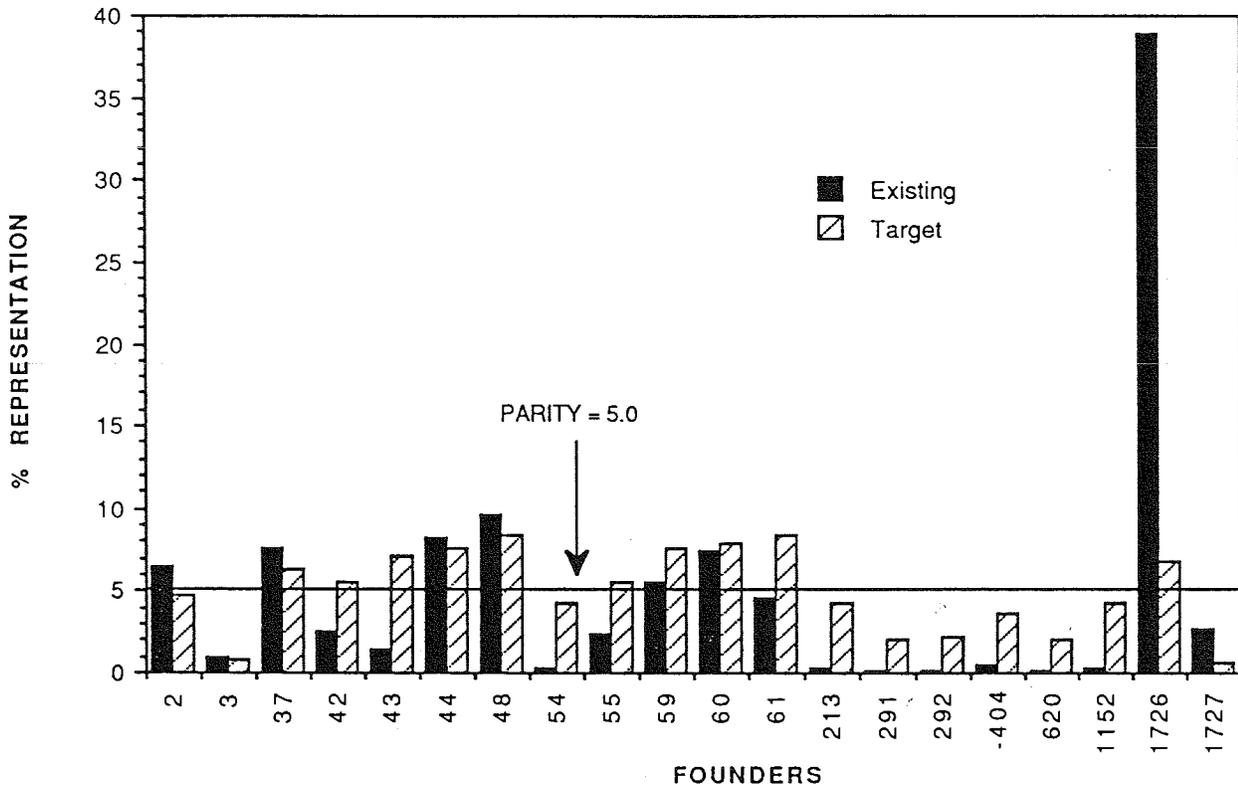
01 June 1989

Founder	Retention	% REPRESENTATION		TARGET REPRESENTATION		DIFFERENCE	
		With Unknown	Without Unknown	With Unknown	Without Unknown	With Unknown	Without Unknown
2M	0.560	6.456	6.542	4.740	5.809	-1.716	-0.732
3F	0.093	0.924	0.936	0.782	0.959	-0.141	0.023
37M	0.740	7.557	7.658	6.254	7.665	-1.304	0.007
42F	0.656	2.479	2.512	5.548	6.799	3.069	4.288
43F	0.844	1.490	1.510	7.137	8.748	5.647	7.238
44F	0.900	8.226	8.335	7.615	9.334	-0.610	0.998
48M	0.988	9.683	9.812	8.355	10.240	-1.327	0.429
54F	0.500	0.263	0.267	4.228	5.182	3.965	4.916
55F	0.649	2.346	2.377	5.488	6.727	3.143	4.350
59F	0.889	5.582	5.656	7.518	9.214	1.936	3.558
60M	0.943	7.505	7.605	7.975	9.774	0.470	2.169
61FL	0.708	4.514	4.574	8.457	10.365	3.943	5.791
213M U	0.500	0.263	0	4.228	0	3.965	0
291M U	0.247	0.130	0	2.093	0	1.963	0
292F U	0.253	0.133	0	2.135	0	2.002	0
-404M U	0.427	0.396	0	3.611	0	3.215	0
620F U	0.250	0.132	0	2.114	0	1.983	0
1152M U	0.500	0.263	0	4.228	0	3.965	0
1726M	0.802	38.934	39.453	6.782	8.313	-32.152	-31.141
1727F	0.084	2.726	2.763	0.710	0.871	-2.016	-1.892

GENETIC SUMMARY

	LIVING DESCENDANT POPULATION		POTENTIAL	
	With Unknown	Without Unknown	With Unknown	Without Unknown
Number of founders:	20	14	20	14
Parity (%):	5.000	7.143	5.000	7.143
Mean retention:	0.577	0.668	0.591	0.689
Founder genomes surviving:	11.532	9.355	11.825	9.648
Founder Genome Equivalents:	4.074	3.969	11.825	9.648
Founder Equivalents:	5.245	5.109	16.128	11.933
Fraction of wild heterozygosity retained:	0.836	0.832	0.958	0.948
Fraction of wild heterozygosity lost:	0.164	0.168	0.042	0.052
Mean inbreeding coefficient:	0.431			

ADDAX FOUNDER REPRESENTATION



ADDAX, Addax nasomaculatus, MANAGEMENT
UTILIZING THE INFORMATION
GAINED FROM ANALYSIS
OF THE POPULATION BY MOLECULAR
GENETIC TECHNIQUES

Dr. John C. Patton

The pedigree analysis of captive zoological populations has left many unanswered questions. Many times inaccurate records or total lack of records has caused the ancestor of many individuals unknown. With the formation of organized breeding programs, SSP and studbooks, known pedigrees are needed. Decisions of breeding strategies and animal moves are directly related to the relationship of individuals within the population. To address this issue and determine if relationships within an unknown population can be determined analysis of the living population using molecular genetic techniques has been proposed. The North American captive population of addax, Addax nasomaculatus, is an example of a population that has many unknown animals within the pedigrees and offers a model to test the application of these techniques.

We propose to examine the genetic makeup of the captive addax population and attempt to answer to some of the unknowns presented to the SSP coordinator due to lack of pedigree information. Additionally, the analysis will define the genetic variation within the captive population and relate this variation to that of the natural populations. This information can give important data to determine which individuals should be included in a reintroduction program for this species.

Until recently, genetic analyses were largely confined to chromosomal analysis or protein electrophoresis. The analyses give a limited number of variable characters and require living cells for karyology or freshly frozen tissues (for electrophoresis). Recent advances in molecular analysis of DNA not only allows the use of the above mentioned tissues, but also hair, consignment elephant tusks samples, and even tissues from mummified remains, as well as museum samples. This offers the geneticist new avenues to sample genetic variability of natural populations sample when animals were more plentiful and many times taken from known locations. This information can be used as reference data for the captive populations.

In this proposal, we propose to focus on the assessment of genetic diversity of the North American captive population of addax. Questions subsumed within this focus involve primary genetic identification of current addax stocks. Initial founders came from three locations in Chad and the Khartoum Zoo in Sudan. Sufficient mixing of stocks has occurred among the various zoological collections that they might be thought to represent a relatively heterogeneous mixture of all import animals. Our preliminary data do not support that contention. Analysis of animals from Fossil Rim and the St. Louis Zoo populations shows moderate variability within these populations, but major dissimilarity

between them. On the other hand, the one animal that has been sampled from the San Antonio Zoo population is genetically closer to the St. Louis Zoo population.

The later findings do not follow the predictions that arise from the analysis of the pedigree history of the populations involved. These preliminary data strongly argue that populations must be genetically identified and the relatedness of the current addax populations be genetically confirmed. Reliance on histories of movement for individuals between populations is not adequate as an index of genetic relatedness of the respective populations. Genetic fingerprinting elements are sufficiently variable to allow this analysis to be effectively accomplished.

The mini- and microsatellite elements represent the next level of inquiry into the zoo populations which is the reconstruction of pedigrees. Minisatellite phenotypes such as those shown in Figure 1 are not particularly appropriate for analysis of pedigrees beyond two previous generations and in some cases reconstruction becomes problematic even at the level of the second generation removed. To allow deep pedigrees to be reconstructed requires the analysis of locus specific minisatellites and/or their companion elements the so-called microsatellites. In addition, the small minisatellite and microsatellite elements can be retrieved from museum specimens, thereby, offering the possibility of directly comparing the genetic diversity found in museum specimens obtained directly from the wild with the diversity currently found in captive herds. These elements, individually and as phenotypes, also represent the only method to empirically test the entire genome to see if the Master Plan is maintaining the genetic diversity of the captive population.

PLAN OF ACTION

- A. Obtain 30 ml. blood samples from as many individuals of all populations as possible and survey each animal with four minisatellite probes, 33.15 and 33.6 of Jeffries, the m13 repeat, and the Drosophila "Per" locus repeat. All four probes are in use in Dr. Templeton's lab and all probes have been proven to work on Bovids (Fig. 1).
- B. Make a genome library for addax and begin to screen out "locus specific" minisatellite and microsatellite loci. These elements are critical in reconstructing the addax pedigree and will eventually be used to determine how well the captive population reflects the original populations of this desert antelope using museum specimens.

COST

1. As proposed, this study will require 1/4 time effort by Patton and 1/2 time by one technician.
2. Shipping cost for and supplies to analyze 200 samples.

BUDGET

Patton (1/4 time)	\$ 8,000
Technician (1/2 time)	9,000
Supplies	4,000
Shipping	<u>1,000</u>
Total	\$22,000
Overhead	+ overhead

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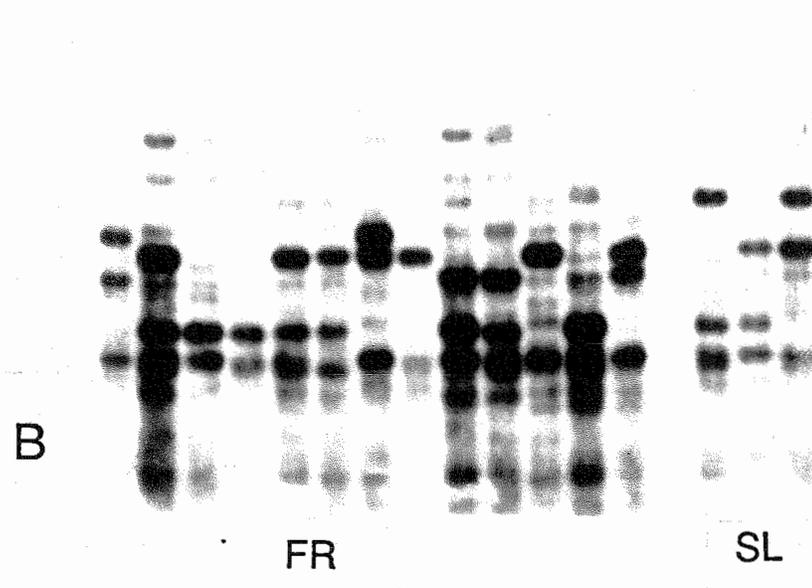
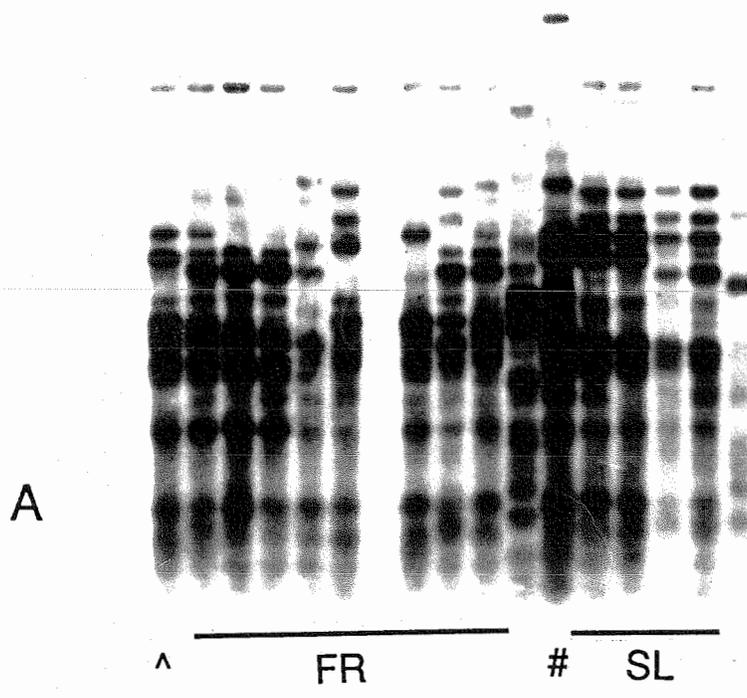


Figure 1. Minisatellite variation of the addax as demonstrated by the Jeffrey's 33.15 probe (A) and the variable repeat element found in the M13 bacteriophage(B). Note the much higher level of variation found within the Fossil Rim population than found within the St. Louis Zoo population (SL) even though the animals shown in 1A are sired by animals of the different major import lineages (one Brookfield and one San Diego WP sires). This combination in theory should have markedly increased the variation within the St. Louis Zoo population. Perhaps most remarkable is the San Antonio animal (#) in 1A which is among the most distinctive animal yet found even though this populations import history would suggest it should be more similar to the Brookfield animal (^).

CBSG ARIDLAND ANTELOPE WORKSHOP

San Antonio, Texas, U.S.A.
13-15 September, 1989

GAZELLES

1 February 1990

GAZELLE PLAN

Many gazelle forms (Gazella sp.) have shown a sharp decline in the recent past, many forms becoming almost extinct (the Arabian dorcas gazelle, is extinct in Saudi Arabia, Cuvier's Gazelle is almost extinct in Morocco, Dama Gazelle is extinct in the western part of its range,).

The lack of knowledge in basic biological features of the known existing forms even at specific level, has been demonstrated by the description of a new species, *Gazella bilkes*, in 1986 in North Yemen.

Therefore, this group urges action plans for the different taxa in order to have viable wild and captive populations of known origin.

The following points have been identified as priorities for the Aridland Antelope Working Group.

1. Sponsor Working Group on gazelles to develop priorities.
2. Organize institutions with similar interests to obtain more information and develop better taxonomy.
Encourage of San Diego, London, the Max Plank Institute and others with adaptive facilities to collaborate with the NCWCD and other various research stations and private collections, particularly in the Middle-East, to obtain samples and proceed with the laboratory procedures to determine systematics.
3. Co-sponsor a workshop on conservation and systematics with Antelope Specialist Group.
4. Develop management plan for captive population.
5. Encourage development of reproductive biological techniques. Additional research and development is needed for adapting gamete and embryo cryopreservation, artificial insemination, embryo transfer and related technologies for application to gazelles. These technologies will be important for translocation of genetic representation from founder animals between locations, enhancing genetic representation of under-represented breeding stock, and propagation of animals in small population of SSP animals where genetically "surplus" animals are available. These technologies have been proven to be biologically feasible in this species, and although improvements in efficiency are needed, their cost/benefit ratios may be favorable at the present time under certain specific circumstances. Likewise, birth control measures, such as vasa-deferens plugging and tubal ligation should be considered for obtaining appropriate genetic balance within populations where carrying capacity is limited and breeding dynamics are enhanced by the presence of peripheral males or females.
6. Encourage Saudi Arabian participants and others active in the Middle-East to learn more about the private captive collections in the Kingdom and elsewhere in the area.
7. Distribute the proceedings of the Aridland Antelope meeting, 14-15 September to ALL countries holding these species.
8. Encourage participation in regional programs.

9. Encourage collection of behavioral and ecological data as soon as possible. To better understand the needs of these animals prior to release and to aid in making the releases as smooth as possible, a thorough study in as normal conditions as can be obtained is recommended.

With regards to the Dama gazelle there is a need to support the Senegal project and to offer assistance if needed. Funds may be needed for the completion of fences at the reintroduction site to proceed with the reintroduction process.

Veterinary Considerations

Veterinary considerations are of great importance when planning an introduction or reintroduction of desert antelopes, and these should comprise one of the vital pre-translocation planning phases of any reintroduction operation. In fact, possible veterinary complications should be taken into account during the search for a suitable release site.

The veterinary hazards are predominantly two-fold:

- 1) it must be ensured that the founder animals, which perforce, will probably originate in the U.S.A., do not suffer from any inapparent infection which will present a disease risk to wild and domestic stock in the reception area.
- 2) since the founders will probably have been raised in relative isolation and may lack immunity to endemic diseases present in the reception area, an appraisal of these risks must be made **PRIOR TO RELEASE** so that appropriate protection (usually vaccinations) can be assured.

Failure to take account of either of these disease hazards has often resulted in unexpected and expensive failures of reintroduction projects in the past and could bring a very useful conservation technique into disrepute.

Subsequent to reintroduction a program of health and disease monitoring should be implemented at the release site. To be effective this program should include a training component for a local national veterinarian.

CBSG Aridland Antelope Meeting
September 13 - 15, 1989

EFFECT OF INBREEDING AND BODY SIZE ON REPRODUCTIVE SUCCESS IN
FEMALE CUVIER'S, DAMA AND DORCAS GAZELLES

by

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Summary

Populations of Cuvier's, Dama and Dorcas gazelles were removed from the Western Sahara to the Estación Experimental de Zonas Áridas, Almería, Spain, between 1970 and 1975. The life history records of all the females living between 1970 and 1988 were examined.

Results show that fecundity is lower in young females than in middle age females, and juvenile mortality is higher in fawns of young females than of the remainder. The adult body length and the birth weight are positively correlated with longevity in female Cuvier's and Dama gazelles, but for Dorcas gazelle, only birth weight is related to longevity. Juvenile survival and reproductive performance of the three gazelle species studied are not related to adult body length or birth weight.

A high inbreeding coefficient reduces longevity in Cuvier's and Dama gazelles but not in Dorcas gazelle. The effect of a high inbreeding coefficient is pronounced in the fecundity and juvenile survival of female Dama gazelle, less pronounced but evident in Dorcas gazelle. The effects of inbreeding are minimal in Cuvier's gazelle and are evident only in the twinning rate. This results is surprising in view of the high inbreeding coefficient in Cuvier's gazelle's relative to the other two species.

As in many mammals, birth weights in the three species studied are closely related to the probability of survival during the first days of life. One of the causes of decreasing birth weight in male and female offspring of Cuvier's gazelles and in female offspring of Dorcas gazelle is their inbreeding coefficient. The inbreeding coefficient of the mother also reduce the offspring's birth weight in both sexes of Dama gazelle, but there is no influence on offspring of Cuvier's or Dorcas gazelle. Mother's age and offspring birth weight are related for male offspring of Cuvier's and Dama gazelles.

Introduction

Several authors have shown the possible deleterious effects of inbreeding (Falconer, 1961; Treus & Lobanov, 1971; Bouman, 1977; Flesness, 1977; Wright, 1977; Lasley, 1978; Seal, 1978; Senner, 1980; Ralls et al., 1979, 1980), which generally increases mortality in young animals and reduces fertility in adults. Close inbreeding is known to have deleterious effects on vigour and fecundity in captive Dorcas gazelle (Gazella dorcas) (Ralls et al. 1979, 1980). Although avoidance of inbreeding appears to be an important factor

(Ballou & Ralls, 1982), limitations to outbreeding behaviour are imposed by the cost of migration (Chesser & Ryman, 1986; Waser et al., 1986). Thus if the risk associated with migration is high, it might be more advantageous to remain and breed with relatives. Smith (1979) and Bengtsson (1978) point out that father-daughter mating should occur in polygynous species if the advantages of having a greater proportion of one's genes represented in one's offspring are greater than the cost due to inbreeding. The evolution of inbreeding may also be associated with the evolution of altruism (Hamilton, 1975).

Accurate measurements of variables affecting lifetime reproductive success in gazelles have not been made before. The vast majority of the published data concerning reproductive parameters is on Thomson's gazelle (Gazella thomsoni) (Brooks, 1961; Hvidberg-Hansen, 1970; Robinette & Archer, 1971) and Dorcas gazelle (Joep, 1908; Slaughter, 1970; Ralls et al., 1980; Bogsch, 1983; Alados, 1984).

Cuvier's gazelles (Gazella cuvieri), which often bear twins, are noted for their high reproductive rate compared with other gazelles that inhabit savannah areas, such as Gazella subgutturosa from Central Asia. In the mountain areas, where Cuvier's gazelles are found, the vegetation is seasonal and birth numbers show two peaks, one in spring and a lower one in autumn (Olmedo et al., 1985), coinciding with the rainy seasons. In some gazelle species, females conceive while lactating and so produce two fawns in one year (Mendelssohn, 1974; Alados, 1984). Baharav (1983) suggesting that the timing of births and the ability of suckling females to conceive are not species-specific characteristics but reproductive strategies that depend on daily access to drinking water.

Since the gazelles in the present study were in excellent physical condition because of supplementary feeding, the post-partum oestrus, which allows two births a year, was not inhibited in Dorcas and Cuvier's gazelles. The reproductive capability of the Dorcas gazelle in which fawns are born singly is not as high as that of Cuvier's gazelle. Normally, the first fawn is born when the dam is about one and a half years old but a number of females produce their first fawn at a year old (Alados, 1984).

No information exists about the reproductive parameters of Dama gazelle (Gazella dama), but a report from Newby (1978) suggested they breed in the wild between July and November.

In spite of the fact that Dorcas gazelle is widely distributed, occupying a variety of desert habitats from North Africa to India, several authors have commented on its decline as a result of increased hunting pressure, and the agricultural and urban expansion, which appears to be adversely affecting several gazelle habitats (Anderson, 1902; Flower, 1932; Russelle, 1949, 1951; El Negumi, 1952; EL Monaiery, 1955; Hoogstraal, 1964; Osborn & Helmy, 1980; Mendelssohn, 1974; Ryder, 1987; Saleh, 1987).

Due to the recent drastic reduction in numbers of several species of gazelles, there is now an urgent need to protect them and an attempt must be made to understand the intrinsic and

extrinsic mechanisms regulating their population density in order to improve their management both in the wild and in captivity. This study is concerned with establishing the phenotypic and genotypic factors affecting components of lifetime reproductive success in female Cuvier's, Dama and Dorcas gazelles.

Methods

A founder population of 2 males and 2 females of Cuvier's gazelle, 4 males and 13 females of Dama gazelles and 36 males and 36 females of Dorcas gazelles were translocated from the Western Sahara to the Estación Experimental de Zonas Áridas in Almería (Spain) between 1970 and 1975. The history of the population has been described by Alados et al., (1988) and Escos (in press).

The gazelles are distributed among different herds, each consisting of about 10 individuals, one being an adult male and the remainder adult females with their offspring. The young males are kept with their family groups until they are 4 or 5 months old, when they are placed in bachelor groups.

Each animal is caught the day after birth for marking, weighing and measuring. The identity of its mother is recorded. Body measurements and weight are recorded sometimes when adult.

For the present study the life history records of all the females living in the Estación Experimental de Zonas Áridas between 1970 and 1988 were examined. All the birth dates of the females and their offspring are known, with the exception of those that arrived as adults.

The following variables have been collected: mother's age in days on 31-12-1987 or at the time of death, number of offspring, number of abortions, if the parturition was single or double, interbirth intervals, offspring survival, offspring birth weight, adult body length and the inbreeding coefficients of the mothers and their offspring.

For the purpose of comparing inbred and non-inbred individuals of Cuvier's gazelles, the animals were divided into three categories: non-inbred calves, which consisted of those with inbreeding coefficient of 0, inbred animals with an inbreeding coefficient greater than 0 but lower than 0.2 and inbred animals with an inbreeding coefficient larger than 0.2. In the case of Dama and Dorcas gazelles, only two categories were considered: non-inbred animals, consisting of those with an inbreeding coefficient of 0, and inbred animals, with an inbreeding coefficient greater than 0. Interbirth intervals were classified into three categories: <200 (two births a year), 200-300 (one birth a year) and >300 days.

For the present study, the following components of lifetime reproductive success were calculated.

Longevity: mother's age in days at the time of death.

Age at first birth: mother's age in days at first live birth.

Fecundity: expressed as the number of offspring divided by the reproductive life in years. The reproductive life being equal to the age at the time of death or on December 31st, 1987, minus the

Since mother's age affects juvenile survival in the three species a more detailed study has been performed (Table 4). For female Cuvier's gazelles less than 3 years old, 68.5% of their offspring survive more than a month, while for females more than 3 years old 84.1% survive. No significant difference exists between age and juvenile survival in mothers more than 3 years old ($X^2=3.2$, $df=1$, N.S.). For female Dama gazelle less than 3 years old, juvenile survival is also low (52.2%) and increases to 83.3% for females over 9 years old. However, after three years, no association was found between the mother's age and offspring survival to one month ($X^2=1.68$, $df=2$, N.S.). There is a similar association between mother's age and juvenile survival in Dorcas gazelle.

In order to see if a mother's inbreeding coefficient reduces her offspring birth weight, the effects of mother's inbreeding coefficient on birth weights of male and female offspring were analysed separately, and the gazelles were classified into 6 age classes in order to remove the effect of a intervening variable, adding a factor for mother's age in the Anova. In Cuvier's gazelle mother's inbreeding coefficient does not affect offspring birth weight in either males (Anova analysis of variance $F=2.31$, $df=2$, N.S.), or females (Anova analysis of variance $F=1.64$, $df=2$, N.S.). Similarly, in Dorcas gazelle mother's inbreeding coefficient does not influence the birth weight of either males (Anova analysis of variance, $F=0.05$, $df=1$, N.S.) or females (Anova analysis of variance, $F=0.79$, $df=1$, N.S.). However in Dama gazelle, mother's inbreeding coefficient reduces birth weight in both male (Anova analysis of variance $F=8.68$, $df=1$, $P<0.004$) and female offspring (Anova analysis of variance $F=10.03$, $df=1$, $P=0.002$).

Conclusions

Female longevity is one component of female lifetime reproductive success and for both Cuvier's and Dama gazelles, is positively related to birth weight and adult body length, and negatively influenced by increasing inbreeding coefficient. In Dorcas gazelles, only birth weight is correlated with longevity.

In mammals mother's age can also affect other components of lifetime reproductive success such as fecundity and juvenile survival (Turner & Dolling, 1965, in domestic sheep, Ovis aries; Nievergelt, 1966, in Capra ibex; Drickamer, 1974 in Macaca mulatta; Clutton-Brock et al., 1982, 1987, 1988 in Cervus elaphus). The three gazelle species studied have a lower fertility rate at high and low ages, and the mother's age has an effect on juvenile survival.

Although other authors, working in red deer, have observed a positive relationship between a female's weight and her fertility (Mitchell & Brown, 1974), this could be due to the effect of body condition on reproduction rather than body size, as Clutton-Brock et al. (1982) have suggested. Albon et al. (1986) demonstrated that body condition, independent of body weight, is an important factor affecting fertility in red deer.

In that study, fertility was inversely related to skeletal size, since at the same body weight, a skeletally small hind has a greater muscle mass than a skeletally large hind.

Since gazelles at the Estación Experimental de Zonas Aridas are in excellent physical condition because of supplementary feeding, body size is not a reflection of their body conditions but probably of inheritance, which may explain why, in none of the three gazelle species studied, does adult body length or birth weight influence the age at first birth, fecundity, offspring survival or abortion rate.

Many authors have reported that a high inbreeding coefficient reduces fertility and juvenile survival (Falconer, 1961; Treus & Lobanov, 1971; Bouman, 1977; Flesness, 1977; Wright, 1977; Lasley, 1978; Seal, 1978; Senner, 1980; Ralls et al. 1979, 1980), and the characters most severely affected by inbreeding are those expressed early in life, such as perinatal mortality and birth weight (Falconer, 1961; Lasley, 1978).

Theoretically, species that naturally inbreed in the wild should show less of a deleterious effect when subjected to inbreeding in captivity, but little is known about the extent to which ungulates normally inbreed in the wild, although several models suggest that inbreeding could be favoured in polygynous systems (Waser et al., 1986). Our results show that inbred female Dama gazelle produce fewer offspring than non-inbred females, as Bouman (1977) showed in Przewalski horses (*Equus przewalskii*). The high inbreeding coefficient also leads to a reduction in juvenile survival in Dama gazelle such as in many other captive ungulates (Falconer, 1961; Wright, 1977; Lasley, 1978; Ralls et al., 1979, 1980; Ryder, 1987). The influence of inbreeding on the age at first breeding is not clear, see Ralls et al. (1980), but in Dama gazelle the high inbreeding coefficient also decreases fertility by raising the age at first conception. The rate of abortions is not related to the mother's inbreeding coefficient in Dama gazelle. The fecundity of Dorcas gazelle is also affected by a high inbreeding coefficient, but not as much as in Dama gazelle, probably due to the higher number of founders of our population. As in Dama gazelle, offspring survival is affected by the high inbreeding coefficient. However, the Cuvier's gazelles with a higher level of inbreeding than the other two species, is affected only in the frequency of twinning.

We suggest that the lower influence of the inbreeding coefficient on the lifetime reproductive success of Cuvier's gazelle in relation to the other two species is caused by ecological factors. The former lives in mountain habitats, in smaller social groups than the other two species (Sclater & Thomas, 1898), which are desert gazelles and have to migrate to find free water and food (Newby, 1978, 1984). Migrations involve large numbers, and although Dama gazelles normally live in groups of up to ten individuals, the migrating herd may number over a hundred (Newby, 1984). According to theory, species that are naturally inbred in the wild should show less of a deleterious effect when subjected to inbreeding in captivity (Ballou & Ralls, 1982).

Birth weight, which is considered to be one of the variables most closely related to the chances of juvenile survival in ungulates (Guinness et al., 1978; Doney & Gunn, 1981; Albon et al., 1987; Clutton-Brock et al., 1987; this study), is controlled partially by genetic and partially by environmental factors. An important genetic factor that influences the offspring birth weight is the inbreeding coefficient. Similar results were observed on the birth weight of Speke's gazelle (Gazella spekei) (Ryder 1987).

Acknowledgments

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Table 3. Logistic regression of juvenile survival and mother characteristics (age, inbreeding birth weight and offspring sex).

	X ²	df	P	R ²
<u>Cuvier's Gazelle</u>				
Age	7.93	1	0.005	0.04
Inbreeding	0.59	1	N.S.	0.00
Birth weight	0.22	1	N.S.	0.00
Offspring sex	6.02	1	0.01	0.03
Model	13.56	4	0.009	0.07
<u>Dama Gazelle</u>				
Age	10.08	1	0.001	0.04
Inbreeding	8.62	1	0.003	0.04
Birth weight	1.45	1	N.S.	0.00
Offspring sex	1.74	1	N.S.	0.01
Model	23.03	4	0.0001	0.08
<u>Dorcas Gazelle</u>				
Age	10.61	1	0.001	0.03
Inbreeding	4.30	1	0.04	0.01
Birth weight	0.78	1	N.S.	0.00
Offspring sex	0.02	1	N.S.	0.00
Model	18.21	4	0.001	0.06

CBSG ARIDLAND ANTELOPE WORKSHOP

San Antonio, Texas, U.S.A.
13-15 September, 1989

NIGER REINTRODUCTION

1 February 1990

NIGER REINTRODUCTION PROPOSAL

Much discussion took place with regard to the ZSL/WWF proposal for reintroduction of addax into Niger. We are encouraged by the opportunity of having this relocation site available and recognize multiple benefits could derive from such a program. Recognizing the critical need of the captive addax program for further genetic diversity and the critical need of the wild addax population for demographic (and perhaps genetic) reinforcement, the following recommendation of John Newby and Chris Magin was discussed:

1. Proceed with the ZSL/WWF proposed short-term release program in Niger.
2. Simultaneously establish a capture program to reinforce captive genetic stock.

Concern was expressed that capture of animals in Niger may be impossible logistically. Concern was also expressed that any release program will have to be monitored very carefully to ensure that the efforts do not place the existing remnant wild population of addax in Niger at further risk (of disease, social disruption, genetic swamping). Recognizing that not all the information necessary to assess this project is yet available, we endorse further development of the proposal with particular attention to the following:

1. Monitoring and protecting the current population remaining in the project area.
2. Training local people in wild animal management to ensure long term successful management of the project.
3. Development of public education and awareness of the project and of conservation issues in this area.

We recommend that a next step is to organize a population viability workshop in Niger, identifying and working with local biologists, reviewing field aspects and logistics. The workshop would include a site visit.

It was also suggested that Algeria, and possibly Senegal, may provide possible relocation sites for addax in the future. Algeria has recently exhibited increased interest in conservation. There is a slender-horn gazelle population there, and perhaps both this species and the addax could be protected in the area. The possibility of this project will be pursued further with the assistance of Jean-Francois Asmode, Ecologist, National Wildlife Research Center, Taif, Saudi Arabia. Further help with such an initiative could come from Mulhouse and the Zoological Society of London where appropriate.

CBSG Aridland Antelope Meeting
September 13 - 15, 1989

THE REINTRODUCTION OF ADDAX (Addax nasomaculatus) INTO
THE AIR AND TENERE NATIONAL NATURE RESERVE
REPUBLIC OF NIGER

An outline project proposal
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Niamey, 7 July 1989
London, 6 September 1989

INTRODUCTION

The following proposal is a preliminary project-description based on a feasibility study carried out by the Zoological Society of London in conjunction with the Marwell Preservation Trust and the World Wide Fund for Nature/World Conservation Union Representative in Niger. Discussions with Nigerian Government Representatives, wildlife officials and local people as well as field inspections were undertaken on a mission by the project executants in June/July 1989. A more detailed management strategy and release programme is currently being developed and it is stressed that the paper presented here is intended as an outline proposal only.

BACKGROUND

The addax, Addax nasomaculatus, is a large antelope closely adapted to the desert environment. Once widespread across Saharan North Africa, from Morocco to Egypt, the species has declined as a result of recurrent drought, overhunting and tourist harrassment. It is unlikely that more than a few hundred addax survive in the Sahara today. Most of these animals are found in isolated populations in the sub-Saharan countries of Niger, Chad and Mali (Figure 1). In the face of continued threats, the future of the addax is bleak and only a concerted effort can now save the animal from extinction in the wild.

Of the states which constitute the current range, Niger presents the most favourable conditions for addax conservation. Political stability and a commitment to conservation have generated opportunities for technical programmes of practical benefit to indigenous wildlife. Furthermore, since 1979, Niger's wildlife services have received technical and financial assistance from the World Wide Fund for Nature (WWF), the World Conservation Union (IUCN), the Zoological Society of London (ZSL) and the Fauna and Flora Preservation Society (FFPS). The major thrust of this assistance has been the conservation of aridland species and habitats, especially through the establishment and management of protected areas.

In January 1988, the Air and Tenere National Nature Reserve was gazetted by the Government of the Republic of Niger. The Reserve, the largest in the world under active management, covers 77,360 sq km, of which 12,805 sq km (the same size as the state of Connecticut) constitute a UN Category I strict nature reserve, the "Sanctuaire des Addax" (Figure 2). The Sanctuary is clearly delineated and protected by patrols. No tourist circulation or other human activity is permitted within its boundaries.

The Sanctuary incorporates all habitat types deemed necessary for the survival of addax. Most of the area is open, sandy desert, much of it inaccessible to vehicles. Ephemeral water supplies occur after seasonal rains and from wadis which drain into it from the Air Mountains. The vegetation consists of scattered desert pasture, growing in response to rare and localised rainfall and run-off from the wadis. Typical plants include Stipagrostis and Panicum grasses, Fagonia scrub and along the wadis, Acacia trees and succulents such as the wild melon, Citrullus.

As a result of the official gazetting of the Reserve and the allocation of substantial resources by WWF and IUCN to protect the area, the prospects for wildlife and habitat conservation are now greatly improved. Dorcas gazelle Gazella dorcas, dama gazelle G. dama, West African ostrich Struthio camelus camelus and Nubian bustards Neotis nuba, occur in significant numbers relative to their status elsewhere in the Sahel. Cheetah Acinonyx jubatus, Ruppell's fox Vulpes ruppellii and fennec V. zerda, are also present, making the area an important one for Sahelo-Saharan species.

Addax have been present in the Air Tenere area for centuries but numbers are now very low. Because of the inaccessibility of the terrain and the highly nomadic behaviour of the species, the precise number of addax within the Sanctuary is unknown but is thought to be no more than 20 individuals. Between 1979 and 1985, numerous sightings of addax were made in the area now gazetted as the Addax Sanctuary. Lack of rainfall in 1984, '85 and '86, and general disturbance caused by continual tourist traffic and the Paris-Dakar Rally which ran through the area in 1986 and '87, are thought to have displaced the addax from the Sanctuary.

Conditions for the addax are now much more favourable. Rainfall over the past two years has generated good quality pasture, which will probably persist for the next two to three years even if this year's rains are poor. The elimination of traffic from the Sanctuary has reduced the disturbance to which the addax are particularly susceptible and there is evidence to suggest that the addax are returning but only in small numbers. Sightings have been reliably reported both in and outside the Sanctuary over the past twelve months. During 1988-89, addax were seen just outside the Sanctuary (Adrar Bous, Wadi Ibel) and twice within the Sanctuary itself in the Tezirzek area. Fresh droppings were also found at Issaouan and, most recently, the tracks of two animals were seen in June 1989 at Ifinyan. It is impossible at this point to establish a carrying capacity for the area because seasonal and cyclical variations in environmental conditions are so extreme and because so little is known about the ecology of wild addax. It should be stressed though that the area in question is enormous and that suitable addax habitat extends far beyond the borders of the Sanctuary and even of the National Reserve. However, even optimistic estimates of numbers of animals in the area would not be sufficient to ensure long-term survival. The population must be increased.

Any conservation strategy developed for the addax will need to incorporate not only physical protection of the species and its habitat but also in situ captive breeding and reintroduction to the wild of animals imported from collections overseas. Over 2,000 addax are currently held in collections in the United States, Europe and the Middle East. The species breeds readily in captivity and there are adequate numbers of healthy animals available for release programmes. Studbooks and comprehensive management programmes can provide the relevant data to identify the most genetically suitable individuals, many of which are already accustomed to a relatively free-range existence. Experience of reintroduction techniques has been gained at Bou-Hedma in Tunisia and with other desert ungulates in Oman and Jordan and there is a rapidly increasing recognition of the viability of reintroduction schemes as a conservation tool particularly for this Order of mammals.

In view of the healthy stocks of addax in captivity, the presence of an existing wildlife project infrastructure (including a full time Conservation Adviser), the favourable conditions in Niger and the urgency of the situation in the wild, it is proposed that a project be established immediately aimed at releasing addax into the Sanctuary using captive-bred animals. The objective is to repopulate areas suitable for addax and in the process, to provide a genetic and social boost to any existing groups. While there are still a few wild addax, their presence and experience could assist the new animals to readapt. Apart from the immediate benefits to this highly endangered species, a successful return of addax would also stimulate national and international efforts to address conservation problems elsewhere in Sahelo-Saharan Africa.

PROJECT DESCRIPTION

Location

Selection of the release site depends upon a number of factors: the presence of available food plants, shade, access to water, logistical considerations, etc. Originally, a site at Issaouan was considered a strong possibility but a recent mission to the area identified several other locations with better vegetation and where the difficulties of getting the animals to the site would be reduced. At this time, Tezirzek, located 90 km north-east of Iferouane, is considered the best choice. It has good pasture for addax as well as shade trees, particularly Acacia - the pods and leaves of which are an important source of food and moisture. There is ready access to the variety of habitats known to be utilised by addax and its immediate proximity to the Addax Sanctuary should facilitate dispersal of the released animals into a protected area. Although there is a permanent well, further investigation of locally accessible water resources may be required. Water is reliably available at Iferouane and could be trucked in as a back-up measure if necessary in the early stages.

Animals

The animals will be selected from captive herds on the basis of their genetic and physical qualities. Although addax do not usually pose a problem in shipment despite their large horns, it may be that young animals of between 10 and 12 months of age may be easier to deal with. However, equally, it may be that the best strategy is to release family units which provide a better social framework; this will have to be investigated further. All animals will undergo careful veterinary screening prior to their departure for Niger.

The sex ratio of the first group will also need discussion. It is envisaged that the first shipment will be of 10 animals to be followed at regular intervals throughout the project period with additional animals chosen to maximise genetic diversity and balance age/sex discrepancies. Based on computer analyses of the likely genetic and demographic trends, it is considered that the project should aim to return a minimum of 50 animals over the course of three years.

Once at the holding facilities, the addax will be introduced to local vegetation and environmental constraints (lack of water, heat) as quickly as possible, but it will be necessary to provide them with some imported foodstuffs (cereal, hay) and water to begin with.

Facilities

The design and construction of the facilities should be kept simple. It is proposed that a 200 x 200 metre chain link enclosure be erected, as the immediate holding area, in one corner of a one km square pre-release pen of either solar-powered electric fencing or high-tensile steel wire. Double fenced pens will be constructed separately for isolation and separation of incompatible animals. A combination of local adobe construction and portakabins would be used to provide storage areas and living quarters for the project staff.

Logistics

Ideally, addax arriving from the United States or Europe would fly to Agadez with a stop in Niamey for refueling, customs and veterinary clearance. From Agadez, the animals would be transferred to a smaller bush aircraft which could land on the 800 metre earth airstrip at Iferouane and then be driven on a flatbed lorry to Tezirzek. Access between Iferouane and Tezirzek is provided by a bush track in good condition. It would also be possible to drive the addax from Agadez to Iferouane, a journey of 350 km, but the last 150 km are over an extremely rough track.

Schedule

The project is designed as a relatively inexpensive quick release programme which benefits from existing experience and techniques developed for other reintroduction schemes. The rapid release of the addax is an attempt to respond to an urgent conservation situation and also has the added advantage of minimising the overhead costs of the lengthier operations undertaken elsewhere. Although it is intended that the addax be reintroduced as quickly as possible, every care will be taken to ensure that the animals are suitably acclimatised before release. As a safety measure, contingency plans to support the addax for longer periods will be developed.

The optimum time for the arrival of the addax in Niger would be in early March, at the end of the cold season, when the risk of heat stress during travel is reduced. The addax would be held in captivity throughout the hot season to allow them to acclimatise under the relatively controlled conditions of the captive environment. Release of the addax would take place at the end of the wet season (September/October) when the vegetation is at its best. The addax would then have several months of cooler weather (October to March) to disperse and explore their new environment. Assuming that support for the proposal is forthcoming, the first addax could arrive in Niger in early 1991. If the operation is a success, further shipments of animals would be requested for 1992 and 1993.

Monitoring

To facilitate monitoring of the addax once released, a number of animals will be fitted with radio transmitter collars and surveillance will be undertaken by local staff. It should be understood, however, that the addax is a highly nomadic animal and much of their habitat is inaccessible both to vehicles and to camels so that contact with the released animals is unlikely to be continuous. Satellite tracking therefore would seem a useful means of monitoring the animals' movements and costs for this element of the project are being investigated.

Administration and Personnel

Technical support and administration in Niger will be undertaken by the WWF/IUCN Representation and by the Nigerien Wildlife Service within the framework of the Air and Tenere Natural Resource Conservation Project. The Zoological Society of London will be responsible for external coordination of the project and recruitment of technical staff.

To begin with, the operation will be directed by a qualified technician with release programme experience. Day-to-day management of the captive stock will be undertaken by an experienced animal keeper who will train local staff in addax husbandry. Additional support staff will be supplied by the Niger Government (Wildlife Service) and by nomads from the area.

CONCLUSION

Experience obtained through other release programmes suggests that the return of some species to the wild could be considerably accelerated. This is particularly true for species for which the reintroduction techniques are already available, and where large numbers occur in captivity, and for which there is a willingness on the part of the owners to see their animals free-ranging in natural habitat. The feasibility of the addax reintroduction project is greatly facilitated by the presence in Niger of a programme aimed specifically at the conservation of aridland wildlife and the existence of a protected area tailored to the needs of addax. Once funding is secured, implementation of the project would be immediate. The outlined proposal, therefore, offers a unique opportunity of assisting the rehabilitation of the addax in the wild and for testing the sort of reintroduction techniques that could benefit species in similar circumstances.

AMD/addax

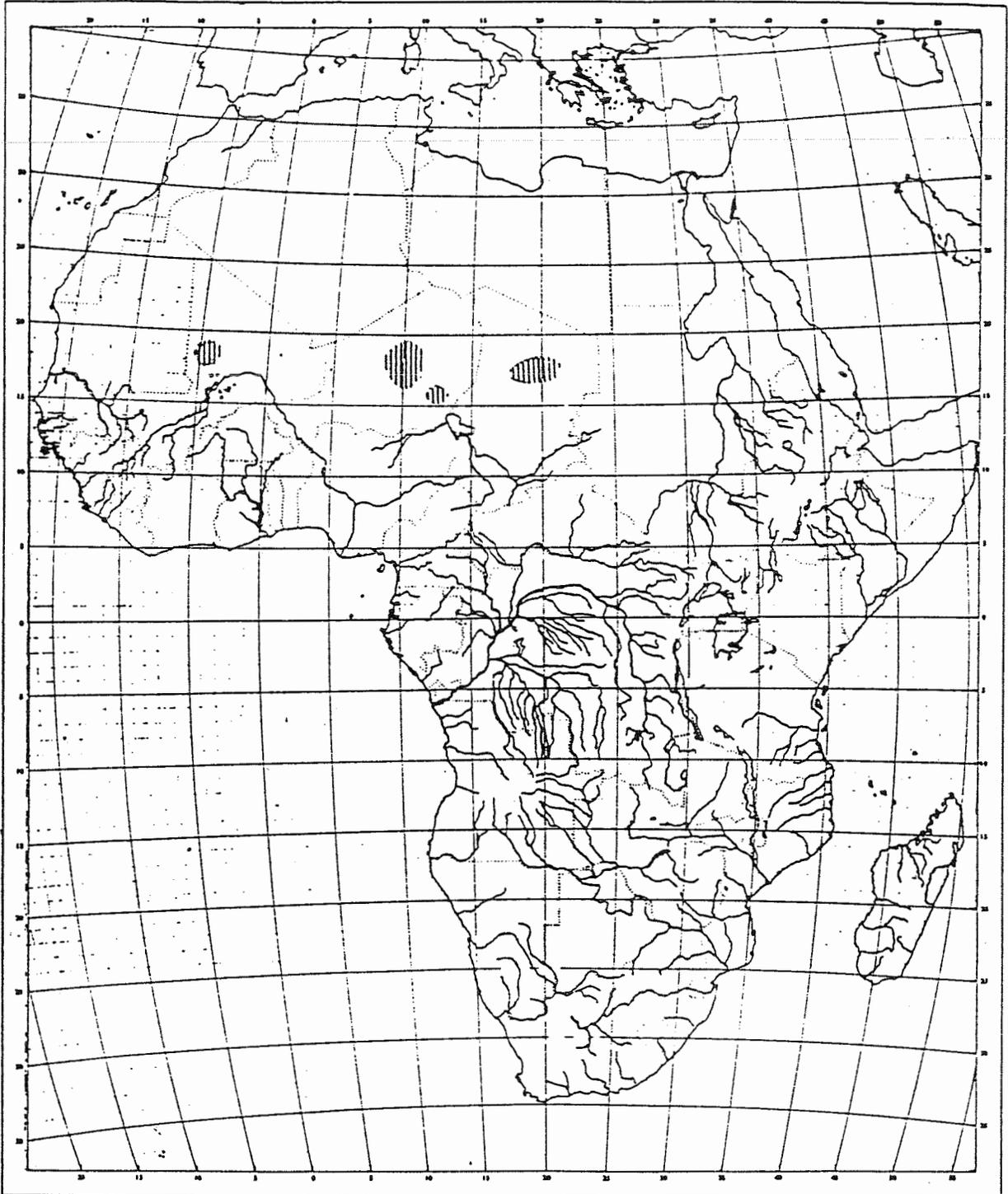
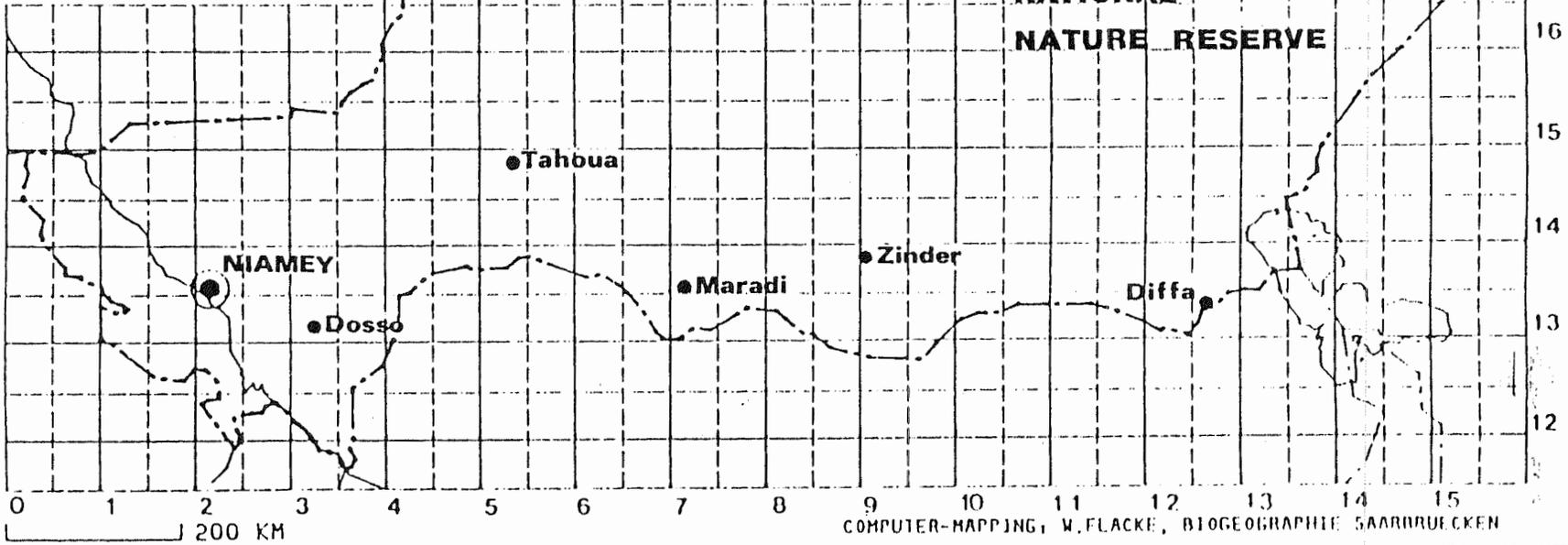


FIGURE 1 CURRENT DISTRIBUTION OF ADDAX

FIGURE 2
THE AIR-TENERE
NATIONAL NATURE RESERVE





**Feasibility Study for the Establishment of a
West African Regional Captive Breeding Centre**

Submitted by

Alexandra Dixon, Zoological Society of London

John Newby, WWF/IUCN Representative - Niger

31 August 1989



INTRODUCTION

Chronic droughts, political unrest and inappropriate land use practices have contributed to the deterioration of fragile desert and sub-desert ecosystems across Sahelian Africa. Wide-scale human poverty and famine have resulted amongst people who, in the absence of their traditional relationships with their natural surroundings, have little or no alternative means of survival. Rehabilitation of the Sahel is increasingly recognised as a serious developmental issue particularly in the wake of government settlement schemes and aid programmes often ill-suited to Sahelian conditions.

A major element in the maintenance or restoration of healthy ecosystems is the presence of indigenous species of wildlife. In the case of the Sahel, many of these species have gone, eliminated by overhunting, droughts and loss of habitat due to human activities and desertification. The disappearance of these species has not only been symptomatic of the general environmental decline, it has also been a social loss to people for whom the presence of particular animals has long been a part of their cultural traditions.

The re-introduction of Scimitar-horned Oryx (Oryx dammah), Addax (Addax nasomaculatus) and Dama Gazelle (Gazella dama), all species indigenous to the Sahel, has been considered as a possibility for many years. The availability of large numbers of these species in captivity, the development of the necessary techniques and expertise with the closely related Arabian Oryx (Oryx leucoryx) and examples of other successful re-introduction projects all prompted an interest in establishing a similar programme in the Sahel. As a result of long standing familiarity with the region and its political and ecological conditions, Niger was initially identified by the World Wide Fund for Nature (WWF) in Niger as a potential host country for such a project. Discussions with the Wildlife Service and Government representatives in Niger over a long period of time further established that there was considerable interest in the return of indigenous species. Accordingly, a proposal for the establishment of a captive breeding centre for the re-introduction of aridland species in cooperation with the Zoological Society of London was submitted to the European Commission. In September 1988, funding was received for a feasibility study and this report is submitted in fulfilment of the contractual obligation under Article 4.

Under the contract's terms of reference, the following were the stated objectives of the feasibility study:

- i) Establishment of Nigerien Government support and active participation in order to determine clearly the cooperative procedures under which the project would operate and the practical role to be undertaken by the Nigerien Government both at national and local levels;
- ii) Logistical arrangements for the establishment and management of the Centre: exact location, building design, water and food supplies, communications, site access and staff will all be described in detail;
- iii) Identification of specific local advantages and employment potential;

- iv) Design of education and training programmes aimed at developing public awareness of environmental concerns, particularly wildlife management;
- v) Identification of long-term funding sources.

BACKGROUND

A total of seven weeks was spent in Niger on two separate missions, the first in November 1988 and the second in June-July 1989. The purpose of the first mission, undertaken by a team from the Zoological Society of London, WWF/IUCN and the Wildlife Service (DFPP) of Niger, was to make preliminary contact with the officers of the Niger Government, principally in the Ministry of Agriculture and the Environment (Direction de la Faune, Pêche et Pisciculture), as well as regional and local administrative and technical officials. A visit to the Gadabéji Reserve to evaluate a possible site was also included in the remit of this mission.

The second mission composed of the same organisations, plus the Director of the Marwell Preservation Trust, was undertaken to follow up on the discussions of November, to answer questions on the part of the Nigeriens as to the implementation of the project and to visit the site during the dry season to assess its ecological status. A list of officials and local representatives with whom the project was discussed is attached as Appendix A.

Extensive discussions were also held with representatives of the European and American zoo community, private holders of Addax and Oryx, and international conservation organisations. The potential for funding from aid agencies was investigated as well.

Addax, Scimitar-horned Oryx, Dorcas and Dama Gazelles (Gazella dorcas and G. dama) and Sahelian Ostrich (Struthio camelus camelus) were considered the most likely candidates for captive-breeding and re-introduction, with other species being possibilities as well such as Slender-horned Gazelle (G. leptoceros), bustards (Otididae) and Giraffe (Giraffa camelopardalis). However, it became quickly apparent that Gadabéji would not provide suitable habitat for Addax and a separate re-introduction project would be necessary for this species (Appendix B).

RESULTS

Nigerien Support

Every effort was made to meet appropriate governmental and administrative officials at national, regional and local levels and in this respect the first mission was particularly successful. Follow-up meetings were held on the second trip, as well as introductory discussions with individuals unavailable on the first visit, most importantly the Chef de Groupement of the Peul who was away when the first mission visited Gadabéji.

The meetings held in Niamey, Maradi, Dakoro and Gadabéji on the first mission indicated broad support for the re-introduction of native species and this was endorsed on the second trip when it was obvious that a great many more people knew of the re-introduction proposal and were interested

in its development. Prior to the arrival of the ZSL representative in November, a telex addressed to Mme Dixon (Appendix C) stating the Nigerien Government's approval of the proposed Centre had been signed by the Minister of Agriculture and the Environment, M. Brigi Rafini. We were also openly encouraged by the Secretary of State and the Prefet of Maradi to seek funding for the project as actively as possible.

The meetings clearly indicated that the proposed Centre is perceived as regionally important to the conservation of Sahelian wildlife and locally useful as a means of catalysing recognition of the need for environmental management. The potential of the Centre to educate and to train personnel in wildlife management is also much appreciated by the Wildlife Service, for whom such opportunities are limited. Also significant is that the return of indigenous species is viewed as culturally important by the central Government who are fully aware of the critical status of the species concerned, and by the local nomads who volunteered the express wish of having the animals available to show their descendants. This applies particularly to the Oryx which many Tuareg and Peul have never seen, and to Ostrich which provide essential products for Peul ceremonies.

Requests for further information and expressions of interest in the establishment of a regional captive breeding/re-introduction centre have also been received from Algeria, Chad, Mali, and Mauritania. Clearly, there would appear to be considerable potential for this Centre to be used as a base from which to initiate similar rehabilitation projects elsewhere in the Sahel. This will be discussed further below.

The investigators received assurances of the Niger Government's willingness to help in any way possible. Realistically, this is unlikely to include any financial support but there are other areas where the Government's active participation in the project would be critical, for example the development and enforcement of protective legislation. The first mission coincided with the circulation by the Nigerien Government of a series of memoranda re-iterating the existence of a nation-wide ban on hunting and this was pointed out to us as a demonstration of the Government's commitment to conservation. However, there is increasing pressure from high level Government officers to open a limited hunting season for certain species. Aside from re-instituting a favourite pastime, the argument is that if properly controlled, hunting could generate revenue for conservation efforts. As things are, illegal uncontrolled hunting does occur, with no benefit to either wildlife or the wider community. It is clearly understood that strict controls will be necessary but it remains to be seen whether the Nigerien Wildlife Service is allocated the resources necessary to secure the infrastructure to enforce these controls.

Concern was expressed by the investigators with regard to the re-introduction of species which could be targets for indiscriminate hunting activity. In response, assurances were received from the Wildlife Service that, if a limited hunting season were to be ultimately agreed upon, the increased manpower and influx of resources associated with the control of the hunters would enable them to monitor the released animals more effectively. They also took the view that public awareness of the project would increase the protection of the animals, particularly if their return were made an issue of national pride.

Poaching was not viewed as a serious threat, provided that people were

informed in advance of the existence of the project and the importance of the animals released. It was stated by the Secretary of State, and endorsed by the Prefet of Maradi and the Chef de Groupement (Kel Ferwan) in Gadabaji, that the animals would be viewed as owned by the Centre, a status which would inherently provide them with considerable protection. The perception of ownership would be enhanced by the participation of several international organisations and the direct involvement of local people in the welfare of the animals. As could be expected, education and publicity prior to the release of the animals would therefore be essential.

Constant and close liaison with the Nigerien government on both local and national levels has been agreed with the Wildlife Service and is viewed as an essential part of the operation of the Centre. A Forestry warden is already stationed at Gadabaji with whom the Centre would expect to work closely. On a more immediate basis, practical assistance would be provided with such things as the construction of fire breaks and wells. While these offers are not in themselves extensive, it is important to put them in the proper context of a country where the resources available for any wildlife project are minimal.

Location

Located approximately 875 km from Niamey by road and 225 km north of Maradi between latitudes 15'00 and 15'10 and longitudes 7'01 and 7'19E (see map, Appendix D), the Gadabaji Game Reserve has been identified as a suitable site for the Centre. The Reserve, covering roughly 76,000 hectares, was gazetted in 1955. It is unfenced, bounded on all sides by a dirt track which in parts disappears altogether. Topography is typical of the central Sahel, with parallel fields of fixed dunes interspersed with flatter expanses of more clay-rich soils. The whole is punctuated by drainage pans and depressions ranging in size from small scrapes to temporary lakes and flood pans of several hectares in surface area. There are no rocky outcroppings within the Reserve other than a few calcareous deposits along the rims of the deep fossil watercourse bordering the Reserve to the North-west.

The Reserve's drainage system is highly diffuse; general seepage between high and low points is typical. Wadis or well-defined temporary watercourses are rare and limited to the steeper flanks of the taller dune systems. Altitudes vary little.

Climate

The climate of the Gadebeji region is typically Sahelian. The year is composed of a hot, wet season (July-September), a cool, dry season (November - February) and a hot dry season (April - June). Transitional periods occur during the months of March and October. Average annual minimum and maximum temperatures are around 18 and 28 degrees Celsius, with extremes of around 10 and 45 degrees. Rainfall varies greatly from year to year, a Sahelian characteristic, with an average of approximately 200mm. In an average year, there will be some 15 to 20 rainy days in July-September. Rainfall is usually short-lived but torrential and the pools created by such precipitation usually dry up by the early cold season.

Vegetation

Vegetation within the Reserve and immediate area is unusually varied for the Sahelian biome and includes a large number of typical Sahelian plants with a reasonable complement of sub-Saharan species, especially trees and shrubs. The Reserve's fixed dunes are colonised principally by annual grasses, with the burr grass Cenchrus biflora dominating. Several species of Aristida and Eragrostis are also well represented on the sandier soils, with Brachiaria appearing on muddier land. Perennial grasses, such as Panicum turgidum, are restricted mainly to the transitional habitats between dune and flatter terrain. This latter substrate, being seasonally muddier and more prone to inundation, is also favoured by tussock grasses such as Cymbopogon and Hyparrhenia.

Woody vegetation, although well represented throughout the Reserve, is denser in the interdunal depressions and in the major drainage features (temporary lakes, flood plains, pans etc). Acacia species are common with at least seven recorded. There are also extensive populations of Balanites, Boscia, and Maerua. Sub-Saharan shrubs and trees like Combretum aculeatum, Guiera senegalensis and Sclerocarya birrea are particularly widespread and occur in stands which are quite unusual for the northerly latitudes.

Fauna

The Reserve was originally gazetted for Scimitar-horned Oryx in 1955. None survives today, nor are there any Dama Gazelles or Giraffes left in the area though they too were once typical. Although heavily depleted, Dorcas Gazelle and Red-fronted Gazelle can still be found, the latter being at the northernmost extension of its range. Small carnivores such as Jackal Canis aureus and Sand Fox Vulpes pallida are present as are Patas Monkeys Erythrocebus patas. The birdlife is varied, with a wide range of resident Sahelian species including Ruppell's Griffon Gyps rueppellii, Nubian Bustard Neotis nuba and Chanting Goshawk Melierax metabates plus a fair number of local and palearctic migrants.

Water Resources

As a result of its legal status as a Game Reserve and National Forest, there are no wells within the Reserve's boundaries but there are frequent water points on the perimeters. There does not appear to be any shortage of water (this may change of course during periods of prolonged drought) nor any difficulty in reaching the water table approximately 50 m down. Most of the wells are privately owned and maintained by individual nomads or family groups.

Human Use

Gadabegi is, or could be, prime pastoral habitat. The area around the Reserve is largely impoverished and, although rain-fed agriculture for millet is occasionally attempted by local residents of the Gadabegi and Bermo villages, yields are poor in anything but the most exceptionally rainy years. Fulani-speaking groups are clearly dominant in the area but both Tuareg and Peul (wodaabe) nomads use the area, herding cattle, camels, goats and sheep. Semi-nomadic herders (Hausa) also visit the area temporarily in the wet season and the transhuman population in the area can become heavy given sufficient pasture after the rains. Many of these herders, often with their households, come north from Maradi and Nigeria, travelling up into the region east of Agadez in search of grazing and salts (the cure salee). In times of drought or if pasture is short in other areas, Gadabegi is also exploited by other non-resident groups.

Pastoral Strategies

The availability of pasture and water are the two major influences on the movements of the herders. As elsewhere in the Sahel, households operate with maximum flexibility in order to best exploit the micro-environmental differences typical of this sort of habitat and which vary dramatically on a yearly and cyclical basis. Local wells are individual property, named after the household head originally commissioning the work by Hausa artisans from the south. Members of the same lineage may use the well as may other herders but for limited periods and with the understanding that the owner will eventually receive a "non-compulsory gift" (Price, unpubl.). Preconditions for using a well and the rigour with which these conditions are enforced vary significantly depending on the owner and the availability of water.

The devastating droughts of 1972/73 and 1982 to 1984 have resulted in fundamental changes in the ownership of livestock. Few of the households have significant numbers of cattle any more although they are trying to rebuild their herds with a combination of a few personal cattle and flocks of rapidly reproducing and readily marketable sheep and goats. Indeed, many households now rely on herding cattle under contract to merchants to supply subsistence needs for dairy products (Price, unpubl.)

Ecological Conditions

At first sight, the Reserve would appear to be in quite healthy ecological condition, particularly following the good rains of the last two years. Drought-resistant annual grasses such as Cenchrus and Aristida grow rapidly in response to moisture and even in this year's dry season the vegetation looked relatively lush in comparison with the surrounding areas. However, closer inspection showed that much of the Reserve has been seriously degraded. Erosion is severe in some places and overgrazing has greatly reduced the plant cover which will inevitably lead to loss of top soil. The zone's principal human activity, nomadic herding, is now not only threatened by habitat degradation as a result of past drought and persistent overgrazing, but is itself the cause of future problems. Regeneration of both perennial grasses and shrubs which are valuable sources of food in dry periods, is not possible because of grazing pressures which allow livestock to eat new growth as soon as it appears. Enquiries made of the nomads indicate that several desirable species of perennial grass, that used to exist, have disappeared or become extremely rare. It should be noted that not only are the perennial grasses an insurance policy for the years when the annual grasses fail to develop but they are a staple dry season resource for livestock and wildlife. Whilst some perennials had already disappeared because of the prolonged droughts, many of those which remain have suffered as a result of systematic overgrazing. Annual pastures are also under threat from heavy grazing around the cattle camps, wells and wet season waterholes and from very heavy trampling. At currently observed stocking levels, it is unlikely that reseedling of useful plants will succeed without physical protection from livestock.

Considering its latitude and annual rainfall, Gadabeji is surprisingly woody. The many interdunal depressions and pans are well covered with vegetation and in many parts there are quite substantial stands of trees. Unfortunately, the growth and foliage of these stands have suffered, particularly in the dry season, from occupation by the nomads. Considerable amounts of wood are cleared or cut by the Peul for

construction of their homesteads and corrals and for firewood. As the same problems of regeneration apply to new shoots of Acacia, Ziziphus and Sclereocarya, all of which provide the means for nomads to feed their stock in dry periods, long-term and serious deterioration is inevitable.

As in many parts of the Sahel, land degradation provoked by drought, desertification and overgrazing has had and is having a severe consequence on soils in Gadabéji. Denuded of their natural protection, soils once exposed are prone to erosion from water and wind, compaction and break down. Overgrazing and trampling in Gadabéji have resulted in fairly serious compaction with increased water-runoff, gullying and lack of infiltration. This not only means loss of water but further hampers germination and plant development. However there is as yet no sign of dunal destabilisation within the Reserve or of the accompanying build up of wind-blown sands along dune crests.

Rehabilitation

Despite the overgrazing and erosion, many parts of Gadabéji, particularly those the farthest from permanent water, are by and large still in good condition relative to the surrounding area. In the opinion of the local population and foresters familiar with the area, the relatively good condition of the Reserve is due to the fact that, at least in its early days, the rules and regulations regarding its limited use were generally respected. Unfortunately, this has changed in recent times. As a result of the droughts of the past 20 years, the nomads have increasingly colonised the Reserve and on both visits many seasonal camps within the boundaries of the Reserve as well a great deal of livestock were observed. The nomads fully recognise the anomalies of the situation and, together with the Forestry Department, identify the lack of interest on the part of local authorities, including the Forestry and Wildlife Services, as being the principal factor in creating this situation.

Given that there is currently no shortage of water in the vicinity of the Reserve, the exploitation (and over-exploitation) of its pastoral resources is easy and potentially destructive unless reasonable control is imposed on stocking levels, movement and residency. Equally evident is that re-establishing control of the Reserve will require a great deal of skill and study to identify appropriate management procedures and mechanisms. Preliminary discussions with local people, including the Chefs de Groupement of both the Peul and the Tuareg, were extremely positive. They are aware that the degradation of local natural resources upon which they survive is accelerating and the pastoralists stressed the importance of the Reserve for the entire region as an "island refuge" with vegetation and ecological conditions now rare in the region (Price, unpubl.). This included the availability of plants which were important not only for their animals' use but also their own, and applied also to wildlife towards which the nomads generally expressed a benign desire to see them again in their former numbers (ibid). Because of this appreciation of the resources of the Reserve, there was a general concern that new projects in the Gadabéji area would compromise pasture rights, a concern which it would be essential to address in the development of the re-introduction centre.

Setting aside this particular concern, it was generally recognised by the pastoralists as well as the Chefs de Groupement that use of the Reserve was governed by certain restrictions although many were ignorant, or at

least professed to be ignorant, of the precise definition of these regulations. For example, families may pasture their animals in the Reserve but may not camp, a restriction which is widely disregarded. Nevertheless, because the restrictions exist and because the pastoralists know they exist, there is a general predisposition to effect a compromise solution which recognises their need to exploit the Reserve within a context of habitat rehabilitation and wildlife conservation.

Wildlife Restoration

On a national level, the government view is that wildlife restoration must be directed as much as possible to developmental aspects and that the success of any initiative will depend upon there being a perceived economic value to local people. Although the nomads agree with this to a point, they have also clearly stated that for them the disappearance of the wildlife is a great cultural loss and as such they want the animals back.

The Gadabeji Game Reserve would be a very suitable area for the re-establishment of large Sahelian species, but must be seen in a wider context of habitat restoration, improved land use management and sustainable development. Whilst short-term technical objectives can be met without due regard for the wider picture, the long-term success of wildlife rehabilitation will depend on not only a thorough understanding of the socio-economic factors (land-use, nomadic patterns, attitudes, etc.) but also the ability to integrate wildlife into other priority sectors such as pastoral and hydrological development. Equally, operations which lead to better wildlife conservation and management can be expected to have a catalytic effect on the success of range management systems in general as it is demonstrated that ecological relationships and biological diversity can be restored.

The fact that operations in this case will begin within a gazetted game reserve should be of considerable help. It is already accepted that the area is technically set aside for wildlife and the legal structures exist to enforce the regulations regarding its use. However, given that substantial incursions into the Reserve have been tolerated by the authorities and that exclusion of the nomads and their livestock could cause problems in an area where resources are so limited, clear benefits must be obvious to the people affected. In short, the rehabilitation of wildlife must not be geared solely towards protection but must adopt an innovative approach that combines protection, exploitation, research and education.

DISCUSSION

This feasibility study set out to examine the potential of establishing a captive breeding centre for the re-introduction of aridland species as a means of restoring Sahelian ecosystems. The aims of this centre would be as follows:

1. To assist governments to plan and execute conservation activities in the Sanelo-Saharan zone.
2. To establish a captive breeding capacity for in situ propagation of aridland wildlife, and especially for those species locally, nationally or internationally endangered.

- 3 To undertake re-introduction programmes for aridland species using captive-bred, locally or internationally obtained stock.
4. To establish the research capacity necessary for the comparative study of aridland wildlife and domestic stock.
5. To establish an intensive breeding and management capacity for the farming of ostriches in order to provide a direct and rapid economic incentive to local people.
6. To develop and support initiatives for environmental education within local schools.
7. To provide an opportunity and staff for the training of Nigeriens in wildlife management techniques.

Benefits

In addition to the obvious scientific and conservation benefits, the establishment of the Centre would also have material benefits for local people. In an area where there is little employment or steady cash income, the creation of jobs, even the limited number which would be offered by the Centre, is clearly desirable. It is envisaged at this stage that the Centre would require between ten and twenty local support staff to deal with the re-introduction element, plus an additional ten workers for the ostrich farm.

In addition, the Centre would serve as a focus for a variety of conservation and resource management objectives. The establishment of viable populations of several aridland species in the wild would immediately increase both the wildlife interest and the biological diversity of the Reserve. As the Reserve incorporates typical Sahelian habitats and is subject to increasing pressure from nomadic pastoral use, the habitat restoration and land-use practices developed at Gadabeji in association with the re-introduction project could be of considerable practical use elsewhere in the Sahel. Education on the conservation of wildlife and natural resources, an essential ingredient for the long-term management of both, would be a natural product of the project.

Location

As stated in the midterm report, a good site for the location of a centre had been identified in the Gadabeji Reserve at Yaltema, (see map, Appendix E). Located roughly in the centre of the Reserve, the site affords good grazing, adequate shade cover, relatively easy access and is suitable for the construction of the facilities for holding captive-bred animals for breeding purposes and prior to their release. Fixed sand dunes also provide vantage points from which newly arrived animals may survey their surroundings and which may help them to develop their navigational abilities. Excavation of a well would be necessary but according to local people, water is reliably available below 45 metres.

Logistics

Access to Gadabeji from Niamey, the capital of Niger, is by tarmac road to Maradi, hard-top to Dakoro and then by bush track the last 76 km to the Reserve. By road, the travel time is roughly a day and a half so when

bringing in animals it would be helpful either to build a landing strip in the Gadabeji area and fly the animals in directly or alternatively fly them to Maradi and truck them north. Either way would be feasible.

Facilities

Holding areas which allowed for the formation of large social groups as well as the isolation of individuals in cases of disease or incompatibility would be required, as well as a larger area in which the animals could lead progressively free-range lives prior to their total release into the Reserve. The facilities would therefore include several holding pens with water and food provided. These pens would be adjacent to, or in a corner of a much larger, 25 square km enclosure from which all domestic stock would be excluded. Within this area, the animals would be allowed time to become familiar with natural food plants to the point where they were essentially self-sufficient. Solar-powered fencing is being investigated but alternatively high tensile steel would also be suitable, particularly in view of the intention to re-introduce gazelles which require higher walls.

In addition, a simple laboratory and an education room would be needed, as well as areas for food storage, vehicle maintenance, and staff accommodation. The design of these facilities would be kept simple. All permanent structures would be built in adobe brick, using techniques pioneered in the Air Tenere National Nature Reserve Fauna Project.

Animals

The first animals to be re-introduced would be Scimitar-horned Oryx, of which there are over 2000 currently held in collections in the United States, Europe and the Middle East, more than 500 of which have known pedigree histories. The species breeds well in captivity and there is a ready willingness on the part of many owners to contribute animals for release projects. Extensive data already exist for the Oryx in captivity and animals would be carefully selected on the basis of their genetic and behavioural qualities. All animals would undergo comprehensive veterinary screening prior to shipment to Niger.

Efforts would also be made to start very quickly with Sahelian Ostrich as well, so as to establish enough at Gadabeji to begin commercial farming operations as soon as possible. While this element of the project is viewed primarily as a means of generating economic support for the Centre beyond any external funding which may be obtained for the first five years, it is likely to receive particular support from the Peul for whom ostrich feathers are extremely important but now prohibitively expensive. Bone marrow, grease and meat would be consumed on a local basis but skins would be intended for a broader artisanal market either in Niamey or perhaps ultimately in France.

Other more delicate species such as Dama gazelle would be brought in as the Centre established itself and developed the necessary level of animal keeping expertise. All animals would, regardless of species, be selected based on their genetic representation and behavioural suitability.

Preparation of the animals for life in the wild would be accomplished using two techniques. The first would be to bring animals in, hold them at the Centre until they are acclimatised, first in the pens and then in the large enclosure, and then to release them simply by opening the

gates. Obviously, sufficient time for the animals to learn the basics of survival as well as to form coherent social groupings is required but this method has been used with significant success with Arabian Oryx in Oman and Jordan and with Scimitar-horned Oryx in Tunisia. The second possible method would be to hold parental stock at the Centre and to release offspring born of these parents into the wild. This might be a more appropriate system for Dama Gazelle, for example, which can be very nervous and where it would be advantageous from a captive management point of view to have tamer animals than would be suitable for release.

Post-Release Monitoring

Surveillance of the released animals will be necessary both to obtain appropriate scientific data and to ensure the safety of the animals, at least for the first five years. For this reason, wardens recruited from the local populations will be required. Radio collar monitoring of released animals would be carried out as a matter of course, particularly as it is not anticipated that the Oryx will stay in the Reserve. Indeed the expectation is that once the Oryx have settled into life in the wild, they will gradually adopt the nomadic behaviour typical of the species. This likely behaviour has important implications for the survival of the Oryx from the point of view both of their own ecological independence and of their protection. Undoubtedly, some Oryx will not survive, indeed lossrates may be as high as 50%. Every effort will be made to assist the Oryx through the transition period and it is therefore critical that the animals be monitored whether or not they are in the Reserve. Mobile wardens would be expected to collect relevant data as well as provide assistance to Oryx where feasible. Furthermore, these wardens would be a visible deterrent to any illegal hunting of released animals until public awareness of the project is assured.

Education and Training

A major function of the Centre will be the education of local people - adults as well as children - in the need for environmental conservation. The availability of live animals for people to see and learn about is a very potent means of inducing a wider awareness of wildlife and nature. The programme would be kept simple, placing the animals at the Centre in an instructive context which stresses the interdependence of man, animals and the environment.

A second contribution to be made by the Centre would be the provision of opportunities for Nigeriens to learn wildlife management techniques including population censusing, surveillance, husbandry and practical animal management. Close liaison with the external zoo community would also enable interested Nigeriens to participate in exchange programmes abroad, for example the special field veterinary course offered by the Zoological Society of London at Whipsnade Wild Animal Park.

Public awareness programmes would be undertaken on both a local and national level. Locally, news of the project would spread very quickly by word of mouth and it is expected that large numbers of pastoralists would simply "drop in" to see the animals. National awareness would be heightened through the activity of the WWF-IUCN representation in Niamey and by utilising every possible opportunity to focus international attention. Based on the publicity awarded to the Arabian Oryx project in Oman, media attention is likely to be considerable.

Staff

It is envisaged that the Centre would be managed by a Director, originally an expatriate experienced in release projects and with a strong scientific background in ecology, range management or some similar field. The Director would be supported at least for the first year by an experienced animal curator who would train local staff in the necessary husbandry techniques. Because of local familiarity with domestic livestock, it is anticipated that the required training could be accomplished relatively quickly. Further support would be provided by Nigerien counterparts in the Wildlife and Forestry Services and ultimately the Centre would become the responsibility of the Nigerien Government. A third post would develop the education and public awareness programmes.

External Support

Extensive discussions with zoos and private individuals have identified considerable interest in the project. A two week mission to Texas and California established that several private ranches which have Scimitar-horned Oryx on their lands as part of exotic animal programmes would be interested in contributing animals as well as money. Additional discussions have been held with the Species Co-ordinators in the United States as well as in Europe, the IUCN Captive Breeding Specialist Group, the IUCN Antelope and Re-introduction Specialist Groups, the IUCN Species Survival Commission and the Conservation Director of the American Association of Zoological Parks and Aquariums (AAZPA) all of whom have responded with broad support for the project.

Financial support has also been identified with several zoos from the UK and the United States expressing a willingness to commit funds as well as animals. This potential is being investigated now. Discussions have also been held with the IUCN Sahel Programme who have assisted and advised on the development of the project from the beginning. Currently, the IUCN Sahel Programme is keenly interested in participating in the rural development aspects of the Gadabegi project but, although it strongly supports the idea, it is not considering making any financial contribution to the re-introduction project itself.

Of particular interest is the establishment by the Association Neerlandaise d'Assistance au Developpement of a habitat rehabilitation project in the Gadabegi area. They have expressed their willingness to cooperate in the re-introduction project as they perceive the aims of the Centre to be compatible with their own. This involvement of the Dutch aid agency offers the advantage that necessary elements of the overall project proposed, specifically large scale habitat rehabilitation and definition of pastoral land use strategies, would be dealt with by another funding source. However, until at least partial funding for the captive-breeding/re-introduction centre is obtained, discussions as to precisely how the two projects would work together were considered premature.

Financial Considerations

There are three elements to be considered in the assessment of the economic feasibility of this project: the capital construction costs, the provision of staff, animals and equipment, and the base running costs over a period of time. At this time, a commitment can be made by the international zoo community, coordinated by the Zoological Society of London, to provide staff, equipment and animals (plus their transport) for at least the re-introduction of Scimitar-horned Oryx. A further

commitment can be made to contribute to the running costs of the project for the next five years but the burden of building the Centre and total financial support of all of its activities cannot be taken on. External assistance is therefore required, the amount of which would depend on the extent to which the funding agency wished to incorporate aridland research activities and to extend the Centre's work to other Sahelian countries.

CONCLUSIONS

In areas as ecologically restricted, even depauperate as the Sahel, wildlife should play an integral role in sustainable land use strategies. The loss of indigenous species is increasingly recognised to be not only economically and biologically significant but culturally as well, and several Sahelo-Saharan governments (Niger, Mali, Chad, Algeria, Mauritania) have expressed a keen interest in the conservation and restoration of aridland wildlife. This concern has been officially transmitted to major technical and donor agencies eg WWF, ZSL, FED, etc.

The establishment of a regional aridland captive breeding centre for the re-introduction of native wildlife would seem an appropriate way of tackling the issue although clearly an integrated approach will be needed which ensures that ecological potential is matched to long term requirements and local socio-economic strategies. Such a centre could either be private (with the status of a non-governmental organisation) or fall under the umbrella of other regional organisations such as CILSS. Close cooperation between expatriate staff, Nigerien counterparts and local people would be essential and the Centre would seek not only to stimulate local and national interest in the development of sustainable exploitation of the natural resources but to train Nigeriens in environmental management.

As indicated above, Gadabeji is deemed a suitable location for such a Centre. The site offers a unique opportunity for innovative work in wildlife rehabilitation and the restoration of ecological relationships. There is broad popular support and the area is already gazetted as a protected area. In addition, there is complementary activity already underway in the area which could reduce the financial implications for any one donor.

The results of the feasibility study have indicated that the establishment of a captive breeding centre for the re-introduction of aridland species is technically and logistically feasible. A suitable site has been chosen, the animals and expertise are available and there is the necessary national and local support. It is appreciated that the project would require a long-term commitment if it is to accomplish its aims. However, true economics must take into account more than just the cash return of a given activity or commodity. In the case of Gadabeji and the return of native species to an impoverished land, the scientific, cultural and aesthetic value of the project make such a commitment extremely worthwhile.

CBSG ARIDLAND ANTELOPE WORKSHOP

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APPENDIX I RELEVANT PAPERS

1 February 1990

**A THREAT TO WILDLIFE - THE NEW WORLD SCREWORM (Cochliomyia hominivorax)
IN NORTH AFRICA**

Dr. Michael Woodford

The recognition of the New World Screwworm (NWS) in North Africa in 1989, its first occurrence outside the Americas, resulted in the Director-General of FAO, issuing a press release of 3 May, stating that spread of the infestation could have disastrous consequences to livestock, wildlife and perhaps even human populations in Africa, the Middle East and southern Europe. It was also stated that the screwworm could be particularly damaging to wildlife where inspection and treatment of individual animals is not possible, as it is with livestock.

The NWS is a parasite of all warm-blooded animals. The female is attracted to wounds, even those as small as tick bites, where she deposits a batch of eggs which hatch into larvae within a few hours. These larvae penetrate the flesh, increasing the size of the wound. Other females are attracted to the wound, quickly aggravating the situation. Wounds become infected. Non-treatment of affected animals leads to debilitation or even death, with consequences to newborn animals being particularly severe.

Cochliomyia hominivorax is considered the most important insect pest of livestock of the Americas. Its economic consequences to the livestock industries were considered severe enough to warrant the expenditure of more than \$500 million by the U.S. and Mexico to eradicate the pest from both countries. The program included the use of the sterile insect technique. Eradication was achieved to the Isthmus of Tehuantepec in southern Mexico by 1985. This program, the world's largest international animal health effort during the height of the campaign in Mexico, was considered highly cost beneficial.

FAO has responded to this new threat with a variety of consultancies and projects in infested Libya and neighboring countries at risk in an effort to assist countries to control and if possible eradicate the parasite where it exists and to prevent its spread to the rest of the hemisphere. As of this date, more the US\$ three million have been committed by FAO, UNDP, and the Government of Libya through a UNDP trust fund, for screwworm prevention and control activities.

Wildlife conservationists should lend wholehearted support to the efforts to control and eradicate this pest before it establishes itself in the Eastern hemisphere. Since populations have overwintered in North Africa, there is no room for optimism that it could not spread and cause damage - including to wildlife - equivalent to or worse than that which occurs in its home range of all tropical and subtropical America.

There is immediate risk to the several endangered mammalian species in North Africa and, if the parasite spreads, mammals of sub-Saharan Africa and Asia. The parasite could possibly establish itself in Mediterranean Europe.

The wide host range of the NWS includes the expected range of mammalian wildlife, seen more frequently in captivity, but also observed in nature under difficult circumstances. Most American observations and reflections about wildlife have been made about North America's major ungulates, the indigenous deer. The whitetail deer (Odocoileus virginianus) population increased rapidly in normally enzootic areas after the eradication of the pest. A frequent observation in those areas is that NWS eradication was the major cause of deer population increase. There had been many observed cases of infestation in deer, particularly as a cause of death by infestation of the umbilicus of newborn fawns.

The American cowboy was unemployed largely as a result of eradication in the American southwest where there is no longer the necessity of "riding the range" to inspect and treat all wounded animals for NWS infestation in order to prevent its debilitating, and often, in newborn animals, mortal affects. Part time ranching by the small owner who could not handle his animals routinely has been made economically feasible.

One type of ranching = that of game animals, where routine preventive treatment is difficult for the owner and traumatic for the animals, is said to have been made possible by screwworm eradication. As this group knows well, game ranching, primarily of Asian and African ungulates exotic to America, is a growing activity, particularly in areas of the U.S. previously enzootic for NWS.

Mammals indigenous to tropical and subtropical America evolved with NWS and presumably developed some defense mechanisms against the parasite. How NWS will behave in the Eastern hemisphere is unknown but again there is little reason for optimism. The Old World Screwworm Chrysomia bezziana has characteristics similar to the NWS but cases similar to the latter, in which in some areas of the Americas there is massive herd infestation taxing the livestock owners' ability to maintain preventive treatment, are less well documented with Chrysomia. If NWS spreads to the Nile Valley and up this river to the game (and livestock) rich areas of eastern and southern Africa, significant morbidity and mortality of wild animals could occur. Populations of otherwise endangered species may suffer.

The insect is a strong flier, but most long range spread of the parasite in the Americas has been with the mechanical transport of larval infested animals. The larval stage within the animal wound takes about a week, and wherever animals arrive during this period there is a potential new outbreak. Some African mammals naturally move a considerable distance in a week. Wild animal transport for management or other purposes from infested to non-infested areas would require movement control.

FAO is assisting the countries in their efforts to establish effective domestic animal movement control, in addition to providing sampling/treatment kits for individual farmers for surveillance and preventive treatment of wounds. No such efforts are possible for wild fauna. Only the sterile insect technique can reach wild hosts of the parasite. FAO is also working with the Government of Libya and the Mexico/U.S. Screwworm Commission, owner of the world's only sterile screwworm fly production facility, to determine the feasibility of transporting flies from there and using this technique to eradicate NSW from North Africa.

RECOMMENDATIONS FOR VETERINARY INVESTIGATIONS
PRIOR TO A REINTRODUCTION PROJECT

Dr. Michael Woodford

The success of potentially expensive reintroduction (or introduction) projects depend to a large extent on the ability of wildlife biologists and their veterinary advisors to assess and evaluate the suitability of the release site chosen and the ability of the translocated animals to colonize the area and establish viable breeding populations. The veterinary implications of proposed reintroduction projects are also proving to be extreme importance and failure to carry out adequate preliminary investigations has already resulted in several expensive failures and worse still, the introduction of destructive parasites and diseases into naive, resident wildlife populations. It is therefore necessary strongly to recommend that thorough, systematic veterinary investigations be carried out prior to and during the choice of the release site so that the veterinary risks can be assessed in advance and if necessary modifications made in the reintroduction plans.

- A. Veterinary investigations at source of animals to be translocated.
1. Study health record of herd/individuals to be translocated.
 2. Investigate relevant regional disease patterns amongst contiguous wild and domestic animals.
 3. Check endo- and ecto-parasite spectra.
 4. Screen sera for appropriate antibodies (Brucella spp., Leptospira, etc.)
 5. Carry out specific virus isolations (Bluetongue, Epizootic haemorrhagic Disease, Malignant catarrhal Fever) from founder stock.
 6. Carry out appropriate tests for tuberculosis.
 7. Carry out relevant vaccinations for founders.
 8. Establish quarantine arrangements for founders.
 9. Develop protocols for all specimens to be collected when animals are restrained or immobilized.
 10. Evaluate results of all tests and assess veterinary hazards for resident wild and domestic animals at release site.

- B. Veterinary investigation at proposed release site.
1. Contact head of national Government veterinary services.
 2. Consult with local veterinary authorities re relevant regional endemic diseases and disease threats.
 3. Check at local diagnostic laboratory re any existing regional domestic animal disease surveys and thus identify prevalence and incidence of local endemic diseases.
 4. Ascertain degree of contact likely between founders and (a) domestic stock; (b) wild animals.
 5. Ascertain if vaccination of contiguous domestic stock is adequate to provide an effective immune barrier against rinderpest and foot and mouth disease.
 6. Inspect proposed release site and assess likely presence of disease vectors and foci by studying landscape epidemiology. (Swamps, irrigation canals, watersheds, night bomas, domestic animal shelters, etc.)
 7. Ensure adequate vaccination cover for founders to protect (where appropriate) against disease hazards identified during investigations.
 8. Check if any large scale pesticide use in watershed of release area (e.g. quelea roost spraying of cotton, etc.).
 9. Check if any "problem animal" control operations in area. (e.g. quelea roost spraying with parathion, jackal poisoning with strychnine).
 10. Check if any "uncontrolled" wild animal releases have been made or are planned in the release area.
 11. Check possible mineral deficiencies or excesses release are (via agricultural extension service, local farmers and herdsmen and indicator plants).
 12. Prepare report and send one copy to the Director of Veterinary Services of the recipient country.

NOTE: This survey should be carried out **EARLY** in the release site selection procedure so that changes can be made if necessary.

A REVIEW OF CURRENT MOLECULAR GENETIC PROJECTS ON ARID-LAND ANTELOPES

Ed Spevak

The arid-land antelopes, as a group, are some of the most endangered animals on earth. Habitat loss, over hunting and prolonged drought have placed many of the desert antelope species on the verge of extinction. As their populations decline and become more fragmented there is a greater risk of inbreeding with the subsequent loss of genetic diversity. With this loss of diversity the various populations and species become more prone to extinction as they lose the ability to evolve to changing conditions. Similarly, captive populations have also lost diversity having gone through a population decline in the form of a genetic bottleneck going from the wild into captivity.

Small numbers of animals were brought to zoos or breeding facilities, usually representing a fraction of the amount of genetic variability found in the wild. In captivity, not all individuals bred, which continued the reduction in variability. Today, attempts to rectify the situation by equalizing founder representation to maintain genetic diversity are hampered by incomplete or inadequate records. In order to determine the relationship between various populations and clear up many of the pedigrees and to estimate the amount of genetic variability that is presently in captive populations the techniques of molecular biology are being utilized.

Presently, the majority of the molecular genetic work is being performed on the addax (*Addax nasomaculatus*). Of the arid-land antelope, the addax possesses one of the poorest and most confusing pedigree histories. Due to probable inbreeding, the number of potential founders is most likely under-represented and the amount of genetic variability is probably lower than for comparable mammalian groups. Like many other species there is little opportunity for new blood lines being acquired from wild populations. Therefore, the captive population must be managed for the maximum retention of genetic variability.

In order to estimate the amount of genetic variability or heterozygosity still being maintained in the captive population two techniques are being utilized: protein gel electrophoresis and restriction fragment length polymorphisms (RFLP's) of the major histocompatibility complex (MHC). Robert Lacy, Ph.D. at Brookfield Zoo outside Chicago, Illinois, is performing the protein gel electrophoresis. Protein gel electrophoresis utilizes small samples of whole blood, blood serum, red blood cells (RBC's) or tissue placed in gel matrix. An electric current is passed through the gel causing the various proteins to migrate through the gel. Proteins migrate and are separated due to differences in charge. Different versions of the same protein, coded for by different alleles of the same gene, will also migrate at different rates allowing an individual to distinguish between the different versions of the same protein. An examination of the population gives an estimate of the frequency of heterozygous loci in the population. However, there is little or no evidence that variability estimated by this technique is essential for the long term survival of a

species. The levels of variation determined by protein gel electrophoresis may or may not be evolutionarily significant, i.e. allowing for the evolutionary change of the population with changing conditions. Conversely, a lack of variability estimated by this technique does not necessarily mean that the organism lacks variability at essential gene loci.

Edward M. Spevak at Fossil Rim in Glen Rose, Texas and the University of Illinois is examining the Major Histocompatibility Complex (MHC) to get another estimate of genetic variability. the MHC locus is that section of the nuclear DNA which codes for an individuals immune response. This locus must be variable in order to combat the myriad number of diseases and parasites that attack the body. A number of studies have found significant decreases in the probability at this locus. Variability at this locus is estimated by cutting the DNA with restriction endonucleases which recognize specific short DNA sequences identifying RFLP's, restriction fragment length polymorphisms. these RFLP's are then probed with a sequence of repetitive DNA normally found at this locus to produce a banding pattern of the number of alleles. This technique has been successfully employed with a number of other organisms including the cheetah.

The pedigree history, number of female lineages represented in the captive population and the relationship between the various captive populations is being estimated through DNA Fingerprinting and RFLP's of the mitochondrial DNA genome (mtDNA). John Patton, Ph.D. at Washington University in St. Louis, Missouri is presently DNA fingerprinting the population of addax at Fossil Rim in Texas. DNA fingerprinting utilizes total cellular DNA. The DNA is cut by restriction endonucleases and probed producing a bar pattern similar to those found on items in a grocery store. By comparing the amount of shared bands one can determine the probable parents and relatives. The Fossil Rim herd numbers around 60 animals and is maintained in a large herd situation with a minimum of three breeding males. It is essential to find out the relationships between the individuals at Fossil Rim in order to determine the breeding structure and relationships between individuals in the herd. John Patton has proposed to "fingerprint" the entire captive population to help confirm and clarify the pedigrees found in the studbook. However, the errors involved with DNA fingerprinting increase with increasing generations past first order relations, i.e. parent offspring or full-sibs. There are also problems with reconstructing pedigrees when individuals are missing. RFLP's of mtDNA can also be used to examine the relationships between the various captive sub-populations and can be used where DNA fingerprinting may be unsuccessful.

Edward Spevak is also examining the RFLP's of the mtDNA. MtDNA is transmitted only from females to their offspring and does not recombine with the mtDNA from the male. Because of this it is possible to examine the female lineages that are represented in the population. Since mtDNA remains, unchanged, except for the rare mutation, it is possible to follow female lines when individuals are missing. RFLP's of mtDNA are produced in a similar manner to that of the MHC locus and DNA fingerprinting, its difference lies in the type of DNA utilized.

All of these techniques are complementary. However, the work on the addax is just beginning and it will be a little while before any conclusions can be drawn. In order to coordinate the genetic research and other research projects on the addax, Evan Blumer, VMD, staff veterinarian and research coordinator at Fossil Rim, has been designated research coordinator for addax. The examination of the North American addax population will be one of the first times that all of the currently used molecular techniques will be used on one population at the same time. This will allow curators, wildlife biologists and other researchers to compare the merits of the different techniques and how each can best be used for the conservation of endangered species and those populations that have become fragmented.

Other projects that have been proposed or are in progress utilizing molecular techniques include the establishment of a genetics lab in Saudi Arabia to look at the changes in heterozygosity of the Arabian oryx populations and a survey of game ranches in North America to see which endangered species they possess and to try and get blood or tissue samples to estimate their relationship to the currently managed populations. There is also an urgent need to examine the phylogenetic relationships between the gazelles in order to establish which are good species or subspecies. This might best be accomplished through karyotyping, examining the differences in their chromosome number and structure.

All of these techniques are best accomplished when complete records are kept in regard to place of origin and the identification of individuals and their offspring. Permanent identification of individuals should also be undertaken which could alleviate many future pedigree problems. In reconstructing many of the lost pedigrees, samples from as many animals as possible are essential. Where animals are no longer living it would have been helpful if tissue and/or blood samples from the animal were taken and stored for later use. Small tissue samples and separated blood can be maintained for years in an ultra-cold (-70° C) freezer. By maintaining these tissue and blood samples, reconstruction of questionable pedigrees could be undertaken as could the examination of changes in overall levels of heterozygosity in the captive and wild populations. All of the techniques that are being utilized can and should be used on wild populations where they can be of use in helping to save the many endangered species of the world.

R.A.S.P.

*Regional Antelope Stocking Policy
for Australian
and New Zealand Zoos*

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REGIONAL ANTELOPE STOCKING POLICY

- 1) INTRODUCTION
- 2) INTERNATIONAL CONSERVATION
 - 2.1 CBSG
 - 2.2 Antelope Specialist Group (IUCN)
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 - 2.4 Regional Cooperation
- 3) REGIONAL CONSERVATION
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- 5) OBJECTIVES
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- 10) QUARANTINE PROTOCOL
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- 12) LIST OF SPECIES MANAGEMENT PLANS
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REGIONAL ANTELOPE STOCKING POLICY

1) INTRODUCTION

An outline of this policy was first made at the 1988 AZDANZ Conference in Sydney to give some positive direction to the expanding opportunities that are available to zoos in Australia and New Zealand for Antelope propagation.

The original intention was to include all African ruminants but since the initial survey in May of 1988 and the first draft plan circulated in March 1989, this has been modified to include African members of the family Bovidae, with emphasis on Antelopes.

Our regional interest in antelope propagation for both display and conservation reasons has increased significantly in recent years resulting in the development of several Species Management Plans as part of our Australasian Species Management Scheme. More SMPs are planned, along with significant importations of antelopes, many including taxa new to our region. A policy document combining all of these elements is obviously needed.

2) INTERNATIONAL CONSERVATION

The international effort towards antelope conservation has increased over recent years both in situ and ex situ with a number of reintroduction programmes successfully underway. There has been a significant increase in the coordination of zoo resources and this is set to continue.

- 2.1 CBSG - A World Antelope Strategy is currently being coordinated by Karen Sausman and will be the subject of a Working Group at the CBSG meetings in San Antonio, September 1989.
- 2.2 Antelope Specialist Group (IUCN) - Global antelope surveys and regional action plans have recently been published by the Antelope Specialist Group for Part I, East and Northeast Africa, and Part II, Southern and South Central Africa.
- 2.3 Aridland Antelope Workshop - A two-day Workshop is planned at the Bamburger Ranch in Texas under the framework of the CBSG to update, evaluate and coordinate the conservation effort for Aridland Antelopes, September 1989.
- 2.4 Regional Cooperation - Progress continues to be made in the joint cooperation between different zoo regions and these will start to be reflected in both regional and international conservation plans.

Clearly there will be new directions developing from many of these meetings and any strategies we develop will have to accommodate these and other influences affecting our region.

3) REGIONAL CONSERVATION

While developing a Regional Antelope Stocking Policy that clearly reflects the conservation principles of a global strategy, we also need to consider the special requirements of our region.

- 3.1 Display Objectives - Because of our isolation from the zoo world and freight costs etc. we will have to continue with our management plans and conservation efforts even for relatively common zoo species which would not figure in management plans for other regions.
- 3.2 Conservation Opportunities - With large areas of semi-arid land being available in Australia for long-term conservation projects, our region offers opportunities for antelope propagation and conservation not feasible in other areas of the world outside their natural range. These opportunities could have significant benefits to the long-term conservation of many taxa.

4) AIMS OF RASP

The Regional Antelope Stocking Programme aims to develop a co-ordinated approach to the importation, establishment and maintenance of breeding populations of antelopes to fulfill display requirements of urban and rural zoos and in so doing to assist in the conservation of threatened taxa by maintaining viable populations, managed according to the principles of conservation genetics, in co-operation with other regional and international captive-breeding programmes.

5) OBJECTIVES

The objectives of the programme are to:

- 5.1 Options - to evaluate the opportunities which exist in Australasian zoos for the establishment of viable captive-bred antelope populations.
- 5.2 Strategy - to develop a strategy for the selection of suitable taxa (species or sub-species) to meet these options.
- 5.3 International - to coordinate with international conservation efforts to ensure that the optimum benefits are achieved from the combined zoo resource within the Australasian region.
- 5.4 Regional - to coordinate the development of long-term Species Management Plans with other zoo regions which will allow antelope taxa to be managed on a collective basis.
- 5.5 Importations - coordinate importation efforts aimed at maximising the resources available.

6) SELECTION CRITERIA

This programme covers the African members of the family Bovidae, with emphasis on the antelopes and gazelles which are important groups in the African fauna. Taxa are selected on the basis of:

- 6.1 Wide taxonomic coverage, representing eight of the nine sub-families present in Africa, and 13 of the genera.
- 6.2 Conservation status, preference within genera being given to species which are threatened in the wild and in need of captive-breeding to support long-term conservation measures.
- 6.3 Availability for importation from captive-breeding populations in countries which have a quarantine status adequate to allow importation (currently U.K., Ireland, Canada, USA).
- 6.4 Suitability for captive maintenance in either urban zoo or open-range zoo conditions.
- 6.5 Potential for involvement with other regional or international captive-breeding programmes.
- 6.6 Space being adequate to maintain a reasonable population size, to minimise the frequency of importation and to maximise the potential to retain genetic variability. Private facilities will be of utmost importance in maintaining adequate population sizes for many antelope species.

In most, if not all cases, the target population will be a subspecies, or animals derived from a geographically limited population. The taxonomy of many groups varies with the opinions of taxonomists, but it is important that we maintain captive-breeding populations of animals which derive from and represent a natural gene-pool. This is of critical importance with taxa which are of conservation concern. It is less important where a species is common and the primary requirement is display, but a common display species today may be a threatened species tomorrow.

There is little point in providing for the importation of small numbers of a taxon for display in a single zoo, unless that zoo has the capacity to maintain and manage a population of sufficient size and is able to house multiple breeding groups and non-breeding males.

7) FOUNDER NUMBER

A minimum of 20 founders is desirable for long-term viability, to ensure that the maximum amount of genetic variation can be included in the population. Survival of these founder alleles depends very much on the population

size and maximising N_e . However, we do not need 20 founders to start a regional population. If we can get access to a range of unrelated animals, then our numbers can be as few as six (3.3) for first importation. We do need careful selection of animals to ensure an even representation of founders at the start, but over time, we can increase founder representation by bringing in unrelated new stock for outcrossing from time to time.

8) STATUS

The status of both the wild and captive population of each taxa will be of significant concern in the selection process and it is hoped to develop these further as the strategy progresses.

A summary of the status of a number of Taxa has been included prepared by Rod East, Coordinator for the Antelope Specialist Group/IUCN. It is hoped to expand this list to include all those under consideration.

9) CARRYING CAPACITY

The total carrying capacity for all antelope species will influence the number of taxa we can maintain. In turn, the number of taxa will be influenced by the display requirements and the economics of importing unrelated stock for outcrossing to maintain genetic variability.

The available carrying capacity can be utilised in three main ways:

1. Maintain large populations of very few taxa which could be self-sustaining indefinitely.
2. Maintain moderate-sized populations of a number of taxa which could be supported by periodical import of unrelated stock.
3. Maintain small populations of many taxa which will need frequent boosting through importation.

We recommend the second strategy by suggesting population sizes around 100 for taxa that require conservation through captive-breeding. Display-only species could utilise the third strategy.

10) QUARANTINE PROTOCOL

With the animal health status of both New Zealand and Australia being at a high level internationally, our respective agricultural and quarantine regulations have always been strict. However the improved animal health status of many other countries and the advancement in developing new disease testing protocols has eased this considerably.

In general terms both countries can now import ruminants direct from England, Ireland, Canada and Hawaii (England now in some doubt due to the disease SPONGIFORM ENCEPHALOPATHY).

Recent protocol (1989) now allows direct importation into New Zealand from mainland U.S.A. and following further quarantine then on to Australia.

AFRICAN BOVIDS - PROPOSED REGIONAL STOCKLIST

<u>Taxon</u>		<u>No. of Zoos</u>	<u>Stock Level</u>
Family <u>Bovidae</u>			
Sub-family <u>Tragelaphinae</u>			
Tragelaphus angasi	Nyala	2	6.16 (24)
T. spekei	Sitatunga	7	16.46 (62)
T. strepsiceros	Greater Kudu	1+	2.8 (10)
T. (Booceros) eryceros	Bongo	5?	9.9 (18)
Taurotragus Oryx	Eland	4+	21.40 (61)
Sub-family <u>Bovinae</u>			
Syncerus caffer caffer		1	10.10 (20)
Syncerus caffer nanus		2	4.8 (12)
Sub-family <u>Cephalophinae</u>			
Cephalophus sp.	Duiker sp.	?	?
Sub-family <u>Reduncinae</u>			
Kobus e. ellipsiprymnus	Eastern Waterbuck	4	9.28 (37)
Kobus lechwe lechwe	Red Lechwe	4	10.27 (37)
Sub-family <u>Hippotraginae</u>			
Hippotragus equinus	Roan Antelope	2	12.14 (26)
H. niger	Sable	3	8.20 (28)
Oryx dammah	Scimitar-horned Oryx	9	45.100 (145)
O. gazella	Gemsbok	3	6.22 (28)
O. leucoryx	Arabian Oryx	4	22.52 (74)
Addax nasomaculatus	Addax	3	16.36 (52)
Sub-family <u>Alcelaphinae</u>			
Connochaetes taurinus albojubatus	White-bearded Gnu	3	19.28 (47)
Sub-family <u>Neotraginae</u>			
Oreotragus oreotragus	Klipspringer	1	2.2 (4)
Sub-family <u>Antilopinae</u>			
Aepyceros melampus	Impala	1	10.10 (20)
Antidorcas marsupialis	Springbok	2+	6.18 (24)
Gazella dama ruficollis	Addra Gazelle	2	6.18 (24)
G. granti	Grant's Gazelle	3?	-
G. thomsoni	Thomson's Gazelle	2	20.35 (55)
Sub-family <u>Caprinae</u>			
Ammotragus lervia	Barbary Sheep	(Not included in survey)	
TOTAL:			812+

SPECIES MANAGEMENT PLANS

NAME	COORDINATOR	STATUS
Eland	Graeme George	Full Plan
Nyala	Orana Park	Species Profile
Bongo		
Sitatunga	Graeme George	Full Plan
Greater Kudu		
Addax	Orana Park	Species Profile
Roan		
Sable	Orana Park	Species Profile
Waterbuck	Paul Garland	Full Plan
Red Lechwe	Orana Park	Species Profile
Scimitar-horned Oryx	Graeme George	Full Plan
Gemsbok	Paul Garland	Outline only
Arabian Oryx	Orana Park	Species Profile
Springbok	Orana Park	Species Profile
Addra Gazelle	Orana Park	Species Profile
Grants' Gazelle		
Wildebeest		
Klipspringer		
Impala		
Thompson's Gazelle		
Forest Buffalo		
Cape Buffalo		

CBSG ARIDLAND ANTELOPE WORKSHOP

San Antonio, Texas, U.S.A.
13-15 September, 1989

APPENDIX II
THE ARIDLAND ANTELOPE WORKSHOP

1 February 1990

12:30 - 2:00

LUNCH

2:00 - 4:00

SCIMITAR-HORNED ORYX



Status of Populations & Habitat in the Wild & Of the Wild
Estes (15 minutes)

Captive Populations (Status & Plans)

NA - *Tuttle*; UK & Europe - *Jones*; Australia - *Baker/Garland/Lacy*
(60 minutes)

Reintroductions

Bou Hedma - *Jones* (15 minutes);
Niger Proposal - *Dixon* (30 minutes)

4:00 - 4:30

BREAK

4:30 - 5:30

Integration of Captive & Wild Populations
Seal, Foose, Lacy, et al. (60 minutes)

Friday, 15 September

8:00 - 10:00

ADDAX

Status in Wild & Of the Wild
Dixon, Estes (15 minutes)

Captive Populations

NA - *Correll/Lacy*; Europe - *Jones*; Middle East - *Jones/Dolan*
(60 minutes)

Reintroductions

Bou Hedma - *Jones* (15 minutes);
Niger Proposal - *Dixon/Newby* (30 minutes)



10:00 - 10:30

BREAK

10:30 - 12:00

Integration of Captive & Wild Populations
Seal (90 minutes)

12:00 - 1:30

LUNCH

1:30 - 2:30

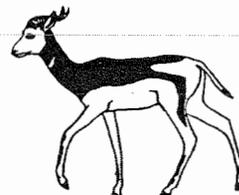
DAMA GAZELLE

Captive Breeding & Reintroduction
Vericad (30 minutes)

Reintroduction Plans
Niger - *Dixon/Newby* (10 minutes)

Other Contributions (20 minutes)

Future Plans
Seal (30 minutes)



2:30 - 3:30

General Wrap-Up & Conclusions

3:30 Onwards

Depart for San Antonio

ARIDLAND ANTELOPE WORKSHOP

13-15 September 1989

MINUTES

14 September 1989

The meeting opened with welcome by David Bamberger. David's goal to rehabilitate abused, unproductive, juniper-covered land. He and his staff have made the ranch, SELAH, (name derived from a Biblical reference as place to stop and pause) a truly beautiful and productive ranch, with livestock including about 70 scimitar-horned oryx. Buddy Francis and the Bambergers developed registered trademark of Grassmaster beef cattle.

SEAL: Reviewed the goal of the meeting: to promote survival of the antelope species by producing viability analyses and population management plans for the antelopes as with other species like Puerto Rican parrot. The change of emphasis within captive community to conservation allows everyone here to be active participant in planning. Species targeted for 5-year plans at this meeting are scimitar-horned oryx, Arabian oryx, addax, if possible, the Dama's gazelle.

ESTES: Dick Estes, Chairman of the Antelope Specialist Group. An IUCN Specialist Group formed in 1978. 84 species of antelope; 75 species found in Africa. All antelope in trouble except Nilghiri. Briefed on Antelope Survey agreed upon in 1979, conducted in 1982. North Africa not yet surveyed; other 3 regions of Africa already surveyed. The survey of Central and West Africa ready to print except for few countries' surveys. Other two surveys, of East and Northeast Africa, and of Southern and South-Central Africa, available from IUCN, Cambridge \$20 each.

Rod East's (survey's compiler) conclusions from the surveys:
9 species and 6 sub-species immediately endangered or threatened (these include species endangered in North America). See summary in report document.

East's conclusions:

1. Overall conservation strategy needs to be considered.
2. Long-term survival depends upon local cooperation.
3. Habitat and effective protection are needed.

Q: How to safeguard these areas provided one has them?

ESTES: Promotes buffer zones surrounding protected areas for locals to harvest fruits of the area also. Buffer zones allow dispersal of surplus to be cropped in tribal hunting zones which tribes protect. Fencing is commitment to actively managing the area and to cropping the surplus.

Antelope Conservation

1. Political and governmental actions -- examples of priority projects

- a. Survey of antelopes in the wild in areas of Somalia.
- b. Establishment of protected areas in Sudan; no protected areas in northern Sudan.

Antelope Workshop Minutes

2

- c. Re-establish protected areas in Mozambique and Angola (Giant Sable).
- d. Development of national strategies of conservation that are synonymous with governmental policies.
- e. Regional cooperative project of game reserves that cross international boundaries.

2. Field Projects

a. Viv Wilson's survey of duikers. 16 species of duikers; 3 or 4 species are important source of food. Cannot create management plans incompatible with local traditions and customs, i.e. protected parks with no access to traditional hunting grounds. Hence, buffer zones have argument to promote local conservation. Money needs to accompany attempts to African governments to protect animals. Their resources are insufficient.

b. Improvement of management and protected areas.

ESTES: Concern to study behavior and adaptations of unstudied antelopes. These differ with large herds and small, fragmented groups. Low sex dimorph = adaptation for forming mixed groups either seasonally or perennially. With Wildebeest- there is a threshold of about 25 animals before males can blend in.

All antelopes are territorial except for Bovinae.

ESTES: Predicts that enough open range lands to allow large herds that true behavior will resurface. Antelope males are territorial in resident populations. With bigger groups and nomadic movements males and females will blend together and not exhibit territoriality.

SAUSMAN: Reviewed 'SURVEY OF DESERT ANTELOPES IN CAPTIVITY' by section. IZY numbers show 3900 spaces for antelopes in captivity. 2000 spaces are filled with red data species. 6 species have no captive populations; 3 species have no captive populations except in the Middle East. 7 or 11 sub-species have no captive populations except possibly in the Middle East.

SEAL: Taxonomic recommendations need to be made at this meeting for species and sub-species designations.

DOLAN: The question of the validity of dik-dik species needs to be looked at chromosomally. It has been demonstrated that there are chromosomal differences in populations of dik-diks, all considered to be *Madoqua kirki*, which have resulted in infertile captive-bred offspring. Additionally, chromosomal work needs to be carried out on a number of described gazelle species in order to clarify their status. This is particularly true of the Middle Eastern species, *Gazella gazella* and *Gazella arabica*. (

FOOSE : Population Analysis Slide Presentation

ESTES: Intraspecific competition and male/female sex ratios need to be maintained.

- SEAL: 1. Sizes of populations needed for this intraspecific competition to occur?
 2. How to incorporate these strategies in captive populations?
 3. Can you identify fitness of males?

ESTES: Examples of natural conditions of intraspecific male competition.

LACY: Stated absence of problem by representing "bad" genes of inferior (i.e. non-dominant) males.

Different habitat or food situations would favor different genomes. With populations of 100 or less randomness overrides genetic selection.

READ: There is a need for captive management strategies to incorporate bio-genetics keeping the goal of viable populations in mind. Fossil Rim is doing research with testicular plugs allowing natural behavioral selection processes and hierarchies while manipulating genetic selection processes.

SEAL: Emphasized need to discuss this issue and to voice concerns regarding other aridland antelopes management strategies now at this meeting.

KNOWLES: Comes from an insulated island environment, Marwell, England, -- believes that the rigorous veterinary standards necessary for them to practice at Marwell should be incorporated into vet practices. Stressed importance of sound genetic management and questioned whether are presently seeing inbreeding depression and deleterious genes or if we are planning for the future?

SEAL: In the Arabian oryx table survivability is looked at as a function of the inbreeding coefficient. It is first necessary to develop the best possible options, theoretical and analytical, then look at the more practical aspects of vet practices, regulatory concerns, and factors of human cooperation and interaction.

LACY: Brookfield Zoo has a body of evidence that inbreeding does affect survivability of offspring. There is definitely increased mortality with inbreeding. Mortality decreases with the infusion of new genetic material, then increases again as the new influence fades.

DIXON: According to G. Mace there is a possibility of scimitar-horned oryx existing in the wild.

WOODFORD: A problem exists with vet regulatory commissions and movement of animals because of unfamiliarity of situations and of the literature. Our best defense would be to take the initiative and develop our own protocol to show our knowledge so that the veterinarians do not routinely refuse our requests, but instead come to us for answers and recommendations.

ARABIAN ORYX

DOLAN: About 55 animals in Europe. There are more males than females, there is a need for more females.???origin of American stock with exception of one animal; nothing new since last year. 29.21 + 3 females 2 in E. Berlin and 1 in London all males. In the United States there are 30 herds of 295 animals. 73 with IAE. 19 on TASAJILLO Ranch. More herds are being established in zoos. We may get 2 males from Abu Dhabe, 1 for Berlin and 1 for the U.S.

ASMODOE: PRESENTATION

1972 marks the official extinction of the Arabian oryx in the wild. There were unofficial sightings until 1979 in an area that is very difficult to survey.

WOODFORD: The origin of 1962 herd is probably from the same population as the unofficially sighted herd.

31 ANIMALS recd from King Khalid in 1982. All records lost with the king's death. 57 animals were transferred to Taif in April 1986. From June-Oct 86 there was a severe outbreak of bovine TB; 21

animals' deaths were attributed to directly and indirectly to the TB.

1. disease 2. stress of transfer 3. method of transfer 4. climate change

Question then how to proceed. Decided to treat TB. Any animal born before 10 /87 treated for TB. Treatment described in Table 1. 4 females of the 34 filter animals gravid to produce spring of 90 to become "clean herd." 3 types of TB tests performed.

?problem with alpha males and aggression.

No positive TB titers since treatment; 2 prior to treatment. TB tested each 6 months. Reprod. status also monitored. 10-12 days the young begin to graze. Current population = 71.

Other collections in SA see Table 2. 102 total as of 01/09/89.

Discussed identification of oryx.. Identified individuals visually with a key they developed. All from Thumama are considered founders. Breeding based on most divergent phenotypic characteristics.

Table 3 - perinatal mortality in Taif

Fig. 3 monthly distrib. of births and between birth intervals. 37% of females have 270-275/6 btwn birth interval; 260 days gestation on average n=4
4 loci found to be polymorphic.

1st re-intro site chosen because of perennial grasses present. Steppe grostis = grass repeatedly determined as prevalent A. oryx food

JEBEL slide diagrams space of re-intro. 1988 1st re-intro? First reintroduced animals were kept together in a holding area; stayed close to fences until a week past then had explored all of 25 ha site. 4 births Another 8 animals from Jordan for re-intro. 2 dead on arrival; 1 died later. 2 herds combined. One day of intense fighting by males. They formed one herd - did not remain separate herds. Eldest calf weaned at 7 months. 2 other calves not weaned at 7 months. With combination of herds and 200 ha enclosure -- cut off pellets. Fighting, and weight decrease of American animals caused concern; increased feeding of hay and made permanent waterers--condition of Amer.-origin animals improved.

Table 4 Composition of oryx herd. oldest is 8 years. Release scheduled for Oct. Dolan will resupply then with more oryx.

Reintroduction 3 gazelles

33% perinatal mortality; 1 calf/female/yr. 8 animals release fr. U.S.

Buildup of 700 animals in about 10 years. Taif: Even with removals pop will be at 700 in about 10 yrs. Showed 2 possible scenarios with movements between populations and reintroductions. Hearing the message that additional founder stock is needed to supplement

SEAL: 4 males from Qatar for 4 females from U.S.

ASMODE: Also attempting to get 4 from Qatar.

JONES: 700 in ? up to 900 by end of year. Both herds Katheri and ? subject to catastrophe. Abi Dobi. 2 herds - 1 separate wild captured herd; 1 from Ali Katheri staff from LondonZS run the zoo, appear to accept help. 60-70 Israel. 1-2 pre 1966

JONES: Must be concerted and cooperative effort.

WOODFORD, Chairman Veterinary Specialist Group: General terms applicable to oryx and other animals. MUST develop protocols backed with solid evidence to produce changes. Believes standard disease should be checked for reintroductions-Check founder stock so don't introduce new diseases to existing animals; check existing animals so don't transmit new diseases from those being introduced.

1. African Horse sickness -- traced to a zebra from Namibia - killed 156 animals in Spain.
2. Naive koalas caught a tick that causes ?
3. South Africa - springbok moved to where the vector tick occurs.
4. Domestic reindeer from Norway to Greenland -- warble flies from domestic transmitted to wild caribou; bad hides and meat; also bothered by the flies so much that they do not put on sufficient fat to overwinter.

Protocols should be standardized so all know precautions being taken. EX. A. oryx. If all states in U. S. and all countries would accept a certification process it would assure certain standards being set. IUCN and FAO (Mr. Sauuma) convinced to store genetic material - of domestic animals 1 or 2 per continent. Storage of material needs to be near or in country of origin.

Disease : anthrax endemic where soil is alkaline which can be caused by overgrazing. Survives long time in blood of diseased, and from feces of scavengers. Water holes not such a problem as once thought. Carnivores develop immunity; antelopes do not.

New World screwworm: worm lays eggs in wound; attracts others flies of same species; animals die of septicemia. Found in Libya now. Umbilicus of newborns very susceptible. Can spread very quickly from waterhole to waterhole. Threat that infected animals would be shot in order to control outbreaks. If only sterile males released, controllable. But flies developed in Mexico (sterile ones) - long way to Libya.

JONES: Libya attempting to gain animals from UK - dept of defense

SEAL: -Incorporation of founder stock, -staging of operations

SCIMITAR HORNED ORYX

DIXON: No reports in the last 10 years of any in Niger. Perhaps in Chad though based on French air force sightings. Newby may be asked to do survey.

SEAL: Suggests for summary then that for all practical purposes the s-h oryx is extinct in the wild. Dixon agrees.

TUTTLE: North America- Draft masterplan - Niger pop. is extinct but Tuttle believes that animals may be there. 23 institutions participating in SSP program?Reproduction is excellent. Get objectives from Tuttle. Kings Island had embryo transplant this yr
Garland with Metro Toronto AI in Orono - 2 on the ground

31 founders either alive or have contributed; 23 SSP; 98 surplus total. 159 breedings slated for

1989? Problem with space and males fighting after females have given birth - experimenting with male implants. Discussed example of extremely aggressive males. 117 births - not all maintained b/c not enough space for males

Bamberger Ranch proj. began in 1980. 1982 - 1st oryx arrived. Soon, had 11 animals not all of known lineages, so some eliminated. 33.33 animals now. 56 births 27 of 31 the founders represented on ranch. Super handling facilities here at B. Ranch. Serious problem is carrying capacity of 90 animals at the ranch. 275 acre paddock will add space.

2-fold goal:

1. Ranch animals are better re-intro candidates - know how to graze selectively.
 2. Want to get a grad student here to study herd relationships.
- Other ranchers are interested in getting involved.

ROST: Births thru June 1989. Small number of totally unknown animals-surplused them and their descendants. Lost 25% of pop. in process. Another 90 animals would be cut looking hard at the data. Had to add all unknown females and some males; that eliminated only 25 animals. Left nothing in older male categories, so added those back in - basically all animals were back in. Hypothetical - developed offspring under worst case scenes

FOUNDER SITUATION:

Older and more recent European stock possibly available. 41 /44 Rost knows where went of those captured over 2 yrs in the 1960s in northern CHAD

SEAL: Population people need to evaluate pursuing this type of info and its value.

KNOWLES: One animal to Pretoria was wild caught?

TUTTLE: Number of other obscure ranches where s-h oryx are held.

SEAL: Not so critical to solve some of these lineage problems and founder problems as it is for A. o and addax.

JONES: UK: Several animals need more tracing re: lineages; 80 animals in UK. G. Mace evaluating European situation.

100 S. African, 60 Israel, 20 0 Mid-East, 100 Far East
Thinking of moving animals to Cairo to be discussed later

GARLAND: 1978 Oryx shipment into Australia/NZ?; 60 animals. Prior to 1987 very inbred. 2 AI births fr. Metro Toronto (some Marwell blood in AI). Hoping now for NA animals. Regional policy developing on antelopes in Austr./NZ to change policy of importing any animal to importing those animals that contribute best to world situation. Quarantine situation changed a lot They are in close contact of vets - stroke them.

BAKER: Space in zoos and outside of zoos. Dry climate similar to SA Texas. Movement of animals isn't labelled with a cash value on any of the stock.

BSE - UK introduced diseases. Slow virus related to scrappy?

LACY: A/NZ has their own computer system similar to ARKS. Info will be automatically transferred to ISIS? Land control and disease control in Australia a benefit.

JONES: 12/1985 5 prs from UK, Marwell and Edinburgh, re-intro to Tunisia. In pens then released to 10 ha area. Within days selected vegetation. Still receive some supplemental food. S-h male killed 3 addax males in a 1500 ha area. Not a true re-intro; area too small though probably had been in area. Vegetation had been rundown. 14 animals now. Projected pop.= 70 for 1500 ha space.

ESTES: Questioned carrying capacity of this amount of habitat.

JONES: Very rich in diversity of plant species.

ASMODE: Digging is instinctual for moisture and salt even for "orphan" calves. Politics to convince them to incorporate new genetic material not from UK stock -- make CBSG stock.

DIXON: Niger reintroduction project

London long been involved in Niger Jones and Newby. 1986 Newby suggested s-h oryx reintroduction in NE Africa. Niger best candidate. Plans of addax and other antelopes reintroduction to follow. Have done 2 studies. Studied feasibility of reintroduction - doesn't cover details. Originally thought both s-h o and addax but land too lush for addax. Addax project now separate.

Reviewed geography etc. of Niger and the proposed reserve choice. Three local peoples have strong environmental ethics citing cultural and traditional reasons; they wanting to share these animals with their children. Water and grazing land are vital to the nomads who spend much time in search of these two items. Local government support critical. Government very supportive of project. Logistically roads exist. Establish center in established reserve. Size 76000 ha. Capacity difficult -- not fenced. Oryx would not be maintained. Would have to co-exist with livestock.

Question of royal families hunting these antelopes and other animals. Dispute whether this has actually happened in Niger.

SEAL:

1. Can animals be protected?
2. Over time will enough habitat be accessible?
3. Not really a question - remnant population?

Commitment needs to be 10 yrs at minimum, 20 years better.

KNOWLES: Tremendous turn-around in the past 20 years in taking s-h oryx into captivity to discussing the reintroduction of them in Niger. Bug-a-boo: the Dutch project wanting to improve domestic grazing opportunities.

Question of Niger government stability.

ADDAX

50 in Mali, 2 pop in Niger total 200 , chad 200

BEST case scenarios. Fragmentation of habitat b/c of drought; tourism-vehicles chasing animals; drought. Newby's estimates based on

1.?

2. type and amt of human activities going on

ASMODE: 60-70 in Algeria.

CORRELL

ADDAX Has been herd-managed; used worst-cast scenario. 20 founders for NA population; SSP pop has 12 founders; 6 of those over represented. 10% growth. 190 alive.

1. assist addax reintroduction
2. 85% represent. over yrs
3. 200 to 300 animals over 5 yrs
4. 10-30 animals for reintroduction
5. 5-15 additional founders
6. target representation for founders

PATTON WASHINGTON UNIV. PROJECT

DNA fingerprint. 4 different probes; 5-10 most diverse loci will be tested. Use of Museum specimens additionally. See paper.

SPEVAK: Brief description of DNA finger printing

1. Nuclear DNA
2. Mitochondrial DNA
3. Major histocompatibility complex(MHC)

Survival rates increase as MHC diversity increases.

Techniques not before used for an entire population as is the plan for addax.

READ: Can determine genetic variability of museum specimens by DNA finger printing to determine lineages.

Embryo transfer - addax SSP moving towards this. Problems: disease, etc.

Need to DNA f-print the whole population A COMMITMENT - 200 animals to sample.

KRAEMER: Views embryo transfer as last resort; ease of transport; called safest method of genetic transfer. Little done until this point with addax embryo transplants. Have made 4 unsuccessful attempts at obtaining embryos. Respond to prostaglandins

Can pass catheters without surgery with a number of species, ? addax included.

No cryopreservation for addax yet. Necessary of course. Useful recipients. Would use "surplus" SSP females as surrogates filling a valuable niche. Nuclear transfer or cloning would be useful if embryos of important founder stock became available. Being used in cattle, though not efficiently. ? of mitochondrial influence.

FOOSE: How long until successful ET? til they drop on the ground - 3 years.

How old are the Qatar females? 6-7 years estimated

1/3 attempts in cattle result in 0-1; 1/3 result in 2-4; 1/3 result in 5-27 pregnancies. 4 bison in WY this week - 8 embryos 15 eggs not fertilized.

If Qatar animals are 7 yrs old, add 3 yrs research, they're 10 yrs old.

?Is it worth a sample of tissue from females (Qatar)

Yes, to know relatedness; yes, to know if mother/daughter.

When could an answer be determined re: entire pop. genome -- 1-3 years.

FOOSE: If such slow results, can't wait. Need to try to breed different male into Qatar herd.

JONES: 40 addax in Europe no EEP. 15 animals in UK; short of males; others are E. Berlin, etc. 1/2 founder in Europe not in U.S.; exchanges should take place both ways.

Mid-East: Bahrain 50-60 all American origin. Very few in private collections, from dealers. Ali has a small group already represented.

NO NEW POTENTIAL FOUNDERS EXCEPT IN QATAR.

REINTRODUCTIONS

4 pr in Hannover + 10 s-h's held together in 85? Added 6 females from Dolan. Friction btwn s-h male and 3 addax. Jackals killed offspring; due maybe to absence of adult males to protect.

SEAL: Need for more intensive management?

DOLAN: They want addax for another site

JONES: USAID money being used for fencing, etc. Tunisian government naturally jealous. We are adding animals.

DOLAN: Area important for slender-horned gazelle lambing because only one other possible viable populations. Cheetah here too.

ESTES: Surprised if male addax would have helped in the jackal situation.

1988 establishment of Air Tenerife. All human activity excluded. Drought, hunting, tourism - factors all contributed to decline of addax. See Newby report. 12,500 ha for addax. 77,000 sq km = total area. Addax are incredibly nomadic; necessity for survival. Last addax in NIger 1986.

Build release site at Ifiwan. Has permanent water. Costs: over 3 yrs startup costs 1/2 million pounds. Possible money from IUCN project.

How much money from zoos? None for setup. Need money for transfer, and research once set up. see knowles for money figures.

KNOWLES: Low-budget project for this soft release. Would focus world attention. Need to find balance between priorities of space in zoos, reintroduction and captive breeding.

LACY: Serious concerns even if cost-free.

1. population exists
2. population not monitored at all
3. need much pre- and post- monitoring

FOOSE: Need secure managed population, which is depauperate. Animals from the wild could bolster

captive. Wants to capture some wild before releasing any.

DIXON: Field situation makes wild capture difficult and expensive. People 3 years in the field working in prime areas haven't seen one animal, just tracks. Need to consider that government would not likely easily agree to removal. Need to consider losses if animals removed.

LACY: Question of biological value if animals added.

DIXON: Ecological timing good for reintroduction.

ESTES: Newby's estimates that addax should have recovered from drought. Suggestion of separate captive breeding population in this area.

LACY: Need to determine if existing population is viable.

15 September 0815

VERICAD PRESENTATION (See paper)

Dorcas gazelle prevent total extinction, intensive captive breeding, maintain biological diversity, supplying animals and scientific support. 8 different sub-sp of dama's gazelle
3 sub species

Dama gazelle is endangered . Chad. Captive breeding in Almeria. species is totally extinct in this country.

1984 - began building of facilities; giraffe, ostrich, dama gazelle

720 ha total area

1/3 is salty water

150-500mm rainfall mainly in the summer months

28-20 degrees

10-40 degrees -- extremes

listed plant species, endogenous mammals, other activities had been allowed but now are disallowed except fishing.

After 4 years of having the reserve closed the depleted vegetation has grown. Observations are made and recorded daily. Animals are individually recognized by phenotype but also assigned a numbered tag at birth

Population now 11 - 5 males , 6 females

Number of births 11; 9 survived breeding coincides with season rainfall

Causes of deaths

1. perinatal - one very weak; one orphaned
2. pathological perinatal -
3. trauma - one interspecific competition

Conclusion: Send more animals would be advantageous because the park service is willing to maintain daily records.

How many do you plan to release? The fencing provides the opportunity to do a soft release with the animals, allowing them to acclimate to the area, the vegetation, and to browsing. This area is too populated to release more animals. 80 dama gazelles in Almeria

Slide presentation by VERICAD

Dr. ALADOS: Phenotypic and Genetic Characteristics Affecting Lifetime Reproductive
17 individuals of dama gazelle in 1971; 2 males and 2 females were brought from the Western Sahara; Each animal is caught for marking, longevity, fecundity

Comparisons of cuvieri, dama, and dorcas: birth weight affects longevity
Inbreeding coefficient in Dama's affects birth - delaying first birth. Fecundity not affected in any of the three species. Birth weight compared to juvenile survival for all three species.

Birth weight compared to . Juvenile survival compared to mother characteristics. Mother's inbreeding coefficient was compared to birth weight of offsprings - affected only dama gazelle. In damas social rank and herd stability. Social rank and age of first birth, fecundity and offspring survival were compared; dama not affected; cuiveri affected.

LACY: This data and some other data indicate that with high inbreeding coefficient more males are produced. The male populations in NA have been on the increase.

ASMODE: 6-7 damas possibly available in Saudi Arabia but they would need to be convinced to give them up.

Developed untrackable conservation on additional animals and accessibility.

ROST: Founder stock of 20 animals of subspecies at Catskill. Time to act now before this situation approaches the addax problem.

SEAL: The tip of the iceberg is showing and a working group needs to be established to resolve the many problems that have are being brought forth with the presentations of this meeting.

ESTES: Expressed concern that the subspecies not be lumped together, with no efforts on maintaining the subspecies.

SAUSMAN: Of the high priority species of IUCN endangered animals, there are 22 forms. 3 forms with studbooks underway, 4 , maybe 6. Speke's - 100; gerenuk; Curvei's about 100; slender, damas each have a pop. of about 100

A. sand gazelles 50-60 in NA 807 in Mid-East, big populations in Saudi Arabia 0 in Europe.

Proposes a collective small antelope working group because so many species, so much work to be done, and only limited energy.

Could dovetail meetings with the larger species' working group for the same people would be contacted in the same geographical regions.

DOLAN: Though everyone here concerned and interested, institutions are less likely to want the smaller animals that are more likely to suffer casualties.

GARLAND: When looking at the regional programs and space availability, perhaps the city zoos could provide space for a number of smaller species instead of the larger ones.

ESTES: Suggested that exhibit design should be investigated, particularly barriers inside of the fences to prevent gerenuk killing themselves on the fences.
Proposes meeting of those interested in what?

DOLAN: Enormous mortality in capture -- wild capture.

DIXON: Presentation on dama gazelle reintroduction in Niger. Dama did occur in the area. London's plans for dama are to first introduce the oryx and addax then as husbandry techniques are solidified. Dama would be introduced into the Center at Gadabeji. Point of discussion: to release captive animals or some wild-caught.

SEAL: Product of 3 documents - 1 page synopsis for each of the 3 species, A. oryx, S-h oryx, and the addax, plus the dama gazelle if possible

A document of this meeting will also be produced including summaries of the papers and the species synopses.

Karen Sausman will lead the team with Alexandra as her counterpart; Georgina Mace will lead the population analysis work, with Bob Lacy also contributing.

Dewey Kraemer has promised a summary of the status of the reproductive work and will report on discussions with those in the field.

The publication deadline is one month from today, 15 October.

Karen Sausman will serve as a focus for an antelope working group until the group meets.

FOSSIL RIM will employ grad students to determine numbers of desert antelopes on ranches.

Working document group products.

A.ORYX - Karen Sausman, recorder

The aim of the group is to reintroduce the best genetic animals into the wild.

2 important animal groups

1. one of crown prince
2. Qatar

SEAL -- broad goals are:

1. Survival of the species.
2. Recovery of the species.

JACKSON: Suggests that as many tissue samples as possible be obtained worldwide.

KNOWLES: Allocation of resources are important. Fact new to him that some antelopes are being shot on Texan ranches. Male at Rabat came to L.A.

SEAL: Useful to give demographic additions to Saudi oryx. Need demographic and genetic analysis to

2 Saudi proposals in order to determine the best use of resources if it comes to that.

1. Yalooni pop.
2. Saudi pop.
3. second Jordan pop.
4. need to also look at the NA pop.--many young animals being given to reintroductions.

SEAL: At some time the pop. needs to expand on its own without supplemental animals. At 50-60 animals, no animals should be added. 5-10% growth rate will be anticipated for the herd. This

LACY: Had a chance to do some analysis. With 50 animals on-site in a population, extinction is unlikely in the next 100 years.

SEAL: With the strong captive population, given a catastrophic event, the population could be reestablished.

ASMODE: Mace stated that 700 animals are needed in order to have sufficient genetic material.

LACY and SEAL: The suggestion is to build up to that 700 animals by not supplementing the population.

DIXON: Described the modelling run that Mace did with 40 addax -- went extinct in 50 years. Discussion concluded that her model included genetics which were the demise of the pop. in the model.

ASMODE: Reintroduction costs very high, particularly at pre-release sites. Suggestion to involve the (Texas) ranches in the SSP program.

SEAL: Need a few more items; genetics statement.

JONES: Will Yalooni meeting results be mentioned? Yes.

SCIMITAR-HORNED ORYX

Dale Tuttle, Recorder

SEAL: Founder problem is not severe. One possible remaining pop.; no certain numbers or survivability; hence dependent upon captive population. Recommends that all founders be represented in all herds.

Alan Rost and Ed Spevak will work on genetics. Spevak suggests that samples be obtained from Texas ranches and lineages compared to the zoo captive pop.

European and NA herds not related. European stock needs new blood. Lacy recommends an infusion of new genetic material. Seal recommends that the suggestion go to the EEP. Rost's studbook can serve both populations. Alan and Mace suggested to communicate and share information in order to develop the international studbook.

JONES: Advice needed with Pretoria and Cairo for added founder representation.

ROST: Demographic problem exists in NA. There are surplus males from the age structure that would leave no animals more than 5 years old.

Woodford is handling vet problems which are similar for all three species. Kraemer will have a write-up on the reproductive situation.

ESTES: Suggested that behavioral studies regarding the social structure in larger groups be looked at.

SEAL: The money limits the availability of graduate students.

JACKSON: Suggests that this aridland antelope group form recommendations on raising money to support a student(s) to study the problems deemed most immediate by the scimitar-horned group.

ESTES: Niger presents a unique opportunity to reintroduce animals back into the wild from the point of captive breeding.

SUMMARY

SEAL: There is clear-cut support for the s-h oryx reintroduction project.

1. Reintroduction as goal extinct
2. return animals to the wild as soon as possible to former range
3. pilot project for reintroduction and conservation in this part of the world
4. establishes strong need for training at all levels of nationals

JONES

- 4.... development of an education program from school children on up through the adult population
2. Multiple aid agency integrating conservation with nomads
incorporate a reintroduction project in to multiple land use organization

BLUMER: Concern about the integration of feral nomadic animals and the introduced animals and the possibility of transmission of disease.

WOODFORD: Hopeful that the pre-release reintroduction veterinary protocols will include precautions that must be followed and will address this issue.

Release will not be a hard release. Tunisian and subjective need to be made to support the recommendation. Mauritania proposition killed when 3 biologists were killed. Morocco animals coming from Israel needing to go thru Europe then down. 60 or 70 s-h oryx that Israel want to unload with no source because cannot unload in the Islam countries now.

SEAL: Suggest establishment of a reintroduced free-ranging, wild population of 5000 animals. Inclusion is important to have a ballpark figure as a goal. The number is subject to change as the process of reintroduction continues.

ASMODE: The goal with the A. oryx is to build the numbers of oryx to the point of use.

SEAL: Recommends that numbers be established early as goals for

1. Clear idea by all of what numbers need to be established in order for harvest to begin.

ADDAX

Ann Petric, recorder

LACY: Entire population is in poor state.

SEAL: Mid-East founders would be desirable to add to NA and European pops.

FOOSE: Could add a male to the Qatar population.

BLUMER

1. Collect blood from females to determine relatedness to each other and NA herds.
2. Send a new male for two reasons: a. if cannot obtain the females, b. if embryo transplant work develops, sperm from a male other than the resident male would be desirable.
3. Continue cryopreservation work to bring frozen genetic material out of Qatar within one year from now.
4. Bring animals out of Qatar, possibly offspring particularly if the other reproductive work is unsuccessful.

READ: Has permission to bring embryos out of Qatar.

JACKSON: Suggests that a male be sent to Qatar. Breed the females for the next season. If and when the embryo transplants techniques are developed, proceed. No breeding season would have been lost.

READ: Has a commitment to call Qatar Oct. 1.

GARLAND: What about infusion of NA genetic material into Australian region population. Wants about 100 spread out in a number of populations. Quarantine regulations are now favorable for import. He will write a statement to the SSP.

FOOSE: Suggests that the EEP add the addax to their EEP species. There is a need for the EEP to develop their regional studbook. The entire population would benefit if the captive herd had new founder material added. Coordination of this with the reintroduction program would be beneficial.

JACKSON: Request Texas ranches hold off for a year while situation with addax is sorted out. Survey of ranch-held stock be made to determine the demography, locations, history, distribution and exchanges.

FOOSE: We encourage the survey of Chad where both S-h oryx and addax may be found in the wild.

ASMODE: Another team exists that has proposed surveys of Chad and always been refused because of security reasons. He recommends no hard feelings or competition between groups if one survey is allowed to proceed.

SEAL: If any are found they should be protected.

LACY: With any reintroduction extensive pre-and post-investigation be made. Suggests reintroduction only after extensive pre-investigation occurs and deem that reintroduction could indeed be successful.

SEAL: 1. Goal of captive breeding is reintroduction. 2. Encouragement of these range countries to develop education and conservation in the process of the reintroduction.

JONES: Fears expressed: 1. Survivability of existing herd. It is certain that the herd will not survive without supplementation because the government will not enforce protection. 2. . The presence of people, conservation officers, wardens, the personnel will in itself protect the pop. 3.. There is a fairly well geographically delimited population in Niger so this population is likely to need new material.

JACKSON : Concern that the resources be spent on the reintroduction project when other critical issues exist. The trade could be oryx for addax, not necessarily addax for addax.

JONES: The proposals are separate with separate funding sources.

DOLAN: Proposes that Vericad's site with the More gazelles be looked at for the reintroduction of addax.

JONES: Consider both sites.

SEAL: Receipt of suitable addax, including release. Survey for extant population with attempt to incorporate any genetic material found.

JACKSON: Recommends that a climatological study for the next 30 years be made for the proposed release site.

SEAL: Reemphasize that locals need to be trained to eventually manage the project. Workshop in Niger itself, involving locals to explain the logical step-by-step to identify helpful Nigerians

SEAL: Uncertain after re-reading proposals that the Nigerians understand the proposals as we do.

DIXON: Proposes an on-site visit.

ASMODE: Algeria has a remnant pop., was part of the historical range of the addax and should be looked into as a potential reintroduction site. The country is stable on poaching issues.

JONES: They have also expressed interested in something like this. And this may be a vehicle for access to slender-horned gazelles.

SMALLER GAZELLES

SEAL: Recommendations: Immediate attention must be paid to their status in captivity. 1. Priorities need to be assigned 2. Identification of systematic taxonomy of gazelles. 3. Join with Antelope SG to determine the subspecies taxonomy.

GARLAND: Regional program involvement encouragement.

DOLAN: Taxonomy proposes that JF group do the lab work.

VERICAD: Encourage the taxonomy, the , and work on the reproductive biology.

JONES: Again encourage JF to obtain as many samples as possible from the private collections.

VERICAD: Suggestion from the professional community to provide financial support to do additional fencing of the dama gazelle reintroduction project.

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APPENDIX III

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