action or directing further study. in the first example, different probabilities of extinction of *bicornis, minor,* and *michaeli* were used to show how the decision strategy might change. In the second example, sensitivity of the decision to the probabilities of outbreeding depression, of survival in the wild, and of successful establishment of separate captive populations can help identify the circumstances under which semicaptive management would be better than zoos.

A structured analysis shows where additional information about chance events could reduce uncertainty and lead to a better decision. Genetic analyses of rhino subspecies can help reduce uncertainty about outbreeding depression in mixed populations, guiding the sampling of geographic regions for founders of captive and semicaptive populations and the merging of these populations in the future.

Tradeoffs among conflicting criteria, particularly between financial and biological criteria, are typical of endangered species management decisions. The two examples presented here raise the difficult question of how the value of obtaining founder animals from the northern-western subspecies of black rhino should be weighed against the difficulty and expense of doing so.

in addition to the two questions addressed by these preliminary examples, many other rhino management decisions might benefit from formal analysis:

(i) Under what circumstances is wild, intensive *In situ,* or *ex situ* management best? Among the criteria to be used for this decision are: biological impacts, including disruption of behavioural adaptations or coadapted gene pools; political impacts on local and national support for conservation; socio-economic impacts on local economies; and likelihood of sub-species survival.

(ii) How many founders are required to justify maintaining a separate subspecies population? At what point should some subspecies populations be merged for semicaptive or captive management? Among the issues here are the genetic and demographic risks of few founders weighed against the irreversibility of merger.

(iii) What are the optimal strategies for translocating animals among semicaptive and/or captive populations? Which sexes and ages should be moved, what size groups, how frequently? The concerns here are the relative genetic and demographic contributions of different sexes and ages, social disruption caused by moving animals, risks of mortality during and after translocation, financial cost, and hazards of inbreeding in isolated populations. Some of these issues are addressed in Maguire (1986) and in previous analyses of translocations to augment grizzly bear populations (Maguire, unpublished report to U.S. Forest Service).

(iv) What are the risks and benefits of ongoing exchanges of animals, or genetic material, among captive, semicaptive and wild populations? Social disruption, impact of removals, transmission of disease, risks of injury or death to individual animals, disruption of local adaptation, and loss of genetic variation from drift and inbreeding are among the considerations here.

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# SMALL POPULATION MANAGEMENT OF BLACK RHINOS

**Session Chairman DAVID CUMMING**

## STATUS OF BLACK RHINOS IN THE WILD

The black rhino has declined more rapidly over the past 20 years than any other large mammal. In 1970 there were about 65 000 black rhinos in Africa; the total is now under 4 000, a decline of 94%. The population sizes in the various African countries within this decade are roughly as shown in Table 3. The remnants of a number of the populations are scattered as individuals or in very small groups over vast areas. For instance, the estimated 200 rhinos remaining in the Selous Game Reserve of Tanzania are dispersed over 55 000 $km^2$.

The recent decline of the species is due almost entirely to commercial poaching for rhino horn. The decline in South Africa, due to natural factors in the Umfolozi-Hluhluwe complex, appears to be the one exception (the 1984 figure was probably an overestimate). In the early 1980’s about half of the horn put onto the world market went to North Yemen where it is used for making dagger handles, while the remaining half went to eastern Asia for the production of traditional medicines. Most of these rhino horn mixtures are produced because they are believed to lower fevers, not because of alleged aphrodisiac properties. North Yemen has recently strengthened some controls on the import and use of rhino horn, so there may be changes in the relative importance of the markets.

Prices for African rhino horn have risen from about $30 per kg wholesale in 1970 to about $900 per kg today. Asian rhino horn is believed to have more potent medicinal properties and therefore commands much higher prices in eastern Asia. To halt and reverse the precipitous decline in the numbers of black rhinos will require concerted action by many individuals and organisations. International, national and local conservation efforts will be most effective and make the best use of scarce resources if they are part of a planned campaign. To achieve this coordination of effort, a broad framework of policies on rhino conservation (i.e. a continental rhino conservation strategy) must be agreed upon by the principal agencies involved, and plans of action ——with clear priorities ——must also be elaborated in line with—these policies, and kept updated as the black rhino situation changes. The African Elephant and Rhino Specialist Group (AERSG) is currently developing a continental black rhino conserva-

Table 3. Status of black rhinos in Africa.

| | 1980 | 1984 | 1987 | % of total 1987 rhino population |
|---|---|---|---|---|
| Tanzania | 3 795 | 3130 | 270 | 7% |
| C.A.R. | 3 000 | 170 | 10? | 0.2% |
| Zambia | 2 750 | 1650 | 110 | 3% |
| Kenya | 1 500 | 550 | 520 | 14% |
| Zimbabwe | 1 400 | 1 680 | 1 760 | 46% |
| South Africa | 630 | 640 | 580 | 15% |
| Namibia | 300 | 400 | 470 | 12% |
| Sudan | 300 | 100 | 3 | — |
| Somalia | 300 | 90 | ? | — |
| Angola | 300 | 90 | ? | — |
| Mocambique | 250 | 130 | ? | — |
| Cameroon | 110 | 110 | 25? | 0.7% |
| Malawi | 40 | 20 | 25 | 0.7% |
| Rwanda | 30 | 15 | 15 | 0.4% |
| Botswana | 30 | 10 | 10 | 0.2% |
| Ethiopia | 20 | 10 | ? | — |
| Chad | 25 | 5 | 5? | — |
| Uganda | 5 | — | — | — |
| **TOTAL** | **14 785** | **8 800** | **3 800** | |

tion strategy, and has been producing annually-revised action plans for the conservation of rhinos and elephants.

In discussing the draft strategy, an emphasis that emerged from the workshop was the need for interactive management of wild and captive populations in order to maintain genetic variability. However, it was agreed that *ex situ* breeding programmes should avoid mixing rhinos from different regions of Africa in order not to destroy probable adaptations to particular environmental factors in these ecologically divergent regions. The numbers of remaining rhinos in the four regional groups that were identified for separate genetic management are shown in Table 4.

**Table 4.** Estimated numbers of black rhinos in regional units.

| **Regional conservation unit** | **Number** |
|---|---|
| Southwestern | 500 |
| Southern/Central | 2 600 |
| Eastern | 600 |
| Northern/Western | 50 |

## STATUS OF BLACK RHINOS IN CAPTIVITY

Tables 5 and 6 summarize the current status of black and other rhinos in captivity at the time of the workshop. Figures differ slightly from those used by Lynn Maguire and Robert Lacy in their analyses in these proceedings—owing to different sources of information—but not to a significant extent. There appears to be captive habitat in zoos for about 700-800 rhinos, using current collections as a crude estimate. Black rhinos are currently allocated about 20% of these spaces, while white rhinos occupy a disproportionate 60% (owing largely to their ready availability from South Africa). The black rhino population in North America, now under management of the AAZPA Species Survival Plan (SSP), has been increasing slowly over the last five years at a rate of about 2% per annum (Table 7). Birth rates have been quite encouraging (in contrast to the white rhinos, which have not reproduced well as a probable consequence of this species' inclination to breed better in group situations than when kept as pairs). Death rates in black rhinos have been high, largely because of the haemolytic anaemia syndrome discussed later in these proceedings. intensive research to resolve this problem is in progress and some hopeful insights have already been obtained, especially in terms of possible vitamin E deficiencies.

**Table 5.** Current populations of rhino in captivity. Sources are AAZPA Species Survival Plans (SSP), the international Species Inventory System (ISIS), International Zoo Yearbook (IZY), and the International Studbooks for African Rhinos (Zoo Berlin) and Indian Rhinos (Basel Zoo).

| **Species** | **North America** | **World** | |
|---|---|---|---|
| | | IZY | Studbook |
| Black | 30/38 =68 | 68/80 = 148 | 82/98 =180 |
| White | | | |
| Southern | 70/93 = 163 | 177/215 = 392 | 313/357 = 670 |
| Northern | 1/0 = 1 | 6/5 = 1 | 6/5 = 1 |
| Indian | 16/12 = 28 | 44/35 = 79 | 44/35 = 79 |
| Sumatran | 0 | 3/6 = 9 | 3/6 = 9 |
| Javan | 0 | 0 | 0 |
| TOTAL | 117/143 = 260 | 298/341 = 639 | 448/501 = 949 |

**Table 6.** Estimated captive capacity or habitat (space and resources) for rhinos in the world's zoos.

| **Species** | **North America** | **World** |
|---|---|---|
| Black | 125 | 200-250 |
| White | 100 (+25?) | 200-250 |
| Indian | 75 | 150 |
| Sumatran | 75 | 150 |
| Javan | ? | ? |
| TOTAL | 375-400 | 700-800 |

**Table 7.** Performance of North American zoos with black rhinos, 1982-1986.

| **Year** | **Births** | **Deaths** | **Dispersed** | **Imported** |
|---|---|---|---|---|
| 1982 | 1/3 | 2/2 | | 1/1 |
| 1983 | 2/2 | 0/1 | | 2/0* |
| 1984 | | | | |
| 1985 | 2/5 | 3/2 | 0/1 | |
| 1986 | 4/3 | 3/3 | | |
| TOTAL | 9/13 | 8/8 | 0/1 | 3/1 |

*Captive born in Japan

## LONG-TERM MANAGEMENT OF SMALL RHINO POPULATIONS

*Thomas Foose (American Association of Zoological Parks and Aquariums).*

### Overview of concerns

As discussed by Lynn Maguire in the preceding session, and elaborated by Robert Lacy in the following presentation, the trend towards very small and fragmented populations in the wild (i.e. towards the situation of rhinos to captivity) makes these populations vulnerable to extinction for genetic and demographic reasons. Small populations lose genetic diversity rapidly at the population level (Fig. 3) as well as at the individual level. At the population level, genetic diversity Is