POPULATION BIOLOGY: THE SCIENCE OF POPULATION MANAGEMENT FOR CAPTIVITY, REINTRODUCTION, AND CONSERVATION

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Population Biology and Conservation

Captive populations, as well as wild populations requiring conservation action, are typically small. As a result, biological and logistical challenges to their successful management exist. Small populations experience high levels of demographic stochasticity (random variation in individual reproduction, mortality, and sex ratio) and deleterious genetic effects, which combine to greatly enhance extinction risk. As genetic effects influence reproduction and mortality rates, populations decline further and demographic stochasticity increases. These declines lead to smaller populations and increased inbreeding and loss of gene diversity. Genetic and demographic effects are therefore highly synergistic. Populations of sizes less than 200 are generally considered to be especially susceptible to synergistic dynamics of demographic and genetic risk.

Through the application of standardized methods for population management, these potentially detrimental demographic and genetic effects can be mitigated, and optimal management strategies for captive populations can be devised. Examples of such strategies include those employed by the Species Survival Plan® (SSP) of the Association of Zoos and Aquariums and the EEP of European Association of Zoos and Aquariums.

The goals of these programs include rapid growth of founding populations to achieve demographically stable populations at program carrying capacities, creation of stable age structures, and limiting extinction risk. Management strives to maintain the genetic variation present in the founder stock to the greatest extent possible, avoiding loss of heterozygosity due to genetic drift and inbreeding, and thus maintaining adaptive potential in populations. These populations are managed both for genetic health in captivity and as genetic reservoirs in the event of future reintroductions to wild populations.

To ensure the suitability of these captive populations as genetic reservoirs, management goals also include avoidance of artificial selection, including both the unintentional selection of animals with characteristics "well-suited" to captivity, and the intentional selection for or against specific traits. The role of selection in captive populations is poorly understood and maintaining maximum genetic variation is therefore prioritized over selection for or against specific traits.

Data for Population Management

A prerequisite to the development of a population management plan is the compilation and maintenance of a studbook. This is a computerized database of parentage information and life history events (births, deaths, transfers, etc.) for individuals within the population from the time of population founding to the present. Data entered into the studbook should be as complete as possible, but unknown or missing data is to be expected. "Analytical studbooks" incorporating potential or assumed values for missing information can be created and evaluated.

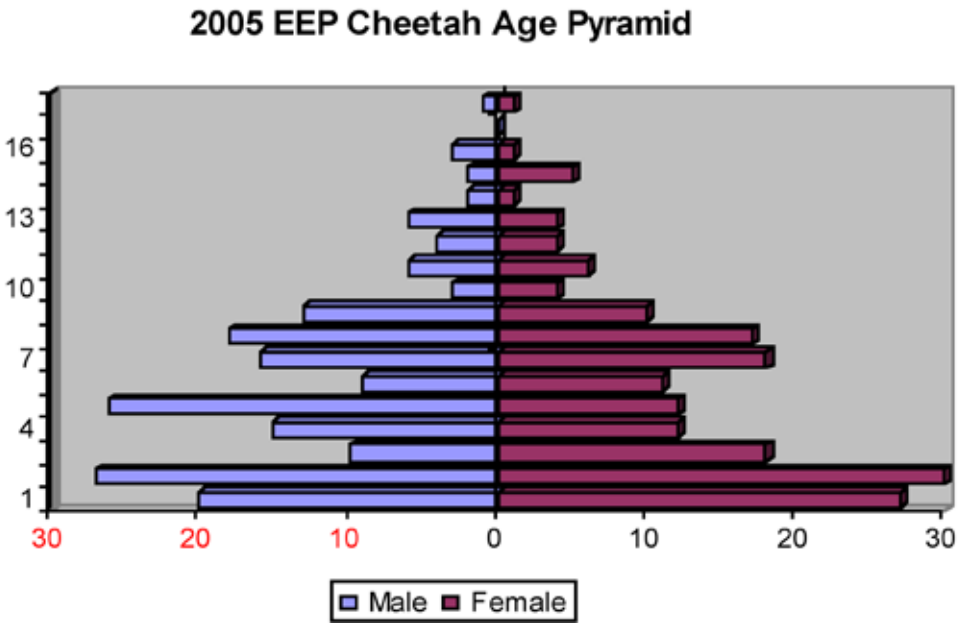

Figure 1. Example of an age pyramid from European Endangered Species Programme for cheetahs generated from the SPARKS collection management software.

Population Status

Once compiled, studbooks can be analyzed using a variety of software tools. Demographic evaluations of age-structure, population growth rates, and population vital rates (fecundity and mortality) are conducted. Genetic parameters including gene diversity, kinship, and inbreeding are calculated. Studbook analysis is used to examine population history, evaluate current population status, and predict future population status under varying management conditions. Analyses are conducted as part of informed population management planning resulting in specimen-by-specimen recommendations for breeding and non-breeding individuals.

Population Management Plans

Population biologists create population management plans suited to needs of specific programs. These needs vary from the creation of breeding and transfer recommendations for individual animals to overall strategies for long-term management of healthy populations in captivity and the wild. Captive populations may be managed to supply specimens for exhibit facilities, provide redundancy for endangered wild populations, or to supply in situ conservation plans. Plans include designating animals for breeding, holding, or release. They may include the transfer of individuals between holding facilities or between captive and monitored/managed wild populations through meta-population analysis. Plans are also able to address the special needs of conservation programs by creating genetically informed evacuation strategies for breeding facilities, and nest/den protection prioritizations for monitored wild populations.

In the selection of individuals for conservation programs such as reintroductions, it is critical that the genetic and demographic integrity of the source population be maintained. Indiscriminately selecting animals for reintroductions can have serious genetic and demographic effects, such as skewed founder representation or loss of founder lines, and destabilization of age structure through over-harvest of targeted age classes. Selection of animals for reintroduction must consider the maintenance of the remaining captive population's ability to serve its conservation role into the future, for the perceived extent of the program.

Conclusion

Whatever their role, captive populations must themselves be stable and secure, being managed for demographic and genetic health, to support these functions. Mean kinship management strategies are generally employed, though they may be customized to meet specific program needs. Monogamous, polygamous, and colonial breeders can all be accommodated. Using this strategy, populations can be managed to maintain at carrying capacity or to supply surplus individuals for reintroduction or for export to other managed programs.