Guidelines for Conservation Breeding Programme

1. Introduction

India is one of the rich biodiversity countries of the world which harbours a large number of mammals (350 species), birds (1224 species), reptiles (4808 species), amphibians (197 species), fishes (2546 species), insects (57548 species) and plants (46284 species) in a large landscape of 77.47 million hectare of forest cover. It is one of the twelve mega biodiversity country of the world and has 8% of world biodiversity.

The country faces huge challenges on account of population growth coupled with expansion of agriculture and human settlements, industrialization and resulting in environmental degradation and loss of prime/ critical habitat for a large number of species. The growing pressure on the wild population due to shrinkages of habitat and loss of critical resources for the fauna as led to dwindling of population of many species which are on the verge of extinction in various parts of the country. India has established a large protected area network comprising of 4.58% of the total geographical area and for ex-situ conservation, there are 194 recognized geological parks housing 40,000 wild animals in captivity across the country.

A study of the status of the population in captivity in zoos reveals that a large number of species are not of important conservation value. There are few species in the category, endangered and threatened which are housed in the zoos. Moreover, the species do not occur in natural social group and with unknown lineage and therefore the task of initiating a conservation breeding programme with the available population is a challenge.

Zoos in India are regulated as per the Recognition of Zoo Rules, 1992/2009 framed under the provision of the Wild Life (Protection) Act, 1972 and reflects the policy enshrined in the National Zoo Policy, 1998. The Wild Life (Protection) Act was amended in 1992 and a Central Zoo Authority was created to oversee the functioning and management of zoo and to provide technical support to facilitate the development of zoos in the country. The main objectives of zoos as per the National Zoo Policy, 1998 is to strengthen the national efforts in conservation of rich biodiversity of the country by supporting conservation of endangered wild animals species by giving species which has no chance of surviving in the wild, a last chance to coordinated breeding programme under ex-situ conditions and raise stocks for rehabilitating them in wild as and when it is appropriate and desirable. The National Wildlife Action Plan (2002-2016) also lays emphasis on ex-situ breeding.

Captive breeding programmes are initiated to conserve a population of endangered species which is in danger of becoming extinct but it is not known with certainty whether such efforts can really conserve genetic diversity and produce healthy offspring for re-establishing a stable self-sustaining population in the wild. Conservation biology research suggests that in breeding and loss of fitness and health of animals can occur very rapidly, with such high magnitude with the increasing number of years of an animal in captivity. Nevertheless, there are successful examples of capti9ve bred individuals release in the wild which maintain healthy genetic diversity and continue to sustain a healthy population. There are several scientific technologies which assist in captive breeding which stored the genetic material through cryo-preservation and artificially reproduction. There are still lots of research and studies required to investigate to what extent captive breeding procedures might ultimately help in species recovery programmes and the specific genetic factor necessary to help success captive breeding programme and alternate solutions required.

Concept and theme of conservation breeding programme

Captive breeding programmes are initiated to prevent the imminent population collapse in the wild due to a large number of eliminative pressures. The ultimate aim is to conserve to genetic diversity and re-establish self sustaining population in the wild.

Why Conservation breeding programme?

Conservation breeding programme for species recovery in the wild should be initiated after careful field research to assess the status of population of a particular species in wilderness and of comprehensive assessment of the reason for decline of the species as a judgement is to be made whether the species can on its own recover in the wilderness through a species recovery strategy based on mitigation of the factors which in the first place cause the decline of the species which could be habitat degradation, change in hydrological regime of the tract, natures balance in maintaining prey-predator ration, fire and poaching. If a determination has been made that conservation alternatives are not immediately available and that captive breeding is essential for long-term survival of species. Can it be included to initiate captive breeding programme? Not as a long term conservation strategy but as a recovery technique integrated with supplementary efforts to augment and re-establish wild population. Every proposal to establish a captive population for recovery merits thorough evaluation and review. Captive breeding should not be constitute as a rehabilitation and recovery measures for species whose number has crashed in the wild below a minimum viable population. This population may still be far more viable and captive population, given the many limitations associated with captive breeding and reintroduction. Proponents of the programme justify captive breeding based on population viability enhances but regress assessment of the viability of wild in captive population is necessary. It is possible that alternative non-captive approaches may be more effective and safe than the captive approaches.

The National Zoo Policy reiterates that if population has decline in the wild it is necessary to supplement in-situ population with the captive stock bred in ex-situ facility. This should be qualified by the fact that each species needs to be assessed whether it truly needs captive interventions. Many zoos feed that they must carry out the mandate of the policy by involving in captive breeding of endangered species and reintroduction. However, this is not the end all they may contribute by developing husbandry, reproduction, social behaviour and dietary protocols which will ultimately help raising a captive breeding stock whenever required for reintroduction.

Can Captive Breeding Programmes conserve a sustainable and healthy population?

A study of empirical and theoretical data suggests that captive breeding programmes can to a great extent maintain genetic over a longer period. Recent studies have shown that on an average quantitative genetic variation may not be lost with a small population as rapidly as neutral genetic diversity but that levels of quantitative genetic variation can be highly variable among small population (Willi et. al. 2006).

Captive breeding for reintroduction is an important management tool for endangered species conservation and management. Several studies have shown that a pleasure very vital role in rehabilitation of a species which is likely to become extinct. The role of captive breeding and reintroduction in conservation is similar to NOAH'S ARK those species which are on the brink of extinction are managed in captivity as if riding on in Arc which are escaping the flood until those factors which threaten their existence are minimized or eliminated until they can be rehabilitated in the wild. This theme has been widely popularized in the scientific literature (Durrell 1976, Soule et al. 1986, Balmford et al. 1995).

The importance of captive breeding and reintroduction as a conservation strategy is reflected in the National Zoo Policy 1998 and Recognition of Zoos 2009. Now this concept is being emphasized for rescue in hundreds of species represented several taxonomy group, captive breeding is being mandated in the policy statement of the world conservation union (IUCN 1997). The role of the zoos in conservation was maintaining population of threatened species who was seen as role adapted due to the long tradition of keeping, breeding, developing husbandry practices. The World Zoo Conservation Strategy (IUDZG/CDSG 1993) also accepted this particular role of the zoos. A series of global captive action plans, the IUCN Conservation Breeding Specialist Group (CBSG) have recommended hundreds of taxa fro captive breeding, Seal et al. (1993) recommended captive breeding for 1192 vertebrate taxa out of 3550 examining.

When to initiate conservation breeding programme

Conservation breeding programme can be best initiated when there are sizeable population in the wilderness throughout the original geographical range of the species even though the size of the population is relatively small and may be in small pockets widely separated from recovery can be achieved by habitat ameliorated measures, management action, management interventions for reducing the reasons for mortality. There could be a possibility that the species has been extirpated over portion of its range but still survives in healthy population in other portion of this range. In such cases the animal can be translocated to vacant low density habitats once the causes of decline of population has been addressed.

Often, however, action for endangered species recovery is delayed beyond the point when in situ management or even translocation among natural areas is possible. Remnant wild populations, if they exist at all, may not be self-sustaining, and it may be impossible to reverse their decline before the projected date of extinction. For example, black-footed ferrets (Mustela nigripes) were thought to be extinct until a single population of about 30-50 adults were discovered near Meeteetse, Wyoming, in 1981 (see Clark 1989, and Chapter 11).That population crashed in 1985 and 1986, when a plague epidemic decimated the prairie dog colony that was the primary food base for the ferrets, and then an epidemic of distemper decimated the ferrets themselves. Analyses of the rate of loss of ferrets indicated that the species would soon be extinct unless animals could be rescued from the Meeteetse area (Seal et al. 1989).

There are cases where endangered species recovery is delayed to such an extent that the population declines to low levels may be less than 1000 and habitat improvement or translocations may not produced good results because the remnant population may not be self sustaining and it may not be possible to reverse the decline by reintroduction. The examples of such decline are must deer and hangul in the Himalayan region though the exact status of the population is not known. Examples of such population decline were observed in USA for black footed ferret and Florida panther. It is possible that in some species the last chances of recovery lies in capture of some or the entire remnant population, breeding in conservation breeding centres and releasing back into its natural habitat. The best chance of success lies when the population is in few thousands much before the population declines to such low level and captive breeding programmes for eventual reintroduction may succeed.

It is also possible that conservation breeding may not be the best option because of the biology and ecology of the species which may have low reproduction rates and therefore ex-situ conservation and in-situ conservation recovery programmes have to be given equal importance. There is a likelihood that the animal in captivity under those genetic behavioural and physiological changes and in spite of best efforts to train the animal into learning its natural trades, it may still not readapt to the natural environment and able to forage and defend itself. In some animals reconditioning trainings have been successful and animals have been well adapted to the natural habitat environment after release.

In the release programmes, the use of serogates have been experimentally tried so that the species bred for reintroduction is not lost. There is also a possibility that the species in the wild may be highly in bred with no opportunity for dispersal and breeding and therefore the only hope is to capture the remnant population for ex-situ breeding. The captive environment can disrupt adaptations and cause genetic changes in the form of genetic rift, random fluctuation in allele frequencies. The preserve genetically animals for the purpose of restoration to the wilderness captive management must minimize both adaptive and no0n-adaptive genetic changes.

Franklin (1980) suggested that for endangered species management, whether in captivity or in the wild, a short term minimum effective population size should be kept above 50 to avoid the immediate deleterious effects of inbreeding. For long term management, he suggested keeping the effective population size above 500, to allow new mutations to restore heterozygosity and additive genetic variance as rapidly as it is lost by random drift. The concept of the effective size of a population was originally introduced by

Wright that by breeding, as consequences of population decline, might limit recovery efforts.

When population is extirpated or nearly extirpated in the wild, the captive stock may be so small and the founders available in the wild to initiate captive lines may be so small that the low effective population size in the absence of gene flow, new genetic diversity at a much higher rate through the process of genetic drift. The smaller population also susceptible to breeding and ultimately cause in breeding depression and. This is common in many captive bred species that have often experience decline in population. Frankham et al. have proposed that the retention of 90% of genetic diversity (Allelic richness, hetero-zygosity) over a hundred year of period in captivity should be a targeted conservation goal. This period would be equivalent to 25-40 generations for most captive rare species (Soule et al. 1986) in a similar situation (Franklin 1980 and Franklin and Soule 1981) have shown that a reduction in new heterozygosity of 1% per generation (in breeding rate of 1%) due to low population size was an acceptable loss of diversity in animal population. There is now theoretic justification to conclude the extent of genetic diversity required to conserve a species population. The 1% per generation loss of heterozygosity may be true for domestic agricultural use animals but not terrestrial experiment with other species. So the goal of captive breeding programme is to conserve as much diversity as possible. The relationship between genetic diversity population in viability to very complex and varies between species and different population within species. Therefore, conservation goals should not be stand diluted or abandoned if the population is found to be using genetic diversity rapidly of 20% or more over 100 years of captive raring and such population can still be reintroduced specifically into the wild.

There are methods to reduce the rate of loss of genetic diversity based on theoretical calculation done to initiate random mating and ideal population. Ideally, it is better to start with as large founder captive population is possible (Llle Rymen 1987). One simple approach is to ensure that each individual contribute the same number of progeny to the next generation. Thus equalize family sizes from matings of animals yield a rate of inbreeding and genetic drift i.e. Roughly half to those generated from contribution of parents in idealize population (Wright 1938, Wang 1997). Another more sophisticated and scientific method and approach recommended is to use pedigree or molecular genetic marker data to minimize mean inbreeding or kinship coefficients between parents before generating new captive generations.

Captive Breeding Programme where in both captive and wide stock of endangered species contribute towards the assemblage of a founder population it can be safely generalized that such programmes can help in supplementation of a severely decline population or reintroduction of extirpated one. Captive breeding technizues have been improving continuously, as have techniques for reintroducing captive breeding animasl into the wild. For some species such as asian vulture, red panda, pigmy hog from India and California condoer (gymnogyps Californians), the Mauritius kestrel (Falco punctatus), the black footed flared (mustela nigriepes) and the guam rail (rallus owstoni), captive breeding has clearly represented the difference between survival and extinction in the short-term (Snyder and Snyder 1989, Derrickson & Snyder 1992, Johns et al. 1995). The Conservation Specialist Group has recently generated a series of conservation assessment and management plan that called for long-term captive breeding of numerous taza.The draft camp document has recommended long-term captive breeding for roughly half of the 330 parrot species in the world. For vertebrate, the recommendation is for 1192 (34%) of the 3550 taxa examined. Further, captive breeding recommended in a remarkable 64% of the 314 approved recovery plans for US endangered and threatened wildlife. The implications of such large scale captive breeding are profound. Therefore, a review of this technique in species recovery is necessary. Therefore, we have to examine the seven important limitations of this technique. Captive breeding for species recovery (ultimate reintroduction to the wild) should not be confused with captive breeding for other purposes suggest exhibit conservation education or research. In a height side captive breeding plays a important role for species recovery for only those endangered species of which we have knowledge of the status and population dynamics in the wild, husbandry practices, reproduction biology and ecology. For others for which we do not have knowledge we must wait and generate this information through research and if necessary employ captive breeding programmes. Therefore, this programmes is good for species where viable alternatives are unavailable and should not be proposed for a long term solution for rehabilitation of the species.

Short comings/Limitations of Captive Breeding

There is a large number of biologists who have in spite of the grand visions for captive breeding questioned a utility of the captive breeding programme (Snyder et al. 1996) provided a comprehensive summary of the limitations of captive breeding as an approach to the recovery of endangered species. These limitations are: difficulty in establishing self sustaining captive population, high cost involved in captive breeding and who were success in reintroduction which could potentially be overcome given increased resources and improved methods. Though captive breeding can form a gene pool for hundred of species maintained in captivity for centuries and eventually as an insurance to the wild population which may rapidly dwindle in crash. Other limitations of the captive breeding programme are human habituation/ domestication and administrative continuity. The NOAH's ARC has now found acceptance as it will hold substantial gene pool which can be called as assured survival population for the safety net population. Snyder et al. (1996) has suggested that captive breeding should not normally be recommended or initiated before careful field studies have been completed and comprehensive determination has been made that preferable conservation alternatives are not available and that captive breeding is essential for near term survival of a species. How could a species is for captive breeding and reintroduction depends on a number of factors, the most important one whether the species which are subject to threat in the native habitats due to a several eliminative/ deleterious practices and such causes are unlikely to be removed and controlled in the short-term. Conservation breeding will gain importance as the threat to biodiversity increases and it may be an important recourse for certain taxonomic groups which can be rehabilitated and species save for the extinction. Zoos are predominately contributing directly to in-situ conservation by expanding the conservation programmes beyond management of captive population by using special techniques like assisted reproduction technology which allow zoos to breed captive populations and through the long term storage of genetic material using cryo preservation.

It remains to be determined when captive breeding programme are essential and warranted as ex-situ management of threatened species in zoos have to be directly linked with in-situ conservation programmes who achieve goals of conservation.

In recent years, zoos in India have generated tremendous interest in the captive breeding programmes largely due to a greater understanding at zoos are not merely to play a role for using the vast genetic resource of animal species as an exhibit for education and research but to achieve the fundamental task enshrined in the National Zoo Policy of Captive breeding of endangered species for the purpose of reintroducing dealt into wild. The Central Zoo Authority has in consultation with the Chief Wildlife Warden of the States compiled a large list of species which may require interventions for raising a self sustaining and genetic and demographic stable population for rehabilitating in the wild. The identified list contains 76 species. However, knowledge on husbandry, behaviour and reproduction is deficient for a large number of species and also the conservation status species in the wild is not known. Therefore, the task of prioritizing species for initiating conservation breeding programmes becomes difficult. Further, it is not known whether the rehabilitation and recovery will actually succeed.

The Central Zoo Authority, therefore pruned this list and prioritised 26 endangered species out of 73 wild animal species that have been identified under the programme. The Central Zoo Authority in collaboration with different zoos/ states located in the geographical distribution of the species already launched the programme for 23 species. The Wildlife Institute of India through wide consultation with the scientific communities has developed criteria for prioritization and identified 26 prioritized species for Conservation Breeding Programme.

List of 26 prioritized species for Conservation Breeding Programme

Priority Number	Name of the Species	Global Distribution	Distribution in India (wild)	IUCN Status	Wild Life Protection Act, 1972 Status	No. of animals in the captivity	Founder availability in the wild	Founder availability in captivity	Information on Breeding Biology & Husbandry protocol	Threats	Overall rating
1	Pygmy hog (Sus salvanius)	2	5	5	5	4	2	3	2	3	31
2	Vultures (white-backed, long-billed, slender-billed)	2	4	5	5	5	2	3	2	3	31
3	Hangul (Cervus elaphus hanglu)	3	4	5	5	5	2	1	2	3	30
4	Golden langur (Trachypithecus geei)	2	3	4	5	5	2	3	2	3	29
5	Wild buffalo (Buballus bubalis)	2	4	4	5	5	2	1	2	3	28
6	Brow-antlered deer (Cervus eldii)	3	4	4	5	2	2	3	2	3	28
7	Lion tailed macaque (Macaca silenus)	3	3	4	5	3	2	3	2	3	28
8	Red panda (Ailurus fulgens)	2	2	5	5	5	2	3	2	2	28
9	Blyth's tragopan (Tragopan blythii)	2	2	3	5	5	5	2	2	2	28
10	Asiatic lion (Panthera leo)	3	4	4	5	2	2	3	2	2	27
11	Rhinoceros (Rhinoceros unicornis)	2	3	3	5	4	2	3	2	3	27
12	Western tragopan (Tragopan melanocephalus)	2	3	4	5	4	2	3	2	2	27
13	Phayre's leaf macaque (Trachypithecus phayrei)	2	3	2	5	5	2	3	2	3	27
14	Great Indian bustard	2	3	5	5	5	2	1	2	2	27
15	Wild ass (Equus hemionus khur)	2	2	4	5	5	2	3	2	2	27
16	Nilgiri langur (Semnopithecus johnii)	3	2	3	5	4	2	3	2	3	27
17	Musk deer (Moschus chrysogaster)	1	2	4	5	5	2	3	2	3	27
18	Hoolock gibbon (Hoolock leuconedys),	2	2	4	5	4	2	3	2	3	27
19	Swamp deer (Hard surface-C.d. branderi)	3	4	3	5	5	2	1	1	2	26
20	Nilgiri tahr (Nilgiritragus hylocrius)	3	3	4	5	5	2	1	1	2	26
21	Floricans (Bengal & Lesser)	2	3	4	5	5	2	1	2	2	26
22	Cheer pheasant (Catreus wallichi)	2	3	3	5	4	2	3	2	2	26
23	Clouded leopard (Panthera nebulosa)	1	2	3	5	5	2	3	2	3	26
24	Painted roof turtle (Kachuga kachuga)	2	2	4	5	5	2	2	2	2	26
25	Snow leopard (Panthera uncia)	1	1	4	5	5	2	3	2	3	26
26	Shaheen falcons (Falco peregrinus)	2	1	4	5	5	2	2	2	3	26

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