Endangered Species: Role Of Captive Population And Technique For Their Genetic Conservation

Introduction

The impact of the human activities on biodiversity are affecting the survival of both plants and animals. Many of the species are threatened to extinction due to human involvement. It is estimated 63% cycads, 34% conifers, 41% amphibian, 25% mammal, 13% birds are now classified as threatened by IUCN (International Union for Conservation of Nature, 2015). An increasing number of organisms are being effected due to threats impose by human directly (poaching, hunting) or indirectly (global climate change, increasing temperature, pollution) (Songsasen, 2015).

Maintaining balance ecosystem requires conservation of the world species and preventing them from extinction. Conservation effort should include increasing the genetic variations and maintaining the healthy population of these species (Lacy, 2009). The endangered species are being conserved in their natural habitat or in ex situ conditions (zoos and aquariums) which involves conservation in captivity (Sato, Ogden, Komatsau, Maeda & Inoue-Murayama, 2017). The importance of conservation led to implementing plans such as World Zoo Conservation Strategy with a slogan Captivity for Conservation which was launched in 1993. 1970s and 1980s marks the role of zoos and aquariums in helping the endangered species that are in critical need of conservation (Keulartz, 2015).

Captive population are of crucial importance for conservation of the endangered species from direct extinction. Such population are maintained to ensure survival and later re-introduction to the natural environment. Benefit of keeping animals in captive are observed but such conservation strategies shave some drawback (Håkansson, 2004). The captive population are small in number which is very much susceptible to genetic drift and inbreeding. Methods and strategies are being planned in order to control such phenomenon and maintain the genetic variations (Albrecht, Schulte-Hostedde & Mastromonaco, 2015). This assignment will include the role of the zoos and aquariums in conserving of the threatened species, the importance of genetic variations in captive population, technique to maintain the genetic variations in captive population and challenges in captive population.

Role of the captive population

World Association of Zoo and Aquarium (WAZA) which is one of the international conservation program have realized the importance of zoos, aquariums and botanical gardens in conservation of wildlife. These ex situ conservation strategies have been criticized by most of the individual as encaging of the wildlife for entertainment but it has much more role in conservation of threatened species (WAZA, 2005). Animals and plants species which are conserved in captivity are known as the captive population and they play crucial role for conservation.

According to Sato et al. (2017), the zoos and aquariums helps in preserving and have greater

role in maintaining genetic variation in the captive population so that they resemble to the natural population. Similarly Ballou (1984), stated the intention of keeping captive animals is to maintain the genetic variation or heterozygous individual that can better adapted to the changing environmental condition and able to reproduce. This will ensure the successful re-introduction of the species back to the wild.

Captive population are manage by large number of individual that are expert on various field of conservation which helps in educating the general public about the species diversity and their adaptation. It serves in providing research opportunity and restoration of the wild population which are threatened to extinction. It can also function as the insurance against the final loss of a species which will be established later in the wild (Lacy, 2009; WAZA, 2005).

Golden lion tamarin, black-footed ferret, California condor are some of the species which were near extinction in wild due to deterioration of the habitat and now the number have been restored (Kleiman, 1989; Purdue University, n.d). Przewalsk's Mongolian wild horse and Speke's gazelle species native to Ethiopia and Somalia have been breed in captivity since they are known to be extinct in wild. Therefore captive population provide opportunities in conservation and re-establishment of the threatened species from being extinct (Hedrick, 1992).

One of the good example of importance of captivity for conservation is the re-introduction of the black footed ferret which was thought to be extinct in 1970s but discovered in Wyoming in 1981. Ferret were low in population so in order to safe this species from extinction breeding program was conducted with 18 individual in Smithsonian National Zoo and Conservation Biology Institute. 3000 kits were released in wild. Report from 2015 stated that the number of of individual in wild is 370 and 280 in captivity across U.S. The ferret were further re-indroduced in 24 states from which 4 statates have sustainable population of ferrets (Hamilton, 2018).

Figure 1. Adult black footed ferret (left) and Kits produced in captivity (Hamilton, 2018).

Challenges in captive population

Conservation in captivity have major issues such as animal in captivity are prone to inbreeding depression, loss of genetic variation since most of the animals in captive are small in population. The animals might accumulate deleterious mutations alleles and also get adapted to captivity which will cause failure in re-introduction programs (Frankham, 1995). Similar Håkansson (2004), stated captive conservation program is unsuccessful due to genetic variations loss, genetic adaptation to captivity and accumulation of the deleterious alleles cause by inbreeding. After keeping the animals in captive the main aim of re-introduction is limited by high cost, logistical difficulties and shortage of habitat for that species (Kleiman, 1989).

According to leus (2011), the captive population in zoos are kept with the aim to retain genetic variations of wild population as much as possible. In contrast Sato et al. (2017), stated maintaining genetic variations in captive population is difficult. Difference in the wild environment and the one where captive population are kept causes challenges in maintaining the wild phenotype. In captive environment at initial the animal are stressed to get accustom to the captivity. The behaviour of the animal get altered due to the diet, the foraging and predatory activity decreases and lack of fear of human. The captive animals were observed to have changed physiological and morphological.

Figure 2. Diagram on limitation of the captive population

Animals protected in zoo for conservation purpose are usually endangered and small in number. Less number of founder who can start the population which eventually led to creating relative population and inbreeding in the population. The smaller population have high chance of losing variation through genetic drift (Ballou, 1984). The inbreeding population will usually have low genetic variations, reproductive fitness and increase homozygous individual. Accumulation of deleterious alleles take place so such population are prone to disease and have low fecundity. Therefore limiting the survival of the captive animal which is to be re-introduced in wild environment. The captive population are similar to domestication which is influenced by selection pressure. Selection pressure cause the selection of animal that are better adapted to captivity and reproduce in captive condition effecting the survival in wild (Håkansson, 2004).

Related example of the limitation of captive population that failed in re-introduction includes Steelhead trout (Oncorhynchus mykiss) that was kept in captivity for one generation which had been release in the wild. Major effect on the reproductive success was observed so such re-introduction was not successful (Sato et al., 2017). Another example of failure in captivity is of cheetah, the population decline since 1975 from 14000 to 7100 in wild. The animal usually dies due to diseases (gastritis, Kidney and liver illnesses) which is usually rare in wild. It was observed that the 90% of cheetah that died in America and Africa in captivity had the gastritis and kidney disease (Tordiffe, 2017).

Technique for genetic conservation of captive population

The importance of the role of captive population and in what circumstance and how well they serves the roles in conservation is a debatable topic. Studies are being conducted, improved techniques and method are being introduced in conservation of captive population. However the emphasis of captivity is to have good genetic management so that the conservation goals of captive populations can be achieved (Lacy, 2009).

Technologies in recent decades have been introduced that can provide the genetic data on the relationship of individuals in the population. Such data help in predicting the genetic diversity and serve powerful tool in managing endangered species. It can also help in making plans relating to captive population (Irizarry et al., 2016). Example of such tools is the microsatellite markers used for analyzing genetic diversity in western, central and eastern Yak (Bos grunniens) in Bhutan. It provide the information on the genome loci and heterozygosity, in this population of Yak (Dorji, Goddard, Perkins, Robinson & Roder, 2002). Therefore it can help in providing data on future conservation or breeding programs of Yak. This is the first step in collecting genetic data of the animal and plants population so plan and strategies can be made for the future conserve.

i. Reproductive technology

Breeding programmes are important method in increasing the genetic diversity in the captive population. Founder’s population is crucial in determining the genetic diversity in the small captive population. Such strategies helps in increasing the number of high potential founder and limit the effect of inbreeding and genetic drift. Introducing immigrant is another method used in captive population. Semen collection is one breeding method, the semen from founders and

immigrant that did not contribute to gene pool of captive population will contribute to genetic diversity. It is prefer to introduce male itself to mate the female but if such opportunity are not available semen can be collected and used (Ballou, 1984). Similarly Sato et al. (2017), suggested cryopreservation of genetic materials from the wild population gamete or embryo, and artificial insemination. In addition the collection of genetic material should be done at early stage before the animal are in captivity or from wild individual. Conservation breeding programmes can help limit the inbreeding depression and loss of genetic variations.

ii. Population Fragmentation and translocation

The captive population are usually maintained as large non-random mating population in individual institution. The population is manage by regular translocation of animals among the different institutions. The method usually have large drawback such as it is expensive, high risk of transmission of the disease among the population and injury to the animals during transportation. Alternative method to translocation that can limit the risk of disease and cost of translocation is fragmentation of population in to isolated small groups. This method have more advantage in contributing to overall genetic variation, reproductive fitness and minimizing adaptation to captivity. It usually provide opportunity of making appropriate number of founder that will contribute to the captive population and benefit in re-introduction (Margan et al., 1998).

In contrast Håkansson (2004), stated small population usually have problem of inbreeding so occasional translocation is necessary. Both the method have drawback and these methods should be applied hand in hand. Other approach includes exchange animal between wild and captive population which is known as ‘hybrid’ or ‘pan situ’ approach. This approach provide opportunities to increasing the founder, re-introduction of animals in wild where it is extinct or in danger of extinction.

The population of American bison (Bison bison) in 1889 were threaten mammalian species, the population decreased original from 60 million to 835 due to habitat destruction. Concern in the declining number of bison led to captive breeding of a herd of 15 bison in Bronx Zoo in 1907. The bison were successfully introduced in new habitat in Oklahoma. The captive bison were periodically released in different empty ranges such as Montana, South Dakota and Nebraska by 1917. The translation and re-introduction were carried out which led to healthy individual and the number increased to 1000 (Kleiman, 1989).

iii. Strict management of diet, physical and behavioural activities

Animals such as Przewalsk’s Mongolian wild horse and Speke's gazelle had to be breed in captivity since they were known to have extinct in wild (Hedrick, 1992). Another example is cheetahs (Acinonyx jubatus) which is highly endangered so are kept in captivity to study and increase their genetic diversity. It was observed to have low success in breeding which led to focus on the physiology, behaviour, nutrition and reproduction studies of this animal. Captive animals usually become lazy in captivity and the hunting instinct is effected mostly in cat families. So maintaining condition similar to wild and also their diet and behavioural activites can improve breeding success and genetic diversity in the behaviour. Experiment was conducted on cheetahs in captive by providing suitation where they had to run, and actively involve in catching the bait. This experiment in captive providing the chance to be active and increasing hunting motivation (William, Waran, Carruthers & Young, 1995).

Conclusion

The method of conservation through captivity or captive population have shown some good result in past in bringing back the population of near extinct population of species. There are species that have been restored in number and thriving in the wild but still many other challenges and limitation are present. The most important concern for the small population of animals and plants is inbreeding depression which led to decrease in genetic variation that effect the survival in changing environment. Techniques and methods have been develop to combat such problems which is necessary. The captive method of conservation are beneficial in some level still there are controversy relating to its role of captivity in conservation therefore such topic are debatable.

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