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Viability Analysis of the Re-Introduced Onager (*Equus hemionsus onager*) Population in Iran

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Abstract: Different varieties of Asiatic wild ass (*Equus hemionus*) inhabit the Middle East. In Iran distribution of *E. hemionus* var *onager* is limited to two small and isolated populations in two protected area, Bahram- e - gour protected area and Touran protected area. In 2010 onager was re-introduced to Kalmand-Bahadoran protected area in Yazd province. We have used Vortex 9.73 software to calculate the extinction risk of the re-introduced population using four scenarios based on different supplementation. In the first scenario, initial re-introduced population was simulated without supplementation. In the second scenario, 3 female adults were added to population in the second year. In the third scenario, 3 female adults and 1 male added to population in the second year. Finally 5 female adults added to population in the second year and simulation was carried out in four different conditions.Vortex is an individual-based simulation model that uses for population viability analysis. The re-introduced population was investigated during a year (from July 2010 until July 2011) and used data of this species in Bahram-e-Goor protected area and gathered other required information from captive breeding to run the Vortex software. Across all simulations scenario 1 (Initial re-introduced population without supplementation) had population declines with the highest probability of extinction (0.83) and the greatest loss of diversity. Results indicated that the re-introduced onager population in Kalmand-Bahadoran protected area needs at least a few more transfers from the wild or captive breeding center. The analysis demonstrated that an increase in effective population will lead to an increase in genetic variation and survival rate.

Key word: *Equus hemionsus onager* · Extinction · Kalmand-Bahadoran Protected Area · Vortex Software IRAN

INTRODUCTION

Human manipulations in earth planet without attention to environmental carrying capacity are caused that plant and animal species impose endangered. In its result, biodiversity as index in natural environment has decreased [1]. Robert lee, expert of IUCN presented a computer model as called Vortex. In mentioned model, we can predict population extinction probability in time duration. Vortex is an individual-based simulation model for population viability analysis. Vortex simulates a population passing through a series of events that define a typical life cycle of a sexually reproducing, diploid organism [2]. During the late Pleistocene, 40,000 years ago, Asian wild asses are known to have roamed as Far as West Germany [3]. Like many other large bodied mammals, equines vanished from numerous biogeographic regions during a mass extinction about 12,000 years ago, even thought the number of species seems to have remained more or less constant [4]. The range of Asian wild asses has continued to shrink ever since. Six geographically isolated subspecies of *Equus hemionus* are presently recognized [5] of witch one, the Syrian wild ass (*E. hemionus hemionus*), became extinct in 1927. The others are the onager (*E. hemionus onager*) from Iran, the Turkmen and Kazakh khulan (*E. hemionus kulan*), the latter sometimes being referred to as (*E. hemionus finschii*) and the Indian khur (*E. hemionus khur*).

At present, an estimate of the total population of onager in Iran is about 520 individuals [6]. Distribution of these species was restricted in 2 protected regions. Furthermore, in 1997, a captive breeding center of onager was established in Kalmand-Bahadoran protected area, in Yazd province. From 1997 to 2008, the number of these species in captivity reaches to 38 heads and in 2010, 13 (7 males, 6 females) individuals were re-introduced to natural habitats of Kalmand-Bahadoran protected area. The reintroduction project is run by the Environmental

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conservation organization of Yazd province. It is the first project reintroducing onagers to the wild in Iran. Therefore, the aim of this study was to predict survival rate of the re-introduced population of onager in Kalmand-Bahadoran protected area.

MATERIALS AND METHODS

Study Area: Kalmand-Bahadoran protected area with a surface area of 229000 hectares is situated at about 40 kilometers south-east of Yazd in the central of Iran. Mean annual precipitation rate of the region is 66.8 mm and its maximum and minimum temperature has been recorded to 43°c and -12°c respectively. Altitude ranges from 1400 to 3290 meters. Among plant species of the area *Artemisia sieberi, Amygdalus scorparia, Astragalus sp*, *Lacctuca orientalis, Salsola sp* and of the most significant mammals of the area, Wild goat (*Capra aegagrus*), Wild sheep (*Ovis orientalis*), Goittred gazelle (*Gazella subgutturosa*) leopard (*Panthera pardus*) and among major birds of the area Partridge (*Alectoris chukar*), See-see Partridge (*Ammoperdix griseogularis*) and Black-bellied sandgrouse (*Pterocles orientalis*) can be mentioned [7].

Methods: In order to develop a model for population management using VORTEX various data and assumptions are required. Input parameters required include: age at first reproduction for males and females, maximum age of reproduction, inbreeding depression, percent of males and females in the breeding pool, mortality rates, evidence and incidence of catastrophes and carrying capacity.

Investigation on onager captive breeding center in Kalmand protected area during 1997-2008 showed; the average age at first reproduction is around 3 years of age for females and 3 years for males. Due to competition not every male would probably have access to breeding females. From census data in re-introduced population during 2010-2011 and according to study on onager in Bahram-e-Goor National park by Jokar [8], this would account 30% of the males. Mortality data was extracted from existence information in Gourab center (captive breeding). Daemi [6], Examined captive population of onager in Gourab center and showed this population is sensitive to inbreeding depression.

Changes in population growth rate can be affected by a variety factors from predation to disease to environmental variables. But a first examination looked at environmental factors such as rainfall. Since rainfall amounts are correlated with plant productivity and base nutrition levels it is hypothesized that population growth rate would be affected by rainfall and drought. Rainfall data was available for study area for the years 1997 through 2008. This information was used to calculate SPI (Standard Precipitation Index) index for the study area. Carrying capacity was defined in the basis of plant biomass [9].

Four different simulations were run for 100 iterations on the modeled re-introduced onager population. The variable that was changed between scenarios was supplementation. All other variables were kept constant for these trials. The four scenarios were:

- Initial re-introduced population without supplementation

Table 1: Summary of modeling parameters (program: Vortex 9.73)

Parameter	Value
Age at the first reproduction	3 years females, 3 years males
Maximum age of reproduction	20 years
Inbreeding depression	Included
Sex Ratio at Birth	50:50
Maximum number of progeny per year	1
% of males in breeding pool	30%
% of adult females breeding	70%
Mating system	Polygynous
Initial population size	11 (5 males, 6 females)
Mortality estimates	Estimated from captive population during 12 years (1997-2008)
Catastrophes	Drought, frequency 33%. Drought effect on reproduction 70%. Illegal poaching, frequency 60% effect on survival 90%
Carrying capacity	200 with an environmental variation of + 20
Supplementation (animals added to population)	0 (scenario 1) or 3 females (scenario2) or 3 females, 1 males (scenario 3) or 5 females (scenario 4)
Breed to maintain the population at k	Ok
Prevent mating with kinships (inbreeding) greater than F	0.25 [10]

Table 2: Summary of VORTEX simulation for four scenarios of re-introduced onager population in Kalmand - Bahadoran protected area.

Scenario	Probability of Extinction	Mean final population size (SD)	Final expected gene diversity (SD)	Deterministic growth rate	Mean stochastic growth rate (SD)
1	0.710	44.33 (74.71)	0.7761 (0.0560)	0.065	0.003 (0.134)
2	0.420	82.91 (85.80)	0.7764 (0.0760)	0.065	0.014 (0.121)
3	0.360	110.37 (85.38)	0.7891 (0.0595)	0.065	0.020 (0.120)
4	0.040	165.28 (44.47)	0.8332 (0.0623)	0.065	0.033 (0.125)

- 3 female adults were added to population in the second year.
- 3 female adults and 1 male added to population in the second year.
- 5 female adults added to population in the second year.

RESULTS

Across all simulations scenario 1 had population declines with the highest probability of extinction and the greatest loss of gene diversity (Figure1, 2, 3).

Table 2 summarizes the results for mean extinction probability, mean population size, mean gene diversity, deterministic growth rate and mean stochastic growth rate across iterations.

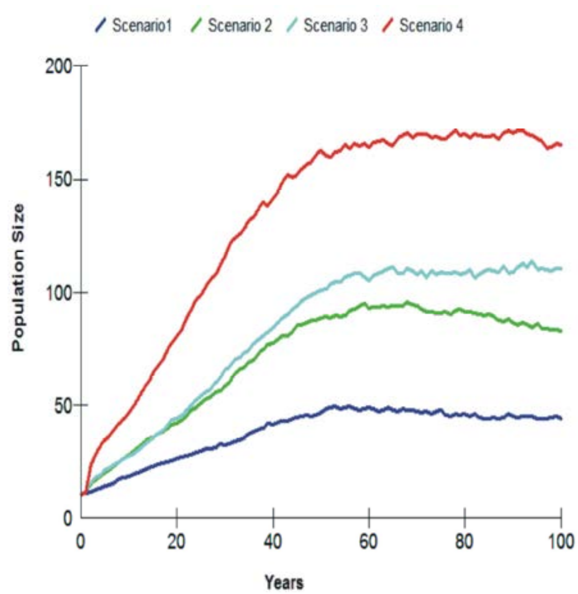

Fig 1: Predictions of population size for the four scenarios.

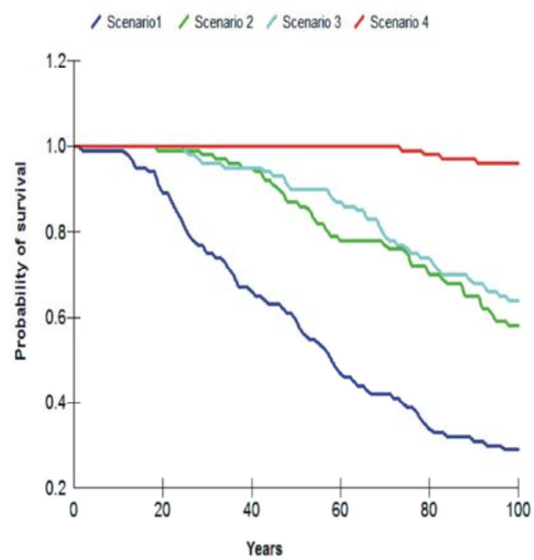

Fig 2: Predictions probability of survival for the four scenarios.

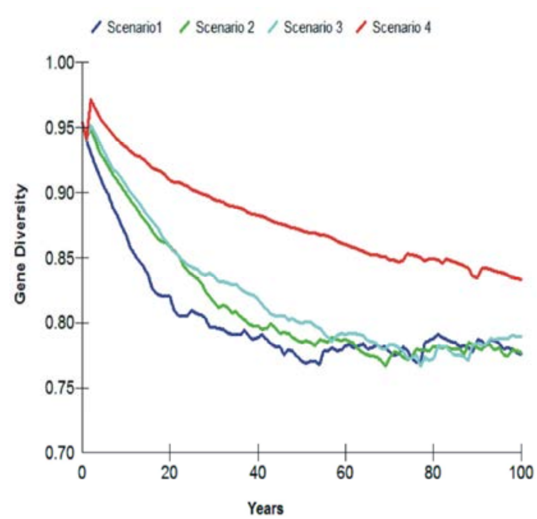

Fig 3: Predictions of gene diversity for the four scenarios

DISCUSSION

From genetic view point the re-introduced onager population in Kalmand-Bahadoran protected area needs at least a few more transfers from the wild (most urgently a male), but simulation on scenario 3 showed that due to existing of 5 males in the population, adding another male has little effect on genetic diversity of the population. Although other stochastic factors are considered a greater threat to small population [11], the low number of effected population (N_e) in relation to total population size contributes significantly to the loss of genetic variability in the re-introduced population and, if possible, should be minimized by active management. Appropriate management depends on identifying the causes of the problem. For example, several possible actions can be taken to increase the number of breeding males. Managers may be able to artificially increase male turnover by removing the dominant male. Releasing a herd with many males creates a large of potential future challengers. Because of the advantage of resident males and the low probability of displaced adult males attaining territorial status, we believe that repeated releases of adult males in the same area are not feasible. The release of more females increase survival of the population but it may also have limited advantages because, in population where few males breed with many females, an increase in number of females has a limited impact on N_e [12]. Consequently, in polygynous species the number of males is key to achieving a genetically viable population.

This preliminary step in population modeling and population viability analysis appears to conform to the re-introduced onager population in Kalmand-Bahadoran protected area.

Results of this study revealed that the initial re-introduced population is not adequate and consequently its survival will be low in the long term. As a result in order to reduce the probability of extinction, an effective population could be 12 onagers(10 adult females and at least one or two adult males). This was confirmed as a viable population under scenario 4, leading to a survival probability of 95% for the next 100 years.However, as with other PVA analyses it has led to questions needing additional research [9]. How do mortality rates in a captive situation compare with the wild population, higher or lower? Additional sensitivity tests of the model also need to be performed to determine what parameters most effect population persistence.

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