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Prediction of Wild Sheep (*Ovis orientalis*) Population in Bamou National Park with Contest Model by Ramas Ecolab Software (Fars Province, Iran)

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Abstract: RAMAS ECOLAB is ecological software that uses for population simulation and population changes predictions in future years. Data's of *Ovis orientalis* populations in Bamou National Park have collected between 1996-2003 years. Survival rates, finite rate of increase and their standard error surveyed between mentioned years. Carrying capacity determined and simulation is carried out in the basis of 50 durations and 1000 replications with Contest model. In contest model is assumed that resources are finite for wild sheep. These resources are intensive in special areas. Therefore, each of species has more potential for making territory and conservation of their resources with contest can increase their populations. in the basis of population trajectory summary, predicate if population is 1839 head in this year, in 2016 year would 1542 head and in last years would decreased to 1203 head. In the basis of extinction probability, 100% probability is that for one time in 50 future years, population decrease to fewer than 2485 head. In the basis of explosion probability, 100% probability is that for one time in 50 future years, population increase to more than 1222 head or 20% probability is that for one time in 50 future years, population increase to more than 3538 head.

Key words: *Ovis orientalis* · Bamou National Park · Contest model · RAMAS ECOLAB software · Fars Province · IRAN

INTRODUCTION

Human manipulative in earth planet attention to environmental carrying capacity are caused that plant and animal species impose endangered. In its result, biodiversity as an index in natural environment has decreased [1].

Parks and protected areas development are as an effective tool for conservation of genetic diversity and species conservation of extinction [2].

Robert Lee, expert of IUCN, presented a computer model as called Vortex. In mentioned model, we can predict population extinction probability in time durations. This model is the most important program for simulating and Population Viability Analysis (PVA). One of the applicable models for PVA calculation is RAMAS ECOLAB. This software is as management software in wildlife sciences. It can predict population frequency, increase or decrease trend for future years in the basis of current population data. Maximum time for prediction is 50 years and indicates the extinction probability or population increase [3].

Wild Sheep (*Ovis orientalis*) is the most important mammal in studied region [4]. This species has suitable population in Bamou National Park. Comprehensive studies have not performed about mentioned subject. Therefore, this paper selected that Wild Sheep population trend predict for determination of conservative condition in future years and presentation a management or conservation technique.

MATERIALS AND METHODS

Studied Area: Bamou National Park has 48075 ha area. It located in marginal of Shiraz city in Fars province. Ecological and habitat values are caused that Bamou introduced as a National Park under the environmental organization [4].

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Methods: Collection of frequency information about Wild Sheep (*Ovis orientalis*) population carried out in environmental conservation office in Fars province. By cooperation with environmental experts, data about *Ovis orientalis* population collected for five years (1996-2003). With attention to current information, formulas, essential parameters for software as a current population, finite rate of increase, survival finite rate and standard deviation calculated.

Survival Rate Determination: For survival rate, below formula is used per year. Then, their means calculated for determination of survival finite rate.

$$\text{Survival finite rate} = \frac{Nt+1}{Nt}$$

In above formula, N_t: alive number in the first of time duration and N_{t+1}: alive number in the end of time duration.

Finite Rate of Growth Determination: For this purpose, ecological methodology software used. In mentioned software, growth rate alternative would select of Extras menu. Then, population frequency in different years would record. Finally, results of rates mean would determine finite rate of growth (Fig. 1). Standard deviation for finite rate of growth would determine per year.

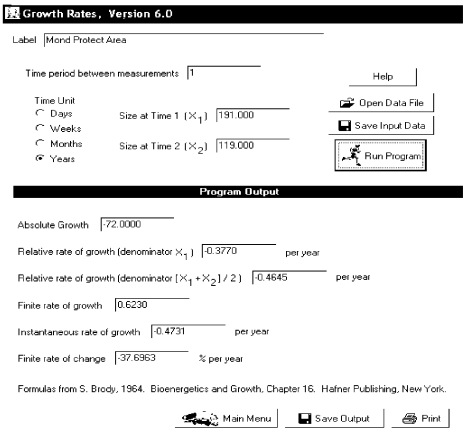

Fig. 1: Finite rate of growth determination by ecological methodology software

Modeling by RAMAS ECOLAB Software: RAMAS ECOLAB is the ecological software for simulating, small population analysis and production of population models. Its purpose is population simulation and population prediction for future years. Then, conservative and management methods for populations and their habitats would use upward recovery of endangered species [5].

Contest Model: In Contest model, assumed that there is limitations for environmental agents. But, resources have not distributed as evenness in studied region. There for, each species would try for more resources by competition with individuals. Carrying capacity definite in the basis of limited factors.

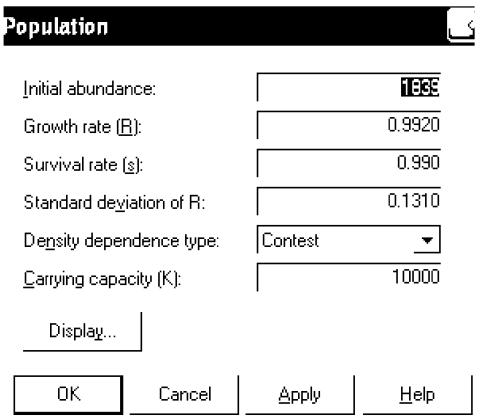

Fig. 2: Essential factors for prediction of population by Contest model

In mentioned model, different factors as a primitive population frequency, finite rate of growth, survival finite rate, standard deviation and carrying capacity would record.

RESULTS

Population Frequency: Data about population frequency indicated in table 1.

Table 1: *Ovis orientalis* number in Mond protected area between 1996-2003 years

years	Number
1996	2061
1997	2003
1998	1564
1999	1501
2000	1687
2001	1552
2002	1894
2003	1839

Survival Rate Determination: Survival rate would determine in the basis of mean of yearly survival rate. These results indicated in table 2.

Table 2: Survival rates between 1996-2003 years

years	Survival rate
1996-1997	0.97
1997-1998	0.78
1998-1999	0.96
1999-2000	1
2000-2001	0.92
2001-2002	1
2002-2003	0.02

Mean= 0.807

Finite Rate of Growth: Results of finite rate of growth and its standard deviation observed in table 3.

Table 3: Rate of growth between 1996-2003 years

years	Finite rate of growth
1996-1997	0.97
1997-1998	0.78
1998-1999	0.95
1999-2000	1
2000-2001	0.92
2001-2002	1
2002-2003	0.97

Mean=0.94

Prediction of Population Trend for *Ovis Orientalis* by Contest Model: 5 graphs (Fig. 3-7) present in below for prediction of population trend.

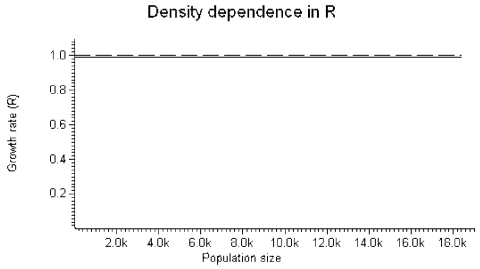

Fig. 3: Density dependence for growth rate about Wild Sheep population in Bamou National Park.

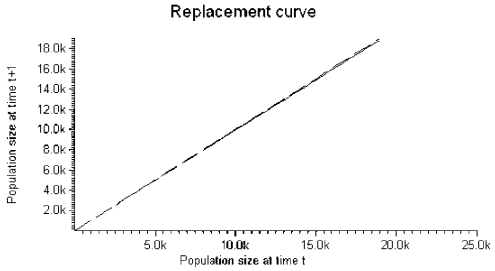

Fig. 4: Prediction of population for 50 future years in the basis of replacement curve

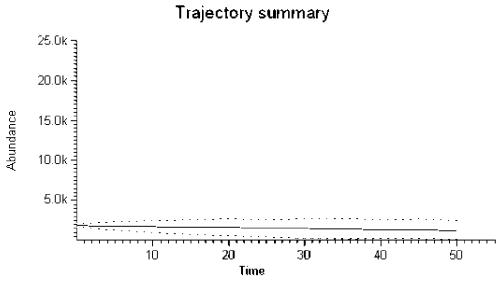

Fig. 5: Trajectory summary trend for 50 future years

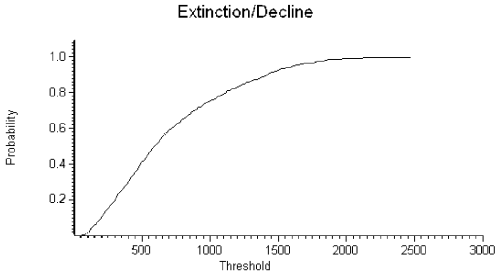

Fig. 6: Extinction probability for Wild Sheep population for 50 future years in Bamou National Park

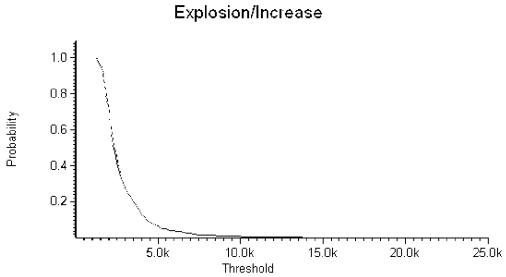

Fig. 7: Explosion probability for Wild Sheep population for 50 future years in Bamou National Park

DISCUSSION

In Contest model, assumed that there is limitations for environmental resources. These resources have not distributed as evenness in region. Therefore, territories would make. Species with territory making would protect of their resources by competition with intra and inter species, finally can be increasing their population. Results of density dependence to growth rate indicate that in the basis of 10000 head carrying capacity, growth rate for 50 future years would constant about 0.9920.

In the basis of population trend by replacement curve, Wild Sheep population would increase. For example, if population frequency be in 20 th simulated year (2016) almost 7372 head, therefore, in next year would decrease to 7313.02 head.

Results for population trajectory trend would indicate that population would decrease for 50 future years. For instance, if population be 1839 head in current time, in 15 th simulated year (2011) would decrease 1646 head and in 50 th simulated year (2046) would decrease to 1169 head.

Extinction probability trend indicate that there is 100% probability for 50 future years, population would decrease at least one time under the 2485 head. With 90% probability, population would decrease under the 1423 head at least one time.

Explosion probability trend indicate that there is 100% probability, population would increase more than 1222 head in 50 future years. With 20% probability, population would increase more than 3538 head for one time.

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