OSNOVI KONZERVACIONE BIOLOGIJE

OSNOVNI STATISTIČKI PAKETI U KONZERVACIONOJ BIOLOGIJI

Prof dr Jelka Crnobrnja Isailović

VORTEX

http://vortex10.org/Vortex10.aspx

VORTEX

= statistički paket zasnovan na individualnim Monte-Karlo simulacijama, a za procenu vijabilnosti populacije (a).

Primenljiv za vrste diploidnih organizama sa polnim načinom razmnožavanja.

Mammalia
Aves
Reptilia (neke vrste)
Amphibia (neke vrste)

Pisces (?)
Invertebrata (?)
Vegetalia (?) – ako imaju mali fekunditet

VORTEX
Ograničenja

Parametri	Maksimalne vrednosti
broj ponavljanja	10 000
dužina simulacije	10 000 godina
broj populacija	50
tipovi katastrofa	25
maksimalna starost jedinki	250 godina
maksimalna veličina okota	50*
početna veličina populacije	30 000 jedinki
kapacitet sredine	60 000 jedinki

*ako distribucija nije normalna; pri normalnoj raspodeli veličine okota u populaciji, program ne postavlja ograničenje maksimalne veličine okota

VORTEX nije od koristi	VORTEX može pomoći
veliki fekunditet	mali fekunditet
kratak život	dugačak život
poliploidni organizmi	diploidni organizmi
genetički efekti nemaju uticaja	genetički efekti veoma bitni
lokalna populacija (N)>500 jedinki	lokalna populacija (N)<500 jedinki
modelirate > 20 lokalnih populacija	modelirate < 20 lokalnih populacija
nemoguće je izračunati demografske stope	moguće je izračunati stope preživljavanja i uzrasno-specifični fekunditet
demografski parametri zavise od uzrasta ili veličine	fekunditet i stopa preživljavanja zavise od uzrasta
ne mogu se izračunati variranja demografskih stopa	variranja stopa mogu se izračunati
nema katastrofa	katastrofe postoje i mogu se modelirati
ukrstanje samo poligamno	ukrstanje mono ili poligamno
ukrstanje po principu slučajnosti	ne učestvuju sve polno zrele jedinke u reprodukciji neslučajna distribucija fekunditeta
osnivačka populacija ima stabilnu uzrasnu strukturu	osnivačka populacija nema stabilnu uzrasnu strukturu
konstantan odnos polova	promenljiv odnos polova
ne očekuju se trendovi u odnosu na kvalitet stanista	očekuju se trendovi u odnosu na kvalitet stanista
nema manipulacije veličinom populacije	postoji izlovljavanje, eksploatacija, pomeranje, premestanje, dodavanje itd jedinki
ribe, vodozemci, beskičmenjaci, biljke	gmizavci, ptice, sisari
dovoljno novca za kupovinu statističkih paketa	nedovoljno novca za kupovinu statističkih paketa

VORTEX je besplatan statistički paket napravljen sa ciljem da podrži biolosku konzervaciju, prosvetu i nauku.

Autorska prava za VORTEX pripadaju Chicago Zoological Society.

Za autorizovanu distribuciju VORTEX statističkog paketa ovlasćeni su:

Chicago Zoological Society

IUCN/SSC Conservation Breeding Specialist Group

Pojedinci, neprofitne organizacije, vladine agencije mogu besplatno kopirati i koristiti VORTEX sa sledeće internet adrese:

http://vortex10.org/Vortex10.aspx

Prilikom upotrebe VORTEX uputstva u svrhu pisanja izvestaja, studije ili naučnog rada citirati sledeću referencu:

Miller, P.C., and R.C. Lacy. 2005. VORTEX: A stochastic simulation of the extinction process. Version 9.5. Useršs Manual. Apple Valley, M.N.: Conservation Breeding Specialist Group (SSC/IUCN)

Prilikom upotrebe VORTEX statističkog paketa u svrhu pisanja izvestaja, studije ili naučnog rada citirati sledeću referencu:

Lacy, R.C., M. Borbat and J.P. Pollak. 2005. VORTEX: A stochastic simulation of the extinction process. Version 9.5. Brookfield, IL: Chicago Zoological Society.

PARAMETRI
KATASTROFE

Učestalost katastrofe se izračunava u odnosu na vremenski interval za koji simuliramo sudbinu populacije.
Na primer:
Za vremenski interval od 100 godina i ako se katastrofa dešava u proseku jednom u 100 godina
(poplava većih razmera, požar, ekstremna suša, jaki vetrovi, Neuobičajeno duga zima itd.) parametar “učestalost katastrofe”
Izražava se u % kao godišnja verovatnoća katastrofe, koja u ovom Slučaju iznosi 1/100 = 0.01 ili 1%

PARAMETRI
INBRIDNA DEPRESIJA

Parametar “broj letalnih ekvivalenata” izračunava se po konceptu prosečnog broja letalnih recesivnih alela po jedinki u populaciji i predstavlja meru oštrine efekta inbridinga kroz intenzitet smanjenja adaptivne vrednosti za bilo koji nivo inbridinga.
Broj od, na primer, 4 letalna ekvivalenta podrazumeva da svaka jedinka u populaciji ima u proseku po 4 letalna recesivna alela ili 8 recesivnih alela od kojih svaki izaziva 50% smanjenja preživljavanja kada je u homozigotnom stanju ili 2 letalna alela i 4 alela od kojih svaki izaziva 50% smanjenja preživljavanja kada je u homozigotnom stanju, itd.

INPUT

- Population fate was simulated for the following **15 years** (the short-term viability), what is recommended when the input parameters are of questionable validity (here: short monitoring period).
- **Iterations** were performed **100 times**, what provide an crude picture.

- **Extinction reports** were obtained for every **2 years.**
- **Extinction** was defined as **the complete absence of one or the other sex,** due to lack of ability to assess the probability of a population dropping below an minimal viable size.

INPUT

- **Inbreeding depression** was incorporated into simulation, having in mind reports of Ujvari *et al* (2000, 2002) and Toth *et al* (2005) about negative effects of inbreeding in an isolated local population of *V. ursinii rakosiensis*.

- Due to lack of quantitative data about severity of inbreeding depression in this species, we entered the default values of **3.14 lethal equivalents** (the median of 40 populations of mammals, study of Ralls *et al*, 1988) with **50%** of that **due to lethal alleles.**

INPUT

- **Annual variation in the probabilities of reproduction and survival** that arise from random variation in environmental conditions (weather, predator and prey population densities, parasite loads) and affects all individuals in the population was assigned as simultaneous or **concordant.**

INPUT

- **Reproductive system** chosen for simulation was **monogamous.** Even we did not succeed to monitor the breeding behaviour in this particular population, the prediction of the monogamous model that there must be a male for every adult breeding female was the most accurate.

INPUT

- **Females normally begin breeding** at age of **4** (Baron, 1997).
- **Males normally begin breeding** at age of **3** (Baron, 1997).
- **The maximum breeding age** is **14** according to Baron (1997), but **8** according to our (restricted validity) calculations.
- **Maximum number of progeny per year** per female was estimated as **12.**
- **Mate monopolization wa**s expessed through **100% of males in the breeding pool**

INPUT

- Since summer 2003 to summer 2006, additional 136 juveniles were born under the laboratory conditions from females collected in the wild. The juveniles were measured, marked and returned into the population together with their mothers, recaptured in consecutive years but they were not incorporated into the estimates of population size due to suspected large sampling error in their recapture rate.
- All data about reproductive biology were used only for estimation of fecundity parameters in this simulation.

INPUT

- **Maximum number of progeny per year** per female was estimated as **12.**
- **Sex ratio at birth in % males** was estimated as **52.13.**
- **Reproductive rates**, presented as % of adult females breeding – were **50** (Baron, 1997) to **53.69** (our data).
- **Environmental variation in reproduction** was entered by dividing the observed range in average % females breeding from 2003 - 2006 (23.74%) by the expected range for a normal distribution (2.33) what was estimated as **10.19%**

INPUT

Distribution of number of offspring per female per year was specified as **exact,** as we calculated average values in **%** among 4 consecutive years for every clutch size class:

1 – 16%
2 – 10%
3 – 17%
4 – 17%
5 – 14%
6 – 3%
7 – 12%
8 – 7%
9 – 0%
10 – 0%
11 – 0%
12 – 4%

INPUT

Mortality was simulated upon literature data of Baron (1997) :

Males

from **age 0 – 1 = 0.500** with **SD = 0.100**

from **age 1 - 2 = 0.468** with **SD = 0.079**

from **age 2 - 3 = 0.421** with **SD = 0.047**

adult males = 0.421 with **SD = 0.047**

Females

from **age 0 – 1 = 0.500** with **SD = 0.100**

from **age 1 - 2 = 0.468** with **SD = 0.079**

from **age 2 - 3 = 0.245** with **SD = 0.056**

from **age 3 - 4 = 0.245** with **SD = 0.056**

adult females = 0.293 with **SD = 0.041**

INPUT

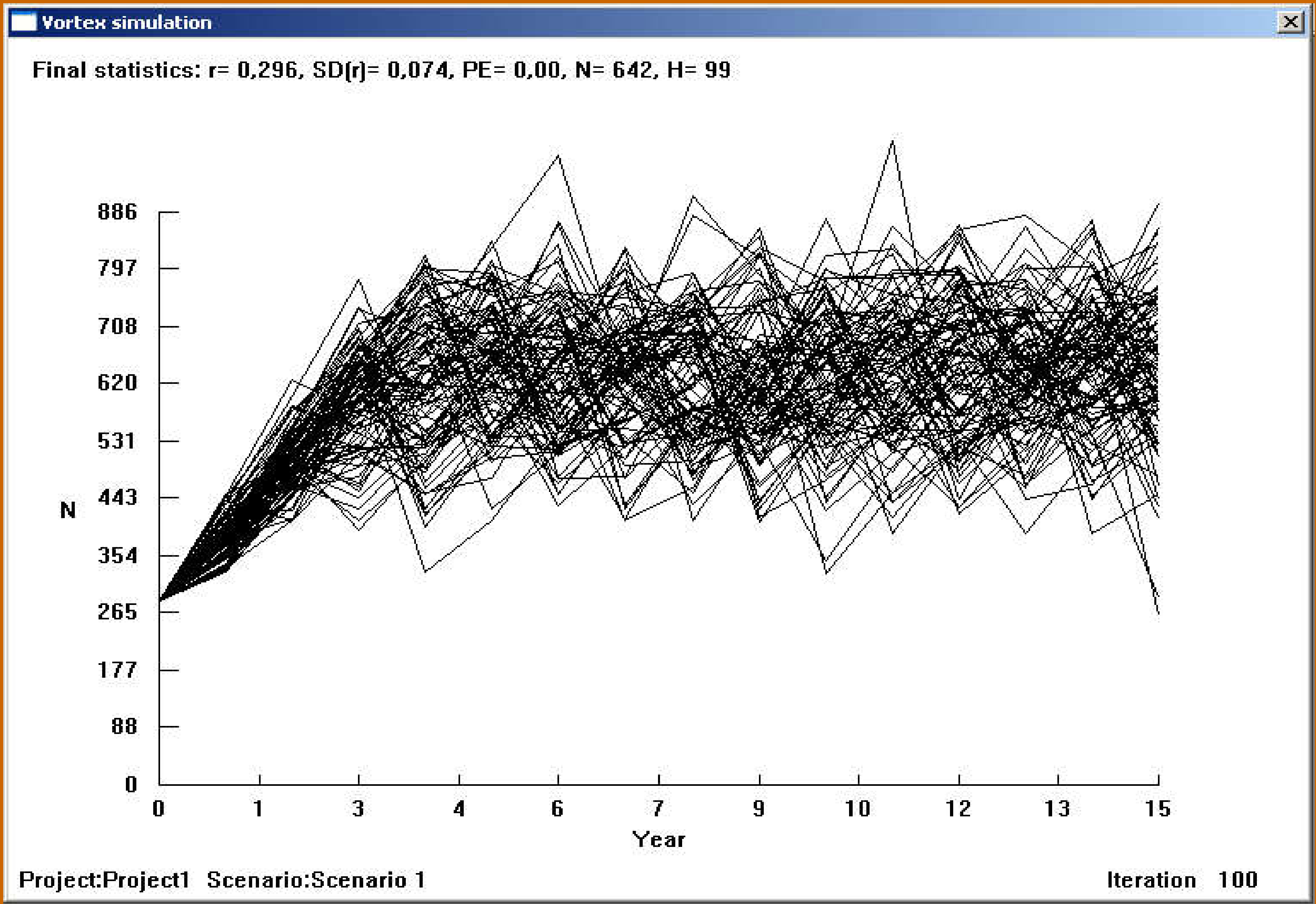
- **Initial population size** was calculated using capture-recapture data and the Lincoln index as the simplest one, even it is far from being accurate for this model.

  If calculated per season (spring/summer, summer/autumn, autumn/spring etc.), N varied between 163 and 479 individuals with the mean value of 275; if seasons were pooled and N calculated by same equation from year to year, then N varied from 190 to 380 individuals, with mean value of 296). Mean value of these two mean values is **285 individuals.**
- **Age distribution** in the population was assigned as **stable**, what is recommended in the absence of exact data.

INPUT

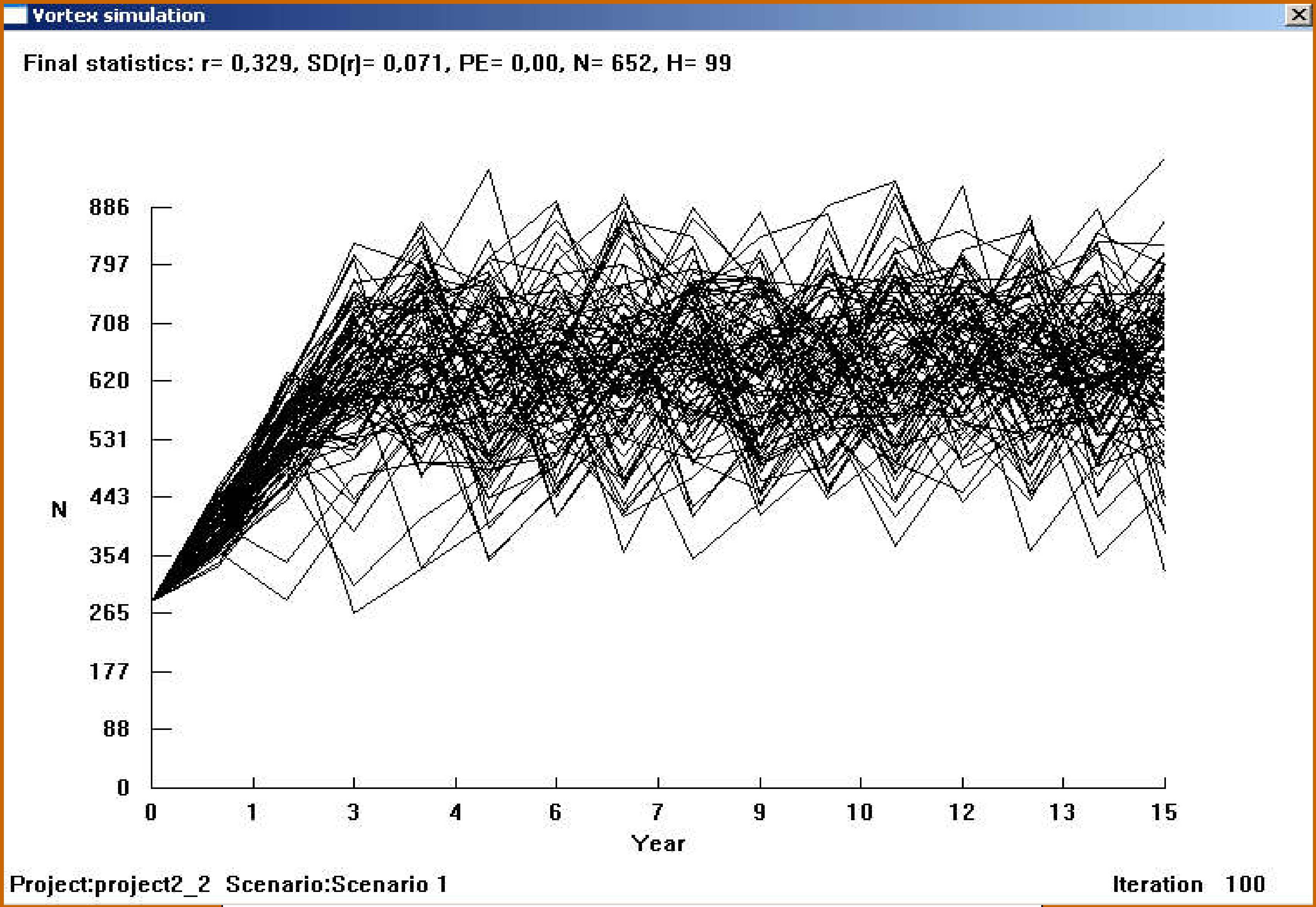
- **Carrying capacity (K)** was calculated according to capture recapture calculations of N; maximal N were up to **658** when calculated per seasons and to 458 when calculated per year.
- K could be estimated on the basis of available food resources. If these data are not available, then the rough estimate of habitat carrying capacity could be done upon data about long term population size.
- **SD in K due to environmental variation** was entered as **114 individuals**, what is a mean value of sample standard error calculated applying Lincoln index per seasons.
- **Future change in K** was **not predicted**.

OUTPUT I



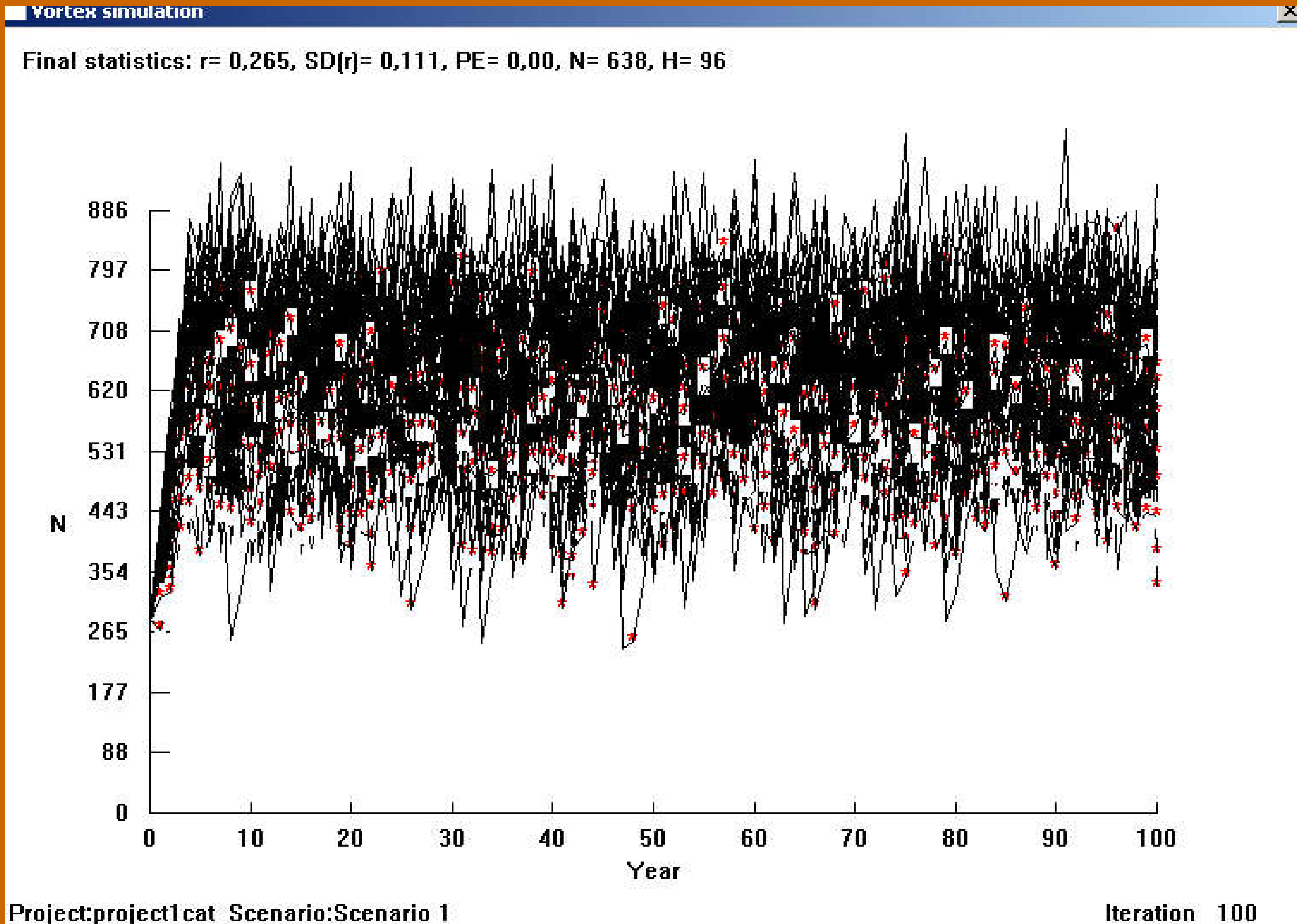
Area = 10 ha, max breeding age = 8 years
Extinct 0% after 100 years

OUTPUT Ia



Area = 10 ha, max breeding age = 14 years
Extinct 0% after 100 years

Catastrophy

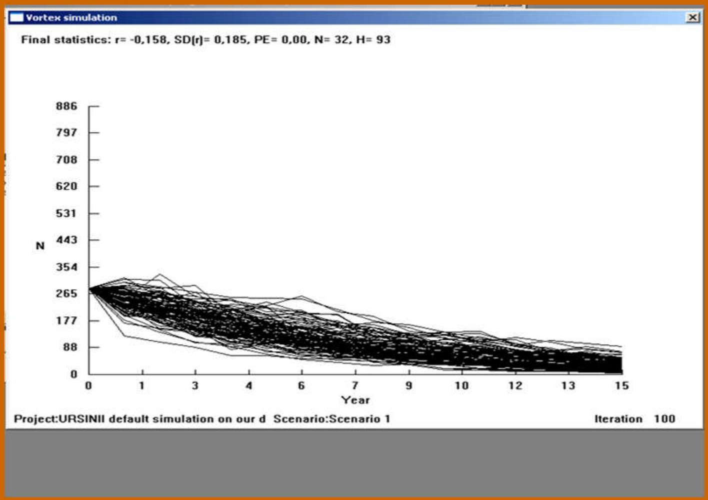


Area = 10 ha, max breeding age = 8 years
frequency of occurence = 0.1, severity = 0.8

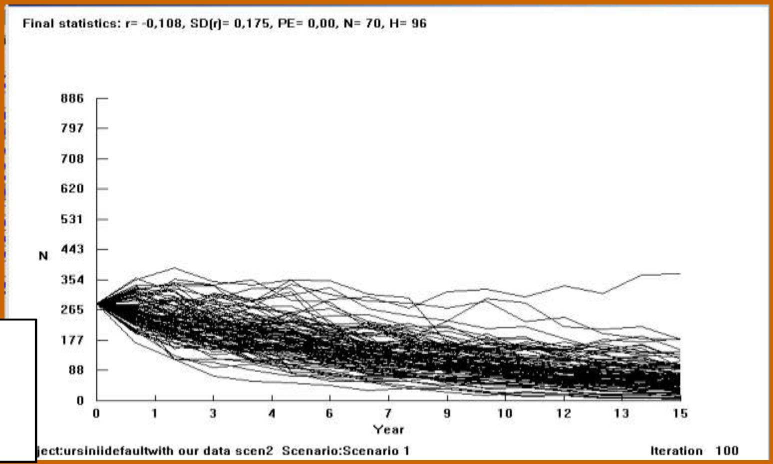
Discussion

Additional simulations showed that differences in some reproductive parameters only, without catastrophic events, could drastically change population fate:

higher rep.rate (55.26%) but less EV in reproduction (1.96%) will drive population to extinction .



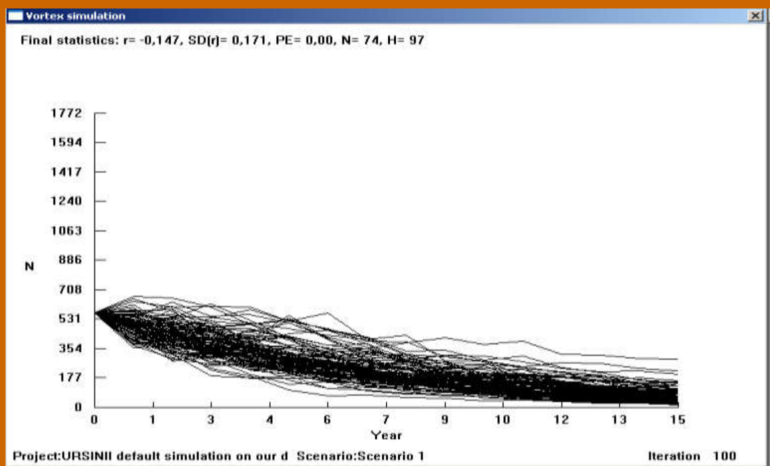
Area = 10 ha, max breeding age = 8 years
Extinct 100% after 40 years



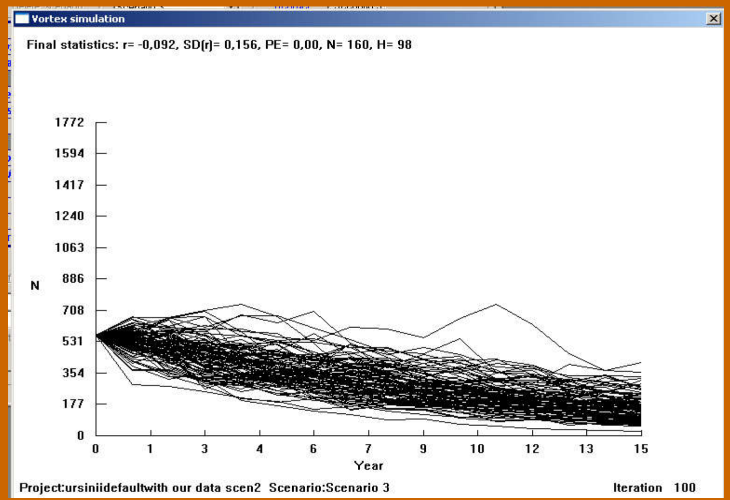
Area = 10 ha, max breeding age = 14 years
Extinct 100% after 55 years

Discussion

It is interesting that, under such conditions, increase in population size, even followed by adequate increase in carrying capacity, will not improve population fate:



Area = 20 ha, max breeding age = 8 years
Extinct 100% after 50 years



Area = 20 ha, max breeding age = 14 years
Extinct 100% after 60 years

First five years of studying population dynamics: a summary

Local population of Orsinii viper on Bjelasica mountain could have real chances for long-term viability if circumstances stay as they are now (minimal disturbance, minimal antropogenic influence, good quality of local orthopteran population as a main source of food).

The extent of annual variation in proportion of females that enter the reproduction in this particular population seems to have much greater impact on long-term population viability than hypothetical mild catastrophy that affect fecundity & survival.

Why it is not enough?

Recapture rate:

Mortality:

Effective population size:

Growth rate:

Environmental fluctuations:

Heritability of life history straits:

"Neither mathematical nor statistical models can predict the future,they can only suggest scenarios that might take place." (White *et al*, 2002)