Analiza vijabilnosti populacija (Population Viability Analysis) PVA

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Šta je PVA?

Proces utvrđivanja faktora koji ugrožavaju opstanak vrste i procena verovatnoće da će se ti faktori održati tokom određenog perioda u budućnosti.

Primena PVA:

-proračuni verovatnoće izumiranja populacije;
- potvrdjivanje da je populacija u opasnosti od izumiranja;

Korist od primene PVA:

- moraju se prikupljati demografski parametri;
-mora se izvršiti analiza podataka;
-utvrdjuju se podaci koji nedostaju;
-shvatanje posledica promene vrednosti parametara.

PVA objedinjuje dva procesa koja prouzrokuju izumiranje populacije:

1. Determinističko izumiranje – kada je stopa rasta populacije $\lambda < 1$ (stopa radjanja < od stope umiranja);

2. Stohastičko izumiranje – prosečna stopa radjanja izbalansirana je sa stopom umiranja ali moguća su slučajna masovna umiranja jedinki ili nedovoljno uspešnih parenja pa populacija iščezne (male populacije).

Primer:

Opstanak lokalne populacije orangutana može biti ugrožen zbog uništavanja šume – njihovog staništa – i to je deterministički faktor. Ali, inbriding i oscilacija odnosa polova po principu slučajnosti su rezultat stohastičkih procesa i oni takođe ugrožavaju tu lokalnu populaciju, ali kao stohastički faktor.
Čak iako je povoljno stanište stabilno, populacija male veličine je u opasnosti od izumiranja zbog stohastičkih fluktuacija raznih parametara.

Genetički vijabilne populacije:

MINIMALNA VIJABILNA VELIČINA POPULACIJE – minimalna veličina potrebna za održavanje reproduktivnog fitnesa i evolutivnog potencijala tokom vremenskog perioda dužeg od 1000 godina.

Genetički vijabilne populacije:

- Da li je veličina populacije dovoljna za izbegavanje inbridne depresije?
- Da li populacija sadrži dovoljno genetičke raznovrsnosti da evoluira kao odgovor na sredinsku promenu?
-Da li je populacija dovoljno velika da izbegne akumuliranje novih štetnih mutacija?

Genetički vijabilne populacije:

Cilj	N_e	Vreme oporavka (generacije)
Izbegavanje inbridne depresije	50	
Održavanje evolucionog potencijala	500 5000 570 – 1250	10^2 - 10^3
Održavanje jednolokusne genetičke raznovrsnosti	10^5 – 10^6	10^5 – 10^7
Izbegavanje akumuliranja štetnih mutacija	12 - 1000	

Genetički vijabilne populacije: za dugoročno preživljavanje

	N_e	N
Ugrožavanje:		
1. Gubitak genetičke raznovrsnosti	500-5000	5000-50000
2. Akumulacija mutacija	1000	10000
3. Demografska slučajnost		10s-100
4. Sredinska slučajnost		1000+
5. Katastrofe		1000+
Empirijski podaci (Thomas 1990)		
1. Ptice i sisari		
prosečno variranje		1000
visoko variranje		10000
2. Insekti		
prosečno variranje		10000
visoko variranje		100000
3.PVA za 100 vrsta kičmenjaka		>6000

Genetički ciljevi pri održavanju uzgojnih populacija

-Oko 2000 vrsta kičmenjaka može opstati na duge staze samo uz pomoć reprodukcije u kontrolisanim uslovima;
-Nedovoljno prostora u zoološkim vrtovima ako bi se držali pravila $N_e = 500$ jedinki;
-Kompromis za održavanje uzgojnih populacija ugroženih vrsta: održati 90% genetičke raznovrsnosti tokom 100 godina*

*Pretpostavlja se, na osnovu proračuna, da će nakon 100 godina staništa u prirodi ponovo postati dostupna nakon očekivanog pada veličine globalne ljudske populacije.

Genetički ciljevi pri održavanju uzgojnih populacija

$N_e = 475/L$ L = vreme generacije u godinama

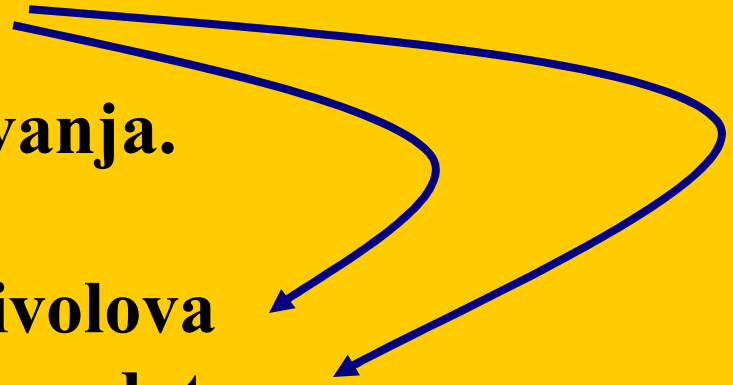
Miš:	**L = 14 nedelja**	**$N_e = 1769$**
Podbel:	**L = 1 godina**	**$N_e = 475$**
Flamingo	**L = 26 godina**	**$N_e = 18$**

Podaci koji se obično unose u PVA:

-stope radjanja i umiranja i njihove varijanse
-broj populacija
-veličina populacija
-kapacitet staništa
- učestalost i efekti ugrožavanja (katastrofe, izlovljavanje itd.)
-drugi podaci o životnom ciklusu vrste (podložnost inbridnoj depresiji, stope protoka gena izmedju populacija itd.)

Koncepti koji se koriste u kompjuterskim simulacijama zasnovani su na prikupljenim podacima dugoročnih istraživanja (više od 100 godina) populacione demografije, ekologije i genetike.

PVA se koristi za:
- predvidjanje rizika od izumiranja odredjene vrste, -
- poredjenje alternativnih strategija oporavka ugroženih vrsta;
- teoretska istraživanja.



uticaj kontrole krivolova
uticaj uklanjanja predatora

Inbridna depresija je jedini genetički faktor u PVA. Potrebno je znati:

-podložnost vrste inbridnoj depresiji;
-koje komponente adaptivne vrednosti (preživljavanje, fekunditet) su pod uticajem inbridne depresije
- nivo medjusobne izolacije lokalnih populacija (stope migracije i protoka gena, ako one utiču na koeficijent inbridinga)
- sistem ukrštanja (autbriding vs. samooplodnja; monogamni vs. poligamni vs. hermafroditni, itd.)
- veličinu populacije i odnos polova

Koliko su korisna predvidjanja na osnovu PVA?

Nedostatak: za veoma malo ugroženih vrsta postoje svi neophodni podaci o životnom ciklusu.

Medjutim, dobija se:

-zbirna informacija o životnom ciklusu vrste
-identifikovanje svih procesa ugrožavanja koji utiču na životni ciklus vrste
- vrednovanje značaja svakog od tih procesa
-identifikovanje mogućih strategija oporavka i vrednovanje njihovih relativnih uticaja
- identifikovanje manjkavosti u poznavanju vrste i formulisanje novih istraživanja čiji je cilj dobijanje informacija koje nedostaju.

IMPORTANCE OF LONG TERM POPULATION STUDIES FOR IMPROVEMENT OF EVALUATION OF CONSERVATION STATUS OF THE SPECIES

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Evaluation of international conservation status of the species

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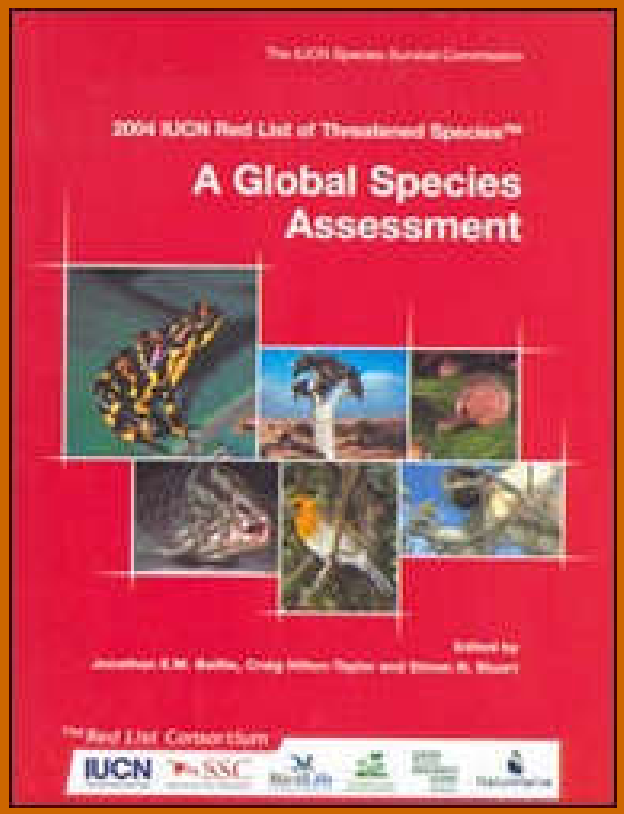

"because of a serious population decline, estimated to be more than 70% over the last three generations, inferred from a decline in the area of occupancy, extent of occurence and quality of habitat"

Vipera ursinii

total range area = 1,151,478 km²

range type

- Native Extant
- Introduced
- Native Reintroduced
- Possibly Extinct
- Extinct

- national boundaries
- n/a subnational boundaries
- lakes, rivers, canals
- salt pans, intermittent rivers

elevation meters

5000
4000
3000
2000
1000

0 2250 km

map created 06/03/2005

IUCN The World Conservation Union

Species Survival Commission

Conservation International

Center for Applied Biodiversity Science at Conservation International

NatureServe

Evaluation of international conservation status of the species

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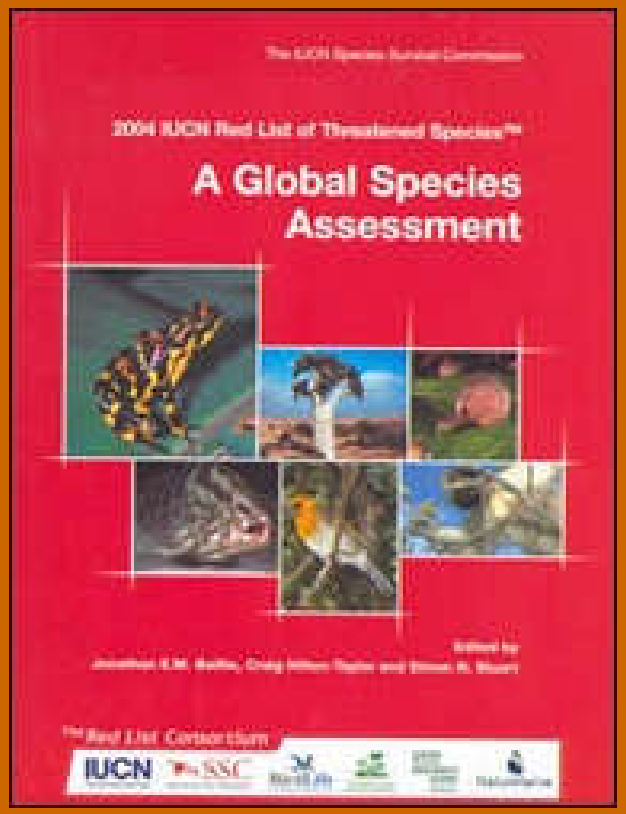


„because its Area of Occupancy is believed to be less than 2 000 km2, its distribution is severely fragmented and there is continuing decline in the extent and quality of its habitat“

Main criteria for prioritising species for conservation efforts

vulnerability to extinction

- evolutionary distictiveness
- likelihood of recovery
- local status

What is important to know for appropriate and accurate evaluation of species conservation status?

Vulnerability to extinction:

- population size
- rate of decline
- threats

What is important to know for appropriate and accurate evaluation of species conservation status?

- changes in number of specimens within species area
- or
- changes in number of population
- but,
- within defined time scale

What is important to know for appropriate and accurate evaluation of species conservation status?

Intensity of change

Extinction vortex

Very large decrease of population size

or

Smaller but repeated decreases within limited time period

shift population below its minimum viable size

road to extinction

What is important to know for appropriate and accurate evaluation of species conservation status?

Minimum viable population size

The smallest population size with a 95% chance of remining extant after the simulated 100 – year period

What is important to know for appropriate and accurate evaluation of species conservation status?

Population viability analysis

Method designed by Schaffer (1981, 1987) and Gilpin and Soule (1986) to allow estimation of the likelihood to extinction of population or populations.

It is important to know that the last two authors broadened the definition of PVA and incorporated the genetic factors, trying to include as many forces as they could suppose that interact in vortices that can affect the viability of a population (Beissinger, 2002).

What is important to know for appropriate and accurate evaluation of species conservation status?

Population viability analysis

Incorporation of genetics

source	relative importance	time frame
Inbreeding depression	high	immediate
Mitochondrial mutations	unknown	immediate
Loss of phenotypic variation	medium	immediate
Loss of evolutionary potential	medium	medium/long
Mutational meltdown	low	long

What is important to know for appropriate and accurate evaluation of species conservation status?

Population viability analysis

Incorporation of genetics

Inbreeding coefficient

Inbreeding depression

Gene diversity

Gene flow

Population genetic structuring of the species

What is important to know for appropriate and accurate

evaluation of species conservation status?

Population viability analysis

Incorporation of genetics

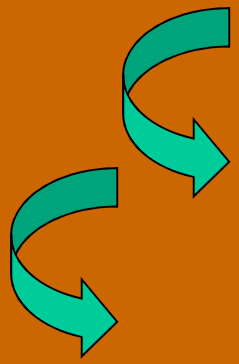
PVA without genetic data included may result in unrealistic prediction of population persistence

low Ne/N ratio & inbreeding & short generation interval &isolation

Greater chances for extinction

What is important to know for appropriate and accurate evaluation of species conservation status?

Population viability analysis



Incorporation of genetics

Unique gene sequences

Good argument for proposing special conservation status for particular population

What is important to know for appropriate and accurate evaluation of species conservation status?

Population viability analysis

Incorporation of genetics

"Ignoring inbreeding and genetic variation in assessing the long-term viability of populations will lead to underestimation of the size of viable populations." (Beissinger & McCullough, 2002)

POPULATION VIABILITY ANALYSIS OF AN LOCAL POPULATION OF *VIPERA URSINII MACROPS* IN NORTHEASTERN MONTENEGRO

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- Local population of *Vipera ursinii macrops* in northeastern Montenegro (Bjelasica mountain) have been monitored from july 2002 .
- Research area covers approximately 10 ha, from 1651 to 1728 m altitude .
- The population has been studied over five consecutive years for parameters of population dynamic and structure, including abundance, age structure, sex ratio, effective population size and clutch size.
- At the end of 2006., data base contained records on 159 individuals of all age classes.

- **Date**: _____
- **Individual no.** _____ **Locality**:
- **Exposition** _____ **Altitude**: _____ m.n.v.
- **Latitude** _____**o** _____’ _____" **Longitude** _____**o** _____' _____"
-
- **Behaviour**:
- Resting in shade _____ Basking _____
- Escaping _____ Moving _____
- Hiding _____ Mating _____

- **Temperature**:
- Cloacal temperature (TC) _____ oC
- Substrate temperature (TS) _____ oC
- Air temperature (TA) at 5 cm above the ground _____ oC
- at 60 cm above the ground _____ oC

- **Weather conditions:**
- Time of day _____
- Atmospheric pressure _____ mb Cloudness _____ %
- Wind direction _____ Wind speed _____ m/s
- Humidity _____

- **Habitat selection – type of the microhabitat**
- 1. Stones and *Juniperus* bushes less than 4 m diameter
- 2. Stones and *Juniperus* bushes between 4 and 6 m diameter
- 3. Stones and open grass
- 4. Open grass
- 5. Open grass and *Juniperus* bushes between 4 and 6 m diameter
- 6. Open grass and other bushes (*Vaccinium*)
- 7. Stones and *Juniperus* bushes less than 4 m diameter and open grass
- 8. *Juniperus* bushes less than 4 m diameter and open grass and other bushes (*Vaccinium*)
- 9. *Juniperus* bushes more than 6 m diameter and open grass and *Vaccinium*
- 10. *Juniperus* bushes between 4 and 6 m diameter and stones and open grass
- 11. *Juniperus* bushes more than 6 m diameter and open grass
- 12. *Juniperus* bushes more than 6 m diameter and *Vaccinium*
- 13. *Juniperus* bushes more than 6 m and open grass and stones
- 14. *Juniperus* bushes more than 6 m and open grass and stones and *Vaccinium*
- 15. *Juniperus* bushes between 4 and 6 m diameter and *Vaccinium*
- 16. *Juniperus* bushes between 4 and 6 m diameter and *Vaccinium* and open grass

- **Morphometric characters:**
- **1. Total lenght (LTOT) _____ cm**
- **2. Snout-vent lenght (SVL) _____cm**
- **3. Tail lenght (TL) _____ cm**
- **4. Tail width (TW) _____ mm**
- **5. Body width (BW) _____ mm**
- **6. Body height (BH) _____ mm**
- **7. Head lenght (HL) _____ mm**
- **8. Head width (HW) _____ mm**
- **9. Head hight (HH) _____ mm**
- **10. Mouth lenght (ML) _____ mm**
- **11. Mouth width (MW) _____ mm**
- **12. Internasal distance (IN) _____ mm**
- **13. Intersupraocular distance (ISO) _____ mm**

- **Meristic characters:**
- **14. Dorsalia (D) _____**
- **15. Ventralia (V) _____**
- **16. Subcaudalia (SC) _____**
- **17. Apical plates 1 2**

- **Other characteristics:**
- **Weight _____ g**

- **Sex _____ Reproductive condition _____**

- **Digital pictures:**
- **Head dorsal view_____**
- **Head left profile_____**
- **Head right profile_____**
- **Body dorsal pattern_____**
- **Marcation_____**