POLITECNICO DI MILANO

Ecosystem conservation and management

PROF. MARINO GATTO

Academic Year 2017/018 – First test

15 November 2017

COGNOME/FAMILY NAME: ……………………………………..

NOME/FIRST NAME: ……………………………………………..

FIRMA/SIGNATURE: ....

100%	100%	100%	100%	100%	100%

RULES

DON'T use the same page to report answers to different questions;

DON'T use additional sheets (they will be trashed): instead, use the back of provided sheets and clearly indicate where to read the sequel of your answer to the question;

DON'T consult books, notes, or class mates.

DON'T use a pencil, use a pen.

WARNINGS:

Clarity, precision and conciseness are positively evaluated.

Unjustified answers are not considered.

If you are not English-fluent, use Italian (or French or Spanish)

Outcomes of the test will be published on the teacher's website as soon as possible. Do not phone or e-mail before grades are published.

1. The platypus, *Ornithorhynchus anatinus*, one of only five extant species of egg-laying mammals, is found in eastern Australia. Two island populations of *O. anatinus* exist there: King Island in Bass Strait, and Kangaroo Island off the coast of South Australia. The population on King Island is naturally occurring, while that on Kangaroo Island was established in 1941 by introducing a few individuals from a large population of the Victoria region. Kangaroo population is small and has therefore been subjected to genetic deterioration. E. Furlan et al. (*Ecology and Evolution*, 2011) have studied the population: they have estimated that it consists of about 110 individuals and that its average heterozygosity in 2009 was 0.419. However, the effective population size is not known.

Calculate the effective population size on the basis of the following information: (a) the 1941 heterozygosity can be assumed to be equal to 0.597, which is the current heterozygosity of the Victorian population; (b) the platypus generation time can be assumed to be about 10 years.

Solution:

2. The Himalyan tahr, a large ungulate native to the Himalayas, was introduced into New Zealand in 1904. It then spread through the Southern New Zealand Alps. Parkes and Tustin (*New Zealand Journal of Ecology*, 1985) have estimated the areas occupied by tahr in subsequent years:

Years	Area (km^2)
1936	129
1946	542
1956	1237
1966	3998
1976	6138
1984	4937

Caughley (*Ecology*, 1970) provides the following information on tahr demography:

- The average numbers of kids produced by one adult female per year is 0.9
- Sex ratio at birth is 1:1
- The fraction of kids surviving to adulthood is 0.6
- The average lifetime of tahr is 8 years

Assume that the areas occupied by the ungulate are approximately circular. Then calculate:

(a) the average expansion speed of tahr in New Zealand;
(b) its Malthusian instantaneous rate of demographic increase;
(c) its diffusion coefficient *D*.

Solution:

3. The population of brown bear (*Ursus arctos*) in Trentino-Italy has been steadily increasing (Rapporto orso 2016). Here below you find the most recent statistics on the total number of bears

Year	Number
2008	20
2009	26
2010	27
2011	33
2012	29
2013	40
2014	37
2015	38
2016	38

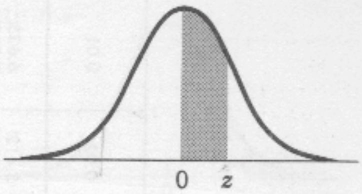
Assume that **environmental stochasticity only** has been affecting the population in recent years. From the table estimate: (a) the instantaneous rate of demographic increase and the corresponding finite rate, (b) the variance σ^2_ε of the logarithm of the multiplicative noise, (c) the probability that the population will fall below 50 individuals in 2026 (use the attached table of the normal distribution).

From other data, the Rapporto orso 2016 estimates an average survival between subsequent years of 88%. Also, it reports that back in 2002 there were 8 bears (sex ratio 1:1). Suppose that in 2002 you wanted to estimate the long-term chance of extinction of the bear population subject to **demographic stochasticity only**. Use the demographic rates from the Rapporto orso 2016 to estimate (d) the long-term probability of persistence of the brown bear in Trentino as resulting from the number of bears in 2002.

Solution:

Table II. Areas of a Standard Normal Distribution

An entry in the table is the proportion under the entire curve which is between $z = 0$ and a positive value of z. Areas for negative values of z are obtained by symmetry.



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

4. Ecological corridors have been promoted as a means to reconnect fragmented landscapes, protect biodiversity, and maintain population integrity. However, a corridor's connectivity may also aid the spread of unwanted guests, including disease, fire, predators, invasive species, domestic animals, and poachers.

Include this trade-off in Levins' metapopulation model by assuming that colonization success is an increasing function of connectivity, but extinction risk is also increasing with connectivity between habitat patches. Assume that connectivity z varies between 0 (no connection between patches) and 1 (maximum connection) and that the colonization rate c (year^{-1}) and the extinction rate e (year^{-1}) are given by the formulas

$$c(z) = 1.2\,z \qquad\qquad e(z) = 0.25 + z^2 \quad .$$

Find out the value of connectivity that maximizes patch occupancy. Then calculate the maximum rate m of environmental catastrophes that can be tolerated by a metapopulation in a landscape with optimal connectivity.

Solution:

5. Answer the following questions by appropriate ticking (right answer: 100% score, wrong answer: -20%)

a) Tick the unique **true** statement among the following ones

☐ Blah, blah

☐ Blah, blah

☐ Blah, blah

☐ Blah, blah

b) Tick the unique **false** statement among the following ones

☐ Blah, blah

☐ Blah, blah

☐ Blah, blah

☐ Blah, blah

6. Answer the following questions **inside the frame only** (penalization -20%)

Blah, blah
Blah, blah