EEB 2208 (Introduction to Conservation Biology)

Homework 8: Lectures 1-15

Conservation biologists frequently make inferences based on imperfect knowledge and extrapolation. Which of the following statements, based on extrapolation, are reasonable?

1. Identifying biodiversity hotspots based on well-studied groups of organisms will ensure the protection of all groups. **B**
2. Data deficient species are so numerous that it is impossible to compare modern extinction rates to those in the past. **B**
3. If a data deficient species is declining, habitat loss is probably a contributing factor. **A**
4. Protecting habitat in the lowland tropics is likely to benefit more species than protecting habitat in the montane boreal zone. **A**
5. If a terrestrial species has declined due to habitat loss, it is likely that agriculture is the cause. **A**

This set of questions was designed to test your ability to make informed extrapolations from information given in this class – and that you recognize that, even in the absence of specific information, useful inferences can still be made. Q1 is wrong because hotspots for different taxonomic groups often do not overlap. Data deficient species are numerous, but it is still possible to make informed comparisons of current vs. past extinction rates, as evidenced by the comparisons I gave in class. Given that habitat loss affects the vast majority of all declining species (several examples given, but the Wilcove table is the most obvious), then it is reasonable to assume that it probably applied to any declining species even if you know nothing about it. You might be wrong, but it is unlikely. Q4 tests your knowledge of patterns of species diversity – since richness declines with latitude and elevation it is likely that more species would be protected by a lowland tropical reserve. Finally, since most natural habitat conversion is caused by agriculture, it is likely (though not guaranteed) that any declining terrestrial species will be affected in this way.

Which of these statements about the role of stochasticity in population models are correct?

6. Catastrophic events are a type of demographic stochasticity. **B**
7. Random variation in the number of offspring produced by each individual in a population is a type of stochasticity. **A**
8. Adding stochasticity to a model makes the resulting conclusions more useful. **A**
9. Adding stochasticity to a model makes the resulting conclusions less certain. **A**
10. Genetic drift is a stochastic process. **A**

Catastrophic events can be stochastic, but would normally be considered an extreme form of environmental stochasticity. Q7 and Q10 simply test whether you can identify correct statements about stochasticity. Q8 and Q9 test your ability to interpret the value of addressing stochasticity – it does make conclusions less certain because it accounts for all of the unknowns in the world. But these unknowns are real and so should be accounted for. Consequently stochastic models are more useful because they help avoid getting a false sense of how good our understanding is.

A group of researchers has created a demographic model to estimate the extinction risk for Sumatran rhinos. The model is designed to determine the probability that the current population of 275 animals will go extinct within the next 100 years. All of the data for the model come from a detailed, long term study of birth and death rates from the wild population. The researchers conducted 10,000 simulations, and found that the population went extinct in 150 of them. Which of the following statements are true?

11. The model is deterministic. **B**
12. The model includes uncertainty in the population's trajectory. **A**
13. According to the model, the population has at least a 90% chance of persisting for 100 years. **A**
14. According to the model, environmental stochasticity is a major threat to the persistence of this population. **B**
15. The species is completely safe from extinction. **B**

Q11 has to be wrong because different simulations produced different results (i.e., some, but not all, resulted in extinctions). Q12 is correct for the same reason. Q13 tests whether you understand how to estimate extinction risk using a simulation model. Q14 is wrong because there is no information about the importance of different types of stochasticity. Q15 is wrong because some simulations (albeit very few) result in extinction – hence there is a very low chance of extinction, but the population is not completely safe.

Which of these conservation actions would be considered representative of the declining population paradigm?

16. Translocating northern quolls to an island where they will be safe from invasive species that threaten them. **B**
17. Reducing the spread of invasive species. **A**
18. Developing a land protection strategy that helps to keep common species common. **A**
19. Captive breeding for the critically endangered California condor population. **B**
20. Implementing sustainable harvest management for waterfowl. **A**

This set of questions tests whether you understand the main conceptual difference between the two paradigms put forward in Caughley's classic paper. These specific conservation actions are not things that I have talked about in detail in class (though I did mention the quoll example in the invasive species chapter). But, if you understand the difference between Caughley's two paradigms, then you should recognize that very interventionist conservation actions focused on the last individuals of a rare species relate to the small population paradigm (so Q16 and Q19 are wrong), while those focused on maintaining populations of multiple species over broad areas before they get to be very small relate to the declining population paradigm (so the others are correct).

Why is it difficult to use observational field studies to determine the MVP for a species?

21. Because it is impossible to estimate the amount of environmental stochasticity. **B**
22. Because it typically takes a long time. **A**
23. Because estimating MVP requires that you track multiple populations. **A**
24. Because the data are difficult, or impossible, to gather. **A**
25. Because many people view it as unethical to let a population decline without doing something. **A**

This set of questions relates to the bighorn sheep example, which is one of the very rare cases where there are long data sets for multiple populations (so Q22-24 are all correct). Q21 is wrong because it is not impossible to estimate environmental stochasticity – it usually requires a long time series of data though. Q25 also relates to the need for large data sets, but addresses a consequence of this – when species are rare/declining, conservation decisions often need to be made in the short term to ensure that a species does not go extinct. Thus, even if you could conduct a long-term field study, it is often not practical/appropriate to do so. Note that I purposely did not define MVP because I wanted to test whether you knew what it means.

Which statements correctly connect the named species to a cause of their endangerment?

26. The Puritan tiger beetle is a narrow range species at risk of catastrophe. **A**
27. The rainbow trout is at risk from hybridization. **A**
28. The large blue butterfly is at risk from co-extinction. **A**
29. The heath hen is at risk from recent climate change. **B**
30. Cone shells are at risk because of their use in biomedical research. **A**

All of these examples were discussed as key examples of important phenomena. I don't expect you to remember every example, but I do expect "A" students to know the bulk of the important ones that I talk about when I introduce an idea, especially when I make a point of referring back to those examples at multiple points during the class (e.g., as I have done for some of these examples).

Which of the following statements about the equation, $H_{t+1} = (1 - 1/2N_e)H_t$, are true? (3 points)

31. N_e is the number of individuals in the population. **B**
32. H_t is a measure of the amount of genetic variation in the population. **A**
33. If you do these calculations, H_{t+1} will always be smaller than H_t. **A**
34. The equation describes the effect of genetic drift on a population. **A**
35. The equation describes changes in genetic diversity in a population. **A**

The first two parts test whether you know what those terms are. Q33 tests whether you understand the main point I was making when describing the equation (i.e., the "big picture" part of that discussion). The last two parts test whether you understand both the general (Q35) and specific (Q34) processes that the equation describes – i.e., change in genetic diversity that is caused by drift.

36. Give two reasons why conservation biologists consider genetic diversity to be important. (2 points)

Reduced evolutionary potential
Inbreeding depression is more likely

37. Describe the advantages and disadvantages of using computer simulations to estimate the chance that a population will go extinct under different scenarios? (5 points)

Various possible responses would be acceptable, but here are a few that would count (1 point for each, up to a max of 5):

Advantages: Can do "experiments" that are impossible in the real world. Can easily compare a wide range of different scenarios. Can replicate many times and quantify uncertainty.

Disadvantages: Need good data to ensure that models produce realistic/informative results. Data collected over long time periods is often necessary to describe environmental variation well. Need to understand biology of organism well enough to design model appropriately.

38. In what ways do the small and declining population paradigms differ? (5 points)

See notes for Lecture 13. For 5 points I would have expected most of the information given in my notes – i.e., 1 point each for defining the paradigms, and 1 point for each of 3 distinct differences (e.g., development of theory, types of species that the approach focuses on, how good we are at addressing problems, etc.).

39. Define the following terms. (3 points)

a) Point endemic: A species with a very small range (a single "point"). The main example I gave was the Tiburon mariposa lily, which is found only on a single mountain in the San Francisco Bay area.

b) Census population size: The total number of individuals in a population (distinct from the effective population size, N_e).

c) Sensitivity analysis: A process whereby one systematically varies either the numbers that go into a model, or the structure of the model, in order to determine whether the main conclusions of an analysis are "sensitive" to potential errors in the modelled conditions.