EEB 2208: LECTURE TOPIC 13

SMALL POPULATION CONSERVATION

The information in the next few lectures is some of the conceptually hardest in the course – THESE ARE NOT CLASSES TO MISS.

Reading for this lecture

Primack: Chapter 11

Discussion reading: Webb & Mindel 2015. Global patterns of extinction risk in marine and non-marine systems. Current Biology 25:506-511. On-line at: http://www.sciencedirect.com/science/article/pii/S0960982214016248

Additional optional reading: These two papers are among the most influential that have been published in the field of conservation biology. The first is one that I have used as a discussion paper in the past. I am not requiring that you read it, but I strongly recommend that you do so, especially if you have an interest in a career in conservation. It is especially worth reading because it reviews a lot of the most important issues that I will talk about in the second half of the course and therefore will provide a good review of material that will be important on the exam. The second paper is one that I will discuss in detail in this lecture.

- Caughley, G. 1994. Directions in conservation biology. Journal of Animal Ecology 63: 215-244. Available on-line at: http://www.jstor.org/stable/5542?cookieSet=1
- Shaffer, M. 1981. Minimum population sizes for species conservation. BioScience 31: 131-134. Available on-line at: http://www.jstor.org/sici?sici=0006-3568%28198102%2931%3A2%3C131%3AMPSFSC%3E2.0.CO%3B2-2

1. Introduction

A) TWO THEMES IN CONSERVATION BIOLOGY

i) In 1994 a very influential paper was published by ecologist Graeme Caughley (see above). This paper suggested that there are two main paradigms followed by conservation biologists and that these themes have some distinctive characteristics.

ii) Caughley referred to the first as the "small population paradigm," which focuses a lot of attention on highly endangered species and the persistence of populations. Much of the work in this area focuses specifically on extinction prevention. It is an area in which a lot of theory (e.g., in conservation genetics and population viability analysis – topics that we will cover in the next two lectures), practical techniques (e.g., captive breeding), and legislation has been developed and which we are getting moderately good at (i.e., we often have the tools to succeed, as long as resources and political will allow). But, it also is a crisis-driven approach, in which we are constantly responding to dire circumstances at the last minute.

iii) The alternative approach is the "declining population paradigm," in which the focus shifts to identifying problems before they develop into crises; before populations are about to completely disappear. In this arena, the goals are more on keeping ecosystems intact, maintaining abundant populations of common species by preventing declines, and understanding the ultimate reasons why species are disappearing. Ultimately tackling problems in this way is likely to be more effective (and less expensive), but the crises often distract us, and consequently theory and practical techniques for this approach are less well developed.

iv) There is a clear parallel here to preventative medicine vs. reliance on the emergency room.

B) SMALL POPULATIONS

i) In the next few lectures (population viability, conservation genetics, captive breeding) I will build on what we know about the first theme, i.e., the conservation issues facing small populations.

ii) Later lectures (reserve networks, matrix conservation, management, restoration) will be more germane to the declining population paradigm.

iii) One of the key questions that comes up over and over when putting conservation knowledge into practice is: How big do populations need to be for there to be little risk of extinction? Another related question (asked especially by economists, developers, politicians, etc.) is "How much land do we need to protect?" We will address the first one in this lecture and return to the second when we talk about reserves in a couple of weeks.

2. Minimum viable populations (MVP)

A) DEFINITION

i) In 1981, Mark Shaffer introduced the minimum viable population concept. This provided an explicit, quantitative, method for identifying the number of individuals that are needed to ensure that a given population does not go extinct.

ii) Shaffer defined an MVP as follows: "A minimum viable population for any given species in any given habitat is the smallest isolated population having a 99% chance of remaining extant for 1000 years despite the foreseeable effects of demographic, environmental, and genetic stochasticity, and natural catastrophes."

iii) This definition is a bit cumbersome, but it needs to be because the problem is a complex one. As I have said in earlier lectures, all populations eventually go extinct for some reason. In addition, chance events (e.g., falling meteors) could always come along and wipe a population out, regardless of its size. Consequently, one cannot ever be sure that there is no chance of a population disappearing.

iv) For this reason, any decent definition must be expressed in probabilistic terms and must be expressed over a given time frame (because if the time span is "forever" then the extinction probability has to be 1 – nothing lasts forever!).

v) The exact numbers expressed in Shaffer's definition are not fixed, and are varied considerably by different users of the concept. In fact, the setting of these numbers is not necessarily a scientific issue, but rather one based on what extinction risk and time frame society views as reasonable. Science does have some influence, however. For example, hardly anyone makes extinction estimates over a 1000 year time-frame any more, because we have come to realize that it is simply not possible to estimate the probabilities in a meaningful way. Both quantitative parts of the definition need to be defined, however, whenever one is talking about the viability of a population – otherwise the statement lacks real meaning.

vi) The second key advance made by this definition was to lay out the different sources of population vulnerability: demographic, environmental, and genetic stochasticity, and natural catastrophes. Any thorough assessment of population viability or MVP needs to consider each of these things. In particular, a good assessment needs to pay attention to variability and account for the worst case scenario – a target population size should be one that is large enough that, even in the worst conditions, the population will not be driven to extinction.

B) ESTIMATING MVP IN PRACTICE

i) Ideally, MVP would be estimated by examining what happens in real populations (empirical evidence). To do this, though, one would need to determine the size of a number of populations, track each population over time (i.e., decades), and then see which went extinct and which did not.

ii) For example, in a study of bighorn sheep 120 different populations were tracked in this way. The study discovered that populations that started with less than 50 sheep almost invariably went extinct within 50 years. In contrast, those with over 100 sheep all maintained fairly stable populations. Intermediate sized populations did not go extinct, but they tended to decline, suggesting that if the study had lasted for longer, these populations also would have disappeared.

iii) Unfortunately, this type of study is almost impossible to do with any species that is of conservation interest. This is because we rarely have multiple populations (because we are dealing with endangered species!). Even if we do have the populations, we rarely have the detailed information on population size and trends over many years that are needed to assess MVP. Finally, even if it was possible to get the data, in most conservation settings it probably would not be considered acceptable to sit around and collect data for years and years while populations are disappearing.

iv) For all these reasons, people primarily study MVP (and, more broadly, population viability) using computer simulations of real populations. By creating a computer model it is possible to run many different simulations over long time spans. It is also possible to conduct experiments in the computer whereby different populations are treated in different ways to see how population persistence varies. To build such models, however, a lot of information about the basic biology of a species is still needed.