EEB 2208: LECTURE TOPIC 6

EXTINCTION RATES

Reading for this lecture

Primack: Chapter 7

1. Extinction

A) DEFINITIONS

- **Extinction** = no members of a species remain alive
- **Local extinction** = gone from a particular area
- **Extirpation** = local extinction
- **Extinct in the wild =** individuals remain, but only in captivity/under cultivation
- **Ecologically extinct** = still persists, but is so rare that it's ecological role is negligible
- **Extant** = not extinct
- **Endemic** = restricted to a certain (usually fairly small) area

B) A NATURAL PROCESS

i) Extinction is not something that is just a result of human activity. Nor is it something new. Instead it is a natural process that has been happening ever since there was life on Earth.

ii) On the other hand, extinction rates are currently very high – much higher than during most of the planet's history.

2. Mass extinctions

A) IN THE DISTANT PAST

i) Mass extinctions are periods during which a very large proportion of all species go extinct; they are times when the rate of extinctions is greatly increased compared to the "background" (i.e., normal) rate.

ii) During Earth's history there have been 5 mass extinctions. These occurred during the Ordovician, Devonian, Permian, Triassic, and Cretaceous periods.

iii) During each of these mass extinctions, a large proportion of all species (>> 50%) and many animal families (> 30%) are estimated to have gone extinct.

iv) See Figures 7.2 and 7.3 in Primack (plus text).

v) Although mass extinctions account for a lot of species losses, most extinction has happened during other time periods. Most of the species that have ever existed on Earth are now extinct.

B) HUMAN-CAUSED

i) Current extinction rates are similar to those found during the past five mass extinctions.

ii) Most current extinctions are caused by humans.

iii) The current period of (largely) human-caused extinction is not something simply associated with modern humans, but has been going on for 10,000+ years.

iv) Large-scale extinctions, especially of large organisms such as mammals and birds, have been associated with the spread of humans into new areas for a long time. Examples include colonization of Australia, the spread of Polynesians across the Pacific (starting ~8,000 years ago), and colonization of North American (~12,000 years ago).

v) For an example of the effects of human colonization, read about Easter Island here: http://www.greatchange.org/footnotes-overshoot-easter_island.html.

3) Extinction rates

A) CURRENT RATE

Current extinction rates are high. Here are a few examples for different groups of organisms:

- 85 (2.1%) mammals, 113 (1.3%) birds have gone extinct since 1600; most in the last 150 years.
- 20% of all bird species extinct in past 2000 yrs.
- 50% drop in populations of Neotropical migrant birds in eastern U.S. in last 50 yrs.
- 50% of fungus species in Europe may have become extinct in past 60 yrs.
- 20% of the world's freshwater fishes extinct or in serious decline.

B) BACKGROUND RATE

i) The "background" rate is the typical rate that is thought to have occurred during most of the Earth's history.

ii) Since we weren't around during this time, it is hard to know exactly what this rate was, but based on the fossil record for marine animals, it has been estimated that the annual extinction rate was about 1 species in every million to ten million species.

iii) In other words, if there are between 1 million and 10 million species on Earth, then 1-10 species should go extinct each year.

C) COMPARING CURRENT TO BACKGROUND RATES

i) Using data for recent extinctions among birds and mammals (which are pretty well known), we can estimate that about 1% of species go extinct every 100 years.

ii) This means that about 1 in every 10,000 species are currently going extinct each year.

iii) These estimates suggest that the current extinction rate is about 100-1000 times greater than the background rate. Other estimates that have been made range from about 40 times the background rate, to 10,000 times the background rate.

iv) How good do you think these estimates are likely to be? Why is there so much variation in the estimates?

D) ESTIMATING CURRENT AND FUTURE EXTINCTION RATES

i) Methods for estimating extinction rates are needed because (a) we don't know extinction rates for most groups of organisms, (b) we don't know if the rates for species we do know something about are representative, and (c) we want to be able to predict what will happen in the future.

ii) Island biogeography theory has been the basis for many estimates. This theory is based on two observations: species richness increases with island size and decreases with the isolation of an island.

iii) From these observations a simple equation ($S = cA^z$) allows us to predict how many species there will be on an island of a certain size. (In the equation, S is the number of species, A is the island's area, z is a constant that describes the slope of the line relating S to A when the data are plotted on a log scale, and c is another constant; z and c vary depending on the type of organisms and islands being studied.)

iv) If we assume that habitat patches are a kind of island, then it is possible to use this equation to predict how many species a given set of habitat patches will contain. And if we know something about the rate and pattern of habitat loss then we can predict how this number will change as habitat is destroyed (i.e., as the "islands" get smaller) – from this we can obtain an estimate of extinction rate by comparing the estimated number of species in a patch before it is reduced in size to the number predicted to occur after the size has been reduced.

v) Applying this approach globally, E. O. Wilson estimated that about 34 species go extinct daily. This estimate assumes: (a) so many species occur in rain forest that we can basically ignore other habitats, (b) there are about 5 million species total, (c) $z = 0.15$, (d) rainforest is lost at about 1% per year.

vi) Many other approaches have been taken to make similar estimates (see examples in text book). All make lots of assumptions. Results vary a lot – but all conclude that 10,000s of species will go extinct in the next few decades.

E) THE EXTINCTION RATE IS NOT SLOWING

i) Most estimates also suggest that the extinction rate is more likely to increase than decrease in the near future.

ii) Here are some examples of the number of threatened species (i.e., species that stand a good chance of going extinct in the near future) in certain groups of organisms:

- Fish: 3% (752 species)
- Amphibians: 33% (1856 species) [Note that just a couple of years ago the numbers I had here were 5% (146 species). Then a new, much more thoroughly researched estimate was produced (see reference above), which revised this figure up to the much larger values given here. This example demonstrates just how poor our knowledge of some groups is.]
- Reptiles: 5% (296 species)
- Birds: 12% (1183 species)
- Mammals: 25% (1130 species)
- Gymnosperms: 32% (242 species)
- Angiosperms: 2% (5390 species)
- Reef-building corals: 33% (231 species)