EEB 2208: LECTURE TOPIC 8

HABITAT LOSS AND DEGRADATION

Reading for this lecture

Primack: Chapter 9
Discussion reading (for 15th Feb): Fonseca, C.R. 2009. The silent mass extinction of insect herbivores in biodiversity hotspots. Conservation Biology 23: 1507-1515.
On-line at: http://www3.interscience.wiley.com/journal/122604670/abstract

Optional extra reading: Gardner et al. 2003. Long-term region-wide declines in Caribbean corals. Science 301: 958-960. On-line at: http://www.sciencemag.org/cgi/content/abstract/301/5635/958

1. Habitat loss is the most common threat to species persistence

A) EXAMPLE 1: TROPICAL RAINFOREST

i) Tropical rainforests harbor much biological diversity, so their destruction has an especially large impact on global diversity.
ii) Estimates suggest that half of all tropical rainforest has been lost since 1940.
iii) Currently, it is estimated that > 200,000 km^2 of forest is destroyed annually. This is an area approximately equivalent to 16 times the size of Connecticut. This estimate, however, is controversial because of the difficulty of accurately measuring forest area and the lack of consistent long-term monitoring data.
iv) Various attempts have been made to estimate what this means in terms of the numbers of species driven to extinction. Estimates vary, but some examples include: (a) 1 species every hour, (b) 5-38% of all species between 1990 and 2020, and (c) 27,000 species each year.
v) The variation in these estimates comes from several sources. For example, we don't know how many species there are on Earth (see earlier lectures). Because so many species remain to be described we cannot be certain how many are found in tropical rainforest (current estimates range from 25 – 70% of all species in this habitat). There is also uncertainty in the rate of forest loss (ranging from 0.5 – 2% each year). Finally – and trickiest of all – is the fact that we don't know the typical range sizes of most species. This last piece of information is needed to determine how often the loss of a piece of forest results in the loss of a species that is found nowhere else. To take an extreme (and unrealistic) case, if all species were found in all forests, it would be possible to destroy almost all of the habitat before any species began to go extinct. On the other hand, if all species have tiny ranges, every piece of forest destruction will result in extinctions. Estimating extinction rates requires that we know where, between these two extremes, the real situation lies.
vi) Despite all the uncertainty, there is no doubt that a lot of habitat is being destroyed and that this will ultimately result in a huge loss of biological diversity.

B) EXAMPLE 2: GRASSLANDS

i) Habitat loss is not just something that is happening far away in the tropics.
ii) In North America, over 99% of all tall-grass prairie has been destroyed in the last couple of centuries.
iii) In Indiana and Illinois (i.e., two states that historically held large areas of grassland habitat) it is estimated that only one ten-thousandth of the native grassland habitat remains.
iv) Most remaining grassland habitat is found in cemeteries, along old railroad tracks, and in a few other isolated spots where something has prevented land from being turned into farmland.
v) As grassland habitat disappears, so do all the animals that rely on grassland plants. E.g., several grassland birds have disappeared from Connecticut, and those that remain are quite likely to disappear from the state in the next few decades.

C) EXAMPLE 3: WETLANDS

i) Since 1780, > 50% of the wetlands in the United States (excluding Alaska) have been drained.
ii) In California, only about 9% of the historic wetlands remain.
iii) These losses are not just a thing of the past. It is estimated that over 700 acres (>300 ha) of wetlands are destroyed DAILY in the United States.

D) EXAMPLE 4: CORAL REEFS

i) Habitat loss is also not something that just happens in continental settings – oceanic habitats are disappearing too.
ii) Worldwide it is estimated that about 11% of coral reefs have been lost and that another 16% have been severely damaged.
iii) The magnitude of the effects on coral are shown by a recent analysis (see Gardner et al. 2003) that looked at the results of 65 studies (263 sites) conducted throughout the Caribbean. This study found that declines were widespread and found at nearly all sites. On average (means were used!) the proportion of coral cover on reefs declined from about ~50% to ~10% between 1977 and 2001. Annual losses of about 5% were typical. On a positive note, declines seem to be slowing in some areas. But, tempering that are the facts that declines have to slow as zero is approached and that most of the likely causes of declines persist.
iv) Lastly, to put the consequences of these coral reef losses into a human context, a report published in *Eos* suggests that during the 2004 Indian Ocean tsunami, there was substantially more damage caused in parts of Sri Lanka where there had been extensive reef damage than in those areas where the reef was relatively intact.

2. Why is habitat destroyed?

A) AGRICULTURE

i) Most natural habitat is destroyed so that the land can be used for agriculture, although development is also a major cause of destruction, especially in more developed countries.
ii) Currently about a third of the Earth's ice-free land surface is under some form of agriculture, and more than a tenth is some form of cropland. Although farmland habitats are greatly simplified compared to the natural habitats they replace, they can still harbor much biological diversity. For example, studies in Costa Rica have shown that as much as 50% of the species in several groups of animals (e.g., birds, butterflies) can persist in agricultural settings.

B) URBANIZATION

i) Development of land for housing, etc. takes the loss of biological diversity in an area a step further.
ii) The effects of urbanization can be expected to grow. This is not just because the human population is growing, but also because average household size (i.e., the number of people living in each house) is declining, which exacerbates an already increasing rate of resource consumption by humans.

3. Habitat can be effectively lost without being destroyed

A) PATTERN OF HABITAT LOSS

i) The total amount of habitat that is destroyed is not the only thing that influences biological diversity. The pattern of destruction across a landscape is also important.
ii) Fragmentation. Numerous studies have shown that the subdivision of a piece of habitat into lots of small patches causes more species to disappear from it than would have if a similar area of habitat were maintained as a few large tracts. Several factors contribute to this result, but two key ones are (a) the loss of "interior" species and (b) the loss of species that are unable to maintain sufficiently large populations in a small habitat patch to persist. (See material on area-sensitivity covered earlier in the course.)
iii) Isolation. Isolated habitat patches also tend to have fewer species than they would if they were closer to other patches of similar habitat. This is largely because populations in small habitat patches often require immigration from other patches in order to persist.

iv) Connectivity. Movement of organisms between patches also often requires that habitat patches be connected in some way (e.g., by strips of habitat) for certain species to persist.

v) (Many of these ideas have developed out of the island-biogeography theory first put forward by MacArthur and Wilson, which we discussed previously and will return to when we discuss reserve networks. Make sure you understand this theory and how it relates to these topics.)

B) EDGE EFFECTS

i) Rock Creek Park, Maryland provides an example of the effects of fragmentation. The bird populations in this park have been studied since the 1940s. Over this time, the number of breeding birds has declined by 30%, the number of migrant birds (things like warblers, vireos, tanagers, etc.) has declined by 90%, and several species have been extirpated. Yet the woodlot appears unchanged.

ii) Even though the wood itself has changed little, the surroundings have changed a lot. It is currently surrounded by suburbia (isolating it from similar habitat), and it is now criss-crossed with roads (further fragmenting what habitat remains).

iii) One consequence of fragmenting habitat is that a lot of "edge habitat" is created. These edges favor certain species and allow numerous habitat changes. For example, microclimates can be different along forest edges (windier, warmer, less humid, etc.) compared to the forest interior. The plant community and structure is often different (e.g., because microclimate and light environment differ). Fragmentation also can result in an increase in the numbers of predators.

iv) Songbirds are also affected by a bird species called the brown-headed cowbird. Cowbirds are **brood parasites**, which means that they lay their eggs in the nests of other birds and let the **host** species raise their young. Often the host species fails to raise any of its own young as a result of this parasitism. As forest habitats become fragmented, cowbird numbers increase. In some cases, a very high proportion of the nests close to a forest edge are parasitized, causing reduced productivity of the host species and potentially contributing to their declines.

C) FRAGMENTATION WITHOUT MUCH HABITAT DESTRUCTION

i) Fragmentation is often tied to large scale habitat loss, such that the two things go hand in hand. But, even minor amounts of habitat loss can cause fragmentation that has harmful effects on populations. For example, roads and power-line cuts can fragment forests with relatively little habitat loss.

ii) Various studies have shown that roads have a range of effects on many species. For some species they create a physical barrier to movement – e.g., they are the main cause of death for moose in Kenai NWR in Alaska (also hundreds of moose are killed in the city of Anchorage every year), for Florida panthers (which are endangered), and for barn owls in the UK. Closer to home, roads kill lots of amphibians on rainy spring nights.

iii) Roads also cause behavioral changes in some species. For example, many species (including beetles, mice, and even small birds) simply will not cross a road. In other cases, species adjust the locations of their home ranges or territories so as to avoid roads. In some birds, singing behavior is affected by proximity to roads.

iv) Other species benefit from roads – but this is not always good. Some invasive plant species have been found to spread along roads – partly because they do well in the disturbed conditions alongside the road, and probably also because they get carried along roads by vehicles. Roads also open up areas to people, improving access for hunting, and other activities that affect wild populations. And some species are attracted to roads and use them as an easy way to travel – e.g. elk herds will migrate along roads, which increases their risk of getting hit by cars.

v) Finally, roads can change the nature of the adjacent habitat creating a series of edge effects that impact a much larger area than that from which habitat was removed. Among the many effects of this type are changes in soil compaction, thermal environment (blacktop heats up more than does dirt – which is why snakes bask in the middle of the road), amount of dust and chemical pollutants, and noise. In areas with snow, simply salting the roads can have considerable effects (e.g., *Phragmites* – an invasive wetland plant that can tolerate slightly salty conditions – often spreads along roads).