EEB 2208: TOPIC 8

HABITAT LOSS AND DEGRADATION

Background for this topic

Primack: Chapter 9
Sodhi and Ehlich: Chapters 4 and 5
Burke et al. 2011: more information on coral reef losses can be found here https://www.wri.org/publication/reefs-risk-revisited

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. This, however, is less than the loss of temperate forests, but far more than the loss of boreal forests from northern areas.
iii) 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 areas and the lack of consistent long-term monitoring data.
iv) Various attempts have been made to estimate what this means in terms of the number of species driven to extinction. Estimates vary, but are all quite high. Examples include: 1 species every hour and 27,000 species each year.
v) The variation in these estimates comes from several sources. For example, we do not 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 (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).
vi) Finally – and trickiest of all – is the fact that we do not 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 went extinct. On the other hand, if all species have tiny ranges (say, the size of one tree), then 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.
vii) 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, 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. Horsebarn Hill, on campus, has several state endangered breeding grassland birds.

C) EXAMPLE 3: WETLANDS

i) Since 1780, >50% of the wetlands in the United States (excluding Alaska) have been drained.

ii) Connecticut is one of 10 states where >70% of wetlands have been lost. In California, losses have been especially severe with only about 9% of historical wetlands remaining.

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, that another 16% have been severely damaged, and that at least 75% of what remains is threatened.

iii) Multiple factors contribute to these losses, but overfishing and damage from fishing activities, coastal development, pollution from both terrestrial and marine sources have all played a role in the past. Increasingly ocean warming and acidification, associated with climate change, are becoming major threats.

2. Why is habitat destroyed?

A) AGRICULTURE

i) Most natural habitat is destroyed so that the land can be used for agriculture. Development is also an important cause of destruction, but often land that is being developed has already undergone an initial transformation to agricultural land.

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.

iii) But, it is worth noting that the ecological footprint of city-dwellers is lower than that of people elsewhere – i.e., those who live in cities on

average use less resources and have a smaller impact than those who live in the countryside.

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 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) 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).

ii) Fragmentation also can change the species composition in ways that can have adverse effects – e.g., by increasing the numbers of predators, competitors, etc.

iii) A specific example involves 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 because they commonly use forest edges, but do not go deep into the forest interior. Several studies have found that a high proportion of all the bird nests close to the forest edge were 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 small 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, 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).