EEB 2208: LECTURE TOPIC 9

OVER-EXPLOITATION

Reading for this lecture
Primack: Chapter 10. Also if you haven't already read it, then you should also read the section on pollution in chapter 9.

Optional readings (papers that I will talk about it class):
Owens, I.P.F. and P.M. Bennett. (2000) Ecological basis of extinction risk in birds: Habitat loss versus human persecution and introduced predators. Proc. Nat. Acad. Sci. 97:12144-12148. On-line at: http://www.pnas.org/content/97/22/12144.abstract
Roman, J. and S. R. Palumbi. 2003. Whales before whaling in the North Atlantic. Science 301:508-510. On-line at: http://www.sciencemag.org/cgi/content/full/301/5632/508

1. Which species get exploited?
A) LIFE-HISTORY CHARACTERISTICS
   i)   Although harvest does not affect as many species as does habitat loss, there is a disproportionate effect on certain types of species.
   ii)   <u>Large body size</u>. Big species tend to be targeted as food (animals) or for building materials (plants). For example, most game species are birds, mammals or fish.
   iii)   <u>Low reproductive rates</u>. Species that produce relatively few young each year are not necessarily more likely to be exploited – but they are the species that are likely to be negatively affected by the exploitation. This is because species with high reproductive rates ("r-selected" species, to use the ecological jargon) are more likely to be able to balance the increased mortality associated with exploitation with higher reproduction.
   iv)   <u>High survival rates</u>. Similarly, species with high survival rates are more vulnerable to over-exploitation (though not necessarily to being hunted or otherwise used by people). These species typically live for a long time, but reproduce relatively slowly. Exploitation that reduces survival rates, means that it is difficult for these species to produce enough young before they die to ensure that the population does not decline.
   v)   There are exceptions to all these generalities. But, there are good reasons why most whales are threatened with extinction, while most zooplankton are not.

B) TAXONOMICALLY DIVERSE SPECIES ARE OVER-EXPLOITED
   i)   Although there are some typical characteristics of species that are over-exploited, there is a very wide range of species that suffer from being hunted.
   ii)   Also, "hunting" covers a wide range of different activities in this context, not just standard hunting and fishing. Activities such as (a) forestry, which often targets particular kinds of trees (e.g., tropical hardwoods, such as mahogany); (b) harvest of wild mushrooms (e.g., edible mushrooms, such as chanterelles, in the Pacific northwest); (c) trade in rare plants (e.g., many orchids); and (d) the exotic pet trade (where the losses are not just those individuals that become pets, but also many others that die in the process of collecting them from the wild).

2. Cultural use of species
A) TRADITIONS
   i)   Many cultures involve the hunting of animals, or the traditional use of certain plants. In many cases (though not all – see below), these uses involve relatively small numbers of individuals and are probably not a threat to the species involved.
   ii)   But, in cases where a species has declined for other reasons, the additional mortality imposed by these activities may be enough to push a threatened species even closer to extinction.

B) EXAMPLES
   i)   The use of whales by Inuit (and other) peoples probably had little impact on whale populations throughout much of history. But once whale populations were reduced by commercial hunting, populations of some species (e.g., bowhead whales) fell so much that the mortality for traditional purposes could be important.
   ii)   Similarly, the use of feathers from birds of paradise in the headdresses and clothes of Papua New Guineans has been going on for centuries with no clear adverse effects. But now, many of these species are extremely rare. Much of their rarity is probably due to rainforest destruction, but hunting probably now has an additive effect.
   iii)   In other cases, however, historic cultural uses can themselves be a problem. For instance, the mamo is a Hawaiian bird that has gone extinct. Native Polynesians used feathers from this bird to make amazing pieces of ceremonial clothing. For one of the most spectacular capes, it has been estimated that the feathers from 80,000 birds were needed! It is hard to imagine that this was not a contributing factor to the species decline.

C) INCREASED HUNTING EFFICIENCY
   i)   One key reason why even traditional (as well as all other) uses of wild organisms may be becoming a greater problem, is that the massive technological advances (guns, bulldozers, fishing gear, etc., etc.) of the last 2-3 centuries have made it much easier for entire populations to be decimated. Many more individuals escape when they are hunted with a blow-pipe, or a bow and arrow, than when using a high-powered rifle.

3. Subsistence hunting
A) PEOPLE NEED TO EAT PROTEIN
   i)   In many areas, hunting provides the primary source of protein for the human population.
   ii)   Many hunt for their own consumption, but some also hunt for market (more on this below).
   iii)   In parts of Africa "bush meat" is a third of the cost of other forms of protein (e.g., frozen chicken).

B) EXAMPLE
   i)   80% of the world's gorillas and common chimpanzees live in western equatorial Africa.
   ii)   A recent study conservatively estimated that these ape populations have declined by more than half in the last 20 years.
   iii)   Logging is part of the problem, but large areas of intact forest remain, yet have no apes – this suggests that hunting is the primary cause.
   iv)   Currently the spread of Ebola fever is compounding the effects of hunting and habitat loss. As in most cases, multiple factors are simultaneously contributing to the decline of these species.

4. Commercial harvest
Many species are harvested for a wide variety of commercial reasons. Here are a few examples.

A) TRADITIONAL MEDICAL USE
   i)   Often the species most threatened are large mammals, many of which are already vulnerable to extinction because of other reasons.
   ii)   Even when legislation exists, preventing the use of these species is difficult because there are often huge payoffs to poachers. For example, a single rhino horn can sell for US$80,000.

B) PET TRADE
   i)   Much of the trade in rare species is for collectors and the pet trade. Legislation (e.g., CITES) has helped somewhat, but much illegal trade continues. We'll talk more about CITES later in the course.
   ii)   As an example of the extent of the trade, over a quarter of the world's parrot species currently are considered threatened with extinction. Although habitat destruction is part of the problem, trade in wild parrots is equally important for many of these species.

C) BUSH MEAT
   i)   Although bush meat has historically been taken for subsistence, such hunting is increasingly
          done for profit. For many people it is cheaper than alternative sources of meat – ensuring that
          there is a demand for it.
   ii)   The foreign demand for "exotic meat" also is huge and is increasing. For example, it has been
          estimated that 10 tons of African bush meat reaches London every day. In Africa, 2.2 billion
          pounds of bush meat are bought annually.
   iii)   The bush meat harvest tends to be relatively unselective (except that large species are
          typically targeted), and a wide variety of species are taken (including primates, deer,
          carnivores, rodents, birds, etc.).

D) WHALING
   i)   Even before modern fishing techniques, the whaling industry managed to completely
          decimate many whale populations. Recent studies (which are controversial) suggest that the
          magnitude of whale declines may be even greater than previously thought.
   ii)   Current population sizes are estimated through some combination of directly counting the
          number of individuals and identifying known animals from unique marks on their bodies.
          Previously, historical estimates have been taken from old whaling records (which were not
          kept for the purpose of estimating population size).
   iii)   In one study (see reading, above), genetic techniques were used to estimate the pre-whaling
          population size. This study measured the amount of genetic variation in various populations
          of whales in the North Atlantic. Because the amount of genetic variation in a population
          tends to be greater for big populations, researchers were able to use the amount of variation in
          current populations to estimate the size of populations prior to whaling. A lot of variation in
          current populations would imply a big population prior to whaling; little variation would
          imply a small population. Based on the genetic data, it appears that the historic populations
          may have been ten times greater than previously thought (see table below).

	Current population	Historical estimate	Genetic estimates
Humpback	10,000	20,000	240,000 (156,000-401,000)
Fin	56,000	30,000-50,000	360,000 (249,000-481,000)
Minke	149,000	?	265,000 (176,000-415,000)

E. OCEAN FISHERIES
   i)   The largest scale harvest of wild animals currently involves fish populations, many of which
          have been over-harvested and which have undergone huge declines. Currently, about 70% of
          the world's most valuable fisheries are over-harvested. In some cases, 80-90% of the
          individuals in the population are taken each year.
   ii)   For example, in the North Atlantic, shark populations have declined dramatically since the
          expansion of the fishery in the 1980s. Hammerhead sharks have declined by ~87%, and most
          other large species have declined by >50%.
   iii)   As with bush meat, reducing the extent of over-fishing is difficult because a lot of the world's
          human population relies on fisheries as their main source of protein.
   iv)   Fishing also has had huge impacts on non-target species, both through habitat destruction
          (e.g., trawling the sea-bed) and through **by-catch** of species that are not targeted by the
          fishery.

v) By-catch is estimated to involve 12-20 billion (not a typo) pounds of marine life each year. This is up to a third of the total catch – all killed and thrown back overboard. In some fisheries most of the animals caught (and killed) are by-catch and are thrown back into the ocean.

vi) Although there have been some attempts to reduce by-catch by shifting to different fishing methods, problems exist with most fishing techniques. E.g., a switch from drift nets to long-lining (in which lines can extend for 100 miles and have 1000s of baited hooks) has shifted the by-catch to seabirds (300,000 seabirds are killed by long-line fishing each year; 1/3 of these birds are albatrosses).

D) RECREATION

i) In general, sport hunting probably does not threaten many species, especially in cases where it is well regulated. For example, mourning doves are by far the most hunted species in the US, with over 25 million killed each year (again, not a typo). This is more than all other game birds put together. Yet populations are stable. (Why do you think this species can withstand large scale hunting, while the closely related passenger pigeon could not?)

ii) Trophy hunting, however, might be an exception. Even though trophy hunting probably results in fewer individuals being killed than other kinds of hunting, it is likely that these individuals will be the biggest in a population – and in many cases these larger (and often older) individuals will play an important role in population persistence.

iii) Rare species also often attract the attention of trophy hunters, and are disproportionately targeted because of their rarity: e.g., egg collecting is a major problem for rare bird conservation in Britain.

iv) Other forms of recreation also result in over-exploitation of species. For example, the exotic pet trade results in the removal of many individuals from wild populations. In addition to the individuals that become pets, many others die in transit to pet stores. Many different types of species are affected by the pet trade.