EEB 2208 LECTURE TOPIC 17

CONSERVATION RESERVES

Reading for this lecture
Primack: Chapter 15

Additional optional reading: Rodrigues et al. 2004. Effectiveness of the global protected area network in representing species diversity. *Nature* 428: 640-643.

1. What land is currently protected?
A) GLOBALLY
- i) 18.8 million km^2 (11.5% of the Earth's land surface), >102,000 sites (click here for more details).
- ii) About 4% of Earth's land surface is strictly protected.
- iii) Much less protection in marine systems. Only about 1% currently. Although there are about 1300 marine reserves, covering about 800,000 km^2, about half of the total area is in only three very big reserves.

B) IN THE UNITED STATES
- i) National Parks, National Wildlife Refuges and National Forests occupy >1,650,000 km^2. Much of this land is not completely protected (e.g., you can hunt on many NWRs) and is not just used for nature conservation (e.g., most National Parks cater largely to tourism; logging occurs on National Forest lands).
- ii) Marine sanctuaries occupy ~46,500 km^2 – you don't need to memorize this number! – the important thing is that you know that it is tiny (~3%) compared to the area that is protected on land.

C) NOT ALL PROTECTED LAND HAS HIGH CONSERVATION VALUE
- i) Many parks are created to protect land that has scenic beauty, e.g., National Parks tend to be found in dramatic mountainous areas.
- ii) Stunning rock and ice often predominates – 7% of protected lands globally are in Greenland (which is not well known as a biodiversity hot spot ….. though I'm sure it is still very nice there).
- iii) The distribution of parks does not overlap very well with areas of high species diversity or endemism.
- iv) For example, almost all (95%) of the alpine and subalpine habitat in California is protected. But, very little (10%) of the chaparral, coastal scrub, or grassland, habitats that harbor many of the state's most rare and threatened species is protected.

D) WHAT IS NOT PROTECTED?
- i) A 2004 study by Conservation International (see Rodrigues et al. 2004, above) attempted to determine which of the world's rarest terrestrial vertebrates are completely unprotected (i.e., not found in any protected areas). This study concluded that if you look at globally vulnerable species, there were 233 birds (about a fifth of all the vulnerable species), 140 mammals, and 346 amphibians that had no protection at all. Combining taxonomic groups, there were at least another 943 species with little protection.
- ii) Another study (cited in your textbook), suggested that about 20% of marine habitat needs to be protected to adequately manage commercial fish stocks. (Compare this to the area currently protected – see above).

2. How is land selected for protection?

A) BIOLOGICAL CRITERIA

i) Areas with high species richness.
ii) Areas with lots of endemic species. For example, BirdLife International has its Endemic Bird Area program, which identifies sites with high numbers of species that have small ranges.
iii) **Focal species** are sometimes used to identify priority areas. These can be **"indicator" species** – those that in some way indicate the presence of an area that is considered to be a high conservation priority. For example, northern spotted owls in the Pacific Northwest are often viewed as an indicator of high priority sites because they tend to be found in old growth forest. Note, that many things get called indicator species, without anyone ever attempting to figure out what it is that they indicate!
iv) **Flagship species** are those that give conservation efforts a higher profile and thus attract attention to an area. Often it is easier to get public and political support for protecting an area if there are high-profile, flashy species involved.
v) Ecosystem criteria are also sometimes used to prioritize areas. Rare ecosystems might be favored. In other cases, attempts might be made to ensure that all ecosystem types are represented within a reserve system (i.e., ensuring that the system is **representative** of what biodiversity is present in the area; more on this next time).

B) EXISTING PROTECTION

i) The suite of sites already protected in an area influences how new sites are selected.
ii) Habitats or species that are already well protected may receive less attention than those that are not so well protected. E.g., globally, temperate rainforests are much better protected than grasslands, so grassland conservation should perhaps be a higher priority than temperate rainforest protection.
iii) New sites are often selected to complement the existing set of sites in other ways – e.g., priority may be given to land that is adjacent to an existing reserve to help make it bigger.
iv) GAP analysis is a formal way of deciding how to select new sites to add to an existing reserve system. The basic components are:
   - Identify what is in an area.
   - Determine the conservation goals (i.e., what needs to be protected).
   - Determine what is already protected.
   - Determine which sites do the best job of filling in any "gaps" in protection.
   - Target these areas.
   - Go back and repeat the process iteratively until all goals are met.

C) ECONOMICS

i) Many things that have nothing to do with biology or conservation goals also influence how sites get prioritized. Many of these things relate to economics.
ii) Land must be affordable for it to be bought and protected. This is why it is relatively easy to protect remote lands in the Arctic, desert, or mountains. Protecting equivalent areas of coastal wetlands or lowland forests is generally much more expensive.
iii) One of the main things that affects cost is the competing demands for the land. Coastal, lowland areas tend to be where people live, hence land in these areas is more expensive than in more remote regions. Equally, if some consumable product (e.g., oil, wood) can be produced from a piece of land then it will be harder to set it aside for conservation.
iv) Yet another criterion is that an area might be selected because it protects an ecosystem that provides valuable services (e.g., a wetland that helps with flood control). Increasingly, the value of these services is being quantified in a way that helps influence the economic decisions that often affect reserve selection.

D) AVAILABILITY

i) For land to be bought and turned into a reserve, someone has to be willing to sell it. Especially in areas where a lot of land is in private ownership, this can be a major impediment to achieving an idealized reserve system.

E) ACCESSIBILITY

i) Another important feature is that reserve lands often need to be accessible to people. Many protected areas serve multiple functions (other than nature conservation), and most (especially big reserves) are owned and administered by governments. Consequently, there is often a need to make them accessible to the tax-payers who pay the bills and consequently feel they have a right to visit the sites.

ii) This can sometimes make it easier to argue for protecting a piece of land where a lot of people are able to visit it. In contrast, a key argument against protecting places like the Arctic National Wildlife Refuge (ANWR) is that it is somewhere that hardly any Americans have been to, nor are many ever likely to go there.

3. How much land do we need to protect?

A) MINIMUM PROTECTED AREA

i) Building on the idea of an MVP, it is possible to estimate the amount of land that needs to be protected for a viable population of a species to persist.

ii) To figure this out, one needs to know the MVP, the amount of land each individual or pair needs (i.e., it's home range size), and the amount of overlap in home ranges (i.e., how territorial it is).

iii) It is also important to know whether individuals need to use more than one site/habitat within their lifetimes. This can be especially important for migratory species.

B) PROTECTED LAND DOES NOT ALL NEED TO BE IN ONE PLACE

i) For many species it is not essential that the protected area is all in one contiguous block. This is because some populations can persist as subdivided populations. This situation is referred to as a **metapopulation** – a group of partly isolated populations connected to each other by dispersal.

ii) In a metapopulation the connections among segments are essential – if no movement exists, the metapopulation will cease to exist and there will just be a set of separate populations.

iii) Example: Bay checkerspot butterfly. This butterfly is an endangered subspecies only found in the San Francisco Bay area. It is a habitat specialist, relying on certain plants that are only found on specific soils (serpentine). The habitat for this species is naturally fragmented, but this fragmentation has been exacerbated by human development.

C) SOURCES AND SINKS

i) Another important concept that relates to metapopulations is the idea that there are **source populations** and **sink populations**.

ii) A source population is one in which reproduction exceeds mortality – meaning that the population produces more individuals than are needed to maintain a stable population size.

iii) A sink population is one where there are not enough births to match the number of deaths. These populations will decline, <u>unless</u> there is immigration to make up the shortfall.

iv) In a metapopulation, this immigration can come from source populations. Hence, it is possible for a population in a habitat patch (or reserve) to appear to be stable, but in fact to be a sink. In this case, the population is only maintained because there is a constant inflow of "excess" individuals from elsewhere. If this flow is cut off, then the population would decline. Consequently, what happens in one part of a metapopulation can affect what happens elsewhere and the loss of one piece of habitat can result in a population decline in another piece where conditions have not changed.

v) This might lead you to conclude that sink populations should not be protected (or at least should be a low priority) – and a lot of effort is placed on identifying sources, and prioritizing protection of these sites. But, the situation is not this simple. First, identifying sinks can be extremely difficult (for reasons I don't have time to go into in great detail in class … if you are interested, I'd be happy to talk about this after class though).

vi) Moreover, there are several cases when sink habitat might be important. For example:
- If the site is a "**pseudo-sink**." This is a site that can switch from having a net loss of individuals to having a net gain. For instance, if the population density is high, breeding and survival rates may be suppressed, e.g., because individuals have to compete a lot with each other. If the population were to decline a bit, however, the amount of competition caused by the high densities might decline, causing the birth and/or survival rates to increase. (This phenomenon is known as "**density-dependence**" because the birth and death rates <u>depend</u> on what the <u>density</u> is.)
- Whether a site is a source or a sink might change over time – in some years it could be a source, in others it could be a sink, e.g., depending on the weather.
- Protecting some sites that are sinks might be valuable if there are only a limited number of potential sites where a species exists. By doing this, the range size is maximized and genetic variation within the entire population could be maximized. Also, it may become possible to turn a sink population into a source population through management.