

EEB 2208: LECTURE TOPIC 3

FORMS OF BIODIVERSITY

Reading for this lecture

Primack: Chapter 2

Discussion reading (for Monday 30th Jan): Hahs, A., et al. 2009. A global synthesis of plant extinction rates in urban areas. *Ecology Letters* 12: 1165-1173.

On-line at: <http://www3.interscience.wiley.com/journal/122581716/abstract>

1. Definitions

Biodiversity is not a simple term to define. Before you read any further in these notes, spend a few minutes thinking about what you think biodiversity is. Then, when you get to the end, see how your definition compares to those given.

A) SOME FORMAL DEFINITIONS

- i) According to the World Wildlife Fund (1989) biodiversity is: “the millions of plants, animals, and microorganisms, the genes they contain, and the intricate ecosystems they help build into the living environment”. Does this definition miss anything important?
- ii) According to the UN (1992, in the Convention on Biological Diversity), biodiversity is: “the variability among living organisms from all sources including ... terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems”. How does this one seem?
- iii) The UN definition is probably as “official” a definition as you will find, but if you spend a bit of time looking you should be able to find many alternative versions, all with subtly different meanings.

2. What are the components of biodiversity?

A) SPECIES DIVERSITY

- i) The units that we tend to focus on are species, perhaps because they are most tangible and the easiest to study.
- ii) There are morphological, behavioral, life-history, physiological, and taxonomic, aspects to diversity at this level.
- iii) Species diversity also can be considered to include variation in the numbers of species (= **species richness**), the relative abundance of species (= **evenness**), and variation in the distribution of species in space (= **turnover**, or **beta-diversity**).
- iv) When assessing the species diversity of a particular place, or group of organisms, issues also arise as to the relative “value” of different species. Some are (often only implicitly) regarded as more valuable than others; e.g., people tend to pay more attention to species that are large, warm, fuzzy, and colorful than to species that are not. Species that have some human use often also get valued more highly.
- v) These things do not necessarily affect an assessment of biodiversity in a direct way, but they have indirect effects – for example, many attempts to describe patterns of biodiversity are based on information about a few particular groups (birds, mammals, butterflies, tiger beetles). These are not necessarily representative of all organisms.
- vi) In some cases, people have argued that there is a good case for valuing some species as more important than others for biological reasons. For example, some argue that species that are evolutionarily very distinct should be given more weight. According to this idea, tuataras (a type of reptile only very distantly related to other extant species) would be considered more important than most other vertebrates.
- vii) Species that play a disproportionate role in influencing the nature of an ecological community or ecosystem also are sometimes viewed as especially valuable. Examples, include “**keystone species**” (e.g., sea otters), or “**ecosystem engineers**” (e.g., beavers).

B) GENETIC DIVERSITY

- i) Another important component of biological diversity is the genetic variation that exists both within and among species. This genetic variation is the basis for evolutionary change, and without it future change will not occur. In some cases, genetic variation can also play a role in determining whether a population will persist or go extinct (more on this in a later lecture).
- ii) Genetic variation exists in a number of forms, and can be measured in several ways. E.g., the number of **polymorphic** genes (i.e., genes with multiple alleles), the number of **alleles** each gene has, the number of **heterozygous** individuals in a population.
- iii) Genetic diversity is not just of intrinsic value, but also can be important for humans too. For example, genetic variation is the basis for crop breeding. In some cases the introduction of genetic variation from ancestral (wild) stocks has improved the productivity of existing crops. The development of genetically modified organisms also depends on the presence of genetic diversity.

C) POPULATION STRUCTURE

- i) Within-species diversity can also involve variation in population structure – i.e., the presence of subpopulations within a species that differ from one another. These subpopulations may have subtle genetic differences, they may have behavioral or morphological differences, or they may act in an ecologically different manner (e.g., due to the different combinations of species that they interact with).
- ii) Maintaining species throughout their ranges, therefore, can be considered important to biodiversity protection.

D) COMMUNITIES

- i) Biological communities, or assemblages of species, form another type of diversity.
- ii) Different communities include different combinations of species and consequently different sets of species interactions.
- iii) Community diversity is also often what influences the way we see the world – the “habitats” we recognize are different collections of organisms. So, maintaining a variety of habitats involves thinking about diversity at the community level.

E) “BIOLOGICAL PHENOMENA”

- i) There are a multitude of phenomena that do not easily fit into one of the categories above, but which nonetheless represent components of the natural world’s biological diversity.
- ii) These include things like the migration of the monarch butterfly, the movements of wildebeests across the Serengeti, or the fall colors of New England. Often these are considered to be a component of biodiversity.

F) IMPORTANCE OF ABIOTIC FACTORS

- i) Finally, there is a diversity of ways in which organisms interact with the non-biological (= **abiotic**) features of their environment.
- ii) Abiotic features (e.g., landforms) and processes (e.g., water and nutrient cycling) are not a part of biodiversity *per se*.
- iii) Nonetheless, they play a critical role in determining how ecosystems function, where species occur, and in influencing the level of diversity in different places. Consequently, a complete understanding of biodiversity has to consider abiotic conditions.

3. Is the term useful?

- i) Some have argued that the term “biological diversity” can be broadened to include pretty much anything. Alternatively, it can simply be seen as another way of talking about “nature” or “Mother Earth.”
- ii) This raises the question of whether a phrase that can mean almost anything (and which is also very difficult to define) is really all that useful.
- iii) Nonetheless, most people seem to have an intuitive sense of what they mean when they use the term biodiversity – and (at least a lot of the time) this sense seems fairly consistent among people. So, what do you think – how useful is the concept?