Chapter 1: What Is Biodiversity?

Biodiversity, a contraction of "biological diversity," may be defined as the variety of living organisms and their processes. For use in this document, biodiversity refers only to native organisms. Because of the rather technical nature of this chapter, the more casual reader is urged to study Figure 1.1 and continue reading at the summary on page 6.

Biodiversity can be viewed at three levels: community diversity, species diversity and genetic diversity (Fig. 1.1). Each of these levels is composed of three components: compositional diversity, structural diversity and functional diversity. **Compositional diversity** is the number of representatives present within the level being discussed. The number of species is a measure of the compositional component of species diversity. **Structural diversity** is variation in the way parts are organized. Patterns formed by plant species are the most easily recognized form of structural diversity. For example, tree species of varying heights, due to age or species characteristics, form multiple layers of canopies in moist forests of eastern Oklahoma. Structural diversity also occurs in animal species, such as population structure (sex ratios or numbers of individuals of different ages). **Functional diversity** is the variation in processes carried out in the different levels of biodiversity. Cycling of nutrients is one process performed by communities. The number of steps within this cycle and their efficiency varies among communities depending on the species present.

Biodiversity is dynamic, fluctuating continuously through the process of succession, disturbance, environmental change or stress and other factors. For example, an eastern Oklahoma grassland may, through

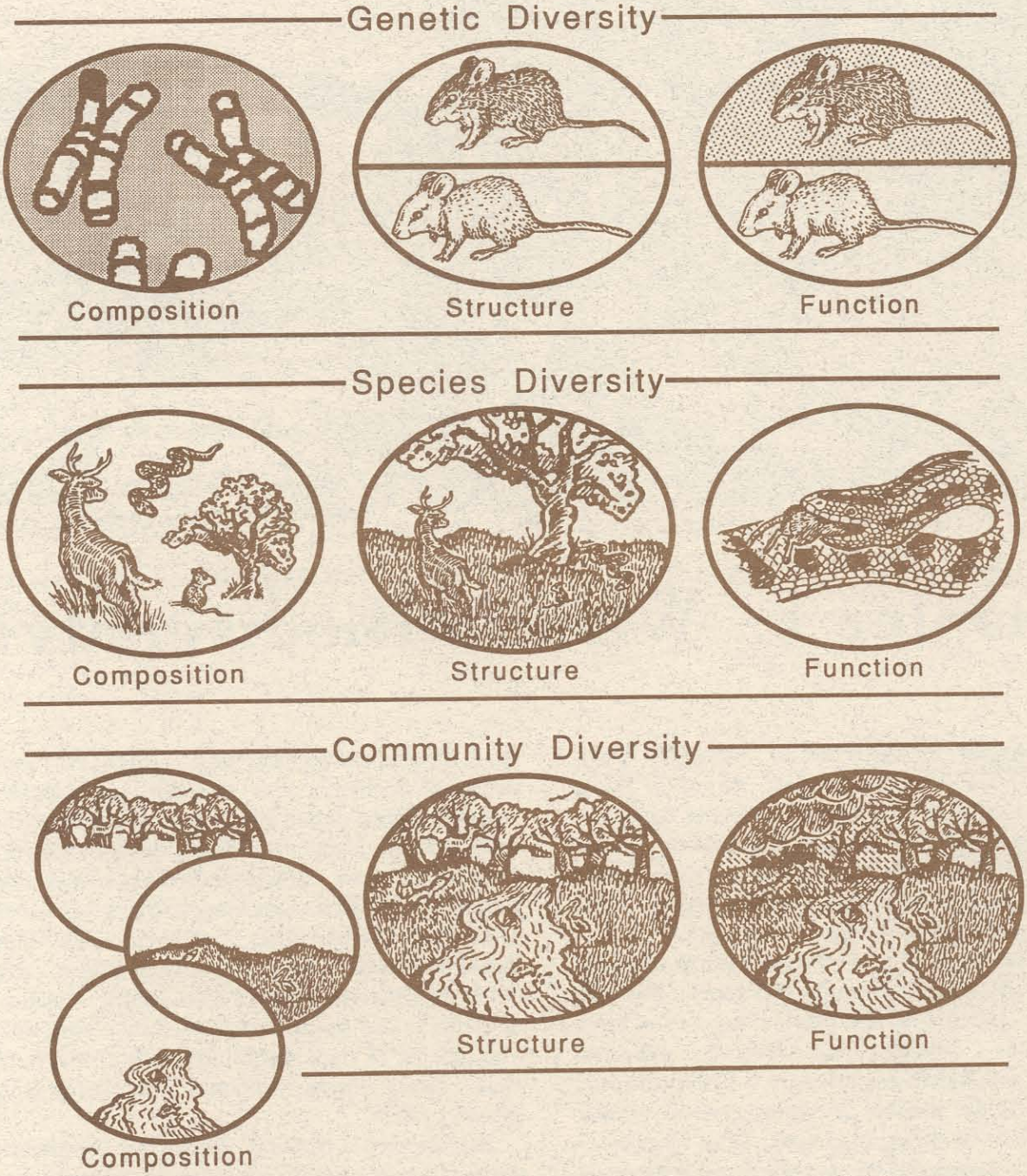

Figure 1.1: *Biodiversity is divided into three levels: genetic, species and community diversity. Each of these levels is further divided into three components: composition, structure and function. Composition is the components or pieces present, structure is the way components are organized, and function is the processes performed at that level.*

succession, become a shrub and eventually a forest community. At any time, the grassland may be restored through clearing or burning. Therefore, measures of biodiversity are only descriptions of an area at a particular time. The dynamic nature of biodiversity must be considered whenever discussing the biodiversity of an area.

Genetic Diversity

Genetic diversity is the variation in genetic makeup of individuals or populations within a species. Genetic diversity often is most visible in variation of growth rates, size and coloration of individuals within a species. It also is important for resistance to disease, adaptations to local conditions and many other subtle differences among individuals or populations. **Genetic poverty**, often resulting from extensive inbreeding or isolation, can result in deformities, reduced reproduction, decreased resistance to disease and inability to adjust to changes in the local environment. Therefore, genetic diversity is essential for maintaining species diversity.

Genetic diversity is reflected by two color phases of Ord's kangaroo rat that survive in Oklahoma.

Genetic diversity is especially important for species to survive in the local environment. For example, Ord's kangaroo rats inhabit the western half of Oklahoma. Individuals living in extreme western Oklahoma are reddish in color while those in the southeastern part of their range are gray, corresponding to soil coloration in their respective area. The correlation between soil and coat color serve to camouflage them while they are exposed above ground. Western kangaroo rats swept east during floods are easier prey for predators because of the contrast between their coat color and that of the soil. Genetic diversity in the species allows kangaroo rats to thrive over a wider area than would be possible without variation in the genes controlling coat coloration.

Species Diversity

Species diversity is the variety of species, including their abundance, distribution and functions or interactions. This is the level most commonly associated with biodiversity. **Species richness**, the number of species present, is most often used to describe the diversity of an area or the rate at which biodiversity is changing.

Although species richness often is used to measure species diversity, biologists have expressed concern that species richness alone is not a good index of species diversity. Several measures of species diversity attempt to combine relative abundance of each species with the number of species in an area. An area having 10 species with one or two dominating is not as diverse as another area with the same 10 species being equally common.

Species diversity of an area is heavily dependent upon the amount of community diversity present. A variety of communities will have high species diversity because of the different species associated with each community.

Diversity is sometimes evaluated at taxonomic levels other than species, such as families or orders. For example, an area supporting gray foxes and freshwater mussels is more diverse at every taxonomic level except kingdom (both are animals) than an area with Carolina chickadees and tufted titmice. The first example contains species from two different phyla (one is a vertebrate and the other is a mollusc), inhabit very different habitats (terrestrial versus aquatic) and perform very different functions in the food web

(omnivore versus filter feeder). The birds in the second example are members of the same genus, use similar habitats and are very similar in their functions. Some organisms cannot be identified at a species level; therefore, they can only be evaluated at higher levels, such as genus. Some species exhibit notable geographic variation and can be evaluated at a scale finer than species.

Community Diversity

A **community** is an assemblage of species that regularly occur together in response to various biological (biotic) and physical (abiotic) factors. A community differs from habitat in that **habitat** refers to a set of resources used by a single species and may encompass several communities. Community diversity is the variation in types, structures and processes of communities in an area.

Ecosystem diversity often is discussed as a higher level of biodiversity. The primary distinction between ecosystems and communities is the inclusion of abiotic factors and processes—such as soil development and nutrient and water cycling—in the definition of ecosystems. However, because it is impossible in practice to separate these concepts, this document incorporates ecosystem diversity into the definition of community diversity.

Because communities are aggregations of species and many species require specific ranges of abiotic conditions for survival, community diversity is largely dependent upon abiotic conditions. These include fire, soil, water, climate, topography and geology. For example, forest types in Oklahoma correlate with the amount of moisture available. Tall forests composed of many tree species occur in eastern Oklahoma where rainfall is most abundant. Central Oklahoma is dominated by post oak and blackjack oak able to survive drier climates. Farther west, forests usually are restricted to areas along streams or rivers. Because physical structure differs among tree species, the communities associated with these forests also differ. Therefore, variation in abiotic conditions is important for increased community diversity.

Community diversity also is influenced by interactions among species (e.g., grazing, predation and competition) and processes (e.g., breakdown of leaf litter) of species forming the community. Some species can change local conditions, making the area unsuitable for their progeny and more suitable for another set of species. For example, cedar trees invading an abandoned field eventually will shade the ground to such an extent that young cedars cannot grow. However, shading makes the area suitable for shade-tolerant hardwood trees to sprout and eventually dominate. This is part of a process called **succession**.

Competition among species, movement of species among communities, and predation also alter communities by creating new conditions. One example of the direct impact from animals feeding on plants is how bison intensively graze some areas while ignoring others, altering plant composition within the grazed areas. Their wallowing also creates a new community by compacting the soil so the wallow retains moisture. Sedges, rushes and other plants that require moist conditions dominate bison wallows and provide ideal breeding sites for the plains spadefoot toad. Often, but not always, biotic processes that alter community diversity do so by changing some aspect of the abiotic environment.

Bison wallows are ideal habitats for plains spadefoot toads.

The spatial configuration, or structural component, of communities across the landscape influences community diversity. Size, shape and location relative to

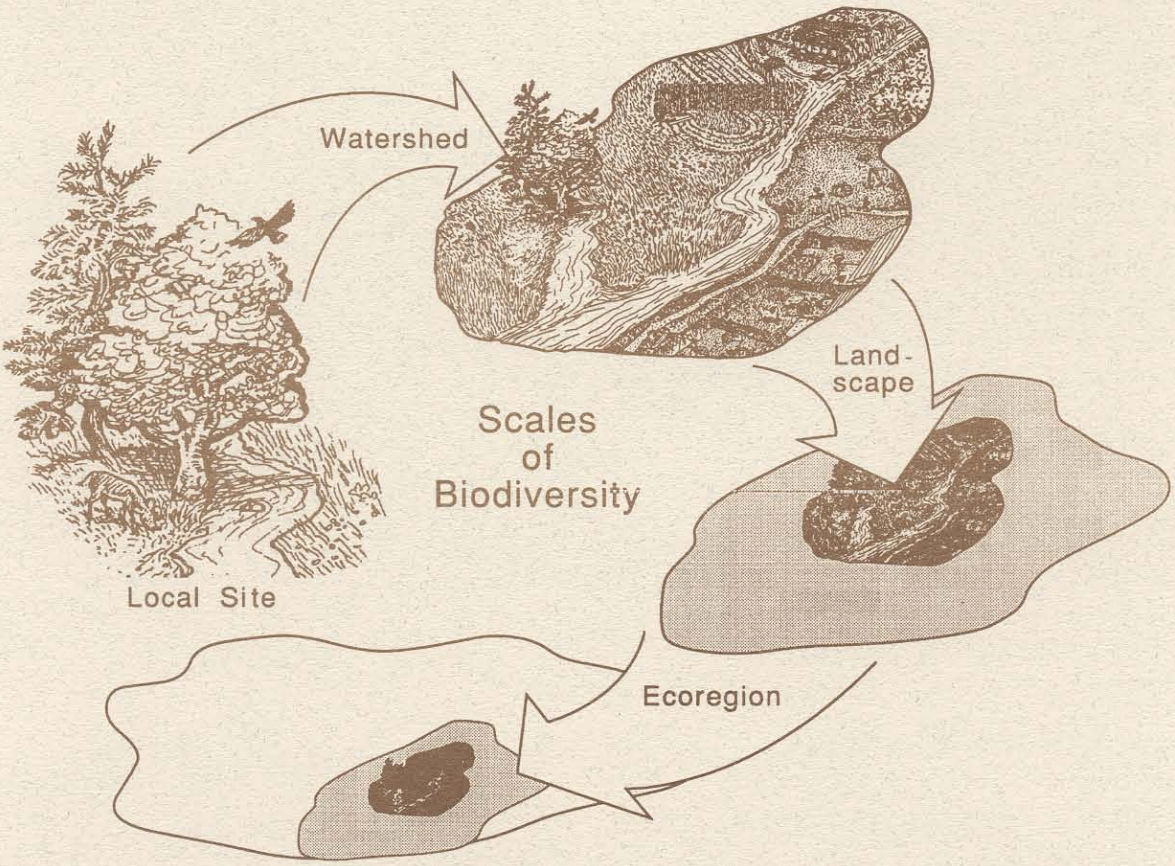

Figure 1.2: *Biodiversity may be measured at several scales, ranging from a small local site to an ecoregion often encompassing multiple landscapes and watersheds.*

other community types can increase or decrease biodiversity. Corridors allowing species to move among similar community types (such as woodlots) may allow populations in small tracts to interbreed, survive or recolonize.

Areas where one community grades into another are called **ecotones**. Rather than being separate communities, these are mixtures of two or more communities. **Edges** along interfaces between community types often support species from both communities, resulting in elevated species diversity in the immediate vicinity, with more pronounced contrasts between communities producing greater **edge effects**. Although these ecotones or edges appear much more diverse than individual communities, some species are unable to thrive in these areas and require large tracts of a particular community in order for their populations to persist. Neotropical migrants that nest in large forests, such as various species of wood-warblers and vireos, are examples of species that decline with the creation of edge or fragmentation of the community. Some of the reasons these species will not live in small communities include the increased attention edges receive from predators and brown-headed cowbirds that parasitize bird nests near these edges.

The Tallgrass Prairie Preserve in Osage County has a high community diversity because it contains many communities that differ from one another in composition, structure and function. A tallgrass prairie community occupies the largest portion of the preserve. Fire is essential to maintain high diversity of prairie plants and to keep woody vegetation from encroaching into the area. However, bottomland forests occur along stream edges because of the high water table and

reduced occurrence of fire. Crosstimber communities dominate other areas that burn less frequently. Streams flowing through the preserve support a prairie stream community, with small wetlands occurring along the banks. Each community is composed of a different set of species, has a different structural arrangement and performs different functions. Each community is important for maintaining the overall biodiversity of the preserve.

Communities are not determined by size. For example, a riffle community in a small stream may cover only a few square yards while a high plains short-grass prairie community may cover several square miles. Community diversity also is often evaluated or appreciated on the ecosystem, watershed, landscape or ecoregion levels (Fig. 1.2). Although these levels do not necessarily define a spatial context, they are useful tools for dividing an area of interest for management or description.

Unique Elements

At each level of biodiversity, elements unique to a location or occurring in low densities are of special concern because of their vulnerability to being lost. A community occurring in only a few locations could easily be lost through disturbance or catastrophe. Likewise, a species that is widely distributed but rare, such as the barn owl, could easily be lost locally with only a slight decline in population because it naturally occurs in low numbers. An element may be considered unique because of a limited distribution or because it occurs in low densities.

Caves in northeastern Oklahoma are very important to the state's biodiversity although they do not cover a large area and support only a few species. Due to the lack of light, organisms living in the inner portions of caves largely depend upon bats to bring nutrients into the cave. Bats supply energy and nutrients by feeding outside and depositing droppings while roosting in the cave. These droppings, called guano, contain nutrients and undigested matter which take the place of plants in the cave's food web. Isopods and other small invertebrates feed on bat guano and dead bats. Spiders and grotto salamanders feed on invertebrates on the cave floor and walls while Ozark cavefish, a federally threatened species, feed on those that fall into or live in the subterranean streams. Cave crayfish scavenge the remains of dead organisms. In addition, these caves are used by three endangered bat species, including most of the known population of the Ozark big-eared bat. Due to their limited distribution and uniqueness, these species and communities greatly enhance the area's biodiversity.

Summary

Biodiversity is the variation of living organisms and occurs at three levels: genetic, species and community. It includes not only the number of types at each level but also their functions and structure.

Diversity existing at each level is not independent from other levels; rather, they are intertwined. Species diversity is dependent upon genetic diversity for a population's survival and adaptiveness, and upon community diversity for providing suitable environments in which to live. Also, because species are the components that form communities, community diversity is dependent on the presence and function of individual species. All levels are constrained by abiotic conditions.

Unique and rare representatives at each level are given special emphasis by managers because of their vulnerability to being lost and the resulting threat of a decrease in biodiversity.