TwoOldGuys™ Study Guides
BI114 Biological Concepts for Teachers
Chapter 5. Ecology, Basics
5.3. Community

Based on Indiana's Academic Standards, Science, as adopted by the Indiana State Board of Education, Nov 2000.
Numbers refer to the age-appropriate grade-level for the content.

Review

Community

grades 2: to 4:

Groups of animals and plants found in natural areas form "communities"

Animals stories from children's literature frequently portray diverse animals as friends who have adventures together. In Nature, wild animals associate mostly with their own species forming populations (see Section 1.3., pg 9: the Species Concept & Phylogeny, subsection: "Population definition"). However, more than one species will live in the same geographic area. For example, those mammals which I have personally observed in or near the Grand Kankakee marsh of northwest Indiana include (identifications based on Weiss):

1) opossum,
2) short-tailed shrew,
3) eastern mole,
4) little brown bat,
5) big brown bat,
6) raccoon,
7) striped skunk,
8) longtail weasel,

9) river otter,
10) coyote,
11) red fox,
12) grey fox,
13) woodchuck,
14) 13-lined ground squirrel,
15) Franklin's ground squirrel,
16) eastern chipmunk,
17) eastern fox squirrel,
18) red squirrel,
19) beaver,
20) deer mouse,
21) Allegheny woodrat,
22) meadow vole,
23) Norway rat,
24) house mouse,
25) eastern cottontail, and
26) white-tailed deer, plus
27) mountain lion [not on Weiss' checklist].

All of these animals [and others I have not observed] not only live in the same area, but also interact with each other in various ways forming a community. Since these are mammals, we refer to this community as a Mammal community. There are also Bird communities, Reptile communities, Amphibian communities, Insect communities and Plant communities.

Natural communities tend to persist over long time periods. The present natural communities of the Grand Kankakee Marsh have had a continuous history since the only human observers were Indians [or Native Americans]. Natural events (such as wind storms, ice storms and forest fires) will certainly have changed these communities, as have human activities (such as clearing woods for farming and building cities and towns). An example of a change in the mammal community was the loss of the mountain lion many decades ago as a result of hunting of mountain lions by the European settlers. In spite of the loss of one species, the natural communities continued to exist. It was not until 2003 that there were again reported sightings [by reliable observers] of

mountain lions in northwest Indiana [which is why they are not on Weiss' checklist published in 2002].

It is the ability of communities to survive disturbance that allows long term survival. When a species, such as mountain lion is lost, the community responses as if it has been injured – and it "heals." When the environment changes permanently, the ability to 'heal' allows the community to adapt to the new conditions. As the Pleistocene Ice Age was ending, as soon as the glaciers were gone from the Grand Kankakee Marsh [about 18,000 years B.P.], various plant and animal communities moved in. As the glaciers continued to retreat northward, driven by global warming, the communities of the marsh changed to adapt to the warmer conditions: tundra species were replaced by north woods species, then by deciduous forest species. Finally, the forest species were replaced by prairie species, but then the warming trend reversed and forest species began returning. Now warming has resumed, so we will have to watch to see what happens to the natural communities next.

To summarize, the key features of natural communities are:

- species interact with each other
- communities persist over long time periods
- communities adapt slowly to change

grades 5: to 6:

Species interactions maintain community structure

By 5th grade, the some of the students will be able to start their own checklists of species. If you want to encourage them, the two checklists by Weiss (website reference in Works Cited sub-section) are intended by Weiss for this purpose. The plan is that amateur naturalists can start with Weiss' lists, and check off those species he/she has actually seen

[as I did to produce the list of species in the mammal community]. My recommendation to any beginning amateur naturalist is that they should start separate checklists for each community type visited in their lifetime, rather than the single "life list" frequently maintained by some avid bird watchers. These checklists become a list of the names of the species known to be in the natural wildlife communities of the area(s) observed. The species list is the simplest description of the community. By keeping separate checklists for each community type visited, the amateur naturalist will begin developing simple descriptions of each community type. On the other hand, the single 'life list' implies that the entire world is a single community. While this may seem to be a nice idea, or even a politically correct idea, it does not allow for compare and contrast studies of community types.

One improvement on the simple species list as a community description is to group species by their 'role' in the community, such as herbivore or plant eater, carnivore [eats meat], omnivore [eats anything], and scavenger [eats dead animals]. For my Grand Kankakee Marsh species list, this yields the following community description:

herbivore	carnivore	omnivore	scavenger
opossum	eastern mole*	raccoon	striped skunk
short-tail shrew	little brown bat*		
woodchuck	big brown bat*		
13-lined ground squirrel	long-tail weasel		
Franklin's ground squirrel	river otter*		
eastern chipmunk	coyote		
eastern fox squirrel	red fox		
red squirrel	grey fox		
beaver	mountain lion		
deer mouse			
Allegheny woodrat			
meadow vole			
Norway rat			
house mouse			
eastern cottontail			
white-tailed deer			

The roles of the animals suggest at least one interaction between species; some carnivorous mammals on the list eat herbivorous mammals on the list [*others eat animals from the insect community]. Another, less obvious, interaction is competition among herbivores for plant material to eat, or between carnivores for animals to eat.

The other two improvements to the species list as a description of a community suitable for 5th to 6th grade students are to include an estimate of how many animals of each species were there, and to include the habitat in which the animals were observed. 'How many animals'

can be estimated as abundance classes, such as one, a few, several, many,.... Habitats within the Grand Kankakee Marsh include streams & rivers, ponds & lakes, wetlands [bog = mostly non-woody plants; and fen = mostly woody plant species], wet prairie, oak island, lowland woods, upland woods, and dry prairie. It is important for the students to realize that animals may move between habitats, or even between communities, so the habitat in which the animal was seen does not mean that the animals is not in other habitats. Obviously, species in the plant communities do not move around, so the habitat in which the plant was observed does mean that the plant should still be there next time you visit the site.

grades 7: to 8:

The three primary characteristics most commonly associated with natural communities are diversity, habitat, and niche.

diversity refers to number of different species in community,
habitat refers to the environmental characteristics where a species is usually found,
niche refers to the role of the species in the community.

Each of these terms has a number of different usages, or definitions, depending on the interests of the ecologist discussing the community, or what aspect of the community is being considered. Unfortunately for the inexperienced student, some of the definitions are contradictory to other of the definitions.

Diversity

Most ecologists tend to consider 'diversity' to be an estimate of how the community is divided up among the species present. I prefer to define it as how the species present divide the environmental resources among themselves. This is the theoretical basis of the concept 'diversity.'

The 'working' definition is the description of the actual data one would collect in the field.

One of the oldest published working definitions is simply "the number of species in the community," which for the Grand Kankakee Marsh mammal checklist above is 27 species. Another definition [from over 50 years ago] requires establishing abundance classes; such as common, uncommon, rare; then tabulating the number of species in each class. A similar approach from the same time period suggested using frequency [the percentage of samples of a pre-determined size occupied by each species], again grouped into frequency classes, also called 'common, uncommon, rare.'

Habitat

Most ecologists agree that the habitat is a description of the environmental factors which provide important resources to the species. For plants, these factors include climatic variables (temperature, precipitation, length of growing season, etc), soil type (sandy, clayey, organic, etc), topography (lowland, upland, hilltop, north-facing slope, south-facing slope, etc). For herbivores, the environmental factors may include all of the above, plus the plant community (nest sites, food, etc). For carnivorous animals, the environment includes the above plus the animal communities that provide the food sources.

Niche

Textbooks define niche as (a) the role of the species in the community (or ecosystem), or (b) a detailed description of the habitat. For example, two closely related insectivorous [insect eater] songbirds [black-capped chickadee and tufted titmouse] co-exist in the same woodlots. One species nests and feeds toward the center of the trees, on large branches;

the other nests and feeds toward the edge if the trees, on twigs. By definition a, that they eat insects and nest in trees is their niche. By definition b, the separation within the trees represents the niche difference, although both occupy the same habitat.

grades secondary: to college:

Diversity is number of species and relative number of individuals in each species

Early attempts to define diversity tended to be very simple; number of species, or number of species by abundance classes. A number of different attempts were made to improve the estimate, including some statistically based estimates and other complicated mathematical models. A commonly used, and simple estimate counts the individuals in a given area [density], then sorts the species list by decreasing density. I usually use a combination of frequency [percentage of samples within which the species is present] estimates and abundance [density] estimates. The species list is sorted by decreasing frequency, then decreasing density counts [in the same samples as frequency was calculated] whenever there is a tie in frequency. To visualize the data, I usually graph the density (bar graph or line graph) against frequency values (x-axis).

Niche separation avoids competition by partitioning resources between species

This hypothesis was originally proposed as the "competitive exclusion principle." Unfortunately, the original proposal involved circular reasoning which is not logically correct. The underlying concept is, however, valid. It would seem to be advantageous to both species if they

were to respond to intense competition by shifting their niches away from each other. For example in the black-capped chickadee and tufted titmouse case described above, both birds nest in the same trees and eat the same insects. These birds may have reduced the competition between them by moving to different parts of the trees.

Theory of Island Biogeography

Definitions of the forms of migration:

migration = animals leave a given site with the 'intent' to return; for example migrating birds.
emigration = animals leave a given site to find new areas to colonize.
immigration = animals enter a new area after having emigrated from another site.
A mnemonic to remember which is which **E**migration occurs when animals leave by the **Exit**; **I**mmigration occurs when animals enter **In**to the new area.

- there is an annual emigration of individuals from occupied habitats
- immigrants arrive by chance; first come – first 'served'
- later immigrants meet competition unless local extinction has occurred
- composition of community is dynamic
    - plant populations, once established, may persist for centuries
    - therefore animals' habitats/niches persist for centuries also

The theory of island biogeography was initially developed to explain the diversity of organisms living on islands. The basic premises are (a) there is a continual emigration of organisms from the mainland; (b) the likelihood that immigrants will arrive [and colonize] the island depends on distance [the greater the distance, the less likely is colonization], and island size [the larger the island, the more likely is colonization. The concept of an island is a body of land surrounded by water. This concept appears to apply equally well to a woodlot surrounded by farm fields, a mountain surrounded by lowlands, or to a grassy meadow surrounded

by woods. In short, this is any habitat surrounded by different communities. And, the theory of island biogeography applies. For all the species in nearby communities or habitats, all of which are sending emigrants outward, only some will arrive as immigrants to the site under consideration. The first one to arrive is more likely to become established due to a lack of competition. Later arrivals will have to complete to gain a foothold, unless death has opened a spot for the colonist. As a result, the composition, and therefore diversity [defined as list of species with relative abundance data] is dynamic. This version suggests [predicts] that the community will continually change in a non-changing environment. It is the tendency of the community to change composition in the absence of environmental change that allows it to respond to any change in the environment.

Works cited

Weiss, R.A. "Field Checklist of the Birds of Indiana." Chipper Woods Bird Observatory, Indianapolis: http://www.wbu.com/chipperwoods, 2002.

Weiss, R.A. "A Field Checklist of Indiana's Amphibians and Mammals." Chipper Woods Bird Observatory, Indianapolis: http://www.wbu.com/chipperwoods, 2002.