Daily EarthPoem
EarthPoem Archives
Search
Artist/Naturalists
Site Map
DONATE
Teacher Resources
Learn Ecology
Kids' Earth Poems
Kids' Earth Heart
Members' Writing
John Caddy
About MorningEarth
Home
Contact
Links

Yearning to be Round:

A Primer in Ecological Concepts in 16 Parts

13. Natural Communities: How They Work

How We Are all Connected

• **1)** We share a common origin—we are all made of Earth and share the same recycled life–materials.

• **2)** We share a common descent—we are all descended from the first microorganisms, all leaves on one tree.

• **3)** We all depend on sunlight energy.

• **4)** We all breathe—we all exchange gases

- **5)** We all live in Natural Communities which have mutually evolved (except, sometimes, humans).

1) Common Origin Connects All Life

Everything alive shares a common origin. The carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur atoms that make up our physical bodies were all born in the thermonuclear heart of a dying star, which exploded and eventually condensed into our sun Sol and the Solar System of planets.

The entire planet Earth is made of these incredibly ancient materials. So in a real sense we are all made of stardust. We are all made of Earth.

Every atom of every living organism was part of Earth before that life took it in as food or breath and made it part of its body. We are all made of Earth. We humans are parts of Earth which have learned to move around and talk and laugh and use tools
.

We have known we were made of Earth for a long time. In the Last Rite of the Catholic Faith the dying person is told, “May you return to the One who made you from the dust of this earth.”

At other funerals we hear, “Ashes to ashes and dust to dust.”

We are all in this thing called life together. We share the same life materials; lives use them over and over in the vast recycling of nutrients we call death and birth.

We all depend on each other.

Although our origin as bits of earth is ancient human knowledge, our society is only recently grasping the literal scientific accuracy of this idea.

2) Common Descent Connects All Life

All living organisms are also linked by common descent. We are all descended from the very first lives on Earth from billions of years ago.

We are all related to each other. It may be hard to claim carrots or caterpillars as your cousins, but it gets easier when you realize you also get to claim the dolphin and the daisy as your cousins.

3) Dependence on Sunlight Connects All Life

Some of us (plants and algae) can capture and store energy directly from the sun’s light. The rest of us (animals) live by transferring that energy from life to life., and from death to life.

All our energy originates in the sun.

One definition of **Life is “light trapped in matter.”** Or you might say that **“Life is matter that has learned to capture light.”**

4) Gas Exchange Connects All Life

All living organisms breathe, or respire. Breathing means taking air inside, absorbing useful gases, releasing waste gases, and expelling the air again.

For example, plants “inhale” air through pores on the undersides of leaves, absorb carbon dioxide, and release oxygen (a by-product of photosynthesis).

Animals, in a mirror image, inhale air and absorb oxygen, and release carbon dioxide (a by-product of metabolism).

This process is gas exchange. Life worldwide constantly is exchanging huge amounts of gases with other life, through the atmosphere.

5) Community Connects All Life

We all live in Communities. In the reading on Interliving we explored **Coevolution**, and considered how organisms co–evolve in response to one another, or reciprocally, rather than evolving singly or in reaction against each other. This coevolution takes place at the community level.

A community, you recall, is a combination of different species. For example, the roadside pond is a community composed of many species [minnows, turtles, muskrats, algae, zooplankton (tiny one celled organisms), cattails, snails, ducks, etc. etc.] which coexist and relate to one another in a great variety of ways.

How Do Natural Communities Work?

Earlier we learned that individual organisms all live within larger wholes called communities that live within still larger wholes called ecosystems.

The word “ecosystem” is sometimes used to mean a collection of interlinked communities, and sometimes used to mean one community.

In human society and law we use the word community to include only human beings, and deliberately exclude plants and all the other animals. However, through the green–colored glasses of ecology, all species great and small are included in a community.

One goal of Morning Earth is to give you knowledge that may lead you toward a view of life as one enormous community to which we all belong.

To refresh your memory, here is how ecology defines “community”, “ecosystem,” and “population.” :

• A **community** is a combination of populations of different species. A community is all the members—plants, animals, and microorganisms—of all the species that live in a particular habitat and affect one another as part of the food web or by influencing the physical environment.

o For example, a roadside pond is a community composed of many species (minnows, turtles, algae, zooplankton (tiny animals), cattails, snails, ducks, etc. etc.) which coexist and relate to one another in a great variety of ways.

• **Ecosystems** are groups of connected communities plus their physical environments, and like communities, their size is also relative. The largest ecosystem is the entire biosphere of Earth.

• A **population** is all the members of a particular single species who live in the same area at the same time.

As we discussed in the essay “Interliving” above, community size is always relative, like those nesting dolls that all fit inside the next larger size. In other words, community size is a matter of scale. In “Interliving” we offered the example of a rainforest weevil to illustrate this life habit of ‘nesting’ within other lives.

When you ‘zoom out’, you see the big picture, and perhaps can grasp the entire biosphere as an enormous living community. When you zoom in, and zoom even farther in, you see that communities exist on every scale, from bacterial communities so small it takes five million individuals to be visible as a pinprick to the human eye, to the mammal scale we mostly use, in which things are large or small in relation to our own bodies.

How do communities work? Natural communities all have some features in common. We will now explore eight features of natural living communities:

1. Communities ‘Fit’ their Environments Reciprocally
2. Each species in a community has its own niche.
3. Many Communities Are Layered
4. There are always many more small species than large
5. In all communities, some species compete
6. Some species in a community cooperate to feed and avoid predators.
7. All species cooperate in interliving
8. Communities all have keystone species.

1. Communities 'Fit' their Environments Reciprocally

Living communities must exist in a place on Earth. Because we humans are such an adaptable species, we tend to think first of changing the environment to fit the needs of the living community.—we try to make places "livable." But most of nature doesn't work like that.

In nature, living communities do alter the environment in ways which make it more hospitable to life, but living communities both change the environment and change themselves over time to 'fit' the physical environment in which they live. It's "push me-pull you."

Life shapes the physical environment; the physical environment shapes life. So the relationship between a living community and its physical environment is reciprocal and mutual.

Let's take a simple example, the community of life on a small rounded stone from a long–dry riverbed. The stone is mostly smooth, but there is one place where there is a little crevice, and this part is right on top as the stone lies on the ground. In this little crack is a bit of green, and when we zoom in we see that the green is a small lichen growing there.

When we look a second time, we notice some gray crumbly stuff in the crack, and just beginning to grow out of the crack is a tiny single thread of greenish-gold that we barely recognize as a moss stem With a small microscope and good light, we zoom farther in and realize that there is a busy community of not only plant life, but also many tiny arthropods (mites and insects).

• The lichen secretes (gives off) an acid which bit by bit dissolves the rock it lives on. It uses the minerals in the rock to build and nourish its body —the leftovers are the gray crumbly stuff in the crack, which are the beginnings of soil.

• The lichen is changing the rock just a little so it can live there. It is making the rock a little smaller. It is eating the rock.

• The lichen has adapted to living on a rock surface.

• It has adapted to being watered only by occasional rainfall

• A rock surface doesn't store water well, so the lichen has also evolved a tough outer 'cuticle' that does not easily give up water

Both rock and lichen are changing in response to each other, and they have not stopped doing it. At some time in the future, the rock will have been 'tailored' so much by life and weathering, that it will break apart into small pieces which eventually will break down into grains of sand.

2. Each Species in a Community has its own Niche

Niche means **the place** occupied by a species in an ecosystem—**where** it lives, **what** it eats, its foraging **route**, **when** it is active, and so on.

Niche is a species' **role** in a community.

Niche is a species' **job** plus **its address.**

The more physically complex a community is (like a tree or a coral reef), the more niches are available.

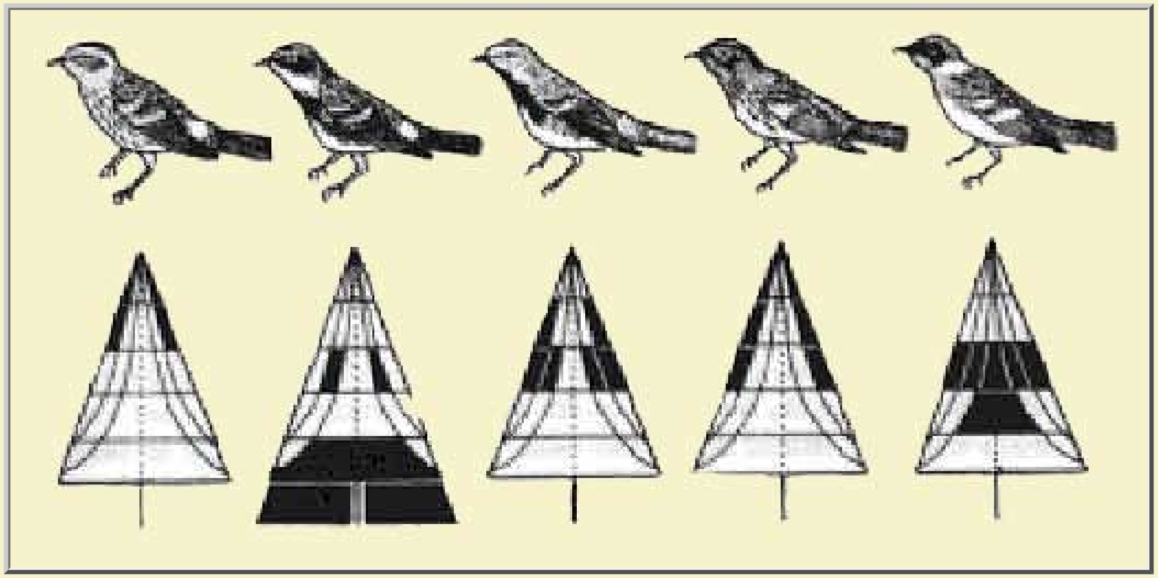
Complex communities contain more species and biodiversity and are thus more resilient than simpler communities.

Many niches are incredibly precise and specialized:

• a parasitic mite has been found that lives only on blood from the hind leg of one species of driver ant in South American rainforest.

• In bird feathers live tiny creatures called feather lice. Most species are highly adapted to one species of bird, and may spend their entire lives clinging to one barb on one feather, eating organic debris as a commensal organism.

• In a northern coniferous forest, five kinds of closely related warblers have “arranged” through thousands of years of evolution to feed in different places in pine trees. The black areas in the trees below the bird species show where that bird species feeds. Their different niches have resulted in five species where there used to be one species.



The species they became are (left to right) the Cape May, Yellow–rumped, Black–throated green, Blackburnian and Bay–breasted warblers.
illustration from *The Birder's Handbook*, ed. Ehrlich, Paul and David Dobson

• The more complex a community or ecosystem is, the more niches it will contain, thus the more diversity of species it will contain.

3. Many Communities Are Layered

Layering is a major physical part of community arrangement and composition. If you look back at the illustration of warblers in pine trees, you will see that they have arranged their feeding two ways: in–out and up–down. Layering is usually a matter of up–down changes.

Where vegetation is concerned, the top gets more light than the bottom, and the outside gets more light than the inside.

The principle of layering allows different species to occupy almost the same space without competing.

Look at the layers of a tropical rain forest, top down.

• **Canopy** layer: 160 feet high and up, overlapping umbrella shaped canopy of trees draped with epiphytes, vines and leaves; rich in species diversity

• **Understory** layer: shorter, shade tolerant trees 100–150 feet tall

• **Shrub** layer: shade tolerant bushes & seedling trees; 4–30 feet

• **Herbaceous** layer: shade-tolerant broadleaf herbs, grasses, and ferns.

• **Moss** layer: shade-tolerant mosses and lichens, fungi

• **Litter** layer; dead vegetation—by now, 90% of sunlight gone—leaves, branches, twigs—and dead animals, mostly insects: the crucible of decay; uncountable billions of bacteria and fungi that decompose the litter or detritus and recycle its nutrients for the community—it blends into the soil layer.

The rainforest is layered from the **inside out** as well:

• at the **tree trunk** layer, vines and lianas hold fast to the tree for support

• as we move out from the trunk on branches, many **epiphytes** grow. (epiphytes are interliving plants that get their water and nutrients from the air and do not harm their host tree)

• as we move toward more light, the **vines leaf** out to feed themselves with light

• as we reach the **outside** layer of a tree, we see leaves that are a mixture of the tree's leaves and its supported vines and epiphytes in a riot of color and textures.

As you can see, the idea of layering is also a way of talking about niches. A niche is a place and way to live. Layering gives a great diversity of animal life many niches to 'choose' from.

Forest animals are layered with the plants.

In a **northern hardwood forest**, from the ground up, you find:

• **Ground/litter** layer: wood processing ants and termites, some beetles, detritus feeders like pillbugs & millipedes, silverfish and springtails; earthworms, shrews, deer mice, chipmunks, robins, thrushes, sparrows, flickers. Salamanders, toads, snakes, lizards.

• **Herbaceous** layer: butterflies, bees, wasps, flycatchers; squirrels, chipmunks, woodchucks, skunks, mink,, ground-nesting birds.

• **Shrub/thicket** layer: squirrels, chipmunks, browsers and berry eaters, such as deer, rabbits, bear, raccoons; nesting cardinals, buntings, sparrows

• **Understory** trees: orioles; flycatchers; deer; squirrels, chipmunks, treefrogs, flying squirrels, woodpecker

• **Canopy**: high nesting birds such as hawks and ravens; owls using old hawk nests; warblers, kinglets, vireos ; jays, tanagers; finches; squirrels

4. There Are Always Many More Small Species than Large

Small species find more places to live and more ways to make a living.

Remember as a little kid lying down in the grass and imagining yourself tiny and living in among suddenly enormous grass stems?

Youmay have recognized many possible places and ways little creatures might make a living.

Small creature have many more possible habitats and possible niches, so they number a great many of the leaves on the tree of life.

Large creatures require large habitats.

Very small organisms are extremely diverse.

- There are many more species of herbs (non-woody plants) than there are species of trees.

- There are many more kinds of insects than there are vertebrates (animals with backbones).

Size and weight has a huge effect on numbers.

A deer weighs about a thousand times what a mouse weighs.

If you reduce the weight of organisms by a thousand times, there will be ten times as many small species than large species. In other words, for every species of deer-sized mammal, there will be ten species of mouse-sized mammal.

For every dragonfly sized insect species, there will be ten gnat-sized species.

In the evolution of communities, smaller size means more species. Within particular groups of animals, such as the insects, the smallest organisms are able to exploit more niches and thus pack more species into local communities.

Small organisms can divide the environment into smaller niches than large organisms can.

If you made a visual **pyramid of biodiversity**, the wide base would represent the smallest organisms, and as the pyramid grew taller and more narrow, the larger organisms would be represented larger in mass, but fewer in number of species and smaller in diversity. At the apex of the pyramid you would find the very largest organisms, such as elephants, whales and redwood trees.

5. In All Communities, Some Species Compete

Generally, species compete with some other species in their community for resources they must have to stay alive and reproduce. A few examples:

- Cavity-nesting birds compete for tree holes.
- Plants compete for pollinators and seed dispersers.
    - Most flowers compete for bees and wasps, etc., because only with animal help can they be pollinated and make seed for their next generation.
- Berries and fruits compete to be eaten by animals, so the seed will be dropped at a distance from the parent plant (in other words, plants compete for dispersal agents).
- Male birds compete for the best territories with which to attract females.
- Plants on the forest floor compete for limited light.

The first example, about how hole-nesting birds, illustrates how **competition and cooperation live side by side in nature.**

• Woodpeckers excavate a new nest-hole every mating season. They use it for one season and move out, leaving it for other cavity–nesters (such as wrens, chickadees, flycatchers, and tree–swallows) to use.

• The woodpeckers in essence cooperate within their community, providing new housing—the other cavity-nesters compete with each other but not with woodpeckers.

The roots of walnut trees give off a poison (*juglone*)which kills most other plants under its leaf-canopy, which surely is effective in the competition for light.

Perennial goldenrod roots give off a poison that kills seedling jackpine trees, which is also competition for light.

Together, walnut trees and goldenrods invented the herbicide.

Competition within species is probably the most familiar kind. Within a population, members compete for food, status, and reproductive opportunities.

6. Some Species in a Community Cooperate to Feed and to Avoid Predators.

Mixed herds and mixed feeding flocks are common in both mammals and birds. This cooperation usually means more opportunities to eat and a better chance to escape predators.

Different species have different ways of being alert to danger; together in a mixed herd they can put all those different alertnesses together in a common purpose—to avoid being eaten.

• African grasslands are characterized by **mixed herds** of antelope, zebra, and wildebeest. This is an example of grazing species in a community cooperating to minimize the danger of predators.

• Deer and elk graze together in North America, as do antelope, deer, and bison.

Throughout the world birds travel and feed in **mixed flocks**, especially in forests.

• Mixed flocks in northern forests may include chickadees, nuthatches, downy woodpeckers, and warblers.

• These small birds tend to use different food sources, in different locations on the plant, so they don’t compete much as they travel through the woods, feeding.

• But should a sudden bonanza of food turn up, such as a mating flight of winged ants, the flock all benefits, for they announce it to each other.

Many kinds of ducks feed in mixed flocks of species which use different feeding strategies, ducks such as gadwall and wigeons.

Some diving ducks form mixed feeding flocks in coastal waters even though they have similar feeding niches.

The advantage is that they can share in the schools of thousands of individuals that small fish often occur in—there is no competitive disadvantage because the school provides enough for every member of the flock.

7. All species Cooperate in Interliving

Symbiosis is the most common living arrangement of life on earth.

In Chapter 11 we introduced the idea of coevolution with these examples of cooperation:

• Plants evolved fleshy fruits (berries, fruits, nuts, acorns) as a seed packaging device to disperse or spread their seed. Fruits all evolved in cooperation with certain animals which eat the fruit (and seed), then excrete the unharmed seed away from the mother plant.

• Oak trees evolved acorns in a long cooperation with squirrels and bluejays. These animals buried (or planted) the acorns as stored food. The great oak forests of Europe and North America were planted by squirrels and jays as part of this long coevolution.

• Many seeds in berries and fruits cannot germinate at all unless their tough exterior has been etched a little by animal digestive juices. In other words, they must pass through a gut to live.

• Flowering plants and hummingbirds coevolved long tubular flowers and long beaks together.

• Fruits and berries in North America, Asia and Europe coevolved with migrating birds; the plants “learned” to time their ripening for late summer, just when flocks of migrant birds would be coming through to eat them and spread their seed.

• Many flowers have coevolved with a species of flying insect to insure pollination of the flower by another member of its species. Often, the structure of the flower is tailored to the size and shape of its pollinator.

• The yucca flower opens only at night, when its pollinator, the yucca moth, is active. The moth has specialized mouthparts to collect and carry yucca
pollen. While visiting a flower, the moth takes some of the pollen she is carrying and places it directly on the stigma of the flower, actively pollinating the flower and ensuring successful seed formation. The moth lays its eggs inside each flower it visits. When the moth’s eggs hatch, the larvae feed on the developing seeds of the plant. The plant is guaranteed pollination so it can make seed; the moth is guaranteed food and protection for her developing larvae. Yes, the yucca loses some seeds (never all), but it gains far more in this coevolved relationship than it loses.

Symbiosis is the term for mutualisms in which neither partner can survive without the other. We learned earlier that in the course of billions of years of life on this planet, we can trace a general progression among living organisms toward more and more interdependence, toward more and more of the intimate cooperation we see in symbiosis.

We discussed earlier the entire biosphere's animal/plant symbiosis in which plants create oxygen, which animals breathe, and the animals create carbon dioxide, which the plants breathe. This symbiosis affects every multicellular life on earth.

Perhaps the most overwhelming symbiosis in the biosphere is the evolution of separate one-celled organisms (bacteria) into the kind of cell that all multi-cellular organisms are made of.

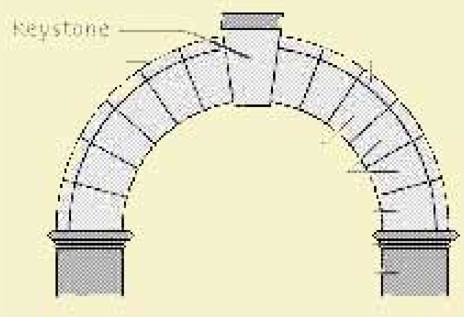
The mitochondria of animal cells and the chloroplasts and mitochondria of plant cells are the living proof that we ourselves are complexes of symbiotic cells. This symbiosis affects every multicellular life on earth.

A third enormous and powerful symbiosis is the mycorrhizal associations of almost all flowering plants' roots with fungi, which help both fungi and the plants thrive. This symbiosis also affects every multicellular life on earth.

A fourth fundamental symbiosis is an alliance between virtually every animal species and the ancient kingdom of bacteria. In worms as much as human beings, we simply cannot digest our food without the help of symbiotic bacteria living in our digestive tracts. Every species of animal apparently has this living arrangement with bacteria, so the symbiosis is an old one. This symbiosis affects every multicellular animal life on earth.

8. Communities all have Keystone Species.

An arch is made of wedge–shaped stones in a curve. In the center of the arch, at the top of the arch, is the keystone. It is called the keystone because it 'locks' the arch into place; if it is removed the arch collapses.



Living communities have certain species which are **keystones** of the community. If keystone species are removed, or become extinct, the community collapses. Not all species in the community are central to its survival—but each species is important to community diversity and health.

Kelp ‘Forest’ Community

Just off the West coast of North America, in shallow ocean. is a habitat and community called the kelp forest. Tall seaweeds called kelp stretch from the bottom to the surface, where airfilled ‘bladders’ keep them afloat. You may have seen kelp washed up on an ocean beach, long whip like stalks with large flat ‘leaves’. To a scuba diver it looks and feels like a forest. In this kelp forest live many animals: seals, many schools of fish taking advantage of the kelp ‘cover’, many shellfish, and many sea urchins, which look like balls covered with spines.

One animal of the kelp forest is the giant sea otter, an agile aquatic predator that is densely furred and about six feet long. Sea otters feed mostly on shellfish from the bottom. Often they swim to the surface with a shellfish and a stone, rest the shell on their chests and crack it with the stone. Sea otters have excellent fur for human purposes, and like the fur seals, they were hunted nearly to extinction during the past 200 years.

By 1900 sea otters were almost extinct. One of the sea otter’s favorite foods is the sea urchin, a grazer which feeds on seaweeds such as kelp. Where the otters disappeared completely, the sea urchin populations exploded, and the kelp forests died.

The sea urchins, unrestrained by predation, simply ate the kelp up, and what was kelp forest became marine deserts called “sea–urchin barrens.”

This story of destruction has a happy ending. Otters from the surviving populations were re-introduced to the sea-urchin barrens, and gradually the kelp forest community re-created itself. Now the gray whales migrate closer to shore, finding the kelp forests good places to park their calves while mama feeds on the dense plankton which is part of the kelp community.

The sea otter is a keystone species; without it the community collapsed.

Ecologists do not know which of the millions of plant and animal species on earth are truly keystone species.

In this time of mass extinctions, when at least 300 species are going extinct every year, and probably more, we need to be aware that some species, and not always the glamorous ones like otters, are keystone species.

And we don’t know which ones they are! *“For want of a nail the war was lost.”* Entire ecosystems collapse when the keystone is removed. An extended arch is a circle, and the circle of community cannot continue as a whole if we keep on making other species extinct for our own convenience, or out of simple carelessness.

One notorious group of keystone species are the **driver ants** of the tropical grasslands and forests. They are sometimes called **safari ants** and **army ants**.

Their presence appears to be central to the grassland communities of Africa. They are the largest predator around in terms of biomass consumed.

Most keystone species are top predators or primary producers (plants).

But In deserts, **termites** are keystones. They are crucial because they recycle dead wood, which is where most organic matter in the desert is found.

Some Sources for Natural Community

Encyclopedia Britannica

Ehrlich, Paul, et al, *A Birder's Handbook*

Tester, John, *Minnesota's Natural Heritage*

Odum, Eugene, *Fundamentals of Ecology*

E.O. Wilson, *The Diversity of Life*

Top of Page

Return to Yearning to Be Round Contents