Title: Ecosystems

Introduction: An ecosystem is defined as being a community of both living organisms and nonliving things that interact and work together to produce an exchange of materials. Ecosystems can be as broad as the entire Earth or as narrow as your bedroom. Each part of an ecosystem is important because the well-being of the ecosystem as a whole is reliant on every individual part. For example, if there are not enough nutrients in the soil, plants will die. If plants die, the insects and animals that eat them will also die, and then the predators of those animals will die as well. This goes on and on in a circle. If one small thing is changed, the impact is huge. Each part of an ecosystem must work together to create the proper balance and promote survival.

Niches: Each species in an ecosystem occupies its own role or niche. A niche is the sum of all of the abiotic and biotic elements an organism needs to survive and its relationship with those. Abiotic elements are the nonliving things such as rocks and water, and biotic elements are the living things such as microorganisms and plants. Niches are narrow and can only be occupied by one species for a long amount of time. If two species are occupying the same niche, there will be competition for resources leading to either adaptation or dying off of one of the species. Charles Darwin’s research has brought light to this in many ways.

Ecosystems: There are two primary categories of ecosystems: aquatic and terrestrial. Aquatic ecosystems are found in bodies of water and contain the flora, fauna, and properties of water itself. The aquatic category can be further divided into subcategories: marine and freshwater. Terrestrial ecosystems are found anywhere as long as it is not a body of water. The terrestrial category is further divided into subcategories: forest, desert, grassland, and mountain.

Marine: The marine ecosystem encompasses shorelines, temperate and tropical oceans, estuaries, mud flats, tidepools, salt marshes, barrier islands, and more. The earth is 70% water, with 97% of that being ocean- this makes the marine ecosystem the largest and most diverse of subcategories. Organisms are not evenly distributed throughout the marine environment; there are areas with more life and areas with much less. Factors that contribute to this diversity and distribution are availability of light and nutrients, topography, water depth, and proximity to land. Light availability is categorized into two zones called the photic zone and the aphotic zone. The aphotic zone is the area of the ocean in which the depth is so great that no light is present and there is an inky blackness. In the aphotic zone, energy consumption is greater than energy production. The photic zone is the area in which light is present, and it is split into the euphotic zone and the disphotic zone. In the euphotic zone, photosynthesis occurs because it is the region in which most light is present. This is a very important way of producing both energy and oxygen for the earth. The disphotic zone does not have as great a presence of light, so respiration rates are greater than photosynthesis rates. Marine organisms are most present in the photic zone, primarily the euphotic zone, because of its high amount of light and nutrients. The marine environment is also split into two other categories: the pelagic and the benthic. The pelagic environment is the water environment which is again subdivided into further categories. The neritic province is one of these subdivisions and is the most nutrient rich and therefore most organism rich area. The benthic environment is the bottom environment consisting of the continental shelf, intertidal zones, the bathyal zone, the abyssal zone, and the hadal zone. The deepest of these areas is the hadal zone. Most of the sediments in the deep zones are results of dead organisms and their wastes. The marine environment has a specific chemical composition that is also important to the development of life and survival of organisms. Seawater is only about 3% dissolved compounds and the rest is pure water. The dissolved compounds include phosphorus, nitrogen, carbon, silicon, and calcium as well as many others. The atmosphere also has a large impact on the chemical makeup of the marine environment because the ocean is a carbon sink, absorbing carbon dioxide. Certain areas of the marine environment are host to a very diverse group of organisms. Deep sea hydrothermal vents provide massive amounts of nutrients and create a very diverse system of life with organisms such as archaea, clams, and mussels thriving there. The marine ecosystem is a very complex environment that is being researched more and more every day.

Freshwater: The freshwater ecosystem includes all areas that are highly saturated with water such as rivers, lakes, ponds, and other free water on continental land masses. The freshwater ecosystem is also known as the inland water ecosystem. It does not comprise a very large fraction of the biosphere as a whole, but is very important in that it contributes to life and the overall diversity of the world. Less than 1% of all water on Earth is fresh, free water because the majority is contained in the oceans, groundwater, and polar ice. Freshwater habitats on the surface of the land are classified into two categories: the lotic and the lentic. The lotic habitat is composed of running water such as rivers, streams, and brooks. The lentic habitat is composed of standing water such as lakes, ponds, and marshes. There are three major types of drainage systems that the lotic and lentic habitats are linked to. These drainage systems are called exorheic, endorheic, and arheic. The exorheic system is open and will eventually drain into the ocean, the endorheic system is closed and drain to inland areas, and the arheic system is unpredictable and has scattered drainage patterns. Lotic and lentic habitats can either be permanent or temporary. Permanent areas are usually found in tropical and temperate regions whereas temporary areas are found in drier regions. Without freshwater, life on the earth would be significantly different. In fact, there would be no life. There are significant properties of water that significantly influence the structure of ecosystems. Water has a high specific heat and does not fluctuate in temperature very rapidly. This allows for steady environments and the accommodation of many organisms. Frozen water is less dense than liquid water which allows ice to float. Because of this, organisms can survive in winter months in lakes and other areas covered by ice. Without this, the entire lake would freeze and life could not be sustained. Water is also an important solvent in which many nutrients are provided. The freshwater ecosystem also has a large impact and relationship to the geology and topography of the earth. Water is responsible for erosion and the formation of diverse geologic landscapes. Runoff patterns of water are indicative of the topography of an area and can be used to interpret the layers under the surface as well.

Forest: The forest ecosystem includes areas that are highly vegetated with trees and other woody plants. Forest ecosystems are highly diverse ranging from tropical rainforests to boreal and taiga forests. More than just trees, they are a complex system dependent upon soil, climate, other plants, and animals. There are five main layers of a forest: the canopy, the understory, the shrub layer, the herbaceous layer, and the forest floor. The canopy consists of the very top of the forest, the tallest and oldest trees and is exposed to the harshest of conditions. It has no protection from wind, storms, sun, and lightning. Sun and rain are very important for the health of the trees, but constant exposure can easily weather them down. The animals that live in this area of the forest are birds, lizards, insects, frogs, and snakes. The understory is the area just under the canopy. It is a less harsh environment because the canopy provides some protection. The trees in this area are not fully grown and are younger than those in the canopy. The foliage on these trees is less dense than that of the canopy because less sun can reach the area. This also causes the trees in the understory to grow more slowly than those in the canopy. The organisms that reside here are more diverse and include caterpillars and butterflies, birds, frogs, squirrels, monkeys, raccoons, and other tree mammals. The shrub layer is just below the understory and consists of young trees, short trees, and other woody plants that do not grow very tall, but most are shrubs. This is an area rich in life and diversity. Lichen grows on the bark of trees in between the shrub layer and the understory. A very large variety of insects, mammals, and other animals are abundant and thrive here. The herbaceous layer is just below the shrub layer and consists of flowers, moss, seedlings, and other plants. The forest floor is covered by leaves, and is primarily composed of the soil. The soil is rich in nutrients and diverse in smaller organisms that are crucial to the overall well-being of the forest.

Desert: The desert ecosystem is composed of areas that are arid or dry and receive less than 10 inches of rain per year. They are typically vast areas with little vegetation cover and a lot of bare soil. Desert ecosystems are more diverse than would appear. They are actually only second in diversity to tropical rainforests. There are two types of deserts: temperate and subtropical. Temperate deserts are too cold for many plants and animals to survive in. For example, Antarctica is a temperate desert. The plants and animals that survive the bitter cold have developed adaptations such as becoming more metabolically efficient and requiring less energy to survive and developing thicker layers of fat and insulation. Subtropical deserts are too hot for many plants and animals to survive in; these are the stereotypical deserts one thinks of. For example, the Mojave is a subtropical desert. The plants and animals here have developed adaptations that allow them to endure extreme heat and little water. Many animals that live in subtropical deserts are nocturnal because it is actually cold at night. Plants have amazing water storage capabilities and are smaller and lower to the ground in order to efficiently find and use water. There are two main factors that contribute to the formation of deserts: global wind patterns and mountain rain shadows. In large mountain ranges, water filled air is pushed up the slope of the mountain where it eventually precipitates before reaching the other side. Deserts are formed on the side of mountains that do not receive rainfall due to the mountain’s rain shadow. Deserts are windy due to the fast temperature fluctuations and air density, and they are characterized by extreme temperatures. Greater than one fifth of the earth’s land is made of deserts. Salt accumulates in the soil because of the soil’s coarseness and incapability to retain moisture creating a difficult environment for plants to survive. Small rodents, lizards, snakes, amphibians, and some larger mammals survive in desert habitats. Because of its extremes, the desert is one of the most fragile ecosystems in the world.

Grassland: The grassland ecosystem includes areas scare in trees and plentiful in grass and forbs (a small bush), and they make-up approximately one fourth of the earth’s land area. Grasslands are among the least protected ecosystems on the earth, with temperate grasslands being less than 1% protected. There are two categories of grassland: temperate and tropical. Temperate grasslands include the Great Plains of North America, the veldts (uncultivated grassland) of Africa, and the pampas (fertile lowlands) of South America. Temperate grasslands are characterized by hot summers, cold winters, and low diversity of plants and animals. However, the abundance of these plants and animals is very large. Animals found in temperate grasslands include coyotes, birds, ferrets, bison, and small rodents. Grasslands are home to large numbers of grazing animals and have extremely nutrient rich soil. Tropical grasslands are also known as savannas and cover much of the surface of Africa and large portions of Australia and South America. Tropical grasslands are found in areas that could support forest but do not because of drought or fire. The grasses here are normally 3-6 feet tall. Animals that are found in tropical grasslands include giraffes, kangaroos, rodents, lions, termites, and many others. Tropical grasslands are found in areas with a hot climate year round and one heavy season of rainfall. The soil in tropical grasslands is porous and allows for large amounts of drainage. Grasslands are found on every continent and are also considered to be a transitional ecosystem because they are often found between deserts and forests.

Mountain: Mountain ecosystems are characterized by high altitudes and harsh environmental conditions. The vegetation and climate of mountains differ from the lowlands surrounding them. The altitude and relief of mountains play a large role in their climate. Air is thinner at higher altitudes. Wind patterns also affect the climate differences, and there is higher precipitation found on slopes on the side of mountains that have the most wind. Mountains in desert regions have little rain whereas mountains found in more temperate areas have very distinct seasons. At higher altitudes, the mountain soils are shallower and often poor in nitrogen and other life sustaining nutrients. Erosion is very common due to frost heaving, runoff, snow accumulation, and steep slopes. Although soil is shallow, the accumulation of peat (an accumulation of partially decayed vegetation) allows for growth and provides needed nutrients to sustain plant and animal life. There is one major vegetation feature of mountains called the timberline. Above the timberline, it is impossible for any trees to grow because of the harshness of the climate, but below it trees are very abundant. Above the timberline, other plants such as shrubs and grasses and forbs are still found in abundance. Mountain ecosystems are normally dominated by the presence of conifers such as pines, firs, and spruces. There are often only very few types of trees that cover a mountain ecosystem. Moss and other smaller plants are also abundant under the trees. Large mammals such as bears, wolves, moose, and others are present in mountain ecosystems. There is also a large abundance of insects and birds. In tropical mountain areas, seasons are not as distinct as in temperate areas. This allows for longer breeding seasons that do not produce as much offspring as the short breeding seasons in the temperate counterparts. Mountain ecosystems are not very productive environments for plants due to poor soil and harsh conditions.

Trophic levels: There are distinct trophic levels or feeding positions in a food chain in ecosystems that allow for the efficient survival and use of energy. Energy is passed up and down the food chain in trophic levels. The first level is composed of the primary producers. Primary producers make their own food. For example, plants use sunlight through photosynthesis to create their own food. The second level is composed of primary consumers. Primary consumers are organisms that feed of of producers. For example, if an animal eat plants, it is acting as a primary consumer. The third level is composed of secondary consumers. Secondary consumers obtain energy by feeding off of primary consumers. For example, a mouse is a primary consumer, and snakes eat mice, therefore the snakes are acting as secondary consumers. The fourth level is composed of tertiary consumers. Tertiary consumers are organisms that obtain energy by consuming secondary consumers. For example, snakes are secondary consumers, and hawks eat snakes therefore hawks act as tertiary consumers. Then when consumers die, their nutrients are broken down and used in soil by plants creating an efficiently flowing energy cycle between trophic levels. Trophic levels are crucial to the health and survival of ecosystems because if one level is affected, all other levels will also be affected in some way that could either be beneficial or detrimental. Only about 10% of the energy from one trophic level is passed on to the next, however. The rest of the energy is used primarily for metabolic function. The trophic levels are often depicted in a pyramid form because a greater abundance of organisms is found at lower levels, tapering off towards the top level. This is due to the inefficient energy transfer between levels. In the fourth trophic level, there is not enough energy to support an abundance of organisms.

Organization: Ecosystems are also organized by other methods. Levels of an ecosystem are normally described as going from smaller to larger. The levels are as follows: individual, population, community, ecosystem, biome, biosphere. An individual is an organism itself or any living thing. A population is a group of individuals in a species that live in a certain area at a certain time. A community is biodiverse and composed of all populations in the same area on the same occasion. An ecosystem is all of the biotic and abiotic factors in an area working together in the same moment. A biome is a set of similar ecosystems in the same relative area. A biosphere includes all of the ecosystems on the earth. Each of these levels interacts and contributes to the next to create a healthy and diverse society in which growth is abundant and efficient.

Hydrologic, Carbon and Nitrogen Cycles: The hydrologic cycle plays a very important role on the health and overall function of every ecosystem. The hydrologic cycle is the cycle of water on the earth and in the atmosphere. First, water on the earth’s surface evaporates and is drawn into the atmosphere. The water condenses to form clouds. Those clouds are transported until they precipitate the moisture back to the earth. Groundwater and runoff are also important parts of the hydrologic cycle. The carbon cycle is the cycle of carbon on Earth. Carbon dioxide begins in the atmosphere and is absorbed during photosynthesis and oxygen is released as waste. Oxygen is then absorbed during respiration and carbon dioxide is released as waste. There are also carbon sinks and reservoirs that cycle carbon long term. Oceans and healthy forests act as carbon sinks. The carbon cycle is crucial to both the sustenance of life and the overall well being of the atmosphere. The nitrogen cycle is the cycle of nitrogen in the earth and is crucial to the survival of all organisms because of the abundance of nitrogen within amino acids, proteins, and DNA. Nitrogen is extremely abundant in the atmosphere, but it is not usable in that form and must be fixed. Once the nitrogen is fixed by microorganisms, it is used by plants and transferred up trophic levels until it eventually reaches decomposers and is transferred back into the soil.

Humans have a large impact on biosphere and every ecosystem itself. It is important to remember that even the smallest action could have the largest of consequences because everything works together and is dependant on one another for health and survival. No one part of any ecosystem could survive on its own, and that creates an amazing and delicate balance that humanity should strive to be more in tune with. One of the biggest human influences is on the carbon cycle and greenhouse gas emissions. Greenhouse gases build up in the atmosphere and lead to climate change and global warming. Climate change is detrimental to many ecosystems, and it puts many organisms at risk due to habitat change and loss. Another human activity that impacts habitat is deforestation. As forests are being cut down, many animals are losing their homes and are at risk of extinction. The loss of forests also plays a large role in climate change. Ecosystems should be treated with respect and should be preserved or at least conserved in order to prevent extremely detrimental change in the biosphere.

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