Notes for chapter 3: Lesson 2

Learning goal: I can understand the types of systems that play roles in environments, as well as the interactions between systems.

Chapter 3, Lesson 2: Systems in environmental science

1. Interacting systems
2. An output of one of earth’s systems is also an input to that or another system
   1. Inputs into earth’s systems include energy, information, and matter.
      1. Energy inputs into a system may include
         1. Solar energy absorbed by plants in a meadow
         2. Geothermal activity heating water in a geyser
         3. Metabolism of rabbits rising the temperature in a warren.
         4. Human activities like burning fossil fuels heating air..
      2. Matter inputs may include
         1. Seeds being brought into an ecosystems by wind
         2. Pollutants and sediments flowing into the gulf of mexico via the Mississippi River
         3. Food taken out of the Gulf of Mexico (fig 11), then eaten in Ohio.
      3. The shrimp output of the Gulf of Mexico serves as an energy input in the digestive systems of the humans that eat them. Also, the profits of selling the shrimp becomes an input of the global economic system.
   2. Feedback loops are cyclical processes in which events can serve as either a cause or input or as an effect or output within the same system.
      1. Negative feedback loops are regulatory and result in stabilizing of conditions within a system.
         1. The thermostat for a house is set at a certain temperature (figure 12); when the temperature rises above that, the air conditioner is activated to lower the temperature, but when the temperature falls below the set-point, the furnace is activated to raise the temperature.
         2. Within Canada’s Isle Royal ecosystem, a negative feedback loop regulates the size of wolf and moose populations. https://www.youtube.com/watch?v=vF0Mhf2ZTco Wolf-moose relationship studied on Isle Royale 2:18 seconds

<https://www.youtube.com/watch?v=M8cgmIytyeE> 3 wolves left

* + - 1. When food is more abundant than usual, when the weather is less harsh than usual, or when fewer moose die of diseases, the moose population size grows, providing more food for the wolf population and allowing it to grow, too. This brings the moose population back down to match the carrying capacity of the island.
      2. When conditions cause a decrease in moose population size, fewer wolves survive, so that the moose population will grow due to the decreased hunting pressure.
    1. Positive feedback loops only rarely occur in nature, because rather they restore balance (equilibrium) of an ecosystem, these loops drive the system to an extremely high or low level. Most positive feedback loops reflect human disruption of an ecosystem and its resulting destruction of the ability of negative feedback loops to operate.
       1. Human stimulated erosion can lead to a positive feedback loop (Figure 1.3).
          1. Normally, if soil erodes as during a heavy rain, more plants will die, leading to more decomposing plants that decompose to form more soil.
       2. When humans clear land, such as when all trees are cut, soil erosion increases, but since the trees have been removed, their decomposing wood can’t be used to restore the lost soil. Then, the exposed soil is eroded at a higher rate due to wind and rain.
       3. Question 3, page 75, is an excellent example of positive feedback: sunlight melts snow, exposing darker colored pavement which absorbs more heat than lighter surfaces. So, snow melts even faster.

1. Earth’s spheres
2. Earth’s geosphere, lithosphere, biosphere, atmosphere, and hydrosphere are defined according to their functions in earth’s systems. (Figure 14)
   1. Geosphere-made of all rock and all below earth’s surface e
   2. Lithosphere-made of hard rocks on and just below earth’s surface; the outermost layer of the geosphere
   3. Biosphere-all living or once living things and the nonliving things with which they interact
   4. Atmosphere-layers of gases surrounding our planet
   5. Hydrosphere-all water—in all of its states and salty or fresh—underground, above ground, and in the atmosphere.
3. Ecological interactions often overlap several spheres. Example given is for how the biosphere, atmosphere, hydrosphere, and lithosphere are all affected when a robin pulls a worm out of rain moistened soil.

Notes for chapter 3, lesson 3, Earth’s Spheres: What are the characteristics of earth’s geosphere, biosphere, atmosphere, and hydrosphere?

1. The geosphere
2. The earth’s geosphere consists of the crust, the mantle, and the core.
   1. Earth’s crust is a thin layer of relatively cool rock forming the outer skin of dry land and ocean bottom.
      1. Mantle is below the crust and is a layer of hot, but mostly solid rock.
      2. Upper mantle and crust🡪 lithosphere
      3. Lithosphere floats on a hotter and softer layer of rock called asthenosphere.
      4. Lower mantle under asthenosphere is solid rock.
   2. Outer core is molten metals near temperature of the sun.
      1. Inner core=solid metal.
   3. 15 tectonic plates move about 2-15 cm per year, so that twice a supercontinent has formed and separated (last: Pangea separated 225 million years ago). (Fig 15)
      1. Convection pushes athenosphere’s soft rock upward as it heats, but allows it to sink again as it cools.
         1. Collisions/separations of tectonic plates results in landforms (mountains, islands, continents).
         2. Some plate boundaries are experiencing convergence (colliding) while others are experiencing divergence (separating).
         3. Landforms affect patterns of rainfall, wind, ocean currents, heating & cooling, so moving of tectonic plates affects the biosphere.
   4. (Figure 16) Molten magma escapes at divergent plate boundaries to form new crusts such as the mid-Atlantic ridge.
   5. At transform plate boundaries, parallel sliding of 2 plates past each other creates friction and earthquakes, such as at the boundary of the Pacific and North American plates near California.
   6. At convergent plates, two outcomes are possible:
      1. Subduction of one plate under the other, creating pressure that pushes up magma as volcanic eruptions, such as at Mount St. Helens.
      2. Mountain building as when indian-Australian plate converged with the Eurasion plate.
3. The biosphere and the atmosphere are the living Earth and the ocean of gas that supports and protects it.
   1. The biosphere is the part of the earth where living things interact; life isn’t known in the mantle or core.
   2. (Figure 17) The atmosphere contains gases like oxygen used by organisms, as well as ozone that protects the biosphere from damaging UV radiation, like global sunscreen!
   3. Greenhouse gases, like Carbon dioxide and methane, keep the earth warm.
4. The hydrosphere is where water cycles through the lithosphere, biosphere, and atmosphere.
   1. Earth’s water is vital as a means of material transport and as a solvent.
   2. Only 2.5% of water is fresh, with all but 0.5% tied up in ice (the cryosphere); most of this fresh unfrozen water is underground in aquifers!
      1. Great activity quick lab page 80—if all earth’s water is 1000 ml, then 975 ml represents salt water, 25ml \*.7 = freshwater in ice, 25ml\*.01= fresh water in lakes and rivers, and 25ml \*0.2% =freshwater in aquifers.
   3. (figure 19) The water (hydrologic) cycle involves :
      1. Return of water from the earth’s surface to the atmosphere via
         1. Evaporation out of bodies of water and moist soil into the atmosphere
            1. faster when temperatures are warmer or winds are stronger.
            2. Faster for exposed soil like a logged area
         2. Transpiration out of plants through their leaves
            1. Both evaporation and transpiration purify water
         3. Cell respiration and combustion both generate water vapor.
      2. Movement of water from the atmosphere back to the earth via
         1. Precipitation like rain or snow following condensation of gaseous water vapor into liquid water.
            1. Some precipitation is taken up by plants or animals
            2. Much precipitation flows as runoff into surface water of lakes, rivers, streams, oceans
         2. Some precipitation and surface water soaks into underground reservoirs (storage areas) called aquifers where rock and soil hold water up to a depth called the water table.
            1. Groundwater may take thousands of years to recharge—or may never recharge—if depleted.
   4. (Figure 20) Humans affect every part of the water cycle.
      1. Clearing plants increases runoff and erosion🡪increased evaporation & decreased transpiration.
      2. Watering crops depletes both surface and ground water, and it also increases evaporation from the soil.
      3. Pollutants affect precipitation, creating acid rain.
      4. Irrigation and industry have depleted groundwater so severely in some areas that water shortages have created conflicts.

Chapter 3, lesson 4: Biogeochemical cycles move nutrients through the environment.

1. Nutrient Cycling constantly moves matter through the environment .

Nutrient cycling is ruled by the law of conservation of matter: matter can be transformed from one type to another, but it can’t be created or destroyed.

Amount of matter in the biosphere is constant

Macronutrients are matter needed in large amounts by organisms

Micronutrients are needed in small amounts

Biogeochemical cycles move nutrients through the biosphere, especially N, P, O, and C, as well as water whose cycle is involved in all the other cycles.

1. The Carbon cycle (Figure 21)
2. Primary producers use sunlight for photosynthesis that moves CO2 from the atmosphere into the biosphere:
   1. 6CO2+6H2O + light energy🡪C6H12O6(sugars/carbohydrates) + 6O2
3. Consumers like animals eat plants or other organisms to obtain nutrients, while decomposers like bacteria and fungi break down wastes and dead organisms to obtain nutrients
4. Most organisms participate in returning CO2 to the atmosphere, via cell respiration
   1. C6H12O6 + 6O2🡪6CO2+6H2O + energy
5. Plants use more CO2 than they return to the atmosphere via cell respiration, so they serve as C sinks.
   1. Other C sinks include sediments, like limestone or fossil fuels, made of dead organisms. These are the biggest C reservoirs on earth.
   2. 2nd largest C sink is absorption of CO2 into sea water. (figure 22)
6. Human activities alter the C cycle
   1. Burning fossil fuels increases return of CO2 to atmosphere
   2. Deforestation decreases removing of CO2 via photosynthesis.
   3. Burning biomass releases C stored in plant tissue C sinks.
      1. Scientists haven’t been able to account for some C, but it is possible that much of it is being incorporated into the Boreal forests.
7. The phosphorous cycle primarily involves the lithosphere (figure 23)
8. Under natural conditions, most P is tied up in rocks, so that it is a limiting nutrient for plant and algal growth.
   1. Plants take up P from soil via roots
   2. Consumers obtain P from water they drink and organisms they eat,
   3. Decomposers obtain P from wastes and dead organisms, then return it to the soil.
   4. All organisms require P for making nucleic acids RNA and DNA, but also for use in making the energy storing molecule ATP.
9. Humans increase the concentrations of P in water due to fertilizer in runoff and detergents in wastewater.
   1. Algae overgrow, resulting in blooms that may be toxic
   2. In the worst situations, eutrophication results in such extreme overgrowth of algae that decomposers eating the algae use up the Oxygen in the water, resulting in severe hypoxia (lack of oxygen) and development of dead zones where neither producers or animals live.
10. The Nitrogen cycle Figure 24)
11. Bacteria take nitrogen out of the atmosphere & make it useful to other organisms, and they also return nitrogen to the atmosphere.
    1. All organisms require Nitrogen to build proteins and nucleic acids, DNA and RNA.
12. 78% of the atmosphere is N2 gas, but only nitrogen fixing bacteria and lightening can “fix N2” into ammonia (NH3) which can be used by other bacteria (nitrifiers) to produce nitrate ions which producers can use.
    1. Most nitrogen fixing bacteria live free in the soil, but some live in nodules of plants like legumes (peanuts, clovers, soybeans).
    2. Planting legumes can be used to naturally fertilized soils.
    3. Denitrifying bacteria complete the nitrogen cycle.
13. Using the energy-expensive Haber process, humans fix more nitrogen every year than nature, using it as plant fertilizer.
14. Humans also force nitrogen into the atmosphere, as NO, when burning biomass or fossil fuels, creating NO2 that leads to acid precipitation.
15. Like P, N is also usually a limiting factor in plant and algal growth, so runoff of fertilizer into bodies of water can also produce algal blooms or even eutrophication and development of dead zones.
16. Potential solutions for dead zones in the Gulf of Mexico include: (figure 26)—via 1998 and 2004 Harmful algal bloom and hypoxia research and control act.
    1. Reduction of fertilizer use
    2. Use of fertilizer in dry seasons to reduce runoff
    3. Planting crops needing less fertilizer
    4. Managing N rich manure
    5. Restoring wetlands to remove N from rivers before they reach the Gulf, as well as creating artificial wetlands around farms
    6. Improving sewage treatment

Reading Guide for chapter 3: Lesson 2

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Learning goals:

1. I can understand the types of systems in environments, as well as the interactions between systems.

2. I can understand the role of negative feedback in undisturbed environments, and the role of positive feedbacks in environments disrupted by human activity.

Chapter 3, Lesson 2: Systems in environmental science

I. Interacting systems

A. An output of one of earth’s systems is also an input to that or another system

a. Inputs into earth’s systems include energy, information, and matter.

1. Energy i\_\_\_\_\_\_\_\_\_\_\_ into a system may include
2. Solar energy absorbed by plants in a meadow
3. Geothermal activity heating water in a geyser
4. Metabolism of rabbits rising the temperature in a warren.
5. Human activities like burning fossil fuels heating air..
6. Matter i\_\_\_\_\_\_\_\_\_\_\_\_\_\_ may include
7. Seeds being brought into an ecosystems by wind
8. Pollutants and sediments flowing into the gulf of mexico via the Mississippi River
9. Food taken out of the Gulf of Mexico (fig 11), then eaten in Ohio.
10. The shrimp o\_\_\_\_\_\_\_\_\_\_\_ of the Gulf of Mexico serves as an energy i\_\_\_\_\_\_\_\_\_\_\_ in the digestive systems of the humans that eat them. Also, profits of selling the Gulf’s o\_\_\_\_\_\_\_\_\_shrimp becomes an i\_\_\_\_\_\_\_\_\_ of the global economic system.
11. Feedback loops are cyclical processes in which events can serve as either a cause or input or as an effect or output within the same system.
12. *Negative feedback loops are regulatory and result in stabilizing of conditions within a system.* *When a condition within a system decreases below the set-point, operations that in\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the condition are activated during n\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ f\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ l\_\_\_\_\_\_\_\_\_\_\_.* When a condition within a system increases above a set-point, operations that de\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the condition are activated during n\_\_\_\_\_\_\_\_\_\_\_\_\_\_ f\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ loops.
13. The thermostat for a house is set at a certain temperature (figure 12); when the temperature increases above that, the air conditioner is activated to **d\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**the temperature, but when the temperature **decreases** below the set-point, the furnace is activated to **i\_\_\_\_\_\_\_\_\_\_\_\_\_** the temperature.
14. Within Canada’s Isle Royal ecosystem, a n\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ f\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ l\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ regulates the size of wolf and moose populations. https://www.youtube.com/watch?v=vF0Mhf2ZTco Wolf-moose relationship studied on Isle Royale 2:18 seconds
    * + - 1. When food is more abundant than usual, when the weather is less harsh than usual, or when fewer moose die of diseases, the moose population size **increases**, providing more food for the wolf population and allowing it to grow, too. Having more wolves to prey upon the moose **d\_\_\_\_\_\_\_\_\_\_\_\_\_** the moose population back down to match the carrying capacity of the island.
          2. When conditions cause a **decrease** in moose population size, fewer wolves survive to prey upon the moose, so that the moose population will **i\_\_\_\_\_\_\_\_\_\_\_\_\_.**
15. In the human body systems, when the body temperature **increases** beyond its normal set-point of 37⁰C, the brain initiates sweating to **d\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** the temperature back to the 37⁰C. When the brain detects temperature has **decreased** below 37⁰C, the shivering is initiated to **i\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** the temperature back to 37⁰C.
    * 1. Positive feedback loops rarely occur in nature, because rather they restore balance (equilibrium) of an ecosystem, these loops drive the system to an extremely high or low level. Most positive feedback loops reflect human disruption of an ecosystem and its resulting destruction of the ability of negative feedback loops to operate.
         1. Human stimulated erosion can lead to a **p\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ feedback loop (Figure 1.3).**
            1. Normally, if soil erodes (**decreases**) as during a heavy rain, more plants will die, leading to more decomposing plants that decompose to form more (**i\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)** soil. This is an environmental normal negative feedback loop.
            2. When humans clear land, such as when all trees are cut, normal negative feedback for soil formation is replaced by abnormal p\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ f\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. As soil amounts **decrease** doe to erosion, decomposing wood is not available to restore the lost soil. Then, the exposed soil is eroded at a higher rate due to wind and rain, so soil levels **D\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** at an even more rapid rate.
         2. Question 3, page 75, is an excellent example of positive feedback: sunlight melts snow, exposing darker colored pavement which absorbs more heat than lighter surfaces. So, snow melts even faster.
16. Earth’s spheres
17. Earth’s geosphere, lithosphere, biosphere, atmosphere, and hydrosphere are defined according to their functions in earth’s systems. (Figure 14)
    1. G\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-made of all rock and all below earth’s surface
    2. L\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-made of hard rocks on and just below earth’s surface; the outermost layer of the geosphere
    3. B\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-all living or once living things and the nonliving things with which they interact
    4. A\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-layers of gases surrounding our planet
    5. H\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-all water—in all of its states and salty or fresh—underground, above ground, and in the atmosphere.
18. *Ecological interactions often overlap several spheres*. Example given is for how the biosphere, atmosphere, hydrosphere, and lithosphere are all affected when a robin pulls a worm out of rain moistened soil.

Notes for chapter 3, lesson 3, Earth’s Spheres: What are the characteristics of earth’s geosphere, biosphere, atmosphere, and hydrosphere?

1. The geosphere
2. The earth’s ge\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ consists of the crust, the mantle, and the core.
   1. Earth’s c\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a thin layer of relatively cool rock forming the outer skin of dry land and ocean bottom.
      1. M\_\_\_\_\_\_\_\_\_\_\_\_\_\_is below the crust and is a layer of hot, but mostly solid rock.
      2. Upper mantle and crust🡪 lithosphere
      3. L\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ floats on a hotter and softer layer of rock called asthenosphere.
      4. Lower mantle under a\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is solid rock.
   2. Outer core is molten metals near temperature of the sun.
      1. Inner c\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_=solid metal.
   3. 15 tectonic plates move about 2-15 cm per year, so that twice a supercontinent has formed and separated (last: Pangea separated 225 million years ago). (Fig 15)
      1. Convection pushes athenosphere’s soft rock upward as it heats, but allows it to sink again as it cools.
         1. Collisions/separations of t\_\_\_\_\_\_\_\_\_\_\_\_\_\_ p\_\_\_\_\_\_\_\_\_\_\_\_\_\_ results in landforms (mountains, islands, continents).
         2. Some plate boundaries are experiencing convergence (colliding) while others are experiencing divergence (separating).
         3. La\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ affect patterns of rainfall, wind, ocean currents, heating & cooling, so moving tectonic plates affect the biosphere.
   4. (Figure 16) Molten magma escapes at d\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ plate boundaries to form new cr\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ such as the mid-Atlantic ridge.
   5. At transform plate boundaries, parallel sliding of 2 plates past each other creates friction and e\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, such as at the boundary of the Pacific and North American plates near California.
   6. At convergent plates, two outcomes are possible:
      1. Subduction of one plate u\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the other, creating pressure that pushes up magma as v\_\_\_\_\_\_\_\_\_\_\_\_\_\_ e\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, such as Mt St. Helens.
      2. Mountain building as where indian-Australian plate & Eurasion plates c\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to build the Himalyas.
3. The biosphere and the atmosphere are the living Earth and the ocean of gas that supports and protects it.
   1. The b\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_is the part of the earth where living things interact; life isn’t known in the mantle or core.
   2. (Figure 17) The atmosphere contains gases like oxygen used by organisms, as well as ozone that protects the biosphere from damaging \_\_\_\_\_\_\_\_\_\_radiation, like global sunscreen!
   3. Greenhouse gases, like C\_\_\_\_\_\_\_\_\_\_\_\_\_\_ d\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and m\_\_\_\_\_\_\_\_\_\_\_\_, keep the earth warm.
4. The hydrosphere is where water cycles through the lithosphere, biosphere, and atmosphere.
   1. Earth’s water is vital as a means of material transport and as a solvent.
   2. Only \_\_\_\_\_\_\_\_\_\_\_\_% of water is fresh, with all but \_\_\_\_\_\_\_\_\_\_\_\_\_\_% tied up in ice (the cryosphere); most of this fresh unfrozen water is underground in aquifers!
      1. Great activity quick lab page 80—if all earth’s water is 1000 ml, then 975 ml represents salt water, 25ml \*.7 = freshwater in ice, 25ml\*.01= fresh water in lakes and rivers, and 25ml \*0.2% =freshwater in aquifers.
   3. (figure 19) The w\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (hydrologic) cycle involves :
      1. Return of water from the earth’s surface to the atmosphere via
         1. Ev\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_out of bodies of water & moist soil
            1. faster if temperatures are w\_\_\_\_\_\_\_\_\_\_\_\_/ winds s\_\_\_\_\_\_\_\_\_\_\_\_.
            2. F\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for exposed soil like a logged area
         2. Transpiration out of plants through their leaves
            1. *Both evaporation and transpiration purify water*
         3. Cell respiration and combustion both generate w\_\_\_\_\_\_\_\_\_\_\_vapor.
      2. Movement of water from the atmosphere back to the earth via
         1. Pr\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ like rain or snow following co\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of gaseous water vapor into liquid water.
            1. Some precipitation is taken up by plants or animals
            2. Much precipitation flows as r\_\_\_\_\_\_\_\_\_\_\_\_into surface water of lakes, rivers, streams, oceans
         2. Some precipitation and surface water soaks into underground reservoirs (storage areas) called a\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_where rock and soil hold water up to a depth called the water t\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
            1. G\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_water may take thousands of years to recharge—or may never recharge—if depleted.
   4. (Figure 20) Humans affect every part of the water cycle.
      1. Clearing plants increases r\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and erosion🡪increased ev\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from exposed soil & decreased tr\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from reduced numbers of trees.
      2. Irrigating crops depletes both surface and ground water, and it also increases evaporation of water from the soil.
      3. Pollutants like NO2 & SO2 affect precipitation, creating a\_\_\_\_\_\_\_\_\_\_\_ rain.
      4. Irrigation and industry have depleted gr\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ so severely in some areas that water shortages have created conflicts.

Chapter 3, lesson 4: Biogeochemical cycles move nutrients through the environment.

1. Nutrient Cycling constantly moves matter through the environment .

Nutrient cycling is ruled by the law of c\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of matter: matter can be transformed from one type to another, but it can’t be created or destroyed.

Amount of matter in the biosphere is c\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Macronutrients are matter needed in l\_\_\_\_\_\_\_\_\_\_\_\_amounts by organisms

M\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_nutrients are needed in small amounts

Biogeochemical c\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ move nutrients through the biosphere, especially N, P, O, and C, as well as water whose cycle is involved in all the other cycles.

1. The Carbon cycle (Figure 21)
2. Primary pr\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ use sunlight for photosynthesis that moves CO2 from the atmosphere into the biosphere:
   1. 6CO2+6H2O + light energy🡪C6H12O6(sugars/carbohydrates) + 6O2
3. C\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_onsumers like animals eat plants or other organisms to obtain nutrients, while dec\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_omposers like bacteria and fungi break down wastes and dead organisms to obtain nutrients
4. Most organisms participate in returning CO2 to the atmosphere, via cell re\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   1. C6H12O6 + 6O2🡪6CO2+6H2O + energy
5. Plants use more CO2 than they return to the atmosphere via cell respiration, so they serve as C sinks.
   1. Other C s\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ include sediments, like limestone or fossil fuels, made of dead organisms. These sediments are the biggest C reservoirs on earth.
   2. 2nd largest C sink is absorption of CO2 into o\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ w\_\_\_\_\_\_\_\_\_\_\_\_\_. (figure 22)
6. Human activities alter the C cycle
   1. Burning f\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ f\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ increases return of CO2 to atmosphere
   2. Deforestation decreases removing of CO2 via ph\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   3. Burning biomass releases C stored in plant tissue C si\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-
      1. Scientists haven’t been able to account for some C, but it is possible that much of it is being incorporated into the Boreal forests.
7. The phosphorous cycle primarily involves the lithosphere (figure 23)
8. Under natural conditions, most P is tied up in r\_\_\_\_\_\_\_\_\_\_\_\_\_ and minerals, so that it is a limiting nutrient for plant and algal growth.
   1. Plants take up P from soil via r\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. C\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ obtain P from water they drink and organisms they eat,
   3. Decomposers obtain P from wastes and dead organisms, then return it to the soil.
   4. All organisms require P for making nucleic acids R\_\_\_\_\_\_\_ and D\_\_\_\_\_\_\_\_\_\_, but also for use in making the energy storing molecule ATP.
9. Humans increase the concentrations of P in water due to fertilizer in r\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and dete\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in wastewater.
   1. Al\_\_\_\_\_\_\_\_\_\_\_\_ overgrow, resulting in blooms that may be toxic
   2. In the worst situations, eutrophication results in such extreme overgrowth of algae that decomposers eating the algae use up the O\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the water, resulting in severe hypoxia (lack of oxygen) and development of d\_\_\_\_\_\_\_\_\_\_\_\_\_ z\_\_\_\_\_\_\_\_\_\_\_\_ where neither producers or animals live.
10. The Nitrogen cycle Figure 24)
11. B\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ take nitrogen out of the atmosphere & make it useful to other organisms, and they also return nitrogen to the atmosphere.
    1. All organisms require Nitrogen to build pr\_\_\_\_\_\_\_\_\_\_\_\_\_ and nucleic acids, DNA and RNA.
12. \_\_\_\_\_\_\_\_\_\_\_\_\_% of the atmosphere is N2 gas, but only ni\_\_\_\_\_\_\_\_\_\_\_\_\_ f\_\_\_\_\_\_\_\_\_\_\_\_\_bacteria and lightening can “fix N2” into a\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (NH3) which can be used by other bacteria (nitrifiers) to produce nitrate ions which producers like pl\_\_\_\_\_\_\_\_ can use.
    1. Most nitrogen fixing bacteria live free in the soil, but some live in nodules of plants like leg\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (peanuts, clovers, soybeans).
    2. Planting legumes can be used to naturally fertilize soils.
    3. De\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bacteria complete the nitrogen cycle, returning N2 to the a\_\_\_\_\_\_\_\_\_\_\_
13. Using the energy-expensive Haber process, humans fix more nitrogen every year than nature, using it as plant f\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
14. Humans also force nitrogen into the atmosphere, as NO, when burning biomass or fossil fuels, creating NO2 that leads to a\_\_\_\_\_\_\_\_\_\_\_\_ precipitation.
15. Like P, N is also usually a limiting factor in plant and algal growth, so runoff of fertilizer into bodies of water can also produce algal blooms or even eu\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and development of dead zones.
16. Potential solutions for d\_\_\_\_\_\_\_\_\_\_\_\_\_ z\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the Gulf of Mexico include: (figure 26)—via 1998 and 2004 Harmful algal bloom and h\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ research and control act.
    1. Reduction of f\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_use
    2. Use of fertilizer in dry seasons to reduce ru\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    3. Planting crops needing less fertilizer
    4. Managing N rich manure
    5. Restoring wetlands to remove N from rivers before they reach the Gulf, as well as creating artificial w\_\_\_\_\_\_\_\_\_\_\_\_\_\_ around farms (the plants in the wetlands use the excess nitrogen, preventing its entry into the gulf)
    6. Improving sewage treatment since wastes contain nitrogen and phosphorous.

Chapter 3, Lesson Two Match the **vocabulary terms** and definitions.

\_\_\_\_\_1 negative feedback loop

\_\_\_\_\_2 positive feedback loop

\_\_\_\_\_3 erosion

\_\_\_\_\_4 geosphere

\_\_\_\_\_5 lithosphere

\_\_\_\_\_6 biosphere

\_\_\_\_\_7 atmosphere

\_\_\_\_\_8 hydrosphere

* 1. The removal of soil by water, wind, ice, or gravity
  2. The parts of the lithosphere, atmosphere, and hydrosphere where organisms live
  3. All water—liquid, ice, and vapor—on earth’s surface, underground, and in the atmosphere
  4. A cyclical process that restores balance and stability to a system; when conditions increase above a normal set-point, operations are activated to decrease the condition back to normal.
  5. The hard rock on or just below the earth’s surface—the outermost layer of the geosphere.
  6. A cyclical process that drives a system farther away from balance or stability; when conditions increase above a normal set-point, operations are activated to further increase the condition. Or, when conditions decrease below a normal set-point, operations are activated to further decease them. These cycles occur after human ecosystem damage.
  7. The layers of gases that surround earth.
  8. All of the rock, both molten and solid, at or below the earth’s surface

Match vocabulary terms 1-8, from the previous section, with corresponding explanations or examples.

\_\_\_\_\_i. the location of the ozone layer

\_\_\_\_\_j. Includes aquifers, as well as bodies of water and clouds.

\_\_\_\_\_k. Includes the tectonic plates.

\_\_\_\_\_l. For example, the when moose population size **increases** after a year of abundant food, wolf populations also increase; as a result the moose population size **decreases** to the level that can be sustained by the ecosystem.

\_\_\_\_\_m. for example, when Easter Islanders cut down all of the island’s trees, soil washed into the ocean, leaving them unable to grow crops.

\_\_\_\_ n. After the Easter Islanders cut down most of the trees, soil washed away at a faster rate, resulting in lower rates of tree regrowth so that even more soil washed away the next season. Also, as they needed to plant more acres of crops to produce enough food in the thinned soil, they even further increased the rate of soil loss.

\_\_\_\_o. Includes the core, the mantle, and the lithosphere.

\_\_\_\_p. probably does not include the core or the mantle, because these are likely too hot to support life.

Quick Check— Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_

Feedback loops-Chapter three, lesson 2

*Sort the descriptions below into two groups:*

*I. Negative Feedback loops OR II. Positive feedback loops*

a. If a condition decreases lower than the homeostatic set point, then a stimulated event increases the condition back up to homeostatic set point  **OR** If a Condition increases above the set point, then a stimulated event decreases the condition back up to the set point

b. If a condition rises above the homeostatic set point, then a stimulated event raises the condition even more **OR**  If a condition falls below the homeostatic set point, then a stimulated event lowers the condition even more.

c. Type of feedback most often associated with human disruption of an ecosystem

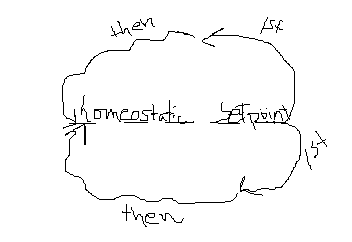
d. Type of feedback typical of most often associated with natural, undisrupted, healthy ecosystems

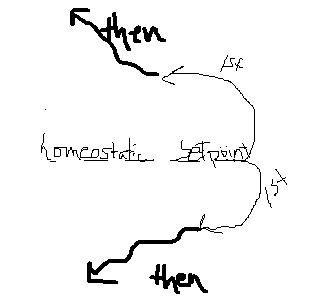
e. Maintains ecological homeostasis, balance, or equilibrium.

f. Drives conditions away from homeostasis towards extremes (e.g., very hot or very cold)

g. During human birth labor, each contraction makes the next one stronger

h. For example, homeostatic body temperature humans is about 37°C; when body temperature rises above 37°C, the brain stimulates sweating and surface blood vessel dilation to lower the temperature. However, when body temperatures fall below 37°C, the brain stimulates shivering and surface blood vessel constriction to raise the body temperature.

i. 

j. 

Practice with inputs and outputs of interacting systems.

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Notes, section 2, 9/28/2015

Scenario.

The Ocean Pacific Paper Company, located in St. Mary’s, Florida, rents 100,000’s of acres for the purpose of planting pine trees that will be cut after six years, then ground into pulp for making paper. Farmers are paid for the use of the land, then they use these profits to pay for seeds and to buy fertilizer. Farmers sell their crops to consumers, then they use the money to buy business supplies, like paper.

consumer input \_\_\_\_\_\_\_\_\_

Farmer Output \_\_\_\_\_\_\_\_\_

Farmer input \_\_\_\_\_\_\_\_\_

OP Output \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Farmers

Consumers in the markets

Ocean Pacific Paper Company

OP output \_\_\_\_\_\_\_\_\_

OP output \_\_\_\_\_\_\_\_\_

OP Input

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Farmer Output\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Farmer input\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Consumer Output\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Chapter 3, Lesson 3 Match the vocabulary term with its definition.

\_\_\_\_1. Tectonic plate

\_\_\_\_2. Landform

\_\_\_\_3. Evaporation

\_\_\_\_4. Transpiration

\_\_\_\_5. Precipitation

\_\_\_\_6. Condensation

\_\_\_\_7. Aquifer

\_\_\_\_8. Groundwater

\_\_\_\_9. Divergent plate boundary

\_\_\_10. Transform plate boundary

\_\_\_11. Convergent plate boundary

\_\_\_12. Greenhouse gases

\_\_\_13. Acid precipitation

\_\_\_14. Fresh water

a. CO2, CH4 methane, & other gases that trap heat, keeping Earth warm enough for life.

b. Where tectonic plates move parallel to each other, causing earthquakes.

c. Only about 2.5% of the matter in the earth’s hydrosphere.

d. The evaporation of water vapor from the leaves of trees.

e. Where tectonic plates are moving away apart, allowing magma to escape & make landforms.

f. conversion of atmospheric water vapor to liquid water that returns to the lithosphere.

g. Water that is stored underground in rock formations; people obtain it from wells.

h. One of 15 large pieces of the lithosphere that float due to convection in the earth’s mantle.

i. Where two tectonic plates are moving closer to each other; either subduction or uplifting.

j. A mountain, island, or continent.

k. The conversion of water vapor to liquid, such as occurs in the atmosphere prior to precipitation

l. The location of groundwater.

m. liquid water in soil or bodies of water is converted to vapor that returns to the atmosphere

n. precipitation contaminated by NO2 or SO2, usually due to air pollution from burning fossil fuels

Match Vocabulary terms 1-14 from the previous section with an example or explanation

\_\_\_\_\_o. cooling water vapor leads to this

\_\_\_\_\_p. one tectonic plate moves underneath another; for example, the cause of Mt. St. Helen’s eruption

\_\_\_\_\_q. rain, sleet, snow

\_\_\_\_\_r. The reason for the existence of the mid-Atlantic ridge, a range of underwater mountains.

\_\_\_\_ s. Most of this is found in ice of the Earth’s glaciers.

\_\_\_\_t. Causes the earthquakes in California

\_\_\_\_u. Results in fish kills in a lake whose pH falls to less than 5

\_\_\_\_v. Hawaii is a chain of these

\_\_\_\_w. This part of the water cycle is directly reduced by deforestation; the process transportation of water from the ground, into roots, then to all other parts of a tree

\_\_\_\_x. This part of the hydrologic cycle occurs more rapidly when soil is exposed after deforestation, especially if conditions are hot or windy.

\_\_\_\_y. Global warming results when these increase in concentration

\_\_\_\_z. These underground storage areas may require 1000’s or more years to be refilled

\_\_\_aa. These landmasses converged over 200 million years ago, forming Pangea

\_\_\_bb. This type of water is used when crops are irrigated with well water.

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Why is analysis of plate tectonics important for determination of:

a. Where to allow a nuclear power plant or waste storage facility to be constructed?

b. Where to locate population centers?

The water table (page 82) has fallen in many parts of the world. Why? Why does this matter now and for the future?

When precipitation increases, water levels rise in lakes and other bodies of water, but absorption of water into aquifers lowers the water levels. Is this a part of a negative feedback loop or a positive feedback loop?

Chapter 3, Lesson 4 Vocabulary practice Match the terms with the correct definitions

\_\_\_\_\_1. Law of conservation of matter

\_\_\_\_\_2. Primary producer

\_\_\_\_\_3. Consumer

\_\_\_\_\_4. Photosynthesis

\_\_\_\_\_5. Cell respiration

\_\_\_\_\_6. Decomposer

\_\_\_\_\_7. Eutrophication

\_\_\_\_\_8. Nitrogen fixation

\_\_\_\_\_9. Biogeochemical cycle

\_\_\_\_10. Nutrient

\_\_\_\_11. Carbon sink

\_\_\_\_12. Combustion

\_\_\_\_13. Limiting factor

\_\_\_\_14. Nitrates

\_\_\_\_15. Dead Zone

a. After nitrogen fixing bacteria make ammonia, nitrifying bacteria make ions that plants can use.

b. The extreme overgrowth of aquatic plants or algae in a body of water contaminated by P and N runoff; as decomposers that break down the algae use oxygen, other aquatic organisms suffocate.

c. A resource that normally serves as to control the size of populations as individuals compete for it.

d. Matter can be transformed from one form to another, but it cannot be created or destroyed

e. Burning organic matter in the presence of oxygen to produce oxygen gas and water vapor

f. Organisms who use light energy for photosynthesis

g. Organisms who obtain nutrients by eating other organisms.

h. 6CO2 + 6H2O + light energy 🡪 C6H12O6 + 6O2

i. cyclic movement of matter through ecosystems; maintains stable levels of nutrients

j. Organisms whose nutrients are obtained either from wastes or from dead organisms.

k. C6H12O6 + 6O2 🡪6CO2 + 6H2O

l. The conversion of atmospheric N2 into ammonia by bacteria living in the soil or in root nodules.

m. A hypoxic region of a body of water; these form as a result of eutrophication.

n. A reservoir of Carbon where it is can be prevented from returning to the atmosphere

o. Matter that an organism requires for its life processes

Match vocabulary terms 1-15 from the previous section with correct examples or explanations.

\_\_\_\_p. for example, plants and algae

\_\_\_\_q. for example, the C cycle, the water cycle, the N cycle, or the P cycle

\_\_\_\_r. for example, fungi and many bacteria

\_\_\_\_s. in bodies of water, these regions are devoid of organisms that require Oxygen

\_\_\_\_t. bacteria that carry out this process are found in roots of legumes, so they are protein rich

\_\_\_\_u. The amount of matter in the biosphere is constant.

\_\_\_\_v. Farmers use fertilizers to provide these for plants.

\_\_\_\_w. In most ecosystems, N and P are examples; algae growth increase when these are added

\_\_\_\_x. This can be seen in a pond with a thick layer of green scum and dead fish.

\_\_\_\_y. the process used by producers to store energy in sugars

\_\_\_\_z. for example, animals

\_\_\_\_aa. Oxygen requiring process that allows organisms to extract energy from food

\_\_\_\_bb. Important reason that greenhouse gases have increased in concentration since the 1800’s

\_\_\_\_cc. The largest is sedimentary limestone; the second is carbon dioxide dissolved in oceans; another is organic compounds stored within the tissues of plants.

\_\_\_dd. Vitamins, minerals, and food are examples for humans

Describe two processes that return C to the atmosphere.

Describe two processes that remove C from the atmosphere.

Describe a process that adds P to soil and water.

Describe a process that removes P from soil and water.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Describe two processes that remove nitrogen gas from the atmosphere.

Describe a process that returns nitrogen gas to the atmosphere.

Explain why plants can’t survive without nitrogen fixing and nitrifying bacteria.

Explain why N and P runoff from fertilized lawns and fields are the primary causes of algal blooms and eutrophication.

Why is cessation of manmade fertilizer not an option for preventing dead zones?

Describe 3 processes that return water vapor to the atmosphere.

Describe human activities that disrupt 3 different points in the water cycle.

The author stated that the water cycle is involved in the cycling for C, N, and P. Justify this statement with an explanation for where water is involved in each of these biogeochemical cycles.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Practice sketching, labeling, and explaining the N, P, C, and water cycles!

Identify examples of normal negative feedback regulation in at least one cycle.

Identify examples of abnormal, human caused positive feedback in at least one cycle.