Environmental Science

Sample Science Learning Plan

Big Idea/ Topic

Planet Earth, Energy, Succession, Biodiversity

Standard Alignment

SEV1. Obtain, evaluate, and communicate information to investigate the flow of energy and cycling of matter within an ecosystem.

a. Develop and use a model to compare and analyze the levels of biological organization including organisms, populations, communities, ecosystems, and biosphere.

b. Develop and use a model based on the Laws of Thermodynamics to predict energy transfers throughout an ecosystem (food chains, food webs, and trophic levels). (Clarification statement: The first and second law of thermodynamics should be used to support the model.)

d. Evaluate claims, evidence, and reasoning of the relationship between the physical factors (e.g., insolation, proximity to coastline, topography) and organismal adaptations within terrestrial biomes.

SEV2. Obtain, evaluate, and communicate information to construct explanations of stability and change in Earth's ecosystems.

c. Construct an argument to predict changes in biomass, biodiversity, and complexity within ecosystems, in terms of ecological succession.

d. Construct an argument to support a claim about the value of biodiversity in ecosystem resilience including keystone, invasive, native, endemic, indicator, and endangered species.

Connections to other content areas:

ELAGSE9-10RI8: Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid, and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.

ELAGSE9-10W2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

ELAGSE9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

ELAGSE11-12RI7: Integrate and evaluate multiple sources of information presented indifferent media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

Instructional Design

Engage:

Phenomena: How small are we compared to the universe?

Have students watch the following video about the scale of the universe. Have students make sketches of what they notice at each level from the ground to space.

Students could also create a "Know and Wonder" t-chart to record their thoughts (know) and questions (wonder) that they have as they watch.

Students can then discuss their questions and what they know with their peers. Some questions that could help guide the discussion:

- How would you have felt to be the first human to see Earth from this point of view?
- How is Earth like a spaceship?
- What is the significance of the color of the Earth from space?
- What did you "wonder"?
- How do you as an individual fit into this spaceship model?

Students attempt to label the levels of organization from biosphere down to organism in their drawings from the video (this should be a review from biology and 7th grade).

Have students go outside, somewhere safe, to explore the environment and find examples of each of the levels of ecological organization. Students should either draw or take a digital image (a picture) that can be used to show the level of organization in the area that the students live. Students should be prepared to share and justify their images of the different levels of organization.

Unplugged: Students should go outside at night and observe the moon. Is it close or far away? Students should draw the moon as it appears from Earth. Then students should use their prior knowledge to describe or draw how they believe that Earth appears from the moon. Students should then **begin** to look for other examples of the different levels of organization. Students should draw an image of each of the different levels of organization and describe why the image represents the level of organization that it represents. Consider using one of these graphic organizer options, option1 or option 2, to assist students in putting the information in one place.

Explore:

Phenomena: How do ecosystems function and change over time?

Students should then focus on the ecosystem level of organization and begin to describe the many changes at this level of organization. Students can begin to look at the ecosystem level by focusing on energy dynamics within the ecosystem.

Students should begin by going outside and identifying food chains and food webs within their environment. Then students should determine how energy flows within the food chain/food web.

Then remind students about the laws of thermodynamics:

First Law: Energy cannot be created or destroyed only transformed from one form to another.
Second Law: In the path of energy transformation some energy is converted to heat and the entropy increases.

Students should plan an investigation about what happens to energy within the food chain/food web that they identified in their environment. Students should begin to develop explanations about where energy is coming from and where energy is going. Students should include information about the first law of thermodynamics keeping in mind that the energy must come from somewhere (it cannot be created) and it must go somewhere (it cannot be destroyed) and the second law of thermodynamics that shows how heat and entropy must increase as energy transforms.

Students should then create a model food chain that shows the movement of energy, the forms of energy and has descriptions of how the law of thermodynamics apply to the steps.

Unplugged: The teacher should consider providing students with articles to review ecosystems, food chains, energy, and the laws of thermodynamics. The teacher should provide students with the instruction sheet for planning an investigation and be available to answer questions throughout the process. The teacher should provide clear and consistent feedback throughout the process.

Explain:

Phenomena: How do ecosystems function and change over time?
Students should use their food chain/food web to make a hypothesis about why it is important that there is a variety of organisms in the environment. The students should go outside and survey the environment that they live in from a safe location. Students should record the different animals, insects, and plants that they see in the environment. Students should be looking for variety (number of different organism) of the organism than they see and should be worried about the names of the organisms. Students can use this sheet to assist in their observations.

Students can then begin to research information about why biodiversity is important and how it impacts different ecosystems. Then students should construct an argument to support a claim about the value of biodiversity in ecosystems.

Some questions to help students with their research can be found below:

- Are ecosystems with more biodiversity more resilient (more likely to survive change)? Justify with reasoning from your research.
- How do keystone species affect biodiversity in an ecosystem? Justify with reasoning from your research.
- How do invasive species impact biodiversity? Justify with reasoning from your research.
- How do endemic, indicator, and endangered species factor into biodiversity? Justify with reasoning from your research.

Now, students should evaluate the physical factors in environments/biomes that exist in the biosphere. Students can begin by mapping the physical factors that exist within the biosphere. Then students should evaluate the physical factors within the environment that they live in which impact life in the area. Also, students should identify the type of biome that they live in based on the map that they created.
Some questions for students to consider about their environment:

- How much sunlight does the environment get throughout the year (insolation)?
- What is the topography in the area?
- How close are you to the coastline?

Students should begin to think about adaptations that could help organisms survive in their specific biomes. Students can start by filling in the biome and adaptations chart and then they should apply their knowledge by choosing four of the organisms that live on-land in their area and contribute to the biodiversity of the ecosystem that they live in. In Georgia, this could include squirrels, hawks, racoons, rattle snakes and any other species that you can see in various regions within the state of Georgia.

Students should then research these organisms to find out what adaptations help them survive in Georgia. Students should make a claim about one of their organisms that answers the following question, what is the relationship between the environment and the organism's adaptations?

Students should then evaluate other student's claims, evidence, and reasoning about the relationship between physical environments and adaptations in terrestrial biomes.

Unplugged: Teachers should consider providing articles to help students understand biodiversity, physical factors, adaptations and Georgia organisms. Students should, also, be provided with the handouts needed to complete the work. Students will need time to complete the assignment. Students may need two copies of the map, if they do not have access to page protectors, so that students can map the wind currents on a separate map. The teacher should consider providing students with claims to evaluate if the students do not have easy access to the other students' discussions.

Elaborate:

Phenomena: How do ecosystems function and change over time?
Students should observe the different types of succession that can occur in the environment and the causes of both types of succession using video, observations outside or articles. Consider using the following graphic organizer to assist in students comparing and contrasting different types of succession.

Then students should evaluate the scenario. Then students should construct an argument that predicts changes in biomass, biodiversity, and complexity when succession occurs in this scenario.

Unplugged: The teacher should consider providing students with articles and information about succession within an ecosystem. Be sure to provide students with the graphic organizer and the scenario to complete this assignment.

Evaluation:

Phenomena: How do ecosystems function and change over time?
Have students evaluate the following scenario about the invasive species of Tegu. This information sheet can be used to assist students in evaluating the situation.

Then students should construct an argument that describes what would happen if Tegus were introduced to Alaska and Hawaii. Some questions to assist students follow:

- Would the Tegu be able to survive in Alaska? Hawaii? (Think about the adaptations that Tegu's have and the biome/environment that they are being introduced into)
- What effects would the Tegu have on the food chains in Alaska? Hawaii?
- Would the Tegu influence biodiversity?
    - Would it be a positive effect or a negative effect on biodiversity? Justify.
    - How would it impact the biodiversity in the area?

Unplugged: Provide students with the invasive species sheet so that they can complete the assignment. Consider providing students with articles about the Tegu and the environments in Alaska and Hawaii.

Lesson goals checklist

Standards:

SEV1. Obtain, evaluate, and communicate information to investigate the flow of energy and cycling of matter within an ecosystem.
a. Develop and use a model to compare and analyze the levels of biological organization including organisms, populations, communities, ecosystems, and biosphere.
b. Develop and use a model based on the Laws of Thermodynamics to predict energy transfers throughout an ecosystem (food chains, food webs, and trophic levels). (Clarification statement: The first and second law of thermodynamics should be used to support the model.)
d. Evaluate claims, evidence, and reasoning of the relationship between the physical factors (e.g., insolation, proximity to coastline, topography) and organismal adaptations within terrestrial biomes.

SEV2. Obtain, evaluate, and communicate information to construct explanations of stability and change in Earth's ecosystems.
c. Construct an argument to predict changes in biomass, biodiversity, and complexity within ecosystems, in terms of ecological succession.
d. Construct an argument to support a claim about the value of biodiversity in ecosystem resilience including keystone, invasive, native, endemic, indicator, and endangered species.

- ☐ Develop a model of the levels of biological organization.
- ☐ Develop a model that shows energy transfer in an ecosystem.
- ☐ Evaluate claims about the relationship between physical factors in the environment and organismal adaptations.
- ☐ Construct an argument that predicts and explains changes in biodiversity, biomass and complexity within ecosystems when undergoing succession.
- ☐ Construct an argument about the value of biodiversity in ecosystem resilience.

Evidence of Student Success
Student mastery is assessed throughout this unit using formative and summative components. Student discussion, explanations and products should reflect the understanding indicated in the Evaluate section above. Each activity in the segment functions as an assessment opportunity as well to plan targeted supports or provide extension items. Formative options using the self-evaluation checklist and the activities at various points during the segment.

Student Learning Supports

The goal for science education in the state of Georgia is as follows: All Students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields.
The learning experiences provided for students should engage them with fundamental questions about the world and with how scientists have investigated and found answers to those questions.
This lesson includes the disciplinary core ideas, science and engineering practices and crosscutting concepts to actively engage students in exploring science concepts with real world topics. As part of the vision we must support the inclusion of all students in science learning.

Some **general** ideas to consider when planning lesson supports are as follows:

- Be sure that students can access the information that you they are learning. Make sure that you can answer the following questions:
    - Do students have what they need to get the information? This is about them having the book or internet access to get to the information.
    - Once students obtain the information, are students able to determine what information is important? This is about the students having materials on the appropriate grade level and that is in a format that students can understand.
    - Is the material presented in multiple ways that allows all students to interact with information in a way that works for them? Such as video, audio, and articles.
    - Consider read aloud as a potential option for students that have reading deficits as an option to assist students in accessing the material. This could be done using video or via phone.
- Students may need ideas about where to find information. Providing students with information about what a reliable source is and even where to find reliable sources may be beneficial for students.
- Some students may find it difficult to complete the entire lesson workload. Some students may benefit from a reduced workload (note: this should be used only when absolutely necessary). Be sure that the information that is removed will not negatively impact the student's understanding of the disciplinary core idea.
- Consider how students show their knowledge. Students need multiple ways and opportunities to show their knowledge. Things to consider:
    - Recording video or audio
    - Drawing
    - Writing
    - Typed
    - Verbal
- Provide students with a way to ask questions in a forum that does not cause anxiety. Frequently students do not want to ask questions in front of their peers because they are afraid of what their peers may think of them. So, be sure to provide students a way to ask questions that is private or anonymous.
- Consider materials that students need to complete the assignments.
    - Do students have needed materials?
    - What are some alternative mateirals that students may have available to them?
- Have a clear and consistent set of guidelines for providing consistent feedback to all students.

- Utilize graphic organizers such as those from the Wonderofscience.com
- Use high leverage and evidence-based practices to reach all students.

Some ideas to consider for supporting students, **specific to this lesson**, are as follows:

- Consider discussing the know and wonder chart to help students see what questions everyone has and to activate prior knowledge that students have.
- Discuss what students saw at each level of organization within the video. How are the levels similar and how are they different?
- Provide opportunities for students to show their knowledge in different formats. These formats could include drawing, writing or verbally explaining.
- Remind students about what an observation is and how it is different from an inference.
- Provide students with organisms if going outside and observing is not suitable for the student based on location, time, safety concern or another factor.
- Consider providing students with videos and articles reminding students of the laws of thermodynamics.
- Consider guiding questions to help students plan an investigation.
- Consider providing students with sources to find information about the topics contained in this lesson.
    - Consider teaching students to evaluate sources to find reliable sources.
- Consider giving students a place to get their work checked as they work through the lesson.
- Have a clear and consistent way to provide feedback to students.
- The teacher may need to consider providing students with some adaptations and having students match it to the physical factors that the adaptation would occur around.
- The teacher may need to provide examples of relationships between adaptations and physical environments.
- The teacher should consider providing a rubric for explanations, projects, and other products. This allows students to evaluate their progress as they work.
- The teacher may need to consider providing an example scenario and answer to assist students in understanding the requirements of evaluating scenarios.

Engaging Families

Additional resources to support this segment can be found at GPB: Georgia Home Classroom. Also, encourage families to join in on the student's exploration of nature and research about the Tegu as an invasive species.

Know and Wonder T-chart

Know	Wonder

Levels of organization

Level of organization	Description	Picture
Organism		
Population		
Community		
Ecosystem		
Biome		
Biosphere		

Organization of Ecology Matching- match the terms to the image picture and then use the last box to justify.

Organism			
Population			
Community			
Ecosystem			
Biome			
Biosphere			

Energy Transfer and Thermodynamics

Instructions: You should plan and carry out an investigation to show energy movement throughout a food chain. However, it might be better to begin by looking at energy in an individual organism, such as yourself, and focusing on the laws of thermodynamics. Below you will find a reminder of the first and second laws of thermodynamics.

First Law: Energy cannot be created or destroyed only transformed from one form to another.
Second Law: In the path of energy transformation some energy is converted to heat and the entropy increases.

Use the box below to plan your investigation. Hint: Think about how you could show energy usage in yourself or another organism that lives within your environment.

Answer the following questions about your investigation and findings:

1. Where did the energy to sustain the organism you were planning your investigation come from?
2. Where did the energy come from that was used to sustain the organism's food chain?
3. What happens to the energy within the organism that you chose to investigate?
4. What form does the energy leave the organism in?
5. Is energy created or destroyed? Justify.

Mapping the Physical Factors

Evaluating evidence of the relationship between the physical factors and organismal adaptations within terrestrial biomes.

Materials:

- Copy of the World Map
- half of a Page protector (Optional)
- Colored pencils
- Permanent markers

Draw and label the following oceanic surface currents directly on the map. Use red for the warm currents and blue for cool currents.

- Antarctic Circumpolar
- Benguela
- Brazil
- California
- Canary
- East Australian
- Equatorial (north and south)
- Gulf Stream
- Equatorial countercurrent
- West Australian
- West Wind Drift
- Peru (Humbolt)
- North Pacific Drift
- North Atlantic Drift
- Mozambique
- Kuroshio (Japan)

Draw and label the major mountain ranges directly on the map.

- Appalachians
- Alps
- Andes
- Himalayas
- Rockies
- Pyrennes
- Sierra Madres
- Australian Alps
- Urals

Draw and label the major terrestrial biomes directly on the map. Create a color key for your biomes

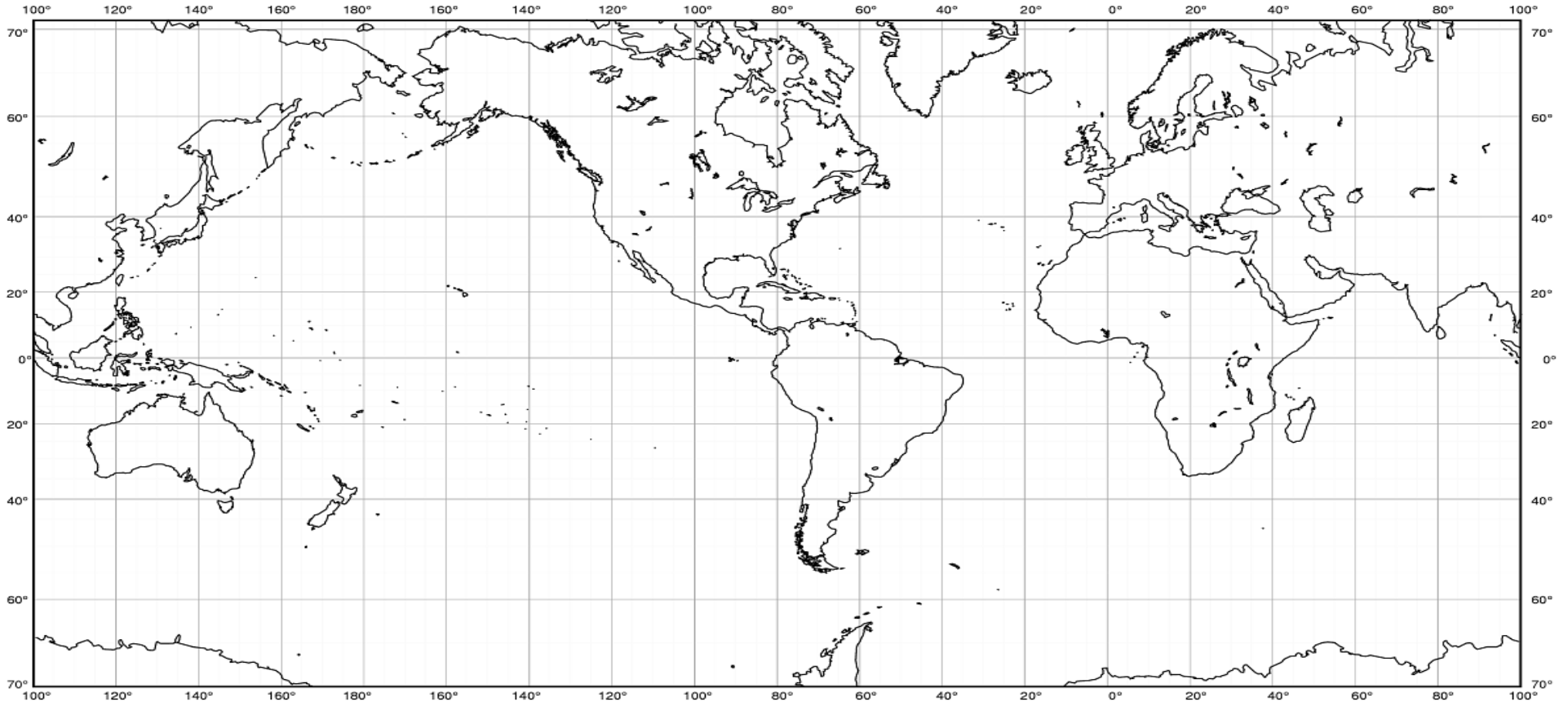
- Boreal forest (taiga, coniferous forest)
- Chaparral
- Desert
- Savanna
- Tundra
- Tropical Rain Forest
- Temperate Grassland
- Temperate Deciduous Forest

Staple the clear page protector to the paper map. Using permanent markers draw and label the prevailing wind patterns in each hemisphere. Include the direction in which the winds move across the Earth.

- Polar Easterlies
- Trade winds
- Westerlies
- Doldrums

Using the evidence, you have collected in this activity, construct an explanation of the relationship between the physical factors and the location of the major terrestrial biomes.

World Map



Terrestrial Biomes: Physical Factors and Organismal Adaptations

Biome Name								
Climatogram (temperature and precipitation)								
Latitude or angle of Insolation (variation in day/night)								
Proximity to Coastline (impact of major ocean currents and prevailing winds)								
Topography (impact of mountain ranges)								

Amount of Biodiversity								
Major Plant Adaptations*								
Major Animal Adaptations*								
Keystone species								
Endangered Species								
Bioindicator species								

*These should be general adaptations, not necessarily adaptations of a specific species (e.g. deciduous plants lose leaves in winter, thick coats of fur for cold weather) *

Variety of Species in My Environment

Directions: How many different types of organisms can you find in your environment? Use the tally marks to record the different organisms that you see in the following categories. Ex: I see a fly, a blue bird, red bird, and a squirrel. This observation would lead to a tally mark for insects, 2 tally marks for birds and one tally mark for mammals.

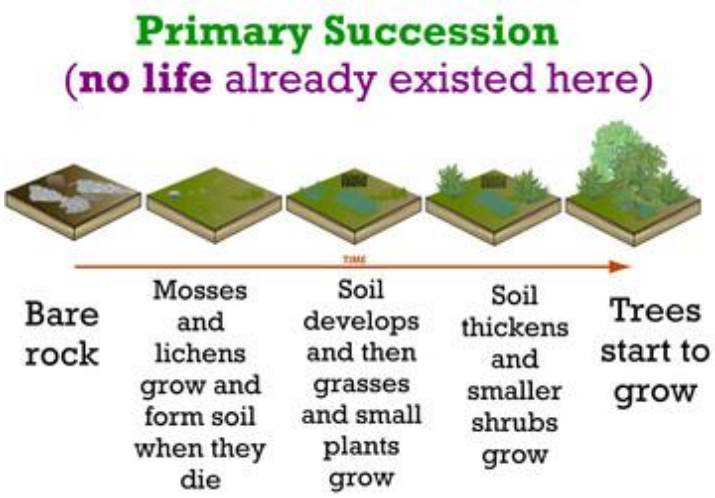
Types of organisms	How many do you see?
Insects	
Birds	
Mammals	
Reptiles	
Amphibians	
Fish	

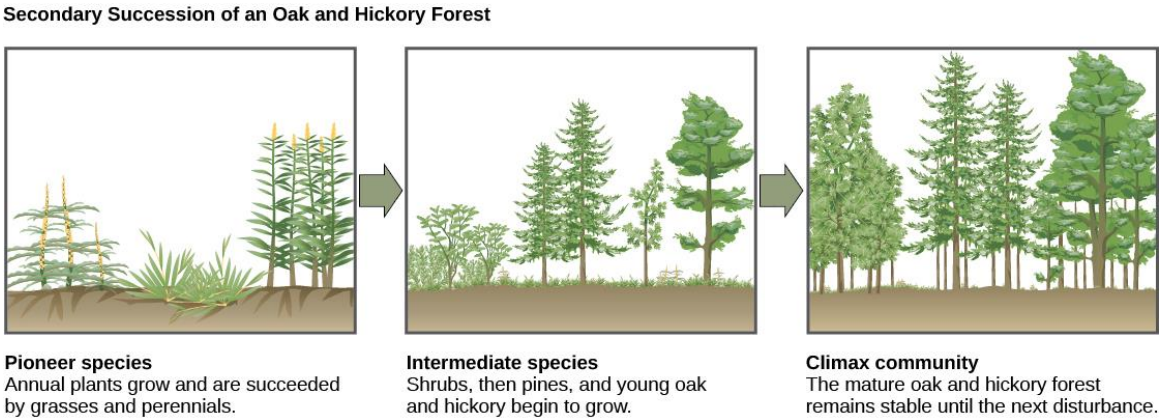
Now, count the tally marks in each box and record the total number of organisms that you encounter in your environment below.

Total: _____

Types of Succession and Changes in the Environment

Directions: Use the images below to compare and contrast primary and secondary succession.





Primary succession	Both	Secondary Succession

Changing Environments and Biodiversity

Directions: Evaluate the following scenario. Be sure to provide information about how the events in the environment could impact biodiversity, biomass, and complexity of the ecosystem.

Scenario:

1. You are a biologist that is working to help preserve some species of plants and animals in the Amazon rainforest. In the middle of the night, you get a phone call waking you up to let you know that a volcano is erupting in the exact area that you have been studying and working in. The company that you work for is asking for a report that will assess the damage to the environment. The company has asked that you include a description of what is occurring the in ecosystem and what impacts this will have on the entire ecosystem.

Invasive Species and Ecosystems

In Florida there is an invasive species of lizard, the Argentine Tegu, that is moving into habitats closer to Georgia. Some Georgia counties have seen the Tegu appear in their area and the Georgia DNR (Department of Natural Resources) has been working hard to combat the spread. Let us look more closely at the Argentine Tegu and then predict how it would impact environments that it is introduced into.

The above picture is the Argentine Tegu. It is a large lizard that can grow up to four feet long and can weigh more than ten pounds. The Tegu is native to South America and has a range that includes much of the continent, see the image below.

The Tegu was introduced to Florida as a pet. There is not concrete evidence as to how the Tegu was introduced to the wild. However, there are a couple of theories such as, many pet owners that buy a very small lizard are not prepared to handle a lizard that can be four feet long. So, some pet owners released their pets into the wild. Also, during some of the hurricanes that Florida experienced some pet stores and homes were damaged which allowed the Tegus to escape.

Now, Tegus have invaded much of Florida and some of South Georgia. There are many consequences to having invasive species in the ecosystem. Tegus reproduce quickly and have destructive eating habits. Take some time to research the Tegu to answer the following questions:

1. What type of habitat/biome do Tegus live in during their native environment?
2. What do Tegus eat?
3. Where do Tegus live (i.e. burrows, in trees, in water)?
4. Are Tegus dangerous?
5. What temperatures can Tegus survive in?
6. What types of adaptations do Tegus have to help them survive in their natural habitat?

Now, take a minute and think about adaptations that the Tegu would have to allow them to survive in Florida and South Georgia. Then predict what would happen to biodiversity, biomass, energy, and new adaptations in the following situations:

1. A native Hawaiian called into the Department of Natural Resources (DNR) and reports that they have found some strange large lizards on their property. The DNR sends in a biologist who identifies the lizards as Tegu from Argentina. The DNR biologist contracts with your company to get a report on the impacts of the Tegu to the area and the likelihood that they will survive in Hawaii.
2. A native Alaskan called into the Department of Natural Resources (DNR) and reports that they have found some strange large lizards on their property. The DNR sends in a biologist who identifies the

lizards as Tegu from Argentina. The DNR biologist contracts with your company to get a report on the impacts of the Tegu to the area and the likelihood that they will survive in Alaska.