The National Aquarium is a nonprofit organization whose mission is to inspire conservation of the world’s aquatic treasures.
Bountiful Biomes
A 60-minute outreach program session for Grades 2—4

PROGRAM DESCRIPTION
Bountiful Biomes will excite and engage your students as they explore the world and the animals that live in it. A PowerPoint presentation exposes students to a wide variety of biomes and aquatic environments around the world including the rain forest, theintertidal zone, and even their schoolyard. Exploration of these biomes reveals the animals living in each area. A hands-on lab experience follows the presentation where students explore the ways in which animals’ adaptations help them survive in different biomes.

PLANNING FOR THE PROGRAM
This lesson includes pre- and post- program activities that will supplement the program and discovery lab sessions. These activities can be incorporated into science, reading and social studies units about Maryland, map studies or ecology lessons. This lesson should be covered in three days including the Outreach program at your school.

PRE-OUTREACH PROGRAM
Before educators from the National Aquarium’s Formal Education Team visit your school, read the Teacher Background section found on pages 5-14 and share with your students. As a class, complete Activity 1– Homes Around the World found on pages 15-20.

This activity will allow students to familiarize themselves with vocabulary and material that will be taught during the Outreach program as well as to reinforce what the students already know about biomes and aquatic environments. These activities incorporate content areas touched upon during the National Aquarium’s Outreach program including information about the characteristics of different biomes and aquatic environments, adaptations animals possess, map reading skills and creative writing skills.

AAAS Benchmarks
5D/E4-3-5: Changes in an organism’s habitat are sometimes beneficial to it and sometimes harmful.
12D/E7-3-5: Write a clear and accurate description of a real world object or event.

MD Voluntary Curriculum: Science
Grade 3- 1.0 Skills and Processes B.1.a
Develop explanations possessed and evidence from observations, reliable print resources, and investigations.

Grade 3- 6.0 Environmental Science A.1
Use scientific skills and processes to explain the interactions of environmental factors (living and non-living) and analyze their impact from a local to a global perspective.

Grade 4- 3.0 Life Science F.1.
Explain ways that individual and groups of organisms interact with each other and the environment.

Grade 4- 6.0 Environmental Science B.1.
Recognize and describe that people in Maryland depend on, change, and are affected by the environment.
DAY OF THE OUTREACH PROGRAM
The Bountiful Biomes program is a 60 minute program. The Aquarium staff will arrive at your school approximately 30 minutes before the start time listed on your contract. The Aquarium staff cannot move materials between classrooms; one dedicated classroom for all classes to use is required for the program. The Aquarium staff requests that you allow at least 10 minutes between each program to clean up and set up for the next class. The Aquarium staff also requests a one hour break at midday for lunch. Please have a copy of the day’s schedule available for Aquarium staff upon arrival. If you would like the Aquarium staff to review your schedule, please fax it to 410-659-0116 ATTN: Outreach, or email to Schoolprograms@aqua.org.

Although parent volunteers are not required for this program, parents are strongly encouraged to assist with the lab portion of the program. Volunteer information is included with your teacher packet.

POST-OUTREACH PROGRAM
After educators from the National Aquarium’s Formal Education Team visit your school, complete either Activity-2A What can you do? found on pages 21-23 or 2B-Bayscaping: Building An Environmentally-friendly Yard, found on pages 24-27. Both of these activities focus on the concept of your schoolyard as part of a biome. They also reinforce critical thinking and language arts skills, as well as conservation issues addressed in the presentation.
area, The living organisms, such as plants and animals, are referred to as **biotic**. The non-living materials, such as water, sand, sunlight and oxygen are referred to as **abiotic**. Ecosystems may vary in size and can be as large as the Sahara Desert or as small as a puddle.

The world’s major terrestrial communities and ecosystems are placed into categories called biomes. A **biome** is considered a large, distinct region of land, consisting of major plant and animal communities and ecosystems, which is named and classified by its plant cover. In addition to plant life, a biome is differentiated by its unique combination of **climate** (average temperature and precipitation), soil type and animal species that are adapted to living in that particular environment. Therefore, it is the combination of plants, climate, soil type and animals that make a biome unique. Although each biome is distinct, borders/transitions between biomes are not.

**Transitional regions** are formed where the unique plant life of two different biomes begin to overlap and blend together. Due to this, scientists often debate about whether or not to call a large transitional region a separate biome. Therefore, the number of biomes will vary according to the source. Some of the major terrestrial biomes are temperate deciduous forest, temperate coniferous forest, taiga, tropical rainforest, grassland, tundra and desert. There are also major aquatic environments such as freshwater and marine systems.

**AQUATIC ENVIRONMENTS**

Since biomes are named and classified by their plant life, the term biome is used mainly to describe terrestrial systems only. According to this definition, the aquatic environment, whether freshwater or marine, is technically not considered a biome. Instead, the aquatic environment is classified by other factors such as salinity, water movement, and depth. However, aquatic environments are usually grouped with lessons on biomes and represent major ecosystems and habitats.

**FRESHWATER AND MARINE ECOSYSTEMS**

Water covers about ¾ of the Earth’s surface and the aquatic environment breaks down into two major water ecosystems: freshwater and marine ecosystems. Each of these ecosystems may be broken down into even smaller ecosystems and habitats.
A freshwater ecosystem is one that is found to have a low concentration of salt. Typically, fresh water has a salinity that is less than 1 part per thousand (ppt). Only about 2.5-3% of the water in the world is fresh water. Two thirds of the fresh water is ice and the rest is under or at the ground surface. The freshwater system breaks down into many smaller ecosystems and habitats such as ponds, lakes, streams, rivers and a few types of wetlands. This system is important to humans on many levels. Freshwater systems provide us with drinking water, water for farming and business and food such as fish. Most animals in this system do not have adaptations to help them survive in the salty marine systems.

A marine ecosystem is one that is found to have a high concentration of salt. About 97% of the water found in the world is salt water. Typically, salt water has a salinity of 30-35 ppt. It is this high salt concentration that prevents the salt water such as water found in oceans from freezing in the winter. The marine environment is only second to the rain forest in diversity of plant and animal species. The major marine ecosystems are oceans, coastal areas, a few types of wetlands and estuaries (where fresh and salt water mix) each of which can be broken down into smaller ecosystems and habitats. Most animals in this system have adaptations for living in such salty conditions.

This program focuses on the following biomes and aquatic environments: the rain forest, the coastal beach, the desert, and the deciduous forest. Grasslands are discussed in the pre-activity Activity 1-Homes around the World on page 15-20.

RAIN FOREST
A tropical rain forest is a hot, humid, wet, dense forest that is characterized by an enormous diversity of plant and animal life. The wet tropical climate consists of an air temperature between 68°F and 93°F (20°C-34°C), with an average humidity of 77%-88%. Annual rainfall can range between 7ft and 25ft (83 inches-300 inches); most rainforests receive upwards of 100 inches of rain per year, as compared to the average yearly rainfall in Maryland of 41 inches (1 m).

The soil of the rain forest has a top layer of dead plant material, such as leaves, that have fallen from the surrounding trees. The dead plant material on the top of the soil is quickly broken down and nutrients are released. These nutrients are then quickly taken up by the surrounding plant life. Therefore, the plants themselves not the soil contain most of the nutrients in this biome. Space and light are limiting factors for the type of plants that can grow in the rainforest. Competition for sunlight and space results in layering of the rainforest plants. The four distinct layers of a rainforest are: forest floor, understory, canopy and emergent layer. Each layer provides a different habitat type and therefore is home to a certain variety of animals that are adapted to live in that specific layer. Common animals in the rainforest layers are millipedes, hissing cockroaches, wood turtles, agouti, caimans, anacondas, piranhas, poison dart frogs, tarantulas, lizards, toucans, sloths, spider monkeys and parrots. Common adaptations of the rainforest animals are camouflage and warning colors.

Most of the world's tropical rain forests are found near the Equator in Central and South America, Africa and Asia. Hawaii is the only state in the United States that has tropical rain forests, although temperate rain forests can be found in both Oregon and Washington State. Even though rain forests now cover less than 6% of Earth's land surface, scientists believe they contain over 50% of the Earth's animals and plants. This high diversity of life in the rain forest is one of the reasons this biome is very important to humans. This is where most of our medicines, wood for furniture and foods such as chocolate, vanilla, cinnamon and coconut are found.
INTERTIDAL ZONE

The intertidal zone is made up of areas near the ocean, such as rocky shores and coastal beaches, that are sometimes dry and sometimes covered with water. They are found all over the world where the ocean meets the shore. It is a place where the tides have created areas that are affected by the force of waves. Tides are a change in water level created by the gravity of the sun and the moon. Because of the changing water line, the conditions of areas in the intertidal zone vary greatly throughout the day. The areas range from mostly dry to mostly underwater exposed only when the tide is extremely low. At high tide, the water line is at its highest point, covering organisms that cannot move and allowing many ocean animals such as fish access to this area. At low tide, the water line is at its lowest point with the most land exposed to the air. This area is regularly exposed to rain, salt water, air, wind, and sun. Animals that live exclusively on the land portion of the intertidal zone must have adaptations.

TEMPERATE FORESTS

Temperate forests in the south in places such as Florida or New Zealand mostly have broad-leaved evergreen trees, winters are not harsh, and it is very unusual to have frosts or droughts. Temperate forests in the north in places such as Maine and the upper mid-west of the U.S., have short winter days, about six months of temperatures below freezing and seasons that are very distinct. Although, there can be broad-leaved evergreen trees and coniferous trees in temperate forests depending on its location, the main type of temperate forest trees are the deciduous trees. A few common deciduous trees are oak, maple and beech trees.

Temperate deciduous forests are forests that have four distinct seasons and lose their wide leaves every year in the Fall. The average annual temperature in a temperate deciduous forest is 50°F (10°C) while the average rainfall is 30 to 60 inches a year. The layering of plants in the temperate deciduous forest is similar to that of the rain forest. There are four layers: forest floor, shrub layer, understory and canopy, with each layer home to unique plant and animal life. The soil is usually high in organic matter such as plant and animal materials. Organisms such as earthworms break this organic matter down and turn it into nutrients for nearby plants. Just like the rain forest is important to humans so is the temperate deciduous forest biome. This is where some of our food and wood for houses, furniture, and paper are found. Many of the trees produce fruits and nuts such as apples and walnuts. We even get maple sugar from temperate deciduous forest trees!

Because this biome has four distinct seasons, the animals living in the temperate deciduous forest must adapt to the changing weather. Many animals adapt by hibernating, migrating, changing the thickness of their fur, collecting and storing food and/or camouflage. Some common animals found in the temperate deciduous forest are raccoons, skunks, deer, squirrels, rabbits, snakes, box turtles and chipmunks. Most of Europe, the eastern half of North America, as well as parts of Japan and Asia were once covered with large temperate deciduous forests. It is very likely that your schoolyard was once part of a temperate deciduous forest!
to survive these two drastic water conditions every day. Some common animals are sea urchins, sea snails, herring gulls, hermit crabs, horseshoe crabs, sea stars, barnacles and fish. Common adaptations are spines or hard shells for protection, camouflage and/or the ability to survive the two drastic water conditions every day. Many of these animals are especially sensitive to human impacts such as being stepped on, trash, oil spills, and shoreline development.

**GRASSLAND**
The grassland is a grassy, windy, semi-dry area. There are many different names used throughout the world for the grasslands including savannah, pampas, plains, steppes and prairies. They are found in Africa, North America, South America, Australia and Asia. In the North American grasslands, the average rainfall is about 16 inches in the west and 31 inches in the east. North American grasslands can be found where the rainfall is about 11.8 inches-33.5 inches (30 cm-85 cm) per year with an average annual temperature of about 50° F-68° F (10°C- 20°C). The average annual precipitation in a grassland, is great enough to support grasses and in some areas a few trees. The soil of most grasslands is too thin and dry for trees to survive while a few are deeper and have a greater amount of organic matter/nutrients. In the grassland biome, seasonal drought is common. This allows natural fire, a very important factor in maintaining this biome, to clear parts of the land. Nearly 1/4th of the Earth's land area is composed of grassland. However, humans have changed this biome more than any other. Typically, we use the land for food production that consists mainly of cereal grain.

Some common grassland animals are coyotes, antelope, bison, bumble bees and prairie dogs. There are many common adaptations of grassland animals. Many birds use their strong legs to walk on the land and eat a diet consisting of seeds in order to get their water. Many of the mammals are large and travel in herds for protection. The smaller animals usually have a body plan that allows them to be very fast in order to escape predation. The ability to have good vision and see far in the open grassland is also important to survival.

**DESERB**
Deserts are very dry areas, and there can be hot or cold deserts. The hot deserts are usually found near the equator around 30°N and 30°S in latitude from the equator (0° latitude), while the cold deserts are usually found near the North and South Poles. The temperature can fluctuate greatly throughout the day in the desert. To be classified as a desert, an area must have an average of less than 6 inches of rain each year. While hot deserts are typically envisioned when describing desert conditions, any area with low amounts of precipitation can be classified as a desert. Because there is little water, few plants exist in the desert. Typically, types of shrubs and cacti are found in this biome. Since there are few plants, the soil often has little to no organic matter. In many deserts, the soil is usually sand, rock and/or gravel. Since there are few plants living in the desert, there are few animals found there as well.

Common animals found in the desert are roadrunners, desert iguana, snakes, desert kangaroo rat and desert tortoise. There are many general adaptations of desert animals. Because deserts are so dry, many animals have adapted to long periods of no water. They have also adapted by migrating, having high concentrated urine and producing only small amounts of it to conserve water and/or getting their water intake from the seeds and prey that they eat. In hot deserts, many of the animals are nocturnal and burrow to keep cool. The large animals tend to sweat and pant in order to cool down. Many animals are lighter in color in order to reflect heat and to camouflage with their environment.

**ADAPTATIONS**
Animals get everything they need to survive in their biome by using adaptations. An adaptation is any behavior an animal does or trait they possess that helps them to survive as well as reproduce. Adaptations can be divided into physical adaptations and behavioral adaptations.

**PHYSICAL ADAPTATIONS**
A physical adaptation is any trait an animal possesses, such as coloration, body shape, teeth, horns, etc. This program discusses several examples of physical adaptations.
Adaptations for Movement
Animals move through their biomes in many ways. Physical adaptations allow them to freely move throughout their environment. To help an animal swim, it may have webbed feet, fins or flippers. Birds have wings, feathers and hollow bones to help them fly. Snakes have scutes or large scales on their underside to help them slither.

Adaptations for Defense
Animals can defend themselves in a number of ways. Some animals have adaptations to help them hide from predators, while others have adaptations to ward off predators.

Adaptations for hiding from predators
Animals may be camouflaged so that they can hide from predators. Camouflage is a type of coloration that allows an animal to blend in with its surroundings. Camouflage is also called cryptic coloration. Sometimes animals may also have shells to hide inside to prevent predators from harming them such as a turtle.

Adaptations for warding off predators
Some animals may have warning coloration. Animals with warning coloration are often brightly colored. This bright color serves as a warning to predators that eating this animal might be harmful to their health. Poison dart frogs are brightly colored. Other animals may fend off predators more aggressively and may rely on adaptations such as horns, claws, spines and hooves to protect themselves.

BEHAVIORAL ADAPTATIONS
Some adaptations involve how the animal behaves instead of how it looks. Animals have different behaviors for eating, defending their territories, protecting themselves from predators, avoiding adverse conditions or finding a mate and caring for offspring.

Diet
Animals’ diets vary to take advantage of available food sources and minimize competition for food. Herbivores are animals that only eat plants. Typically these animals live in areas where vegetation is abundant, such as the rain forest or the grasslands. Carnivores are animals that eat only meat. Carnivores can be found in any habitat or biome that has other animals. Omnivores are animals that eat both plants and meat. This is an extremely valuable adaptation and allows these animals to eat any available food. This is especially important in biomes with low amounts of food like the desert or biomes with harsh seasons, such as winter in the deciduous forests. Most of the time, an animal can be placed into one of these categories by looking at their teeth. For example, a deer predominately has premolars and molars (flat teeth) for grinding plants and is therefore an herbivore.

Seasonal Activities
In biomes, such as deciduous forests, in which the seasons change, animals must have adaptations to survive the changing weather. Many animals, including many species of birds migrate, or travel to a different area, every year to avoid harsh winter weather. Other animals may hibernate, or rest through harsh seasons. Contrary to popular belief, hibernation does not mean an animal sleeps through the winter; they are simply much less active.

Active Periods
To improve the odds of survival, animals are active at different times throughout the day. Many animals, including humans are considered diurnal because they are most active during the daylight hours. Other animals are more active during the night. These animals are called nocturnal. Since
there is less light at night, many animals will be active at night so they will not be spotted by their predators. However, some predators, such as owls, have specialized adaptations to help them hunt at night. For example, owls tend to have larger eyes to help them see at night. Some animals rest during most of the day and night hours. These animals are called **crepuscular**. Crepuscular animals are most active at dawn and dusk, when low light makes it very difficult for predators to see them. Some examples of crepuscular animals are cats, deer and rabbits.

Physical and behavioral adaptations work together to help an animal survive. For example, physical adaptations like large eyes or ears allow an animal to have behavioral adaptations like night-time activity.

**CONSERVATION ISSUES**

**FRAGMENTATION**
Adaptations help an animal survive perfectly in their natural environment. However, when habitats and ultimately biomes are destroyed, an animal's adaptations cannot protect it and it cannot survive. Sometimes only a portion of a habitat is destroyed and the remaining habitat is divided into smaller areas. This is called **habitat fragmentation**. Habitat fragmentation frequently occurs during road construction and is harmful to animal populations because it isolates them and greatly reduces the area in which they can survive.

**DEFORESTATION**
Although habitat fragmentation is very devastating, deforestation is a larger scale problem for habitats, ecosystems and biomes as a whole. For example, all forests, including both the deciduous forest and rain forest biomes, suffer from deforestation. **Deforestation** refers to the cutting down, burning or clearing of trees. Trees are being cut down for a variety of reasons such as lumber, firewood, space for houses and farm land. Soon after trees are taken away, the effects of deforestation begin to show. Typically, there will be flooding, erosion and shortly after the soil becomes very nutrient poor and unable to support the desired plants or crops.

Without trees, floods may wash away the topsoil, leaving behind undesirable soil. Much of the sediment ends up in the streams, rivers and surrounding bodies of water, which changes the quality of the water. The loss of trees also affects the animals since their habitat is destroyed when trees are burned or cut down. Management of logging activities and establishment of national parks and wildlife preserves are just two ways that deforestation can be stopped and wildlife and trees can be protected.

**CLIMATE CHANGE**
Changes in habitat and ecosystems whether small or large ultimately change the biome in which they are found. In addition to habitat fragmentation and deforestation, another issue which is beginning to greatly affect world biomes and major aquatic environments is climate change. **Climate change** is any considerable change in climate such as temperature and/or precipitation over a long period of time.

Climate change and global warming go hand in hand. **Global warming** is the rise in atmospheric temperature which begins to alter large scale climate patterns. The reason for the increase in temperature is due to the trapping of **green house gases** such as carbon dioxide in the atmosphere. Heat from our planet would normally go off into space, allowing it to get rid of this heat and cool off. However, the trapped green house gases in the atmosphere act like the glass in a green house, trapping the planet's heat and causing the temperature to slowly rise. In the past 100 years, there has been an increase of 1.2-1.4 °F in the average global temperature.

Climate change will have an impact on both terrestrial and aquatic environments. We will see an increase in the water temperature as the temperature of the air increases. This rise in water temperature will impact many of the sensitive species of the ocean such as the coral of coral reefs. Even if the temperature increases only a few degrees, the **zooxanthelle**, plants living in the coral, can leave causing coral bleaching. In addition to heat, carbon dioxide, a green house gas from the air, can mix with the ocean water and form an acid. This causes the ocean water to become more acidic. Climate change is also expected to cause a rise in sea level. This could cause habitats, such as wetlands, to disappear.

The forest biomes will also be affected by climate change. There will most likely be a longer summer season which
Conserving energy will reduce the demand placed on fossil fuel plants, thereby reducing the pollution they produce. Of course, “Reduce, Reuse, Recycle” is another important concept for conservation. In addition, it is important to reduce the amount of fertilizer and pesticides we use in our gardens. In a practice called **bayscaping**, you can incorporate native vegetation into lawns and schoolyards. Planting native trees and plants will reduce the need for fertilizer while providing habitat for native animals and reducing the amount of runoff from lawns. Planting trees also prevents sedimentation. Tree roots keep soil in place so it does not run into the water. You can also limit sedimentation by slowing down the flow of rainwater. This can be done by installing a **rain barrel** to collect water as it flows off your roof from rain gutters. Simply picking up litter on the street will also help protect the environment. Remember, that no matter where you live, your actions affect the environment many miles away, so make sure to ask everyone you know to do their part to help!

**CONSERVATION EFFORTS**

Although many of these biomes and habitats are not in our backyard, we can still help. The best practice with conservation efforts is to start local. Our actions at home have a great impact on a larger scale. Everyone can do something to protect their local environment. For example, you can conserve water by turning faucets off when not in use and taking shorter showers instead of baths. This will reduce the amount of water that has to be pumped through sewage treatment plants or septic systems, which will conserve energy. You can also conserve energy by turning lights, radios, and televisions off when not in use; running only full loads in the washing machine and dishwasher; and replacing ordinary light bulbs with energy-efficient bulbs.

Means more time for fires and less water availability for plants. The stress of this longer season will make plants more likely to get diseases and recovery time from fires will take longer. Migration and reproduction of forest and aquatic species will also be affected by an increase in temperature because these processes usually begin with a certain temperature.

With climate change, it is also unknown if native species can adapt to the changes. Competition could become a problem between and among species. Many worry that **invasive species**, harmful non-native species, will outcompete native species causing them to significantly decrease in numbers and even possibly go extinct.

The effects of climate change on habitat, ecosystems and biomes will be great. Over time, there could be an increase in temperature, increase in sea level, increase in ocean acidification, change in precipitation, snow and ice will begin to melt, change in migration and reproduction times and the growing season will get longer just to name a few. The dry areas will get dryer and the wet areas will get wetter. Seeing as biomes are classified by plant cover and the type of plant cover ultimately depends on the climate, biomes will begin to change. If there is a change in plant type and climate, there will also be a change in the animals that are found as well. In the future, plants and animals may not be found in the same area/biome as they are currently. The **biodiversity**, number and types of plants and animals in an area, will most likely change in the future.
Glossary

Abiotic – all of the non-living materials in an ecosystem

Adaptation – any characteristic an animal has or anything an animal does that helps it survive

Bayscaping – a landscaping technique where native plants and trees are planted to provide habitat for animals

Behavioral adaptations – anything an animal does that helps it survive, i.e. vocalizing, diet, activity period

Biodiversity – number and types of plants and animals in an area

Biome – considered a large, distinct terrestrial region, consisting of major communities and ecosystems, which is named and classified by its plant cover. In addition to plant life, a biome is differentiated by its unique combination of climate (average temperature and precipitation), soil type and animal species that are adapted to living in that particular environment

Biotic – all of the living materials in an ecosystem. Anything that is living or ever was alive are the biotic parts of an ecosystem.

Camouflage – a color, pattern, shape or movement that matches an animal’s surroundings and helps it to disguise or blend in

Carnivore – an animal that eats other animals or only eats meat

Climate – average temperature and precipitation

Climate change – any considerable change in climate such as temperature and/or precipitation over a long period of time

Coastal Beach – areas near the ocean where the tides have created sandy areas. Because of the changing water line, the conditions of this habitat vary greatly throughout the day

Community – all of the populations of different species in the same area

Crepuscular – an animal that is active at dawn and dusk

Deforestation – the cutting down, burning or clearing of trees

Desert – a very dry area; to be classified as a desert, an area must have an average of less than 6 inches of rain each year

Greenhouse gases – gases in the atmosphere that trap heat and do not allow this heat to escape into space

Habitat – the environment in which an organism or biological population lives or grows; there are four elements to a habitat: food, water, shelter and space

Habitat fragmentation – the division of a large area into smaller, isolated patches, separating the organisms that lived there; causes of habitat fragmentation include development, road building, logging and agriculture

Herbivore – an animal that eats only plants

Hibernate – a period of time when an animal is in a low activity state

Intertidal Zone – made up of areas near the ocean, where the tides have created areas that are affected by the force of waves. Because of the changing water line, the conditions of areas in the intertidal zone vary greatly throughout the day. The areas range from mostly dry with a slight spraying of water from the wave action to mostly underwater exposed only when the tide is extremely low

Invasive species – harmful non-native species

Migrate – travel between locations to obtain resources such as food and water
Nocturnal – an animal that is active at night

Omnivore – an animal that eats both plants and meat

Organic matter – decaying plant and animal materials

Physical adaptations – any trait an animal possesses that helps it survive, i.e. shape of bird’s beak

Population – a group of individuals all of the same species living in the same area

Producer – an organism that makes its own food; for example - plants

Rain barrel – a barrel designed to collect and store rainwater as it drips from a rooftop

Rain forest – A tropical rain forest is a hot, humid, wet, dense forest that is characterized by an enormous diversity of plant and animal life. Annual rainfall can range between 7 ft (83 inches) and 25 ft (300 inches); most rainforests receive upwards of 100 inches of rain per year

Scutes – large scales on a reptile.; the scutes on a snake are located on its underside and aid in locomotion

Temperate Deciduous Forest – forests that have four distinct seasons and lose their leaves every year.

Tide – changes in water level produced by the gravitational attraction of the moon and the sun; high tide and low tide

Transitional region – formed where the unique plant life of two different biomes begin to overlap and blend together

Warning coloration – a color or pattern that signals to predators that eating an animal might be harmful to their health

Zooxanthelle – plant living in coral distinct seasons and lose their leaves every year.

CONNECTING VOCABULARY

Habitat – the environment in which an organism or biological population lives or grows and provides food, water, shelter and space

Individual – a single animal or plant

Population – a group of individuals all of the same species, living in the same area

Community – all of the populations of different species in the same area

Ecosystems – all the communities of living organisms and their interactions with the non-living materials in a given area

Biomes – the world’s major terrestrial communities and ecosystems which are classified based on plant cover and characterized by plant type, climate, soil type and animal species
### BIOMES

<table>
<thead>
<tr>
<th>BIOMES</th>
<th>LOCATION</th>
<th>AVERAGE TEMPERATURE</th>
<th>AVERAGE ANNUAL RAINFALL</th>
<th>TYPICAL PLANT COVER</th>
<th>SOIL QUALITY/TYPE</th>
<th>COMMON ANIMALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain Forest</td>
<td>Near the Equator in Central and South America, Africa and Asia</td>
<td>68°F-93°F (20°C-34°C), with an average humidity of 77%-88%</td>
<td>7 ft (83 in)-25 ft (300 in); usually upwards of 100 in/year</td>
<td>Forest floor, understory, canopy and emergent layer</td>
<td>Nutrient poor</td>
<td>Millipedes, hissing cockroaches, wood turtles, agouti, caimans, piranhas poison dart frogs, lizards, toucans, sloths, spider monkeys and parrots</td>
</tr>
<tr>
<td>Temperate Deciduous Forests</td>
<td>Most of Europe, the eastern half of North America, as well as parts of Japan and Asia</td>
<td>Seasonal: average of 50°F (10°C)</td>
<td>30-60 in/year</td>
<td>Forest floor, shrub layer, understory and canopy layers. Deciduous trees such as oak, maple and beech</td>
<td>Fertile: rich in organic matter</td>
<td>Raccoons, skunks, deer, squirrels, insects, snakes, box turtles and chipmunks</td>
</tr>
<tr>
<td>Grassland</td>
<td>Once covered all continents except Antarctica but now found in Africa, North America, South America, Australia and Asia</td>
<td>50-68°F (10-20°C) (North America)</td>
<td>16 inches in the west and 31 inches in the east a year. About 11.8-33.5 inches a year in general. (North America)</td>
<td>Grasses</td>
<td>Most thin and relatively dry but few deeper and more nutrient rich</td>
<td>Coyotes, antelope, bison, bumble bees, and prairie dogs</td>
</tr>
<tr>
<td>Desert</td>
<td>Hot deserts are near the equator while cold deserts are near the North and South Poles</td>
<td>Variable: hot and cold desert types</td>
<td>Average of less than 6 inches of rain a year</td>
<td>Cacti and shrubs</td>
<td>Sandy, gravel or rock. Poor quality.</td>
<td>Desert iguana, snakes, desert kangaroo rat, desert tortoise and toads</td>
</tr>
</tbody>
</table>

### AQUATIC ECOSYSTEMS

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<tr>
<th>AQUATIC ECOSYSTEMS</th>
<th>LOCATION</th>
<th>WATER TYPE</th>
<th>WATER MOVEMENT</th>
<th>WATER DEPTH</th>
<th>COMMON ANIMALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intertidal Zone</td>
<td>Every continent</td>
<td>Saltwater: high salt concentration with a salinity of about 30-35 ppt</td>
<td>High tide and low tide, heavy wave action</td>
<td>Varies with high tide and low tide</td>
<td>Sea urchins, sea snails, herring gulls, hermit crabs, horseshoe crabs, barnacles and sea stars</td>
</tr>
</tbody>
</table>
Activity 1 – Homes Around the World

DESCRIPTION
In this lesson, students are introduced to five biomes and/or aquatic environments found around the world. Students will work together in groups. This lesson focuses on reading comprehension, map reading, creative writing and collaboration skills.

PROCEDURE

1. Before the lesson, familiarize yourself with the biomes and aquatic environments on pages 5-14.
2. Make copies of the Homes Around the World activity (pages 15-20) so that each student receives a worksheet on a biome or aquatic environment.
3. Discuss what a biome is (page 5) and brainstorm different types of biomes and aquatic environments.
4. Divide your students into 5 groups.
5. Assign each group a biome or aquatic environment and give each member of the group the corresponding biome or aquatic environment sheet.
6. Have each group work to complete the worksheet. Each group will create one story per biome or aquatic environment.
7. Once all groups have completed their worksheets, share stories from each biome or aquatic environment as a class.
8. Discuss how the animals used their adaptations in each story. For example, if the group wrote about how a duck flew or skunk sprayed another animal, talk about how or why the animal could perform those actions.

ALTERNATIVE METHODS

1. This lesson can be completed by individual students rather than groups. After the students finish their stories, take some sample stories from each biome or aquatic environment and discuss how the animals used their adaptations.
2. If students are unable to locate the exact location of their biome or aquatic environment from its description, they may color the entire continent where the biome or aquatic environment is found.

ANSWER KEY

Step A
Answers will vary for each group.
Activity 1 — Homes Around the World

TROPICAL RAIN FOREST

STEP A
As a group, read the following about rain forests.

Tropical rain forests can be found in Africa, South America, and Asia. The tropical rain forests are found on or close to the equator. The equator is an imaginary line around the middle of the world. Color the tropical rain forest on the map.

The rain forest is an area where it rains almost everyday. The rain helps lots of plants grow in the rain forest. The plants are food for many of the animals that live in the rain forest. They also give them shelter. More plants and animals live in the rain forests than anywhere else in the world.

Poison dart frogs are frogs that live in the tropical rain forest. These frogs like to eat insects in the rain forest. When another animal tries to eat them, poison dart frogs let out poison to make the animal sick. The poison dart frog has bright colors. The bright colors on the poison dart frog tell all of the other animals they will get sick if they eat it.

Toucans are birds that live in the tropical rain forest. They have a very large beak. They use their beak to break open large fruits. Toucans use their wings to fly. Toucans fly from tree to tree looking for fruit to eat.

STEP B
As a group, pick one animal that lives in the tropical rain forest. Work together to create a short story about that animal. Write your story on a separate sheet of paper. Draw a picture that shows what happens in your story.
Activity 1 — Homes Around the World

TEMPERATE DECIDUOUS FOREST

STEP A
As a group, read the following about temperate deciduous forests.

Temperate deciduous forests can be found in North America, Europe, Asia, and Australia. The eastern United States was once a large deciduous forest. Color the temperate deciduous forests on the map.

The temperate deciduous forest is an area with four seasons. The four seasons are spring, summer, autumn, and winter. The trees in the temperate deciduous forest lose their leaves in the autumn every year. Animals in the forest have to live through cold winters and hot summers.

Striped skunks are animals that live in the temperate deciduous forest. Skunks are nocturnal animals. Nocturnal animals go out at night looking for food. Skunks eat insects and mice, but sometimes look through trash to find food. When another animal tries to eat a skunk, the skunk sprays the animal with a bad-smelling liquid. The bright, white stripe on the back of a skunk helps other animals see it at night. Animals stay away from skunks so they do not get sprayed by them.

Deer also live in the temperate deciduous forest. Deer eat grass and other plants growing in the forest. If another animal tries to eat a deer, it can run away very quickly. Deer also blend in with the trees around them. An animal that blends in with the area around them is called camouflaged.

STEP B
As a group, pick one animal that lives in the temperate deciduous forest. Work together to create a short story about that animal. Write your story on a separate sheet of paper. Draw a picture that shows what happens in your story.
Activity 1 — Homes Around the World

DESSERT

STEP A
As a group, read the following about temperate deciduous forests.

Deserts can be found on every continent. Some deserts are hot. Hot deserts are found near the equator. The equator is an imaginary line around the middle of the world. Some deserts, called tundras, are very cold. Cold deserts are near the North Pole and the South pole. Color the deserts on the map.

The desert is an area where it hardly ever rains. Without any rain, there are not many plants in the desert. Without plants, there is less food for animals to eat.

Rattlesnakes are snakes that live in the desert. Snakes are cold-blooded animals. Rattlesnakes hide from the hot sun during the day and find warm rocks to sleep on at night. Rattlesnakes eat mice that live in the desert. Unlike most snakes, the rattlesnake is venomous. When they bite, venomous snakes put venom into other animals to hurt them. If another animal gets too close and scares the rattlesnake, it might bite it to defend itself. The rattlesnake will shake its tail to let other animals know not to come any closer or it will bite them.

Camels are also animals that live in the desert. Camels are omnivores. Omnivores are animals that eat both meat and plants. Usually camels eat plants, but they will eat any food they can find in the desert. Camels can walk through the desert for long periods of time. Camels store fat in humps on their backs so they have energy to travel across the desert.

STEP B
As a group, pick one animal that lives in the desert. Work together to create a short story about that animal. Write your story on a separate sheet of paper. Draw a picture that shows what happens in your story.
Activity 1 — Homes Around the World

GRASSLANDS

STEP A
As a group, read the following about temperate deciduous forests.

Grasslands can be found in Africa, North America, South America, Australia and Asia. Grasslands are found in very flat areas. There are many different names for grasslands. Savannahs, prairies, plains, and meadows are all different kinds of grasslands. Color the grasslands on the map.

Grasslands are large flat areas of land with a lot of tall grass and very few trees. The tall grass provides food and shelter to the animals that live in the grasslands. Rain often forms large pools on the ground. Many animals migrate, or travel, from one pool of water to another.

Bison are large mammals that live in the grasslands. They are herbivores. A herbivore is an animal that only eats plants. Bison live in large groups called herds. Herds protect the bison from other animals because the bison help defend each other.

Bumblebees are insects that live in the grasslands. They travel from flower to flower in the grassland to gather nectar to eat. As they travel, they spread pollen to other flowers to help them grow. Bumblebees have stingers to protect themselves. A bee will only sting if it feels it is in danger.

STEP B
As a group, pick one animal that lives in the grasslands. Work together to create a short story about that animal. Write your story on a separate sheet of paper. Draw a picture that shows what happens in your story.
Activity 1 — Homes Around the World

INTERTIDAL ZONES

STEP A
As a group, read the following about temperate deciduous forests.

The intertidal zone is the area where the ocean meets the land. This area has sand and very salty water. Color the intertidal zone on the map.

The intertidal zone changes a lot throughout the day. At low tide, the water is at its lowest level. Most sand is out of the water at low tide. At high tide, the water is at its highest level. Most of the sand is covered with salt water. The animals that live on the beach are in salt water for part of the day and in sand for rest of the day.

Herring gulls are one of the many sea bird species found around the intertidal zone. They love to eat fish, small crabs, insects, and eggs. They find their food at sea, along beaches, and even by trash dumps. Herring gulls can drink salt water. They have special glands by their eyes where the salt from the salt water comes out.

The hermit crab is another animal that lives in the intertidal zone. Hermit crabs do not make their own shell. They use old shells from other animals to protect themselves. When a crab gets too big, it finds a new, larger shell to live in. The hermit crab is an omnivore and will eat plants and animals.

STEP B
As a group, pick one animal that lives in the intertidal zone. Work together to create a short story about that animal. Write your story on a separate sheet of paper. Draw a picture that shows what happens in your story.
Activity 2A — What Can You Do?

DESCRIPTION
In this activity, students will learn about different types of environmental problems and determine steps they and their families can take to help solve these problems.

PROCEDURE

1. Photocopy and pass out the “Before” images to your students found on page 22-23.

2. Discuss each picture to determine what is “wrong” in the picture. (For example: there are no trees in the park for habitat and to keep the dirt from washing away when it rains, there is trash on the ground, there is trash and recycling left on the cafeteria tables, etc.) This can be done as a class or in small groups. You can assign each group a different picture or have the entire class do all three pictures.

3. Have students draw actions that they and their families can take to help solve the existing problems. (For example: planting trees, picking up litter, using a broom to clean the area, recycling, stenciling storm drains)

4. Instruct students to write a sentence about what types of actions they are doing to help solve each problem.

BEFORE

Answers vary. Students can describe the actions, tools used and reasons behind their conservation efforts. For example: planting trees or other plants, sweeping or picking up trash, placing recycle bins in the school cafeteria, taking responsibility for their own trash as well as that of others, helping build a playground or hanging posters or signs that describe how litter ends up in the Bay.
Activity 2A — What Can You Do?

DIRECTIONS
You will learn about things people do that hurt the environment. You will draw ways you can help fix these problems.

STEP A: LOOK AT THE “BEFORE” PICTURES.
1. Work with your class or group. Look at the “Before” pictures.
2. Decide what things in each picture are bad for that place or environment.

STEP B: DRAW WHAT YOU CAN DO TO HELP.
1. Decide what you can do to help each place.
2. Draw what you can do to help each place. Be sure to include yourself in the drawing.
3. Write a complete sentence below each picture. Tell what you are doing in your drawing to help fix the problem.
Activity 2A — What Can You Do?

Before

[Images of schoolyard, neighborhood park, and school cafeteria]
Activity 2B —
Bayscaping: Building an Environmentally-friendly Yard

DESCRIPTION
Bayscaping is another great activity you can do to help the environment. It can include many different activities and can be performed in many different settings. For more information on bayscaping, refer to page 11 in the teacher background.

In this lesson, students are exposed to the concept of bayscaping and explore how they can help the environment by making environmentally-friendly landscaping improvements. Students compare bayscaped and non-bayscaped areas and will practice writing complete sentences to describe improvements they can make.

PROCEDURE
1. Distribute copies of the Bayscaping worksheets on pages 27-28 to students.
2. Read What is Bayscaping?, located on page 26, as a class.
3. Review the bayscaping improvements mentioned in the reading and discuss how each strategy helps the environment (for example, plant roots hold dirt in place, rain barrels save and slow the flow of rain water, native plants require less watering and fewer chemical pesticides and fertilizer, gravel paths slow down the flow of water into rivers, etc.).
4. Instruct students to color or circle the differences between the two pictures of bayscaped and non-bayscaped schoolyards found on page 27.
5. After they have pointed out the differences between the two pictures, have the students write a short paragraph describing ways they can help the environment (for example, students may decide to plant trees, write letters to government officials, use less water, set up rain barrels, recycle, clean up litter, encourage their parents to use less fertilizer on their lawns, etc.).
Activity 2B —
Bayscaping: Building an Environmentally-friendly Yard

STEP A
There are two pictures below. One picture is of a bayscaped schoolyard and the other picture is of a schoolyard that has not been bayscaped. Color or circle the differences between the two pictures.

STEP A
Write 3 complete sentences about what you and your family can do to help bayscape your yard at home, neighborhood, or schoolyard.

Answers will vary but may include: planting gardens, trees, grass, and other plants; putting fences around areas that can spread dirt or sand; picking up litter; putting recycling bins in yards; putting up a rain barrel at the base of the gutter.
Activity 2B —
Bayscaping: Building an Environmentally-friendly Yard

DIRECTIONS
Read the article *What is Bayscaping?* and complete Steps A and B.

WHAT IS BAYSCAPING?

Bayscaping is changing an area to make it better for the environment. Bayscaping includes changes that help the environment by stopping dirt pollution and saving water.

One example of bayscaping is using native plants in your yard. Native means that they can grow on their own. Therefore, they need less water to grow well. Plants and trees make good habitats for animals to live. Plants also help to keep dirt from washing into streams and rivers when it rains. Too much dirt in the water can hurt underwater plants. It blocks sunlight that underwater plants need to grow.

Rain barrels are also a part of bayscaping. These large barrels are put next to rain gutters to catch rain water. The rain water is saved in the large barrel. It can be used to water plants when it is very dry. Saving rain water before it reaches the ground also keeps it from washing dirt into rivers and streams.

Another part of bayscaping is making paths out of gravel. Gravel is better than blacktop, asphalt or cement. Gravel paths allow rain to soak into the ground more slowly. This keeps extra dirt (called runoff) from moving into rivers and streams.
Activity 2B —  
Bayscaping: Building an Environmentally-friendly Yard

STEP A
There are two pictures below. One picture is of a bayscaped schoolyard and the other picture is of a schoolyard that has not been bayscaped. Color or circle the differences between the two pictures.

![Non-Bayscaped Schoolyard](image)

![Bayscaped Schoolyard](image)

STEP A
Write 3 complete sentences about what you and your family can do to help bayscape your yard at home, neighborhood, or schoolyard.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Resources

BIOME INFORMATION
http://www.blueplanetbiomes.org/world_biomes.htm
http://www.mbgnet.net/sets/index.htm
http://www.epa.gov/bioiweb1/aquatic/marine.html
http://www.yale.edu/ynhti/curriculum/
http://earthobservatory.nasa.gov/Experiments/Biome/

CLIMATE CHANGE INFORMATION
http://www.epa.gov/climatechange/downloads/Climate_Change_Ecosystems.pdf

DEFORESTATION INFORMATION:
http://earthobservatory.nasa.gov/Features/Deforestation/

BOOKS
Ecosystems Around the World
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Essentials of Ecology

Integrated Principles of Zoology
ISBN: 978-0077221263