# The Educator's Guide to

# Fore! The Planet™:

## 18 Holes of Serious Fun

(For Grades 2-6)

THE ACADEMY OF NATURAL SCIENCES
PHILADELPHIA

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# The Educator's Guide to Fore! The Planet™: 18 Holes of Serious Fun

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# *Welcome to the Educator's Guide to Fore! The Planet™*

## *Introduction*

Fore! The Planet™ is a highly interactive and playful exhibition using miniature golf to communicate information about the natural world. As with most miniature golf courses, Fore! The Planet™ has 18 holes, each "themed" with a different topic.

The course is divided into two halves, a "front-nine"—how nature works—and a "back nine"—human interaction in the biosphere. The exhibition stimulates interaction and inquiry among the players, as the more they learn, the better they play the game. Fore! The Planet™® illustrates a variety of natural phenomena, chosen according to their scientific accuracy, relevance and suitability for play.

The exhibit best exemplifies the concept of "serious fun." Students enjoy the whimsical, playful style of the game while learning about science and the environment. The more they learn about the scientific concept the hole is based on, the better they will be able to play. For instance, in Hole 8, Predator and Prey, when players identify their ball as a "fly" (prey) trying to get to the food from a picnic (where the cup is located), they realize they must avoid the mouth of the frog (predator) and the spider's web (another predator). As they avoid these hazards, they are more likely to get to the cup with fewer strokes.

## *How to Use this Guide*

This teacher's guide was created to help teachers prepare their classes for a visit to Fore! The Planet™. It contains detailed descriptions and photographs of the 18 holes, activities to prepare the class before visiting the exhibit, worksheets to enhance student understanding while playing the game and extension activities for following up your visit.

The first section of this guide introduces the 18 holes of Fore! The Planet™. Photographs of the holes and actual text provide an overview of the exhibit's approach and content.

Through understanding the format of the exhibit beforehand and exploring some of the concepts in class, students will increase their success and enjoyment while playing. The worksheets brought to the exhibit help teachers remind their students of the game's environmental concepts. Extension activities after your visit help reinforce the ideas and help students incorporate the ideas explored at the exhibit.

## *A Play by Play of the Fore! The Planet™*

Fore! The Planet™ is like every other miniature golf course. You'll find clubs and colored balls, scorecards, tees and rules and regulations. However at each hole, you will also find something different: a panel of text explaining the scientific concept explored in the hole. The panel begins with "The hole story," a one sentence summary of the idea of the hole and how to play your ball to the best advantage. This is followed with an introduction and then explanatory text, which, if read and understood carefully, can help you play the game a little better.

This section reprints the text from each Fore! The Planet™ hole. Each hole is illustrated with a photograph of the hole to help give you a clear idea of its layout and environmental concept.

# Hole 1: Butterfly Life Cycle

## THE HOLE STORY

**All butterflies live their lives in four stages—a life cycle. Putt the ball through each stage of a butterfly's metamorphosis.**

Butterflies come in an amazing array of sizes, patterns, and colors, but they all have one thing in common: metamorphosis. Metamorphosis is a change in form—in butterflies, it's the change from an egg into an adult, which happens in four stages.

### Egg

Each species of butterfly starts life as an egg, which the female lays on a certain type of plant (the leaves of which are food for the next life stage).

### Caterpillar

Eggs hatch into caterpillars (larvae), which are eating machines! Some eat 20 times their own weight in food before moving on to the next stage of life.

### Pupae

A mature caterpillar attaches to a secure spot and forms a chrysalis (pupa). Inside, the caterpillar's body tissues break down to form the adult butterfly.

### Butterfly

When all is ready, the pupa is forced open by the fully-formed butterfly. The butterfly will now mate and the females will lay eggs to begin the cycle all over again.

### *Butterfly conservation*

Costa Rica has set aside 10% of its land as national parks. People living nearby "farm" butterflies, providing pupae to the growing butterfly exhibit industry. They make a living while continuing to conserve butterfly populations in the rain forests.

# Hole 2: Seed Dispersal


## THE HOLE STORY

**Your ball represents the seed from the fruit of a tree. Feed the ball to the cassowary, the wild pig, or the parrot. Which animal do you think will best disperse the "seed?"**

If the only place a plant could grow was next to its parents, it would probably lose the battle for light, nutrients, and water. Since plants cannot move around the way animals can, they must scatter (disperse) their seeds as widely as possible to survive. Animals provide several ways for seeds to travel.

### The cassowary

Cassowaries, which live in the rain forests of New Guinea, eat huge amounts of fruit every day. They can't digest the seeds of the fruit, so the seeds come out in the birds' droppings. Researchers believe that if cassowaries didn't redistribute seeds as they do, some types of rainforest plants would go extinct.

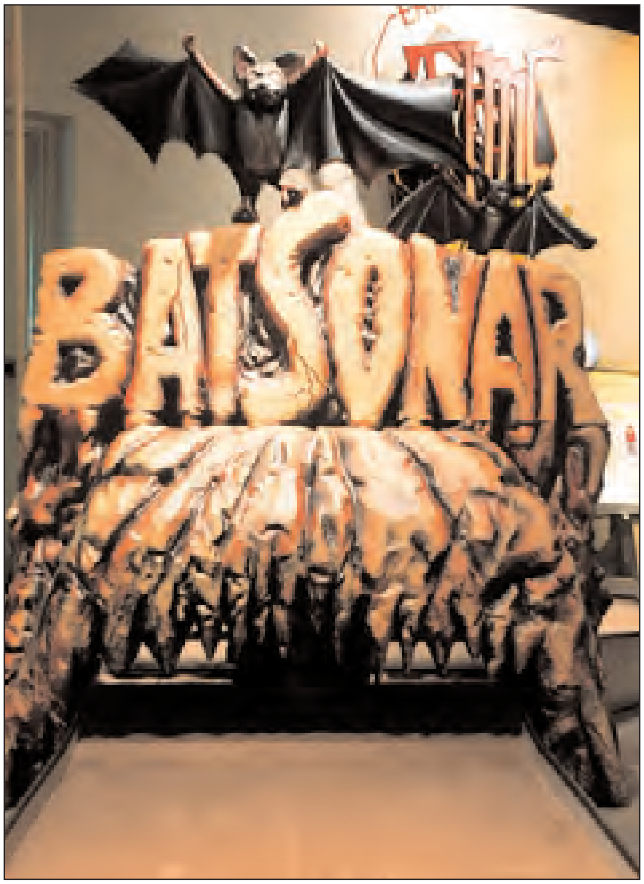
### The wild pig

Animals pick up seeds in their fur as they brush by blooming plants, later dropping them in their travels. Wild pigs distribute seeds in their droppings and on their coats, but they often do more harm than good: they uproot shrubs, disturb soil, and destroy delicate plants when foraging for food.

### The eclectus parrot

Not all dispersed seeds take root where they're dropped. They might be left in unproductive soil or destroyed in the animal's digestion process. The eclectus parrot cracks open hard fruit pits with its sharp beak, but in doing so, it breaks the pits, ruining the seed's chances to grow.

# Hole 3: Bat Sonar




## THE HOLE STORY

**The ball represents a bat. Listen for the noise coming from the cave. The sound tells the bat where there is an obstacle on the way to the cup.**

The myths about bats are not true. They are not blind. They are not rodents. They are among the most gentle, beneficial and necessary animals on Earth! Bats are night animals, and although some have good eyesight, they use sound to find their way in the dark. As they fly, they send out high-pitched squeaks that bounce off objects around them and return to their sensitive ears, helping them avoid obstacles and find their prey.

### Beneficial bats

Bats are not flying rats, they are the only true flying mammals. Bats are beneficial because they eat insects. An single bat can catch hundreds of mosquitoes in an hour, while a large colony can consume thousands of crop-eating beetles nightly.

Some bats pollinate plants and disperse their seeds. The Mexican long-nosed bat pollinates more than 60 species of agave, from which tequila is made.

### Beleaguered bats

Some bats live in massive groups located in small areas, like caves. This makes them vulnerable to human and natural disturbances. Of the 44 species of bat found in America, six are on the Endangered Species List. A million-and-a-half Mexican free-tailed bats live under a bridge in Austin, Texas. Austin has declared itself "Bat Capital of America."

# Hole 4: Food Chains

## THE HOLE STORY

**The ball represents energy being passed through a food chain. Putt along the food chain and link the fir tree to the owl through the energy consumers of the forest.**

In any ecosystem (which includes all living organisms in an environment and their interactions), energy is constantly moving. Plants convert sunlight into energy to support growth. This energy is passed on to animals that eat plants, and then to predators that feed on them, and so on. A food chain is a way of showing how the energy flows between living things. Let's look at the food chain in a Northern forest ecosystem.

### Douglas fir

Plants that make their own food are "primary producers." The Douglas fir turns the energy of sunlight into wood, bark, leaves, and seeds.

### Red tree vole

Plant-eating animals, or "primary consumers," eat plants. Red tree voles eat the Douglas fir's bark, buds, and fungi.

### Great-gray owl

Predators, or "secondary consumers," eat primary consumers. Great-gray owls eat red tree voles.

### Fungi

"Decomposers" eat the dead remains of plants and animals. Fungi break down the dead needles of Douglas firs, supplying the tree with nutrients.

### *Broken links*

The great coniferous forests (found in North America, Europe and Asia) are among the least disturbed habitats in the world, but even so, trees have been overharvested for lumber and cleared for farmland. Removing these primary producers affects the entire food chain.

# Hole 5: Evolution of a Golfer

## THE HOLE STORY

**It takes a long time to develop a golfer. A very long time. Putt through geologic time and watch the modern golfer evolve, piece by piece.**

### A backbone with nerve

600 million years ago

Thank the early cephalochordates like *Pikaea* that had a springy rod (notochord) down its middle and a nerve chord, precursors to your backbone and spinal chord.

### A primitive brain

450 million years ago

A complex of nerves for interpreting information was also useful to early craniates—jawless fish—such as *Sacabambaspis*.

### A jaw

400 million years ago

Before the jaw evolved, all backboned animals, including gnathostomes like the primitive shark, *Stethacanthus,* ate like vacuum cleaners—sucking and filtering.

### Lungs

375 million years ago

Lobe-finned fish had a pair of primitive lungs in addition to their gills. Along with large, muscled fins, this allowed them to live in shallower water close to land.

### Arms and legs, fingers and toes

365 million years ago

*Hynerpeton* was a tetrapod (four-legged animal) that could move on land due to its stronger limbs, flexible joints, and fingers and toes.

### Ability to stay out of water

310 million years ago

*Hylonomus,* an early reptile, is an example of an amniote: an animal that can reproduce on land instead of having to return to water.

### Teeth

300 million years ago

*Dimetrodon* was one of a group of early reptiles, the synapsids, which developed a more diverse set of teeth, rather than having all one type as dinosaurs did.

### Energy and endurance

215 million years ago

Mammals such as *Megazostrodon* were able to maintain a constant internal temperature, an improvement over the reptiles' "cold-blooded" condition, where body temperature varied with the weather.

### A thumb

60 million years ago

*Northarctus* was an early primate that lived in trees, which required an opposable thumb (a thumb that can touch the other fingers), along with good vision and dexterity.

### Moving on two legs

3.5 million years ago

*Australopithecus* was a hominid belonging to a group of primates that include the ancestors of humans. It stood upright, walked on two legs, and used simple tools.

### A big brain

About 150,000 years ago

*Homo sapiens*—YOUR SPECIES—appeared, with a larger brain, good hand-eye coordination, and more sophisticated tools.

# Hole 6: Backyard Explorer

## THE HOLE STORY

**Putt your ball through the "backyard ecosystem." You will find the cup, along with your observations, in the notebook.**

One of the best places to start understanding how an ecosystem works is to look closely at your own yard, garden, park, or even window box. By cultivating native plants that attract wildlife like butterflies, you can provide a small but important haven for local species.

### What lives in your yard?

Look for signs of wildlife like mammal tracks in soft ground, scattered feathers, or droppings. Bark may be torn apart by animals looking for bugs to eat; pine cones are often stripped of their scales by animals trying to reach the seeds. Fallen logs and hollow stumps are usually full of life—covered with fungi, moss, and lichen. Insects like beetles and ants often live underneath.

### *Be a good neighbor to wildlife!*

- Grow native plants.
- Use less commercial fertilizer or try natural methods.
- Grow plants that provide food for wildlife (like acorns, berries, seeds, nectar, and buds).
- Provide places for wildlife to hide from predators or bad weather (like dense shrubs, brush piles, or rock walls).
- Provide places for wildlife to raise offspring, (like nesting boxes for birds or plants for caterpillars).
- Provide water for visiting wildlife, and don't let it freeze in the winter.
- Recycle leaves, prunings, and kitchen scraps by composting.
- Put a bell on your cat or keep it indoors.

# Hole 7: Natural Selection

## THE HOLE STORY

**Natural selection is the mechanism of evolution. Aim for the bird you think is best adapted to survive on this new island.**

Certain characteristics may help some individuals of a species survive in a particular environment. The best-adapted individuals will reproduce more offspring with those traits. Over a long time, favorable characteristics become a common feature of the species in that environment. This is natural selection.

### A story of natural selection

A flock of birds with long beaks and strong wings has blown off course, finding refuge on a remote island with good weather all year. They find plenty of seeds to eat, but few of the big, juicy worms they had eaten on the mainland. There are also fewer predators on the island. As always, each generation of birds includes members with a variety of characteristics. But now, the conditions have changed.

### Longer beaks

Long beaks were great for stabbing worms out of the ground-now there are few worms, but lots of seeds. The long beak is a poor tool for cracking seeds, so these birds have a poorer chance of survival.

### Shorter beaks

Short beaks work well for cracking the plentiful seeds on the new island. The birds with shorter beaks have a better chance to survive and reproduce in the new environment.

### Stronger wings

With fewer predators to escape from and no need to migrate, flying is a waste of energy. There is no natural advantage to stronger wings.

### Weaker wings

Weak wings aren't a disadvantage, since these birds have no need to escape or migrate. Instead of flying, weak-winged individuals use their energy to run on the ground to find food. They have a good chance of survival.

### The weakest one

The runt of this group of siblings lacks all adaptations (wing size or beak size) necessary for success in the new environment.

After 100,000 years of tiny changes, natural selection has dramatically changed the birds to fit their new environment. They now have shorter beaks, and they can't fly at all. A new species is born!

### *The Galapagos Islands*

On the Galapagos Islands, scientists since Charles Darwin have studied the evolution of the finch. These birds are just one example of evolution caught in the act.

# Hole 8: Predator and Prey


## THE HOLE STORY

**The ball represents a fly attempting to reach a safe place to lay its eggs away from the threat of predators. Hungry toads and spiders make the path to the cup a dangerous route.**

We are all part of the "web of life." Every life form has the biological goal of surviving and reproducing and each has a role in the drama of life. Even the house fly plays a part.

### The house fly

The fly needs to find a safe and fertile place to lay its eggs. Flies can be dangerous because they often carry microbes that cause disease, but their ecological role is important. They are scavengers that break down waste by feeding on decomposing material and laying eggs in it. Without flies we'd be up to here in...you know what.

### The toad

The toad is a predator of the fly. With lightning speed, the toad can flick out its tongue and capture its prey. Flies lay lots of eggs, so despite the huge number of flies that are eaten, the species is sure to survive. Without toads and other predators, the fly population would explode.

### The spider

Spiders are also predators; they're among the most active carnivorous hunters in existence today! Insects like flies are the main source of most spiders' food. Although spiders use many methods to capture their prey, the most common is to trap them in a silken web.

# Hole 9: Dinosaur Extinction

## THE HOLE STORY

**The ball is your tool to vote. Putt towards the scientific theory of dinosaur extinction you most agree with.**

Around 65 million years ago, life on Earth changed radically. Three quarters of the life forms that inhabited our planet disappeared. The dinosaurs, which had survived for 160 million years, bit the dust. Almost everyone agrees that dinosaurs died because of changes in their environment. But was it catastrophic (sudden) or gradual? Experts can't agree, so you be the judge.

### Sudden death

Some scientists believe that an asteroid or comet slammed into the earth, causing dust and debris to block out the sun. They envision giant ocean waves crashing on shore, burning forests filling the air with choking dust, and no sunlight reaching the earth. As a result, plants could not grow, the food chain was disrupted, and the dinosaurs died.

### A sloooow fizzle

Some scientists think that a slow change in the climate resulted in the gradual decline of the dinosaurs, because they couldn't evolve quickly enough to adapt to the changes. Over time, this lack of adaptation caused them to die out.

### *Lessons from the past*

Some scientists think we might now be in the midst of another mass extinction. They think changes in the global climate, caused by both human and natural forces, could be leading to the next Ice Age. Combined with the fact that species are already going extinct at an alarming rate, these theories lead scientists to question the future success of life on Earth. Do you think humans will survive?

# Hole 10: Recycling


## THE HOLE STORY

**The ball represents garbage on its way to be recycled. Feed the garbage to "Mr. Bigmouth" so it can be used again.**

Did you know that worldwide, we throw away 2.5 million plastic bottles every hour? That's 420 million bottles every week; almost 22 billion every year. That's a lot of trash, but we don't have to send it to landfills. Instead, plastic bottles can be recycled as plastic lumber, fiberfill for sleeping bags and parkas, and other useful materials. Recycling saves energy, preserves natural resources, and cuts down on trash and pollution.

## WHAT CAN WE DO?

### At home

Support your community's recycling efforts.

Tip: Product packaging makes up over one third of the garbage in landfills. When shopping, choose larger sizes and items that use minimal packaging whenever possible.

### At school

Start a school recycling program—promote the "three R's": reduce, reuse, and recycle.

Tip: The aluminum and plastic you send to your recycling center may not be immediately recycled. Keep recycling, but also buy products made from recycled materials whenever you can.

### At the office

Promote recycling and purchase recycled products, especially paper.

Tip: Styrofoam is not biodegradable and can sit in a landfill for thousands of years. Use glass and ceramic plates and cups for office parties whenever possible. If you must use disposables, choose paper.

### At the store

Buy recycled products. If we don't buy recycled products, there won't be a market for them. Make sure your store knows you'll buy recycled products if they keep them in stock.

# Hole 11: Spawning Salmon

## THE HOLE STORY

**The ball represents a spawning salmon. Natural and human-created obstacles present challenges to the salmon as it attempts to complete its life cycle.**

A half-dozen salmon species born in streams on the West Coast follow the same life cycle. They hatch in rivers and travel to the sea. In the Pacific Ocean they fatten on zooplankton and smaller fish. At maturity they return to breed and lay eggs (spawn) in the rivers of their birth. Guided by senses that scientists do not fully understand, the fish migrate up a river's main stem and tributaries until they've returned to the place where they hatched. The fish die shortly after spawning, becoming food for eagles, bears, and others.

### Natural hazards take a toll

Predators like brown and grizzly bears depend on the annual migration of the salmon, one of their favorite foods.

### Artificial hazards are worse

Unobstructed streams are vital to the future success of wild salmon. Dams have catastrophically affected their habitats. Great effort has been made to transport fish around dams, but the results have often been less than successful. Dams on several major spawning rivers have recently been removed.

### Disappearing species

Salmon populations are in a steady decline, diminished by dam construction, logging, pollution and irrigation systems. The coho salmon have disappeared from the Upper Columbia River, and the sockeye are almost gone from the Snake River. The chinook of California's Sacramento River are now on the Threatened Species List.

***It's not all bad news, though: with effort, some salmon populations have made a comeback and scientists learn more with every success.***

# Hole 12: Landfills


## THE HOLE STORY

**The ball represents garbage. Aim your putt to catch a ride on the ship searching for a port willing to accept its unsavory cargo.**

Philadelphia, September 1986: The freighter *Pelicano's* hold is filled with 14,000 tons of toxic incinerator ash. For more than two years it sails around the world looking for a port to accept its cargo.

October 1988: the *Pelicano* brazenly dumps 4,000 pounds of its unwanted cargo on a beach in Haiti. It is reported that the captain has illegally dumped the rest in the ocean, although he claims that an unnamed country accepted the ash.

### Not in my back yard

Indiscriminate dumping like the case of the *Pelicano* underscores a bigger issue: throwaway societies pollute their land and seas. And understandably, no one wants the trash dumped in their back yard. These members of Mississippi's Choctaw tribe rejected a hazardous waste dump on their reservation.

### 70% of our trash goes to landfills

America's landfills are filling up. The Fresh Kills landfill on Staten Island is the world's largest, receiving over 17,000 tons of refuse from New York City daily. Landfills have the potential to leach toxic chemicals into our water. A plan is underway to close Fresh Kills by January 2002.

### What can we do?

Every American produces four pounds of trash per day. We can each reduce trash at its source by recycling. Discarded building materials—2x4's, sheetrock, bricks—are expensive to throw away, but can be recycled as clean-fill; old wood can become landscaping mulch or fuel.

Americans dump the equivalent of more than 21 million shopping bags full of food into landfills every year. Composting food scraps to make natural fertilizer is the best method of reducing food waste

# Hole 13: Wild Corridors

## THE HOLE STORY

**The ball represents an animal whose movements through the landscape are blocked by new development. Highways and pipelines make the path to the cup a complicated trail.**

Roads and highways separate and isolate populations of wildlife as effectively as walls. Corridors of green space that link fragmented habitats are vital to animals attempting to migrate, find food, and locate mates.

### Forest corridors: tiger

In India, many tigers live in reserves where they are safe from hunters, but these parks are often cut off from one another. Tigers need “corridors”—strips of forest linking two parks—so they can safety travel to find food and mates.

### Tundra migration: caribou

In Alaska, continuous movement across the tundra is part of the natural life cycle of caribou herds, but oil fields, pipelines, and high-traffic roads block their movement. Installation of ramps, elevated pipes, and traffic control have helped them move about, but may not be enough to counter future development.

### Wildlife underpasses: the Florida panther

Roads bring development into habitats, and traffic can be fatal to wildlife. Road kills were once the leading non-natural cause of death among Florida panthers. Special wildlife underpasses have greatly reduced panther deaths in the Everglades, where panthers now have taken refuge because of development in northern Florida.

### “Tunnels of Love”: The spotted salamander

Each spring, amphibians like the spotted salamander leave their wooded winter hideaways and seek swampy grounds to mate and lay eggs. Tunnels built under roads near Amherst, Massachusetts have helped the salamanders move safely under the roads.

# Hole 14: Bird Migration


## THE HOLE STORY

**The ball represents a flock of migrating Swainson's hawks. Putt your way along the hawks' migratory route from Argentina, through the narrow isthmus of Panama, to the Pacific Northwest.**

Breeding and feeding are the two main reasons that most birds migrate. By flying between summer breeding areas and wintering grounds, birds can find consistent sources of plentiful food. This usually requires a long, hard journey twice a year.

### Swainson's hawk

Swainson's hawks migrate up to 8,000 miles, traveling in huge flocks, sometimes made up of thousands of birds.

Each fall, the hawks migrate from western North America to their wintering area in the pampas of Argentina, South America. In late February they leave Argentina, arriving in Oregon, Washington, and southern Canada in late May.

### Natural challenges

Traveling great distances is always difficult, and birds face many natural challenges. These may include bad weather, predators, and difficulty finding food.

### Human-made obstacles

Migration becomes a greater challenge when places where birds habitually stop to rest or eat are developed. Aircraft, transmission towers, and habitat change are all hazards that contribute to the deaths of millions of birds annually in the U.S.

### Chemical hazards

Swainson's hawks eat insects, especially grasshoppers, to build up energy reserves for their long trip. But grasshoppers can become toxic when they eat plants contaminated with poison, such as the chemical pesticides still used in Latin America. In 1995 and 1996, nearly 6,000 hawks died after being exposed to poison meant to control grasshoppers in alfalfa fields.

# Hole 15: Water Pollution


## THE HOLE STORY

**Navigate the way to the cup around a variety of real life water traps, which represent water pollution from different sources. You might be surprised what you learn.**

Water runs downhill. As it travels over the land, water carries soil, bits of rock, and natural chemicals. It can also carry pollutants. Pollutants are substances such as trash, chemicals, and animal or human wastes that change the natural balance of water or make it unhealthy for living creatures.

### Get the point?

A “point” source of pollution is a specific spot (like a factory outlet or sewage pipe) that discharges into a waterway. Today in the U.S., most point sources are closely regulated and are no longer major polluters.

### Get the non-point?

Most water pollution today is from “non-point” sources—runoff from scattered locations like streets, parking lots, driveways, back yards, farm fields, and construction sites. The harmful materials that accumulate in these places can wash into our waterways, either directly or through storm drains when it rains.

### We need clean water

Less than 1% of the world's water is drinkable. The rest is either salty or frozen. Since we don't have that much of it, we can’t afford to pollute it!

### *What you can do about water pollution*

- Recycle used motor oil.
- Reduce fertilizer and pesticide use.
- Properly dispose of paints,solvents, and household hazardous products.
- Clean up pet and animal wastes.
- Participate in litter cleanups.

# Hole 16: Alien Species


## THE HOLE STORY

**The ball represents a native bird on the island of Guam. Try to avoid the dangerous invading alien snakes on your way to the cup.**

When a species of animal or plant is introduced from a foreign place, it can disrupt the natural balance of life. Usually the invasion is accidental; sometimes organisms are imported for a reason. And almost always, these "aliens" are more destructive than anything in a sci-fi movie!

### Brown tree snake

On Guam, a mildly venomous species of brown tree snake, accidentally imported from the Solomon Islands in the 1940s, has wreaked havoc on the local ecology. It has multiplied into the millions. Some have been found on aircraft bound for Hawaii.

### The Guam rail

Ten of Guam's 12 native bird species have been wiped out by the brown tree snake. It eats eggs and small birds. Don't blame the snake; it's following its natural need to survive and reproduce. The Guam rail is now being reintroduced.

### Central American cane toad

In Australia, a toad intentionally introduced from Central America to help control agricultural pests multiplied out of control—and failed to solve the original problem.

### Kudzu

A Japanese vine called kudzu was introduced to America at the 1876 World's Fair Exposition in Philadelphia. When used to battle erosion in the South, it worked too well—it grew over a foot a day and crowded out anything in its path!

### *Invisible threats*

Not all alien species are even visible: micro-organisms brought to the New World by European explorers may have been responsible for the deaths of millions of native people.

# Hole 17: Population Threats


## THE HOLE STORY

**The ball represents a typical population of bears in a given year. Putt the ball toward the cup; different threats to the bears' survival will block the way, such as fire, lack of food or too few families.**

### How rare is too rare?

There are many factors that can threaten the survival of a small, limited population of animals in an *isolated* location, such as a population of bears in a national park. It's not just a matter of numbers; the bears must be able to produce healthy and capable new cubs, generation after generation.

### Some of these threats are human generated

Sport hunting, bounties, pesticide application, and destruction of habitat are all things that limit the number of bears capable of reproduction. These are significant problems, but they can potentially be managed.

### Others are part of the natural cycle

Every season the viability of the bear population is challenged by a chance combination of natural factors. In a given year there could be:

- an unusually low number of newborn cubs
- an unusually high number of deaths among older bears
- too many males and too few females
- habitat loss
- a shortage of food
- an influx of predators or competitors
- an increase in disease or parasites
- genetic problems

### What are the odds?

The chances of the bear population suffering one or more threats to its viability in a given season are random and unpredictable. Too many occurrences in the same year could easily reduce a small population below the threshold of survival. Humans can help animals by establishing continuous wild spaces. This lowers the risk unique to isolated populations.

# Hole 18: Rainforest Threats

## THE HOLE STORY

**The ball is your tool to choose a future for the rain forest. Follow a path toward deforestation or a sustainable future.**

The world's rain forests are important to all life on earth. The trees and plants of rain forests affect our climate, helping to maintain a breathable atmosphere and prevent global warming. Four square miles of tropical rainforest can hold:

- 750 kinds of trees
- 125 species of mammal
- 1,000 types of flowering plants
- 400 species of birds
- thousands of species of insects

### Resplendent quetzal *(Pharomachrus mocinno)*

This amazing bird, native to the cloud forests of Costa Rica, contributes to a $1 billion eco-tourism industry. Eco-tourism can be a non-destructive way to preserve rain forests.

### Rosy periwinkle *(Cantharanthus roseus)*

Found in Madagascar, this plant has been used to make medicines that fight leukemia and Hodgkin's disease. Uncounted species of rainforest plants that could be equally beneficial have been destroyed. Now, research to uncover useful plants is underway.

### Blue morpho *(Morpho peliedes)*

Butterfly farming allows people to earn a living in a rain forest without harming it. It's not the whole answer, but it shows how imagination and flexible thinking can make a difference to the future of rain forests.

### *Environment or economy?*

Each year, a chunk of rain forest the size of Alabama disappears, cut down by people who use the land for farming and economic development. It is important to make better choices to save rain forests from destruction without depriving the people who need the land to live. Sustainable development balances the environment with the economy.

# Preparing Your Class

This section presents a series of pre-visit and extension activities as well as a worksheet to enhance learning during your visit to Fore! The Planet™. To get the most out of your Fore! The Planet™ experience, introduce activities as appropriate to your curriculum in the weeks leading up to your trip; bring the *Learning at the Exhibit Worksheet* along for use during your visit; and follow up with some of the extension activities in subsequent weeks.

The pre-visit and extension activities are grouped into six themes, each of which enhances ideas presented in several Fore! The Planet™ holes:

### 1. Backyard Naturalists

(Collection, observation and classification)
Hole 1: Butterfly Life Cycle
Hole 2: Seed Dispersal
Hole 6: Backyard Explorer

### 2. Animals in Motion

(Animal muscle mechanisms and behavior)
Hole 3: Bat Sonar
Hole 14: Bird Migration

### 3. Eat or Be Eaten

(Food webs, predator/prey relationships)
Hole 4: Food Chains
Hole 8: Predator and Prey

### 4. Evolutionary World

(Evolutionary timeline, evolutionary adaptations)
Hole 5: Evolution of a Golfer
Hole 7: Natural Selection
Hole 9: Dinosaur Extinction

### 5. Save the Animals

(Ecological change and effects on animals)
Hole 11: Spawning Salmon
Hole 13: Wild Corridors
Hole 16: Alien Species
Hole 17: Population Threats
Hole 18: Rainforest Threats

### 6. Save the Planet

(Environmental pollution)
Hole 10: Recycling
Hole 12: Landfills
Hole 15: Water Pollution

# 1. Backyard Naturalists

### Purpose

To enhance student understanding of Fore! The Planet™ Holes 1, 2 and 6 by introducing them to the skills naturalists use to study nature.

*Fore! The Planet™ Holes Explored*

- Hole 1: Butterfly Life Cycle
- Hole 2: Seed Dispersal
- Hole 6: Backyard Explorer

*Introduction*

Children are naturally curious to explore and discover the world around them. The activities in this section encourage students to pursue their curiosity through methods used by scientists who study the environment: collection, observation and classification.

## Activity 1: Seed Explorations

### Seed Explorations Part I

For hundreds of years naturalists have been collecting artifacts from nature. Once compiled, these collections can be used for many different investigations in the laboratory. Have students start their own collection of seeds in the classroom.

**Materials**

- Collection area
- Sandwich bags
- Pencil
- Paper

**Procedure**

1. Discuss with students why scientists collect specimens. Discuss the importance of recording the location of their findings as well as the importance of collection ethics (e.g., not collecting individuals of an endangered species). Have students search for different types of seeds around their homes, schoolyards and nearby parks.

2. Once outside, have students look for seeds in different locations. When they find a seed have them put it into a sandwich bag and record the location of their find.

3. Return to the classroom. Ask students why they looked for seeds where they did. Discuss seed dispersal strategies of different plants.

4. When seeds are not available (depending on the season), other items may be substituted, such as leaves or twigs from different trees or even dried beans and nuts purchased in the supermarket.

### Seed Explorations Part II

Naturalists use their senses to observe animals and plants in the wild. Sometimes they use tools such as magnifying lenses, microscopes and binoculars. While making observations, they record their results for further analysis and comparison. This activity introduces observation and record-keeping skills.

**Materials**

- Seeds collected from Part I
- A worksheet for noting observations
- Magnifying lens
- Pencil

**Procedure**

1. Provide each student with one type of seed to observe. Ask your students to describe the seeds using their sense of sight, smell and touch. Have them look at color, size, texture and special features. Encourage students to use a magnifying lens.

2. Have them record their results on the worksheet.

3. Then mix all nuts together in a pile and have the students pick out their original seed. Encourage the students to use their worksheet as a guide.

## Seed Explorations Part III

Classification is an important part of scientific research. Scientists classify collected specimens according to their individual characteristics. The following activity allows students to identify characteristics that could be useful classification features.

### Materials

- Collected seeds from Part I
- Worksheet from Part II

### Procedure

1. Using the seeds collected as well as the worksheets used in Part II, have your students sort the seeds into different groups.

2. Ask them how they chose their categories. Was size, shape or color more important in their classification schemes? What other features could be used to classify the seeds?

3. In this exercise, there is no right or wrong: it is not important that your students come up with the correct classification scheme, rather that they think about the process of classification. Ask your students why they think it could be important to classify living organisms.

## Extension Activities

Try this activity with plants, insects, birds and/or mammals. Or have your students devise a method for classifying all of their classmates (e.g., grouping by colors and patterns of clothes, hair length, eye color, etc.).

## Further Reading

*175 Amazing Nature Experiments*
by Rosie Harlow and Gareth Morgan
(Random House, 1991).

*Play and Find Out About Nature*
by Janice VanCleave (Wiley, 1997).

# 2. Animals in Motion

## Purpose

To enhance student understanding of Fore! The Planet™ Holes 3 and 14 by illustrating the mechanisms of animal movement and how it plays a part in animal behavior.

*Fore! The Planet™ Holes Explored*

Hole 3: Bat Sonar

Hole 4: Bird Migration

*Introduction*

Movement is a defining characteristic of animals. Animals move to gather food, find mates, escape from predators and migrate to different places. The type of animal movement varies with different animal species. Movement forms include walking, running, climbing, swimming and flying. The main activity in this section focuses on the physical mechanism of movements. Activities about bird migration and bat sonar are in the extension section.

## *Activity 2: Animals on the Go*

### Animals on the Go, Part I

**Materials**

- Posterboard
- Markers or crayons

**Procedure**

1. First get your students thinking about the different ways animals can move. Have your students observe different animals in motion. What types of movements do they make? Are the same muscles used to walk, swim, climb or fly?

2. Have your students draw on construction paper different types of animal motion. Or have them pantomime different animals.

### Animals on the Go, Part II

(Adapted from *Beakman's World on Tour Teaching Guide,* © 1998, Cincinnati Museum Center)

This activity helps students to identify and model the bones, muscles and joints of the arm.

**Materials**

- 3 paper towel tubes or posterboard
- 2 long balloons
- Tape
- Scissors
- String
- Marker
- Pipe cleaner
- Paper hole punch (the smaller the hole, the better)

**Procedure**

1. Have the students label the three paper towel tubes humerus, radius and ulna. (If you are using cardboard, cut a piece of cardboard as long as the upper arm and two pieces of cardboard as long as the lower arm. Roll these into tubes and tape tightly. Then label them.)

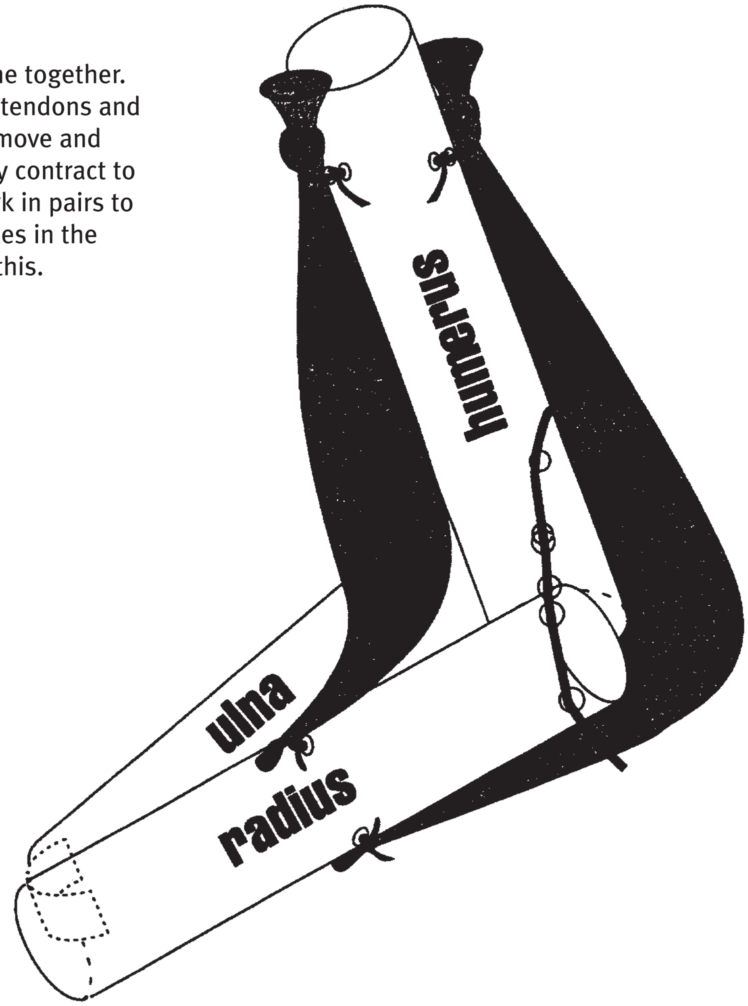
2. Have students punch two holes opposite each other at one end of each bone with the hole punch. Line up all three bones side by side with the holes matched up. The humerus should be between the radius and the ulna. Thread a pipe cleaner through each series of holes. Bend the pipe cleaner ends so they won't come out. Bind the radius and ulna together at the "wrist" with tape.

3. The balloons will represent the biceps and triceps muscles. (In our cardboard "joint", the arm will have only two muscles, but real arms have many.) Have students inflate both balloons only slightly and tie them closed. Attach the balloon muscles onto the bones with string in the following manner: Bend the model at the elbow to about 135 degrees, so it looks like an arm resting on a table. On the front of the "arm" attach the biceps muscle to the top of the humerus and then to the midpoint of the radius. On the back of the "arm" attach the triceps muscle to the top of the humerus and then to the midpoint of the ulna.

4. Have students test the joint by gently pulling on the balloons to stimulate contraction. Ask: What happens when the biceps contracts (gets shorter)? ***The radius and ulna move closer to the humerus.*** When this happens the triceps must relax (get longer). In order for the arm to be lowered, the triceps must contract while the biceps relaxes. The muscles can't both be relaxed or both be contracted at the same time if the joint is moving.

**Discussion**

Joints are places where bones come together. Muscles are attached to bones by tendons and make it possible for the bones to move and bend at the joint. Muscles can only contract to move bones, so muscles must work in pairs to move the bones. The biceps muscles in the upper arm are a good example of this.




## Extension Activity

**Strangers in the Night.**

Movement can help animals find each other. This activity helps students understand how bats use echolocation to locate other bats in the dark. First pair up your students and have one student in each pair wear a blindfold. Have the sighted students move around the room. Ask the blindfolded students to locate their partners using sound only. The blindfolded students call their partners' names. The partners echo back with the same name. The blindfolded students should be able to determine the location of their partners based on where the "echo" is coming from.

**Susan the Swainson's Hawk Flies South**

Movement can also help animals look for better shelter and more food. Bird migration is a good example. Play the computer game **"Susan the Swainson's Hawk Flies South"** from the Academy's Fore! The Planet™ Web site. Check out **http://www.acnatsci.org/exhibits/golf/hawk1.html.**

**Further Reading**

*DK Pockets: Animals of the World* by David Alderton et al. (DK Publishing, 1999).

# 3. Eat or Be Eaten

## Purpose

To enhance student understanding of Fore! The Planet™ Holes 4 and 8 by introducing the concepts of food webs and prey and predator relationships.

*Fore! The Planet™ Holes Explored*

Hole 4: Food Chains

Hole 8: Predator and Prey

*Introduction*

A food web shows the movement of energy through an ecosystem. Animals that eat other animals are carnivores. Examples include lions, hawks and sharks. Animals that eat plants are herbivores. Squirrels, snails and deer fall into this category. Carnivores eat prey to gain energy while herbivores gain energy from eating plants. Plants gain energy from the sun through the process of "photosynthesis." As organisms die, their bodies are absorbed by bacteria or fungi and become nutrition for plants. As a result, we can see that the energy is circulated originally from the sun.

## Activity 3: Food Web Game

This game will illustrate to your students how energy moves through an ecosystem using raptors and their prey as an example. Before playing this game, discuss the feeding habits of raptors, and the feeding habits of the smaller animals that raptors eat. Discuss how plants obtain energy. Indicate relationships between various organisms (what each eats/energy flow) up through trophic levels. Bring in the idea of a web by choosing examples on a sample food web diagram (see materials) and showing how most organisms depend on more than one food source. Explain that in the game there will be three levels: raptors, plant-eating rodents, and plants. Describe how the game works and ask for predictions as to which level (raptors, rodents, plants) will accumulate the most energy.

**Safety rules**

- No tackling
- No grabbing hold of prey's name tag to make a capture (the string rips out)
- When two people are making an energy exchange, they are temporarily safe
- Set definite boundaries

**Materials**

- 2 lbs of peanuts (unshelled)
- Several quart containers
- Food web poster or diagram including sun, plants, herbivores, carnivores, and energy flow between each; this can be a commercial illustration or hand-drawn depiction
- Cardboard name-tags with string (to be worn necklace-style), listing the name of a raptor, a rodent, or a plant. Name-tags should be in ratios of 3 plants to 2 rodents to 1 raptor.

**Procedure**

This is basically a game of tag in which the object is for each person to accumulate peanuts which represent energy.

1. Each student role-plays either a raptor, rodent, or plant. Each student is allowed to capture or be captured only according to the relationships shown on the diagram and listed on the individuals name-tag. Pass out name-tags indiscriminately; avoid typing aggressive students as raptors or shy ones as plants.

2. A teacher or staff member plays the sun, responsible for distributing peanuts (energy) only to plants; no other life form can obtain needed food energy directly from the sun. Peanuts are accumulated but not eaten during the game; the total amount collected by each group will be counted at the end of the game.

3. Plants obtain energy from the sun: they begin with 4 peanuts apiece and maintain a total of 4 by returning to the sun when necessary. Since the student "plants" lack the defenses that many plants have against herbivores, they can run away.

4. Rodents get energy by capturing their specific food plants; they get 2 peanuts from each plant they capture. The rodents put one of these 2 into a special container for used-up energy lost to the food web (a corn plant puts energy into

growing leaves, stem, roots, cob, and kernels. Do we get all that energy when we eat corn?No, we only eat the kernels). Several of these used-up energy containers should be carried around the playing area by staff or teachers.

5. Raptors capture their rodent prey to obtain energy: 2 peanuts for each capture. Again, one of these must be put into a used-up energy container by the carnivore.

6. Organisms aren't out of the game if out of energy; they must simply seek out more from the appropriate source.

7. If enough staff are available, it's useful and fun to denote one staff person as "Death and Decay." When Death tags a player, that player must surrender all accumulated peanuts and start from scratch. Death can also capture raptors and serves as a means of siphoning peanuts from that group.

8. The game continues until the sun runs out of peanuts, or as long as desired up to that point.

### Follow-up Discussion

Collect the peanuts from each group and count up the totals. Do they match the predictions? The game is set up as outlined above so that plants will usually have the highest total, rodents the next highest, and raptors the least. Is this the way things work in nature? How many peanuts did used-up energy accumulate (almost always higher than any of the other totals). Why did used-up energy get the most? How much energy does this leave for raptors? Depending on the age of the group, discuss pyramids of energy, biomass, and numbers. In a forest ecosystem, do you think there would be more raptors, rodents, or plants? Why? Distribute peanuts to be eaten equally among students.

## Extension Activities

Take your students outside to a nearby park or wooded area. Ask them to find as many types of living organisms as they can. Have them try to guess if each organism is a predator, prey or both.

## Further Reading

*Food Chains* by Alvin Silverstein, et. al. (Millbrook Press 1998).

# 4. Evolutionary World

## *Purpose*

To enhance student understanding of Fore! The Planet™ Holes 5, 7 and 9 by exploring an evolutionary timeline and some adaptations produced by evolution.

*Fore! The Planet™ Holes Explored*

Hole 5: Evolution of a Golfer

Hole 7: Natural Selection

Hole 9: Dinosaur Extinction

## *Activity 4A: The Timeline of Life*

Understanding the vastness of geological time is difficult even for adults. The following activity will allow your students to visualize a human timeline with one inch equaling one million years.

**Materials**

- Measuring stick (ruler or yardstick)
- Tape
- Markers
- 10 signs with string (to be worn necklace-style) as follows:

**1. EARTH BEGINS**
4.57 billion years ago
380 feet

**2. FIRST LIFE ON EARTH**
3.5 billion years ago
290 feet

**3. FIRST FISH**
450 million years ago
37.5 feet

**4. FIRST LAND PLANTS**
400 million years ago
33.3 feet

**5. FIRST LAND ANIMALS**
350 million years ago
29.1 feet

**6. AGE OF DINOSAURS STARTS**
245 million years ago
20.4 feet

**7. MODERN BIRDS EVOLVE**
70 million years ago
5.8 feet

**8. DINOSAUR EXTINCTION, AGE OF MAMMALS BEGINS**
65 million years ago
5 feet

**9. FIRST ELEPHANTS**
40 million years ago
3.3 feet

**10. FIRST HUMANS**
5 million years ago
5 inches

**Procedure**

1. Find a room or hallway that measures at least 380 feet in length, or do this activity outside. For younger students, mark the distances in a line on the floor with tape. For older students, let them measure the distances themselves.

2. Break students into 10 groups. Give each group a sign card and ask one student in the group to wear the sign necklace-style.

3. Have Group 1 walk to their point in geological time (if already marked) or have them measure 380 feet and then stand in that spot. Explain this is when the earth was formed. Have each successive group follow same procedure in chronological order, explaining each event.

4. When all groups are on their spots, have them look at the whole spread and explain the concept of geological time again. How far is the formation of the earth to the first life on earth compared to its distance from the evolution of humans? By comparing distances, students get a visual understanding of stretches of geological time.

## *Activity 4B: Design-a-Saur*

This activity introduces students to classifying dinosaurs according to their lifestyle and physical characteristics and helps them understand dinosaur adaptations.

Every animal needs certain things to survive–food, water, shelter, and space. The place where an animal lives and is able to find these necessities is called its habitat. By looking at an animal's body, it is possible to make intelligent guesses about how and where that animal lives. Paleontologists, who study dinosaurs, base their ideas about how dinosaurs lived on both the way their bodies are built and the type of habitats in which they lived.

### Materials

- Design-a-Saur Worksheets
- Crayons
- Scissors

### Procedure

1. Hand out sheets with dinosaur parts.

2. Explain to the class that they are going to design their own dinosaur, and that they can use the pieces in any way they want. Some students may want to assemble a recognized dinosaur; others may want to create a fantasy animal. To get them started, discuss one aspect of dinosaur anatomy , such as feet, or teeth, and the uses that this anatomical feature might have had for different dinosaurs.

3. Hand out crayons, glue, cardboard, and scissors, and allow the children to create their own dinosaurs. Hint: Color before cutting.

4. Tell students that they will be naming their dinosaurs. Explain that scientific names often come from the way people choose to describe the animal. (ex: *Tyrannosaurus* means "terrible lizard".) Other animals are named after the person who discovered them. (ex: *Hadrosaurus foulkii*) Other dinosaurs are named for the place that they were found. (ex: *Velociraptor mongoliensis*) Tell the students that they can name their animal based on a description of the animal, their own name, or any way that they would like.

5. Allow the students to show their dinosaurs to the rest of the class, and to explain their dinosaur's adaptations, habitat, and lifestyle.

### Some Possible Dinosaur Adaptations

**Teeth:**

Flat teeth for plant eaters
*(Hadrosaurus, Edmotosaurus)*

Pointed teeth for meat eaters
*(Tyrannosaurus rex, Albertosaurus)*

**Spikes:**

Nose spikes as defense
*(Triceratops, Centrosaurus)*

**Horns:**

Thumb spikes for shredding vegetation
*(Iguanodon)*

**Spines and plates:**

Back plates for defense
*(Stegosaurus, Ankylosaur)*

Back spines or sails as heat catchers to warm up the dinosaur,
*(Stegosaurus)*

**Feet:**

Pillar-like feet for supporting large weight
*(Apatosaurus, Brachiosaurus)*

Three-toed feet for running
*(Utahraptor, Allosaurus)*

Clawed feet for attacking
*(Velociraptor, Troodon)*

**Head crests:**

Mating display
*(Parasaurolophus, Oviraptor)*

Producing sound, like a horn
*(Corythosaurus, Parasaurolophus)*

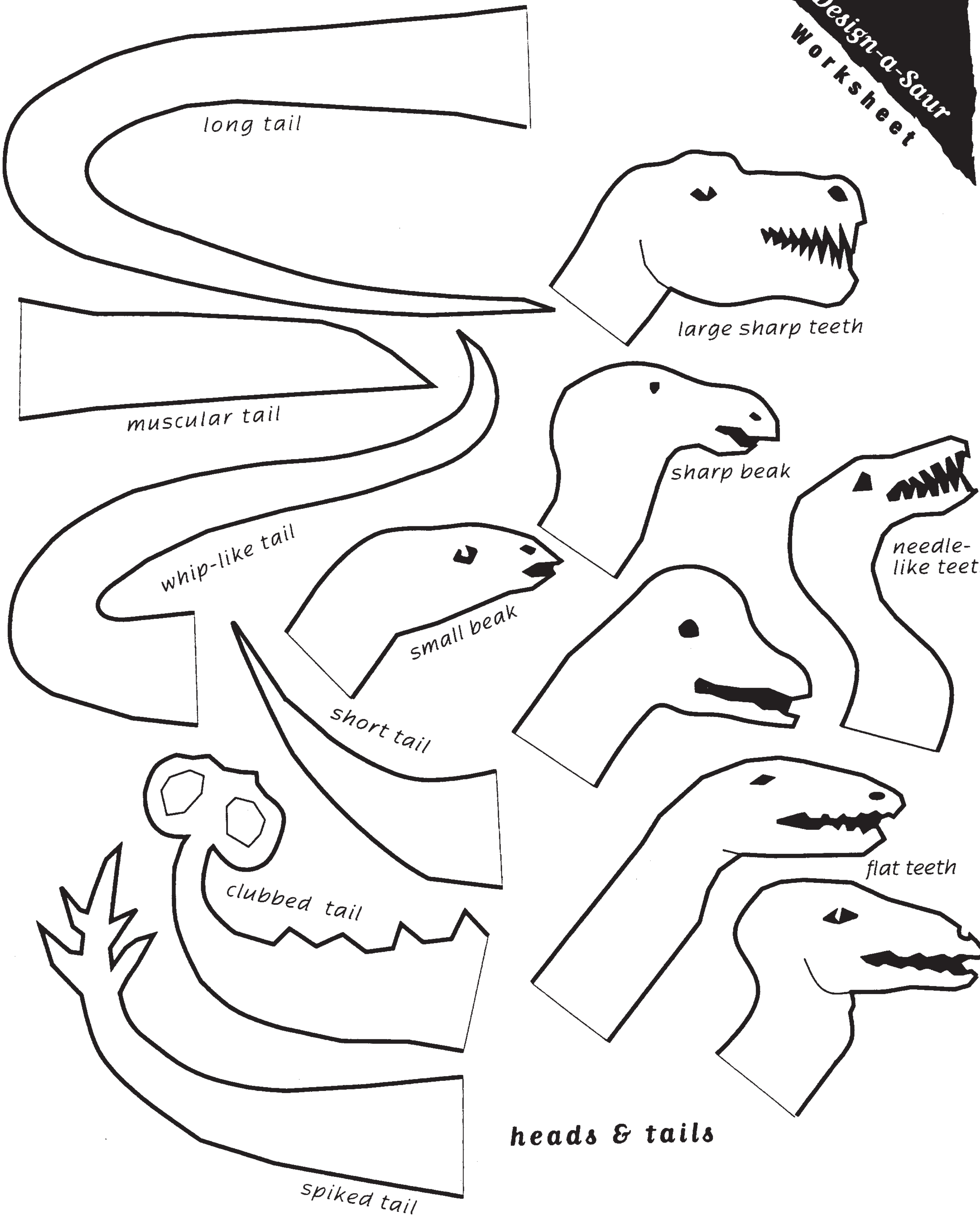
**Claws:**

Digging
*(Segnosaurus)*

Self defense
*(Velociraptor, Deinonychus)*

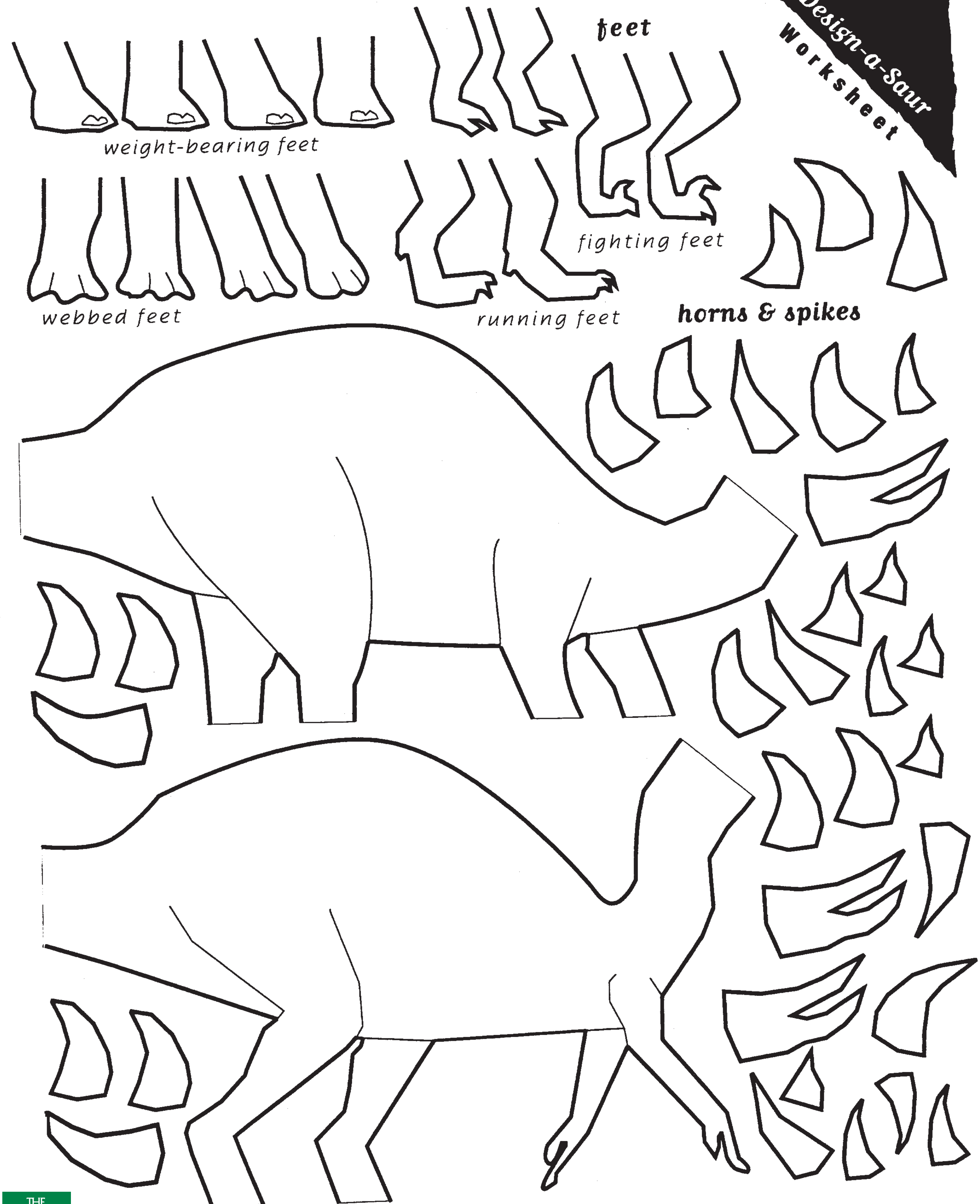
Attacking in order to kill for food
*(Velociraptor, Deinonychus)*

Design-a-Saur Worksheet

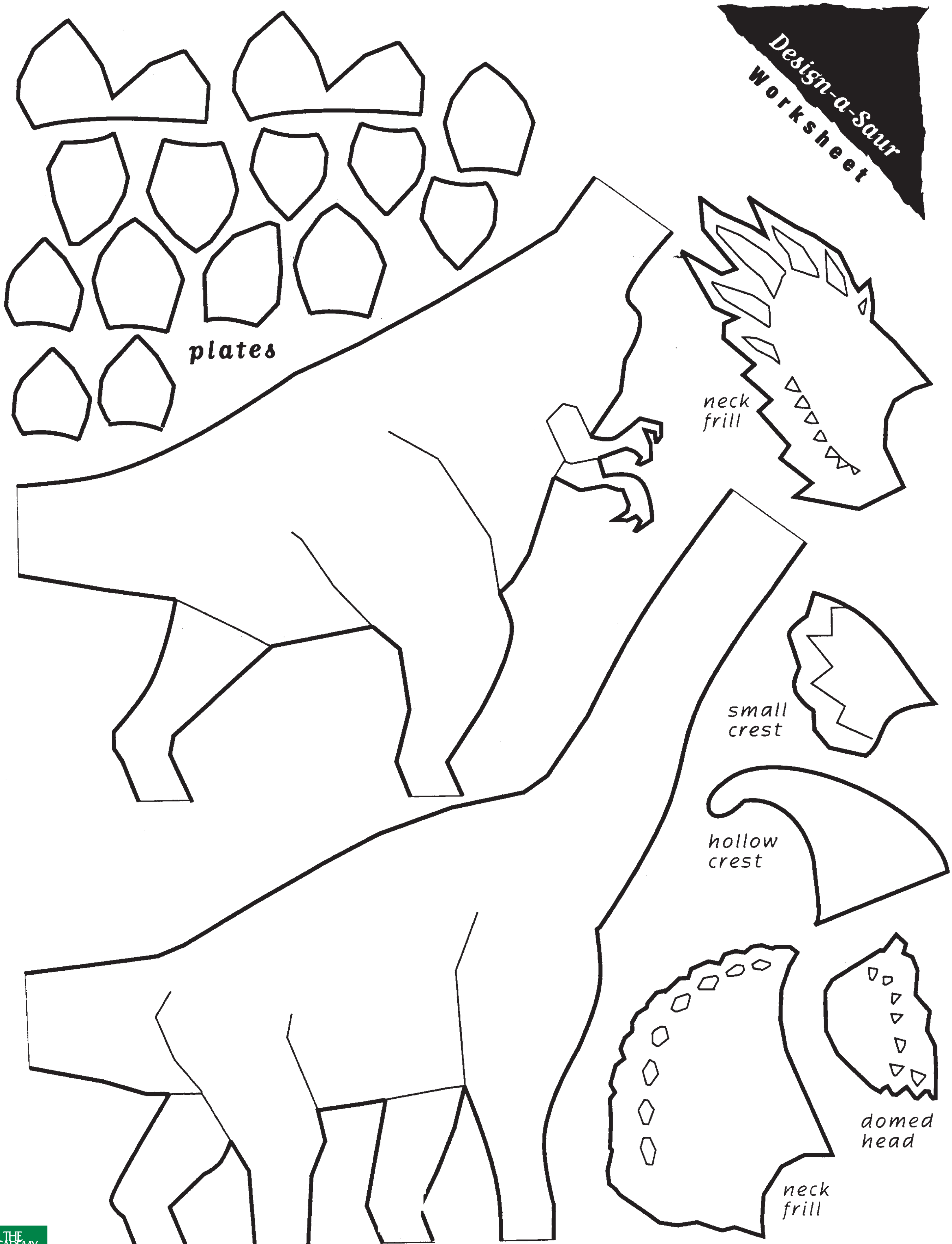



**heads & tails**

# Design-a-Saur Worksheet



# Design-a-Saur Worksheet



## Follow-up Discussion

Discuss dinosaur adaptations and their uses, using a few actual dinosaurs as examples. Ask students what they think of these interpretations of the dinosaur adaptations. Are they similar or different to the way the students interpreted the adaptations? Remind students that these adaptations probably served numerous purposes for the dinosaurs. Ask students how they think that people came up with the ideas about the purposes of dinosaur adaptations. Tell students that the primary way that paleontologists come up with theories about dinosaur behavior is by looking at the fossils from that time period, such as dinosaur bones, dinosaur imprints, and fossils left by other animals and plants. Another method used by paleontologists is comparing dinosaurs to animals that are alive today. What are some animals alive today that have similarities to dinosaurs? What is similar about them? What are the differences? Did students use other animals alive today to decide what their dinosaur's body parts are used for?

## Extension Activities

Grades 3-4:

6. Ask students to write a description of their dinosaur and the different adaptations that it has. Have students write a story about the dinosaur, or pair students and ask them to come up with a story that includes both of their dinosaurs.

Grades 5-up:

6. Ask students to write a detailed description of their dinosaur, its habitat, and the way it lives. Have them write a fictional narrative from the perspective of the scientist who first found the bones of this dinosaur.

## Further Reading

*Ranger Rick's Digging into Dinosaurs* by National Wildlife Federation (McGraw-Hill, 1989)

*The Evolution Book* by Sara Stein (Workman Publishing Company, 1986)

# 5. Save the Animals

### *Purpose*

To enhance student understanding of Fore! The Planet™ Holes 11, 13, 16, 17 and 18 by introducing concepts of ecological changes and how they affect animals.

*Fore! The Planet™ Holes Explored*

Hole 11: Spawning Salmon

Hole 13: Wild Corridors

Hole 16: Alien Species

Hole 17: Population Threats

Hole 18: Rainforest Threats

## *Activity 5A: The Interdependence of Life*

(Adapted from *Project Learning Tree*)

In this activity, students will take a close look at one particular ecosystem (a forest) and will discover the ways that plants and animals are connected to each other. By substituting the appropriate information, you can also use the activity to study other ecosystems, such as oceans, deserts, marshes, or prairies.

A forest is a living community dominated by trees. Each plant in the forest, from tiny mosses to giant trees, has its own specific needs for things like sunlight and moisture. Because environments vary tremendously, a specific location will be better for certain plant species than for others, and those species will grow more abundantly as a result. The most dominant tree species in a forest usually determines the forest's appearance and suitability as a habitat for plants and animals. For example, in some forests, large, dominant trees may reduce sunlight and monopolize soil moisture and nutrients, thus limiting the types of plants that can grow beneath them.

While trees and plants are usually its most conspicuous elements, the forest ecosystem also depends on animals. Animals are vital to most plants because they help pollinate flowers and disperse seeds. At the same time, animals such as deer, rabbits, and insects may eat certain plants, greatly reducing their presence. Some insects can substantially damage a forest ecosystem if their numbers get too high. Insect-eating birds play an important role in keeping insect populations in check.

**Materials**

- Half a ball of yarn
- Resource materials about forest plants and animals

**Procedure**

1. Ask students to work in pairs or teams to brainstorm all the components they think they would need to make a healthy forest. Have each group choose a forest plant or animal and collect as much information as possible about that organism.

2. After they research the organisms, have the teams each make a name tag for their forest plant or animal, including a picture. Ask one person from each group to sit on the floor in a circle.

3. Starting with one "plant," ask that student to hold the end of a ball of string. Ask the team that studied the first plant to name another organism in the circle with which that plant interacts (for example, is eaten by or depends on). Pass the ball to this second student, who will wrap the string around one hand and pass the ball to the student representing an organism that the second team chooses to connect with. This process will continue until each "organism" is linked to the ecosystem and the ball is returned to the first student.

4. Now have students slide back until the string is taut. Tell student to keep still. But if they feel a tug, they should tug in response. When everyone is still, tell the student holding the original end of the string to gently begin tugging. Keep reminding everyone that if they feel a tug, they should tug in response. Through this mechanism, vibration will spread through the web of life until everyone is tugging and the whole web is shaking.

5. Ask students how the tugging demonstration might illustrate what happens when one of the links in an ecosystem is damaged through natural or human-made stress. ***The rest of the ecosystem feels the effects.***

6. Ask students to pick one organism in the system that they feel is the least important and have it drop out. Ask if any other organisms should drop out because they depended on that organism. After one or more have dropped out, ask students again to identify an organism that seems less important and repeat the procedure. Continue playing for a few more rounds, then ask the following questions:

• What happens when we remove a link in the forest ecosystem? ***Organisms that depend on it are affected.***

• Were the changes more dramatic when the system was composed of many parts or when it had fewer parts? ***fewer***

• What can we say about the relationship between how many parts the system has (its complexity or diversity) and how stable it is? ***In general, complexity makes it more stable.***

**Some Forest Plants and Animals**

| | |
|---|---|
| azalea | bark beetle |
| clover | bat |
| columbine | beaver |
| cottonwood | bear |
| honeysuckle | box turtle |
| lichen | butterfly |
| maple tree | chipmunk |
| Douglas fir | deer |
| paintbrush | earthworm |
| pine tree | field mouse |
| poison ivy | red fox |
| shelf fungus | tree frog |
| violet | grasshopper |
| | king snake |
| | lizard |
| | mosquito |
| | hawk moth |
| | opossum |
| | barred owl |
| | rabbit |
| | raccoon |
| | skunk |
| | snail |
| | red squirrel |
| | tick |
| | woodpecker |

## *Activity 5B: Habitat Loss Musical Chairs*

(Adapted from *Beakman's World on Tour Teaching Guide,* © 1998, Cincinnati Museum Center)

**Objective:** To identify a number of animals that are part of the incredible biodiversity of the rain forest and infer the problems caused by their dwindling habitat.

### Materials

- Chairs placed in a circle
- Music (soundtrack to The Jungle Book, The Lion King, etc.)

### Procedure

1. Start out by having students sit in their chairs and explain that their chairs represent rainforest animal "homes" like trees, vines, underbrush, or pools of water. Then invite students to choose a rainforest animal they would like to represent. Here's a short list of animals from rain forests around the world to get you started:

| | |
|---|---|
| alligator | electric eel |
| armadillo | millipede |
| anaconda | nightjar (bird) |
| capybara (rodent) | fer de lance (snake) |
| emerald tree boa | agouti (rodent) |
| mountain gorilla | giraffe stag beetle |
| hoatzin (bird) | hornbill (bird) |
| green iguana | chameleon |
| ring-tailed lemur | potto (primate) |
| kinkajou | praying mantis |

2. Have students stand up. Take a chair away from the circle and start the music. Students walk around the circle while the music is playing. When the music stops, the student who does not find a "home" to live in (sit down in) becomes extinct (is out). Continue on until all the animals are extinct but one. **Ask:** Is this still a rain forest? Does only one species of animal, and one kind of home, have much of a chance of survival?

3. As the game progresses you may want to move multiple chairs to illustrate the interdependence of life. The extinction of one animal in a habitat can result in many animals becoming extinct because a critical portion of the food web is missing.

### Discussion

This game demonstrates that all these species have very little chance for survival without the habitat they require. Habitat loss is the biggest threat facing animals in tropical rain forests around the world. Rain forests cover only 6% of the earth's surface, yet an area of rain forest equivalent to the size of the state of Washington is cut down for timber, firewood, farming, cattle ranching, and development every year. The rain forest supports an incredible number of plants and animals. Four times as many bird species live in the tropical Central American corridor than the entire forested eastern United States. In a rain forest of Malaysia or the Amazon, you will find ten times the number of tree species that you would in the same-sized area of a deciduous forest in eastern North America.

# 6. Save the Planet

## *Purpose*

To enhance student understanding of Fore! The Planet™ Holes 10, 12 and 15 by making students aware of environmental pollution.

*Fore! The Planet™ Holes Explored*

Hole 10: Recycling

Hole 12: Landfills

Hole 15: Water Pollution

## *Activity 6: Talking Trash, Not!*

(Adapted from *Project Learning Tree*)

By taking a look at their own trash, students can learn a lot about how and why they throw things away. They can find ways to cut down on the waste they produce and to improve the way waste is managed in their community.

More and more people are involved in reusing, recycling or recovering materials that people previously referred to as “trash.” In fact this “trash” is composed of valuable raw materials. Consequently, your community may sponsor recycling or composting programs, or have a waste-to-energy facility to decrease the amount of material disposed as waste.

### To the teacher

For this activity, you will need some kind of large container (or containers) to hold a week’s worth of classroom trash. Large cardboard boxes, a large trash barrel, or several plastic trash bags will all work well. You will also need to make arrangements so that no one collects trash from your room during the week.

**Materials**

- Large box, boxes, pails or other containers for sorted waste
- Rubber gloves
- Map of North and South America
- Bathroom scale (optional)

**Procedure**

1. Discuss with students whether it is really possible to throw something away. Where is “away?” Do these things somehow disappear? Can trash continue to affect us even after we’ve thrown it away?

2. Tell students that for one week they will not throw anything away while in school. Explain that everything they want to throw away during the week should go into the large container you prepared earlier.

NOTE: Food wastes can be messy and unsanitary to keep. You might have students collect food waste in a separate container, weigh it and record the contents before they throw it away.

3. Have students predict how full the trash container will be by the end of the week. You might also have them predict the types of items that will make up the greatest proportion of the trash.

4. At the end of one week (or at the end of each day), have students look at their trash. Did more or less accumulate than they’d predicted? You can sort through the trash and hold up items for them to see, or you can have one or more students sort through the trash. Be sure that whoever sorts wears rubber gloves. Record on the chalkboard the quantity and type of each item.

5. Using the following questions, discuss what usually happens to trash:

What usually happens to classroom trash at the end of each day? ***Someone collects it and takes it to a dumpster.*** You might want to take the students to see the dumpster.

Where does the trash end up? How often is it picked up? Have students guess. ***In most cases, someone collects it from the dumpster and takes it to a local landfill where it is buried or to an incinerator where it is burned. Recyclable materials that are separated are often taken to a recycling facility.***

What are the pros and cons of burning trash? ***Greatly decreased the volume of waste. May put harmful pollutants in the air.***

What are the pros and cons of landfills? ***They provide easy disposal for large amounts of waste in a relatively sanitary fashion. Landfills are filling up and new landfills are difficult to site.***

Where do the materials come from that make the items in trash? ***Paper comes from trees, metal cans from minerals in the earth, plastics from fossil fuels, fruit from trees and other plants.***

When people use things only once and then throw them away, what are the effects on our supply of natural resources? ***We have to use more minerals and fossil fuels for energy to create new products.***

## Extension Activity

### Trash Action Plan

Have the students develop an action plan to reduce the amount of trash they generate, then carry out the plan. Here are some suggestions of things your group can do. The students may also have other ideas.

- Set up a scrap box. Have students put papers which they've only used one side of in the scrap box. When someone needs paper for scratch work or a short assignment, he or she can use a piece from the scrap box.
- Set up a "recycling center" in one corner of your room for the class (or for the whole school). You might collect aluminum, glass, plastics, and/or paper. Be sure to discuss what you're going to do with the collected material before you begin! ***Find out what your school, community or city is already doing. Consult the blue and yellow pages of the telephone book to locate recycling centers.***
- Create a compost pile outside your building. (Contact your state environmental agency for composting regulations.) Food scraps from your class, other classes and the cafeteria can all be collected and then dumped in the compost pile. Building maintenance crews can also dump grass clippings and other yard waste into the compost pile.

### Operation Cleanup

Have students clean up one of the public environments in the neighborhood.

### Environmental Times

Create a newspaper called "Environmental Times" and write articles on environmental issues.

## Further Reading

*Project for a Healthy Planet* by Shar Levine and Allison Grafton (Wiley, 1992)

# *Learning at the Exhibit Worksheet* *(Answers are in parentheses)*

**1. Butterfly Life Cycle**

*What does metamorphosis mean?*

(a change in form, like butterfly from caterpillar)

*What are the four stages in a butterfly's life cycle?*

(egg, larva, pupa, butterfly)

**2. Seed Dispersal**

*Why is the eclectus parrot not a good disperser of seeds?*

(its sharp beak may crack the seed pit, preventing the seed's growth)

*Why is the cassowary a good disperser of seeds?*

(it eats fruit, but can't digest the seeds, which are dispersed in the birds' droppings)

**3. Bat Sonar**

*Are bats blind?*

(no, they can see, but they use sonar to navigate in the darkness)

*How do bats avoid obstacles in the dark?*

(they send out sonar waves which hit obstacles and return to the bats so they know what's in front of them)

**4. Food Chains**

*Which organism in this whole is a primary producer?*

(primary producers are organisms that turn light energy into food energy, i.e. plants, in this case the Douglas fir)

*Which is a secondary consumer?*

(secondary consumers eat primary consumers, which eat plants, in this case, the great-gray owl eats the red tree vole)

**5. Evolution of a Golfer**

*What is a vertebrate animal?*

(an animal with a backbone)

*What key feature allows human beings to play golf, among many other things?*

(the brain)

**6. Backyard Explorer**

*What are some tools you can use for studying nature in your back yard? (look for clues in the hole itself)*

(magnifying glass, journal, your sense of observation)

**7. Natural Selection**

*Are long beaks and strong wings an advantage or disadvantage to the birds on the new island with lots of seeds and no predators?*

(disadvantage)

*Are short beaks and weak wings an advantage or disadvantage on the new island with lots of seeds and no predators?*

(advantage)

**8. Predator and Prey**

*What is the fly trying to do in this hole? Why is its job important to the ecosystem?*

(get to the picnic to lay eggs; flies help the decomposition process, breaking down nutrients essential to other plants and animals)

*What predators eat the fly?*

(frog, spider)

**9. Dinosaur Extinction**

*How did dinosaurs die in the sudden death scenario?*

(disruption of habitats and food chains)

*How did dinosaurs die in the gradual change scenario?*

(inability to evolve and adapt)

**10. Recycling**

*What are some alternatives to throwing plastic in the trash?*

(reuse, recycle)

*How can you help the environment when you go to buy a product in the store?*

(buy things with less packaging, buy recycled products, ask the store to stock these items)

**11. Spawning Salmon**

*Salmon are born in rivers but then swim to the ocean to reach maturity–why do they later return to the rivers?*

(to breed and lay eggs)

*What are some of the obstacles in the path of the returning salmon?*

(predators, dams, fishing, pollution)

**12. Landfills**

*What are some of the problems with continuing to dump trash in landfills?*

(lack of space, leaking chemicals into groundwater)

*If on average, every American produces 4 lbs of trash per day, what can you do to help?*

(reduce, reuse, recycle, compost)

**13. Wild Corridors**

*What is a wild corridor?*

(green spaces that are connected, allowing animals to move freely)

*What are some of the solutions people have come up with to help animals in fragmented habitats?*

(tunnels under roads for panthers and salamanders, ramps and traffic control around pipelines for caribou, saving chunks of forest and parks next to each other)

**14. Bird Migration**

*Why do birds migrate?*

(to breed and to feed)

*Where do Swainson's hawks migrate from and to in the fall?*

(from western North America to Argentina in South America)

**15. Water Pollution**

*How do pollutants from our lawns, yards, farms and factories get into water ways?*

(water runs downhill, picking up and carrying trash, chemicals, and other wastes with it)

*What are two things you can do to prevent water pollution?*

(recycle used motor oil, reduce pesticide use, clean up pet waste, participate in litter cleanups)

**16. Alien Species**

*What is meant by the term alien species?*

(when a species of animal or plant is introduced to a habitat from a foreign place)

*What is one example of destructive results from an alien species?*

(the brown tree snake in Guam wiped out many native bird species; the cane toad in Australia multiplied out of control; the vine kudzu in America crowded out other native plants)

**17. Population Threats**

*What are some of the human threats to a small, isolated population of bears?*

(hunting, pesticides, destruction of habitat)

*What are some of the natural threats to a small, isolated population of bears?*

(too few cubs born, too many deaths of adult bears, shortage of food, too many predators, disease)

**18. Rainforest Threats**

*Why is the rain forest important to you and me?*

(the trees and plants are important to the atmosphere and climate, contributing oxygen and preventing global warming)

*What are some of the threats to the rain forest and what is needed to save it?*

(clear cutting for farming and economic development; sustainable development ideas like butterfly farming that support local people and preserve the rain forest)

# Acknowledgements

THE ACADEMY OF NATURAL SCIENCES

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and to inspire stewardship
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Founded in 1812, The Academy of Natural Sciences of Philadelphia is the oldest science research institution in the Western Hemisphere and a world leader in the fields of natural science research, education and exhibition.

Popular features in the Academy's Museum include the new exhibit, **Dinosaur Hall,** home to fearsome *Tyrannosaurus rex* and the newest carnivore on the block, *Giganotosaurus,* the biggest meat-eating dinosaur ever discovered. There's the hands-on experience, **The Dig,** where visitors dig for real fossils; **Butterflies,** the exhibit with live tropical butterflies that fly all around you, taking you into the heart of the rain forest; the **Live Animal Center** that cares for over 100 wild animals unable to survive on their own in the wild; and the children's nature museum, **Outside-In.** Changing exhibits highlight the ongoing research of Academy scientists.

The Academy has three research groups: the **Biodiversity Group, The Patrick Center for Environmental Research, and The Estuarine Research Laboratory.**

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**The Estuarine Research Laboratory** on the Patuxent River in Maryland focuses on the natural processes occurring in estuaries and coastal oceans. The Estuarine Research Laboratory offers diverse educational programs for teachers, students and concerned citizens.

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***The Educator's Guide to Fore! The Planet™***



Fore! The Planet™ was conceived by Willard Whitson, Director of Exhibits. Concepts for the holes were culled from hundreds of ideas created by Academy staff.

**Fore! The Planet™ Exhibit**

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