

Tour of the Toronto Zoo for Grade Seven: “Interactions Within Ecosystems” (the Tropical Rainforest Ecosystem)

Tour for Grade 7: Interactions within Ecosystems

The main themes for this tour are:

- the various positions of the animals in their food web relationships and their trophic level (producer, consumer or decomposer)
- changes both natural and human caused to ecosystems and their effects.
- the importance of special "keystone species" in certain ecosystems.

Background

First a few helpful definitions:

Biome: Very large areas of terrestrial habitat, each with a characteristic climate, day length, topography and climax flora and accompanying fauna. Most authorities only recognize about 15 biomes for the entire earth:

1. Tundra (treeless, sometimes marshy plains; northern Asia & North America)
2. Northern coniferous forest (a.k.a. boreal, or taiga)
3. Temperate coniferous forest
4. Temperate broadleaf forest (oak - hickory forests of eastern USA)
5. Temperate grassland (prairies of North America)
6. Desert and dry shrub (Sahara)
7. Mediterranean shrub
8. Mountain grassland
9. Flooded grassland and savanna (Florida Everglades)
10. Tropical grassland and savanna (African savanna)
11. Tropical dry forest
12. Tropical coniferous forest
13. Tropical moist broadleaf
14. Mangrove
15. Permanent ice cover (Antarctica, parts of Greenland)

Within each biome are hundreds of specialized ecosystems (e.g. a salt marsh, sand dune, cloud forest, stream or pond) and within these are hundreds or even thousands of habitats or potential habitats. (Tudge, Colin. *Global Ecology*, 1991.)

Biosphere: The part of the Earth, including rock, soil, water and atmosphere that contains living organisms.

Community: All the organisms - plants, animals and microorganisms - that live in a particular habitat and affect one another as part of the food web or through their various influences on the physical environment. (Wilson, E. O. *The Diversity of Life*, 1992.)

The Rouge River valley is a community of plants and animals.

Ecosystem: The organisms living in a particular environment, such as a lake or a forest (or, in increasing scale, an ocean or the whole planet), and the physical part of the

environment that impinges on them. The organisms alone are called the community. (Wilson, E. O. *The Diversity of Life*, 1992.)

Keystone species: An organism, which provides conditions in an ecosystem on which many other species depend. This role is so vital that when the "keystone species" is removed the ecosystem collapses or changes radically.

Population: In biology, any group of organisms belonging to the same species at the same time and place. (Wilson, E. O. *The Diversity of Life*, 1992.)

Ontario has a population of raccoons.

Species: a population or series of populations of organisms that freely interbreed with one another in natural conditions but not with members of other species. (Wilson, E. O. *The Diversity of Life*, 1992.) The tiger and the lion are separate species.

Tour

One of the ecosystems we will explore today is the tropical rainforest. This is one of the richest and most complex ecosystems in the world and may contain several thousand different species in each hectare. Rainforests develop where heat and humidity are very high throughout the year.

Rainforest plants, Americas pavilion entrance

- **Did you notice any change when we came in?** Notice the lush vegetation and the high temperature and humidity.
- **Which trophic level do plants fit into; producer consumer or decomposer?** Producer: Plants form the base for the rainforest food chain on which all the other organisms depend. This environment is ideal for plant growth.
- **How do plants (producers) get their energy and form their tissues?** Plants take carbon dioxide from the air, water and minerals from the soil and use sunlight to manufacture their own tissues in a process called photosynthesis.

Elephant ear plant

Notice the big leaves on the plants of the forest floor.

- **Why are their leaves so big?** Very little light reaches the forest floor and big leaves gather more light. Plants compete very aggressively for sunlight in a rainforest and tall trees form a nearly solid canopy layer of branches and leaves that absorbs most of the sunlight and heat. Most of the animal life too is found in the canopy.

Amazing fact: Some of the largest and most diverse forests grow in very poor soil.

- **How does this happen?** In the rainforests of Brazil heavy rains come every year and dissolve and leach away minerals. Highly efficient decomposers (insects, bacteria and fungi) recycle nutrients quickly into the bodies of plants and animals. Most of the 'biomass' (the total dry weight of organisms in a particular area) of a rainforest is contained in the huge trees.

Pygmy marmoset, Common marmoset, Golden lion tamarin, White faced saki, Sloth, Brazilian agouti

Notice that there are 2 or more species in each exhibit.

- **Why are they able to get along peacefully?** They use different areas of the forest. In the rainforest most monkeys spend their lives in the canopy and rarely descend to the forest floor while the Brazilian agouti does not climb trees but searches for nuts and fruit on the forest floor.

There are many types of monkey in the South American rainforests. Pygmy marmosets live in family groups and eat sap from cuts in the bark of trees, which they maintain open for this purpose. They also defend this food source from other marmoset groups. Some rainforest monkeys are wide spread while others have very limited distribution. The Golden lion tamarin for example is only found in the coastal rainforest of Brazil and 95% of this habitat has been destroyed. Without suitable habitat they cannot survive. Fortunately they are breeding well in zoos and are now being reintroduced to protected areas of their wild range in Brazil. This is very expensive and costs up to \$10,000 per animal released.

• **Can anyone see a herbivore, carnivore or omnivore?** Herbivore: sloth, agouti; Omnivore: monkeys (marmosets, tamarin, saki)

The agouti does not climb trees but is attracted to the sound of falling fruit and nuts which are its main foods. It is an important seed disperser for many large rainforest trees. When it has too much to eat immediately it will often hide seeds and nuts by burying them and, fortunately for the trees, its memory is not perfect. Seeds that are not recovered sometimes sprout into new trees. The agouti is also an important agent of change for plants in the rainforest, as we will see later in the tour. The grey squirrel is a local animal that also stores nuts in the ground that sometimes sprout into trees.

Sloth

The sloth occupies a very special niche in the rainforest. It is one of the few animals here that can survive completely on leaves (folivore) and is the most common large herbivore in the South American rainforests.

In a forest leaves are plentiful and easy to get, but they provide only low levels of nutrition, high fibre content and often contain toxins that protect them from insects. Folivores are typically slow moving, and have large, specialized guts that use bacteria to digest their coarse food. They do not need to move fast to "catch" their food, which is just as well because their food does not provide much energy. (Some other folivores: giant panda, koala, proboscis monkey, colobus monkey, howler monkey, and ring-tailed possum)

Parasites: Most large animals have at least a couple of kinds of unique parasites but the sloth is a special example of species interdependence. Sloths get some protection from 2 or 3 species of algae that grow in a longitudinal groove on each guard hair. In the wet season this gives the sloth a greenish tinge, an excellent camouflage. The sloth's algae filled hair is also an attractive home and food source for 9 species of moth, 6 species of beetle, 6 species of tick as well as many species of mites, none of which seem to do the sloth much harm. Sloths also have help from unique bacteria in their stomach that help them digest the cellulose in their coarse leaf diet. Sloths conserve water in their large bladder and only need to urinate and defecate about once every 7 or 8 days. They climb labouriously down to the ground and may even dig a shallow pit into which they make their deposit. Many of the dependant passenger insects, ticks and mites use this weekly opportunity to deposit their own eggs onto the sloth's feces where they mature, pupate and then fly away to colonize another sloth.

Rainforest destruction sign

Ask students to notice the rainforest destruction sign.

• **What happens when you cut down a rainforest?** Erosion usually carries away what little soil there is, temperature goes up and humidity goes down. Rainforests may not be able to re-establish themselves in these conditions.

Current estimates (National Geographic 1998) give the destruction rate of rainforests in South America as 29,000 km² per year.

Eating High on the Food Chain

Although we have seen several plants and animals we have not yet looked at a single large predator. Every ecosystem must have many more producers and primary consumers than predators (secondary consumers) because energy is lost from the food web at each stage. No animal is able to use all the energy from the food it consumes. It takes a very large area to support a single large predator. Canadians and other people in rich countries like to eat a lot of meat like large predators. In poor countries people admire our way of life and want to imitate it.

• What consequences does this have for ecosystems like the rainforest?

Huge areas have been cleared of rainforest to provide grazing land for cattle. Although the cattle ranches mostly fail because of the poor soil the rainforests cannot re-establish themselves and where there once was one of the richest ecosystems on earth there are now highly degraded wastelands.

There are alternatives. Tapping trees for rubber, collecting Brazil nuts and other forest fruit and even small-scale logging can support people without harming the ecosystem.

The Cascading effects of changes to ecosystems:

Black footed ferret, Black tailed prairie dog

The prairie dog used to be one of the most common mammals in North America. On the southern prairies European explorers reported riding for days and days through just one continuous huge prairie dog colony that is estimated to have contained 400 million prairie dogs. This small rodent has since then been wiped out of huge areas by farmers and ranchers who thought of it as a pest. (Only about one per cent of original prairie grassland remains in its original undisturbed condition.)

One unforeseen consequence was the near extinction of the Black-footed ferret. Many prairie animals benefit from the presence of prairie dogs, especially the black-footed ferret. These little weasel-like predators eat prairie dogs and do not seem to be able to survive for long without them.

(See Prairie dog "Keystone species" sign)

• What is a keystone species?

A keystone species is an organism, which provides conditions in an ecosystem on which many other species depend. This role is so vital that when the "keystone species" is removed the ecosystem collapses or changes completely.

American alligator

The American alligator has a "keystone role" in the Florida everglades. During droughts, which occasionally hit the everglades, alligators dig or keep open "alligator holes". Using the snout and feet they remove the mud and many water plants and keep a small pond open in which they endure the dry period. These ponds are also havens for fish and many other aquatic species as well and drinking holes for deer, raccoons etc. and hunting areas for fish eating birds. Many plants find good growing conditions in the mud banks piled up by the alligator. Over several years the alligator hole may even become the centre of a tree island in the everglades.

Beaver

• **How might the beaver be considered a keystone species?** The beaver build dams and flood forest areas. These ponds are habitat created entirely by the actions of this industrious animal. Like the alligator the beaver increases habitats that other organisms can use.

• **How many animals in this area can you find that are at least partly dependent on the beaver for their habitat?** Otter, Large-mouth bass, Pumpkinseed sunfish, Stinkpot turtle, Blanding's turtle, Bull frog... (the back-lit graphic near the exit doors provides more examples)

The life of a beaver pond: There is a natural life span for a beaver pond. When the beaver first builds its dam most of the trees in the flooded zone soon die or are cut down by the beaver. Those left standing will begin to rot and provide many good nesting sites for cavity nesting birds. The pond may last for several years but as sediment builds up on the bottom and all the surrounding trees of interest are chewed down the beaver will move on and build a dam in a new location. The water will eventually breach the original dam and most of the pond will drain away. What is left is called a "beaver meadow". Grasses thrive in the fertile, unshaded soil. Deer and moose find lots to eat among the small trees, shrubs and grasses. Pines, birch, and poplar trees, which cannot grow in the forest shade, eventually re-colonize the site and it once again may become attractive to beavers.

Succession: Constant change is normal in nature. There is a process of natural succession in any plant community once it has been disturbed. Fast growing plants that do not tolerate shade are the usual first colonists. As the site matures larger shade producing plants and trees take over, monopolizing the sunlight and crowding out the smaller shade-intolerant species. Eventually the site is occupied by the climax plant community, larger plants that are so well suited to the site that they can only be displaced by a major disturbance such as a beaver pond, fire, hurricane or the work of humans.

At the pavilion exit you emerge into a mature Carolinian forest

Note the mature forest. This forest at the centre of the Zoo has not been disturbed for many years.

• **How would you describe this forest?** Mature sugar maple, red oak, beech, and white ash. When left undisturbed for many years this is the typical climax plant community that develops on this type of site (hills and ridges in the Great Lakes/ St. Lawrence area).

Jaguar It may be hard to imagine how a top predator (secondary consumer) like the jaguar might also be a keystone species. Edward O. Wilson in *The Diversity of Life* tells an interesting story about Barro Colorado Island in Panama where the agouti population increased ten fold once the jaguars and cougars disappeared due to hunting and because the forest patches were getting too small to support them. The agouti and another medium sized rodent called the paca eat fallen fruit and large nuts, which are the seeds of large rainforest trees. Agoutis and pacas are themselves eaten by cougars and jaguars. Over a number of years the entire forest ecosystem changed as all the seeds of large nut producing trees were eaten while trees with seeds too small to interest agoutis and pacas sprouted and grew in greater numbers. The removal of a keystone species like the jaguar can have a dramatic and unforeseen effect on many other species in the ecosystem community.

Did they get it? Questions for the wrap up of the tour.

- **What is a keystone species?**
- **Name a couple of kinds of animals that depend on the sloth.**
- **What happens when a South American rainforest is clear-cut?**
- **What is plant succession?**