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Rainforests. Beautiful green habitats that have evolved over millions of years and contain our richest collections of life. From ant eaters to quetzals, begonias to rosewood trees, cicadas to slugs, tropical rainforests teem with intricate webs of life. These biodiversity warehouses constitute 7% of earth's land, yet they contain from 50 to 90% of its living species. Like the rainforests themselves, tropical rainforest education may seem like an unorganized jumble of recommendations, activities, and disconnected

efforts. To help point the way through the terrain, this Digest offers four guideposts: (a) structure, (b) location and climate, (c) importance, and (d) Conservation of resources.

STRUCTURE

PLAYERS OF LIFE. One of the most important features of a rainforest is its vertical stratification. Different microclimates and microhabitats exist in the layers. This layering is a major factor in the rich biodiversity of rainforests.
Pranis and Cohen (1995) describe how children can depict the layers of the rainforest. For the canopy, stand on chairs; sub-canopy, stand on the floor; understory, kneel; and ground, lie down on the floor.

Crane (1987) presents a mural guide of the layers made of two 7.5 foot strips of butcher paper on the wall. Each of the five layers (emergent, canopy, middle, shrub, and herb) is 18 inches tall. Student groups illustrate different layers and explain their layer to the class. A similar activity that involves constructing a three-dimensional paper rainforest mural has been suggested by McKee (1991) .

Rosenbusch (1994) suggests that after students learn about the layers they hypothesize about differences in microclimate between the layers.

ADAPTATIONS OF LIFE. Rainforest organisms are adapted for survival in the particular microclimates of rainforests. Comparing these organisms with more familiar organisms is one way to learn their structures and functions. Science supply companies now offer seeds and kits students can use to observe the growth of rainforest plants.

Pranis and Cohen (1995) suggest creating rainforest conditions with a grow light and timer for 12 hours of light, heater for warm temperatures, and plastic enclosure to retain moisture. Humidity is added with a spray bottle. Beyond observing plant growth, students can compare the growing conditions with local and cultivated plants, as well as leaf transpiration rates.

The National Wildlife Foundation (NWF, 1989) described an activity where students observe and draw leaves from local forests. Illustrations of rainforest leaves are provided for students to compare the leaves. Typically temperate leaves have more variety in shape. Tropical rainforest leaves are elongated with "drip tips."

Students become jaguars in an activity by Morris and Morris (1994). Using a paper bag they cut out eye holes, paste on paper ears and a nose, paint it yellow with black spots, and add pipe cleaner whiskers. A tail is created by filling a nylon stocking with paper and gluing on black felt dots. Students can pretend they are jaguars and explain the functions of their structures.

LOCATION AND CLIMATE

WHERE IN THE WORLD. Tropical rainforests are located in the warm regions south of the Tropic of Cancer and north of the Tropic of Capricorn. Tropical rainforests have the greatest biodiversity, but there are non-tropical or temperate rainforests as well (such as those on the northwest coast of the USA).
Several rainforest maps and related activities are available (Morris & Morris, 1994; NWF, 1989; & Crane, 1987). McKee (1991) had primary grade students look at a map of the world and then place a strip of green cellophane along the equator, visualizing the tropical rainforest belt.

TROPICAL RAINFOREST CLIMATE. Tropical rainforests are warm areas that receive a great deal of rainfall. Average temperatures range from 70-90 degrres F. Rainfall ranges from 60-200 inches per year. Relative humidity is typically 70% in the daytime, 95% at night. Thornton et al. (1995) had first grade students graph local rainfall and compare it to rainforests.

GOING, GOING, GONE? Despite the beauty and importance of rainforests, they are being rapidly destroyed or altered. Analogies can help people understand the rates of loss. Between 1981 and 1990, tropical forest loss was 40 million acres a year. This is the size of the state of Washington (Fortner, 1992). According to Schneider (1996),we are currently losing the area the size of Florida each year. Within 75 years, all the rainforests could be gone.

Analysis of data is another way for students to learn about rainforest loss and integrate mathematics into their science learning. Scientific papers can be a good source of data for analysis.

IMPORTANCE

HABITAT FOR BIODIVERSITY. The number of species in tropical rainforests is astonishing. One pond in the Amazon can contain more species of fish than all the rivers in Europe. One 25 acre plot of land in Borneo has almost 700 types of trees. This is more species than in all the six billion acres of North America. One rainforest park in Costa Rica has more species of butterflies than all of North America.
A good introduction to the idea of habitat and diversity is suggested by Crane (1987). Bring children to a natural area and have them count the number of different living organisms. Next take the children to a parking lot or a dirt area and rope off the same size area. Explain that this area used to look like the other area.

PEOPLE OF THE RAINFOREST. Indigenous people to the rainforests are dependent on the rainforest. The Mbuti or Pygmies in Central Africa, Kuna of Panama, and Arowaks of Suriname are examples of indigenous people living sustainably in tropical rainforests. NWF (1989) presents an activity where students read about the lives of a Mbuti family as they look at pictures. McKee (1991) had students create a Mbuti hut. Morris and Morris (1994) present information on building replica huts of the Dyack people of Borneo.

People who live near rainforests, as well as those who live within them, benefit from forest preservation. Rainforests act like sponges for rainfall. They absorb excess rain and slowly release it. When trees are cut, the area becomes more vulnerable to floods and droughts. Rainforests also protect soil from eroding, and they influence the climate of an area.

FOODS FOR THE WORLD. Rainforests are the origin of many foods in our diet. Coffee, chocolate, many fruits (bananas, avocado, grapefruit, guava, heart of palm, mango, passion fruit, papaya, and more), many nuts (Brazil, cashew, and macadamia), many spices (allspice, cloves, vanilla, black pepper) are from rainforests. Wild areas offer plants that can be used as hybrids to prevent disease or loss of valuable food plants (Grove, 1992).

NWF (1989) provides students with a checklist of products that come from or originated in rainforests. In a rainforest unit, McKee (1991) created a tasting center for first and second grade children to sample foods from the rainforest.

MEDICINES FOR THE WORLD. Rainforests supply the world drugstore. Twenty-five percent of all drugs were derived from rainforest organisms. Seventy percent of plants with known anti-cancer properties are from rainforests (Taylor, 1996). Cashew oil and bamboo extracts have been shown to inhibit bacterial growth (Grove, 1992). Curare, a muscle relaxant used in surgery, ipecac for dysentery, and quinine for malaria are all drugs from rainforests.

Not only do many drugs come from rainforests, but rainforests also provide a future resource. With less than 1% of rainforest species identified, new disease fighting compounds may be found.

PRODUCTS FOR THE WORLD. Along with food and drugs, rainforests provide other useful resources. From rainforests come chewing gum, oils (palm, camphor, sandalwood), rubber, houseplants (African violet, "Begonia," bromeliads, "Dieffenbachia," orchids, "Philodendron," rubber plant, and snake plant) exotic hardwoods (mahogany, balsa, rosewood), rattan and bamboo, and fibers (burlap, kapok, and ramie).

CLIMATE FOR THE WORLD. World climate is chaotic, and perturbations in one area can have unpredicted consequences elsewhere. Tropical rainforests provide cooling effects of shade and transpiration. The thick expanses of trees act as windbreaks. The removal of the rainforests may not only alter local climate, but it might change aspects of world climate as well.

PLACES OF NATURAL BEAUTY AND SOLITUDE . In a time of increasing human population, urbanization, suburbanization, and pollution, one refuge we have is unspoiled nature. Actual visits or multimedia journeys to tropical rainforests allow us to witness nature in splendor. Artists and inventive persons use these areas to stimulate creativity. For many others a walk through a tropical rainforest awakens their spiritual selves.

CONSERVATION OF RESOURCES

When we educate citizens who live in a democracy, we must educate them to be active citizens. For citizens wishing to act on behalf of tropical rainforests, the best place to begin is education. Students should learn all they can and seek to share what they know. Through posters, T-shirts, letters, and books, students can share what they have learned.

ORGANIZATIONS AND PROGRAMS. Understanding and assisting conservation programs and organizations can be an effective way to become involved. Most conservation organizations will send free materials to classrooms. A good place to find contact information is through the World Wide Web; the Rainforest Action Network maintains a website with lots of useful rainforest related information [www.wideopen.igc.apc.org/ran/index.html]. Students could work in teams and develop plans to protect rainforests (Pranis & Cohen, 1995). Rosenbusch (1994) describes a project where elementary school students collected soda cans to buy one-half acre of rainforest land for $50.

HAMBURGER CONNECTION. Many conservation organizations suggest a boycott of rainforest beef. Hamburger meat used in the USA frequently comes from cleared rainforest areas in Central America. The low quality rainforest beef is ground and sold to US fast food restaurants. Uhl and Parker (1986) present a calculation of the cost of one hamburger from the rainforest. For each hamburger, 55 square feet of rainforest- home to millions of individual rainforest organisms and thousands of species-is lost.

REDUCTION IN USE OF TREE RESOURCES. Rainforests can be protected by reducing use of tree resources through recycling and conservation. The Rainforests Action Network promotes reducing use of wood products by 75% in ten years. They also urge people not to buy tropical hardwoods such as mahogany and rosewood.

Thornton et al. (1995) used the question, "How many Sunday papers can be produced by a canopy tree?" to guide mathematical problem solving. With the hint that a small canopy tree produces a 90-inch stack of papers, the first grade children were able to calculate that if they recycled 72 Sunday papers they could save one small rainforest canopy tree.

PROMOTE SUSTAINABLE USE. Economics is a driving force in rainforest destruction and conservation. Purchasing products harvested in a sustainable fashion from rainforests helps local people support their families and encourages them to conserve the rainforests. For example, the Brazil nut tree is difficult to cultivate; so places where it grows wild are sometimes protected. When sustainable rainforest materials are bought, the economic value of these materials far exceeds the short term values of clear cutting rainforests for timber or cattle ranching.

Through action, rainforests can be saved. If students become involved in promoting responsible use of rainforests, we increase the chances of protecting one of the most treasured resources of our world. In the process we develop an even greater resource for our planet-young people who know their rights, responsibilities, and powers as world citizens.

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