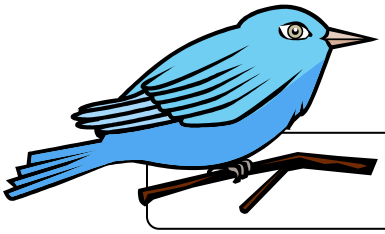

Sustainability

Summary:
Students take part in a simulation of sustainable and unsustainable use of a natural resource. Then students visit the website for Hacienda Verde in Puerto Rico to learn how it is being used a model for sustainable coffee. A guest speaker will give a presentation/fieldtrip and explain how sustainable agriculture is being used in our area.

Background Information:
Hacienda Verde, a 375 acre private ecological preserve, is located in the central mountains of Puerto Rico. Seventy-five percent of the property consists of original Tabonuco and Jaquilla forests. These rare tree species were once prominent in Puerto Rico's primary forests, 99% of which have been lost. Shade coffee is being promoted by some of the most prominent international environmental organizations for the development of habitats for birds and creatures, soil conservation and water management. Hacienda Verde has joined this trend by farming 30 acres of the property for the production of gourmet coffee using sustainable agriculture practices. The area, formerly razed to grow "sun coffee," is being carefully restored through the use of sustainable agriculture and soil preservation practices implemented solely by hand. Temporary shade for the coffee was planted with plantain trees which are now being replaced with permanent trees endemic to the area. This effort serves as an educational model for sustainable agriculture practices and environmental education.

For more information:

- Hacienda Verde
  http://www.haciendaverde.org/eng.html
- Trade and Environment Database- Mandala Projects
  http://www.american.edu/projects/mandala/TED/SHADECOF.HTM
- University of California- Sustainable Agricultural Research Education Program
  http://www.sarep.ucdavis.edu/concept.htm

Grade Level: 5th grade

Goal: All organisms, including humans, cause changes in their environment.

Key Concepts: People can make choices in their lifestyles to create sustainable use of natural resources.

Objectives: Upon completion of this lesson, students will:
1) Define sustainable use of natural resources.
2) Describe the consequences of unsustainable use of resources.

Teaching Location: Indoors and outdoors

Lesson Time:
Five class sessions

Subject Areas for Infusion:
science, social studies

Standards:
Environmental Education
D.8.3

Science
A.8.3

Social Studies
D.4.3
D.4.4

Materials:

- Copy of "Thinking about Tomorrow" for teacher.
- 20 small cups, 4 spoons, measuring cup, one pound of beans, watch or timer, shallow tray
- Model of science notebook for "Thinking About Tomorrow" activity
- Access to Internet (computer lab or LCD in classroom)
- Copy of "Forest for the Trees" for teacher.
- Cardboard and strings to make signs to go around students' necks
- Photocopies of "Forest Silvicultural Systems" (p. 250) and "Forest Stand Puzzle"(p. 251) for each student

Set-Up:

1. Read instructions for Part I of "Thinking about Tomorrow" activity. Set up beans, spoons, and cups ahead of time for students to use. Write a model science notebook entry for this investigation to help with organizing data collection during each round of the simulation. (see attached sample)
2. Make arrangements for computer lab access for Day 2.
3. Make arrangements for a guest speaker/fieldtrip on sustainable agriculture practices being used locally.
4. Read instructions for "Forest for the Trees". Make signs to go around students necks
5. Photocopy "Forest Silvicultural Systems" (p. 250) and "Forest Stand Puzzle" (p. 251) for each student.

Procedure:

Introduction (Day 1)

1. Follow procedure for "Thinking about Tomorrow" activity. Divide students into equal-sized groups of about 4-5 students in each group. Each member in the group will represent a generation in a family.
2. Simulation #1 – The tray of beans represents a nonrenewable resource. Each family member will have 10 seconds to "extract" some of the natural resource using the spoon. They may put as many beans as they *care* to into the cup. Record the results using the science notebook entry.
3. Simulation #2 – Place all the beans back in the tray. Explain that the beans still represent the same nonrenewable resource as in the previous simulation. Inform students they only need 35 beans worth of natural resource to survive. Repeat the 10 seconds of "extracting" from each family member in the group. Record data in the science notebook.

Vocabulary

sustainability: meeting the needs of the present population, while conserving to meet the needs of future generations

renewable resource: a naturally occurring raw material which has the capacity to replenish itself through ecological cycles and sound management practices. Ex. sun, wind, falling water, and trees.

Nonrenewable resource: substances such as oil, gas, coal, copper, gold, which, once used, cannot be replaced in this geological age.

natural resource: any aspect of the environment that species depend on for their survival. Ex. land, soil, freshwater, energy.

4. Discuss the results of the first two simulations and define the term "sustainable". (See activity for guiding questions.)
5. Simulation #3 – Use the same procedure as in #1 & #2, except now the beans represent a renewable resource. After each student's turn, the resources (beans) will be adjusted according to five conditions – drought, flood, surplus, average yield, or contamination by disease. Some of the conditions will add beans to the tray and others will take beans away. Students will draw cards that will determine which of the five conditions will affect their renewable resources after each member's turn.
6. Discuss the results of the simulation. (See activity for guiding questions.)

Activity 1 – Visiting Hacienda Verde (Day 2 – Computer Lab)

1. Review the data and conclusion from the previous day's investigation.
2. Take students to the computer lab, or use LCD in the classroom, to visit the Internet site for Hacienda Verde. http://www.haciendaverde.org/eng.html

****More background information on Hacienda Verde, if needed, is attached to the end of this lesson.

Activity 2 – Guest Speaker (Day 3 – indoors or fieldtrip)

1. Contact one of the following agencies/people to arrange for a guest presentation or fieldtrip to see sustainable agricultural practices being used in our area:

Shelly Wrzochalski
Brown & Kewanee County Forester
(920) 492-5856

Chris Clark
Village of Howard – Forestry Dept.
(920) 434-4640

Dan Shriner
Brown County Extension Office
(920) 391-4612

Conclusion – "Forest for the Trees" (Day 4 – indoor or outdoor)

1. Ask students the definition of a tree farm and explain that it is a forest ecosystem that provides many valuable products.
2. Students participate in a role-play that requires them to manage a tree farm. They begin as seedlings on a barren piece of land and are managed through time and events that will change the population and health of the ecosystem. (See specific directions on pp. 247-248)
3. Read through "Forest Silvicultural Systems" (p. 250) as a class to make sure everyone understands the vocabulary.

Assessment (Day 5)

Give each student a copy of "Forest Stand Puzzle" (p. 251). Students will work independently to number the pictures in a logical sequence. The student will then describe the sequence of events and say what actions were taken in each box. Students will also need to determine if the resource was managed in a sustainable or unsustainable way and what were the consequences of the way it was managed.

References:

"Thinking About Tomorrow", Windows on the Wild – Biodiversity Basics, World Wildlife Fund, 2003, pp. 348-353.

"Forest for the Trees", Project Learning Tree, American Forest Foundation, 1994, pp. 247-249.

"Wisconsin Forests Forever" (CD-ROM and teacher's guide), Wisconsin Forest Resources Education Alliance, 2000, pp. 81-87.

Hacienda Verde
http://www.haciendaverde.org/eng.html
Trade and Environment Database- Mandala Projects
http://www.american.edu/projects/mandala/TED/SHADECOF.HTM
University of California- Sustainable Agricultural Research Education Program
http://www.sarep.ucdavis.edu/concept.htm

Sample Notebook Entry

Date _____

Hour _____

Lesson Title: Thinking About Tomorrow

Focused Question: What is the difference between sustainable and unsustainable uses of managing natural resources? (Students questions will vary, but should address sustainable and unsustainable uses)

Prediction: I think the answer to my question is_____ (answers will vary)
I predicted this because _____ (accept reasonable explanations).

Procedure & Data Collection:

1) We were put into equal groups. Each of us will play the role of a family member. Our family name is _____.

   Great-great-grandparent _____

   Great – grandparent _____

   Grandparent _____

   Parent _____

   Child _____

2) Simulation #1 – Beans represent nonrenewable resource. Some examples of nonrenewable resources are _____. Here's how it will be done:

   - Each family member will have 10 seconds to take as many beans out of the tray that we want.
   - We can only use one hand to scoop.
   - The cup must remain on the table and cannot be lifted to the tray.
   - Beans that are spilled on the floor cannot be scooped. They represent wasted resources.

Here are the results:

Simulation #1	(Family Name)
Great-great-grandparent	(# of beans)
Great-grandparent	
Grandparent	
Parent	
Children	
Total # of beans remaining	

3) Simulation #2 – We're going to repeat the same procedure as in Simulation #1 except we only need 35 beans to survive. Here are our results:

Simulation #2	(Family Name)
Great-great-grandparent	(# of beans)
Great-grandparent	
Grandparent	
Parent	
Children	
Total # of beans remaining	

4) Looking at the data from Simulation #1 & #2, I notice _____

_____

5) Simulation #3 – The beans now represent a renewable resource like _____

_____.

Here's what we are going to do:

- Each member will have 10 seconds to scoop beans into the cup.
- After each round (generation) a card will be picked to determine the condition under which the resource has undergone.
- An "Average Yield" card means only an average amount of the resource was replenished. Add 1 cup of beans to the tray.
- A "Surplus" card means more of the resource was replenished than expected. Add 1 ½ cups of beans to the tray.
- A "drought" card means a lack of available water caused a decrease in the resource. Take away ½ cup of beans from the tray.

- A “flood” card means excess water wiped out some of the resource. Take away ½ cup of beans.
- A “Contamination by Disease” card means some of the resource was infected to unusable levels. Take away 2/3 cup of beans.
- Only 35 beans are needed to survive.

Here are our results:

Simulation #3	(Family Name)
Great-great-grandparent	(# of beans)
Great-grandparent	
Grandparent	
Parent	
Children	
Total # of beans remaining	

Power Conclusion:

(Refer to prediction) I thought that _____

_____ .

(Answer question) I found out _____

_____.

My data shows that _____

_____ .

(WHY you got the results you did) I think _____ happened because _____

_____ .

(Error Analysis) I think _____ could have affected my results because _____

_____ .

(Ideas for future research) In the future, I would like to _____

_____ .

STRATEGY FOR SUSTAINABLE DEVELOPMENT OF THE CENTRAL MOUNTAIN REGION

The deforestation of tropical forest is one of the principle environmental concerns for the entire planet. The Caribbean has been designated as one of eight *hot spots*, i.e., areas in the world with the greatest concentration of biodiversity. Puerto Rico contributes substantially to the area's wealth of biodiversity.

Along the length of the island is the central mountain region with the island's greatest proportion of forests. They hold a significant part of our biodiversity and play a critical role in providing water resources. By maintaining our soils, preventing erosion and sedimentation they help maintain the water retention capacity of our reservoirs. Without them hydrological cycle is broken causing simultaneously floods and water shortages.

In addition to its value in terms of providing natural resources, Puerto Rico's mountain region constitutes a vital part of our historical and cultural context. Its mountains, forests, rivers and wildlife configured the life of our "Jibaro" giving rise to all of her traditions. Its beauty is a source of inspiration of our poets and musicians and a peaceful respite for our overly stressed population.

REVIBE

REVIBE is a nonprofit organization dedicated to promoting conservation of the central mountain region and the natural resources associated with the area. Since the year 2000 we have been involved in environmental education, restoration and research activities in conjunction with several universities and government agencies. These efforts are intended to establish a model of sustainable development that will serve to stimulate conservation initiatives in the private sector.

To that end we offer Hacienda Verde (HV) to universities and other learning institutions, farmers, eco-businesses, artists, practitioners of alternative medicine and others whose projects are related to the sustainable use of natural resources.

Hacienda Verde

This is an old hacienda of 370 acres at an altitude of 2,300 ft. in Utuado, PR at a 15 minute drive from the Indian Ceremonial Center Caguana. It houses REVIBE's headquarters, work-shop facilities with lodging for 40 participants, a 300 acre forest reserve and 30 acres dedicated to sustainable agriculture.

Historically this was a large scale coffee production farm. During a time of major deforestation on the island, trees from the farm's high-land, primary forests were preserved as shade for the coffee bushes. As a result the property maintains an unusually large and continuous, primary forest coverage with tree species that are now rare such as the venerable Tabonucos (Dycrodis Excelsa) and the endemic Jaguilla (*Magnolia Portorricensis).*

The property provides habitats for many wildlife species, some in danger of extinction such as the Coquí Martillo (eleutherodactylus locustus); and others considered vulnerable such as the birds known as Calándria y el Julián Chiví. It also has the potential to house many other important species, in particular the Puerto Rican Parrot. In an attempt to save the parrots from extinction, they have been raised in captivity for the last 30 years, subsequently costing over millions of dollars. They are destined to be released in 2006 just north of Hacienda Verde at the national forest reserve, Bosque de Rio Abajo. From there they are expected to fly to HV's primary forests for their diet and nesting needs.

Restoration Efforts

A Natural Resources Management Plan for Hacienda Verde was developed in 2001 through the USFS & DNA Forest Stewardship Program. The objective of this plan is to achieve, through restoration and protective measures, the highest possible concentration of flora and fauna native to this area. Given its condition is representative of the central mountain region, by restoring it to its maximum potential it may serve as a model for private conservation efforts in this area.

Following are some of the plan's major features:

- establish a private forest reserve with a perpetual conservation easement
- reproduce trees of special ecological value such as Tabonuco and Jaguilla
- design and construction of board walks for protection of sensitive areas
- reforestation of forest clearings
- restoration of wetlands, ponds and creeks
- growing shade coffee
- restoration and reforestation with endemic and native species, particularly those beneficial for wildlife
- establishing habitats that will serve to enhance wildlife

The protected restoration efforts are intended to improve and maintain the integrity of HV's forests and creeks. However, their effects will go further, benefiting the island in general as follows.

- contributing to the water quality and supply of the Rio Grande de Arecibo watershed
- reducing sedimentation of the Dos Bocas lake
- maintaining a forest cover that will allow wildlife to move between the karst and mountain regions

REVIBE has begun to implement this plan with the assistance of government agencies, volunteers and other collaborators. The organization continues to force alliances with private and public entities for these purposes.

Shade Coffee

Our first initiative was to re-establish traditional shade coffee. Coffee is the principle crop grown in the mountain region. By growing coffee bushes under large trees our "Jibaros" were

managing our natural resources in a sustainable manner that replenished the nutrients drawn from the soil into the coffee plants, preserved the soils and maintained an ample supply of water. During the "green revolution" the government urged them to cut down their trees and plant their coffee in the sun for higher yields. This method, requiring strong applications of pesticides, has been implemented on very steep slopes. With the heavy tropical rains the soils and pesticides are washed downhill into streams through which they reach our reservoirs. Thus they affect water quality and the reservoir's capacity to retain water.

Our model of select varieties of coffee on a 12-acre plot was designed and implemented with the assistance of the "Partners for Wildlife" program of the USFS and DNA. We used contour planting, vegetative barriers, ditches to control water flow, and no heavy machinery. Plantain trees were used as temporary shade and five species of leguminous trees were planted for permanent shade. When the permanent trees have gained sufficient height they will fix nitrogen in the soil reducing the need for fertilizers, control weeds and erosion and provide habitats for wildlife. Reforestation by this means will serve in addition to facilitate the infiltration of the rainwater, maintaining the integrity of steams and the hydrologic cycle. We intend to use HV as a model to promote sustainable agriculture practices among coffee growers. Our plan includes developing a strategy for marketing "conservation coffee" that will create an incentive for other growers to adopt these practices. We will acquire the machinery for processing the coffee and thus be able to purchase from other growers engaging in sustainable agriculture.

.

In this manner we hope to promote reforestation of deforested areas and protection of these future forests as well as the biodiversity they will house.

Infrastructure for Conservation Initiatives

Our vision is for a part of Hacienda Verde to serve as a kind of "eco-park" for green businesses such that they may model the possibilities for sustainable development in the mountain region. We see a network of initiatives, both for-profit and non-profit organizations that will share resources in imitation of nature maximizing benefits for all. Some possibilities include: mushrooms, vermiculture, organic chickens, organic fruits and vegetables, an eco-lodge with a restaurant serving food grown on the property, a holistic center and community development and educational projects. Each project may be managed with anywhere from complete independence to various degrees of association with REVIBE or other entities operating on the premises.

We are establishing the facilities that, together with our forests, bodies of water, biodiversity and areas designated for agriculture will make HV an appropriate site for these activities.

To this end we have established a retreat center that can be used by various groups to conduct short term activities with up to 40 participants. It has served, for example for a five month training on sustainable agriculture held by PR's Department of Labor, workshops by various universities, a national meeting of US foresters, retreats for high school drop-outs, environmental groups, and personal development workshops. Participants use the forest and agricultural areas for educational and recreational purposes.

Developing infrastructure also includes that which has an agricultural purpose: irrigation system, green house, storage building, coffee processing machinery, vehicles, etc. These will likewise be available to individuals who wish to use HV as the site of their sustainable agricultural projects.

Universities

Part of our vision is that HV be used by universities and other educational institutions. The property is a living laboratory with lodging facilities available for research and field practices as well as environmental education. Students may also participate in restoration efforts or community development projects.

The participation of universities makes it possible for us to gain new knowledge about the many, complex components of our ecosystem and their interactions. This knowledge can help us determine how we can help provide the best conditions to enhance and protect wildlife.

So far we have collaborative agreements with three universities while others have used the facilities on a less formal basis. Some of the activities that have resulted are: teacher exchange with students from Puerto Rico and Wisconsin, development of watershed and tropical forest curriculum, study and inventory of the Tabonuco forest, research on bats, astronomy workshop, species identification workshops and on environmental education.

Eco-housing

A component of the model for sustainable development that we are developing at HV is a 20 acre residential area for 50 homes. It is the financial backbone of the entire model, allowing for funding to pay for the land and contribute to restoration and maintenance of the forest reserve. In this regard it is an opportunity for individuals to invest in conservation of natural resources while simultaneously acquiring a valuable asset and sound investment. As a result of their investment 300 acres of forest will be donated to REVIBE and placed under a conservation easement to be protected in perpetuity. Its uses will be limited to educational and passive recreation purposes through arrangements made by REVIBE with various educational institutions.

It will also provide the housing necessary for individuals involved in REVIBE's or their own projects at HV. The homes will be built on previously impacted land a manner that will cause the least possible environmental impact both upon building and it their use. They will be designed to harmonize and enhance their natural surroundings and allow their inhabitants the maximum possible contact with nature.

The members of this community will enjoy their proximity to a nature reserve as well as the beauty of their immediate surroundings. They will also belong to a community centered on innovative conservation initiatives. Some may also choose to develop their own projects at HV on land provided for that purpose.

Invitation

REVIBE is a good ways along in the establishment of this model for sustainable development. It is being developed in a manner that is open, flexible, practical and democratic allowing for the harmonious growth of its various components within a conservation framework. This initiative stands to show that there is a way in which we, private individuals concerned for the conservation of the natural resources and scenic beauty of this island, can rescue our mountains and forest from further destructive development. We can build from this base to develop the necessary tools for sustainable development and then replicate the various components of this model to achieve our conservation goals. Therefore we make a call to citizens, business people, investors, agencies and public figures to participate in this important task.

Contact Information:

Luis Miguel Rico, Exec. Dir.
787/894-6341, 787/602-6849
luismi@haciendaverde.org