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Biosphere 2 and Beyond

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CAUSES FOR CONCERN

All life on our planet exists in a delicate balance, a system of interdependency among plants, animals, insects, microorganisms, and the environments in which they live. The earth supports a variety of different ecosystems in the air, water, and land—and each ecosystem, ultimately, is dependent upon all the others for its survival. Humans have been slow to learn this simple yet vitally important lesson. Carelessly and ruthlessly, we have hunted animal species to the brink of extinction, cleared away forests, and released poisons into the environment. We are only recently learning that if we cause an environmental crisis, or destroy a single habitat, even far away—in the sea, under the earth, or on another continent—we are indirectly affecting every creature on this planet and ultimately hurting ourselves.

This unit has been designed to help students in grades 3Ð8, better understand their environment and their world, through a look at Biosphere 1 (Earth), Biosphere 2, and mini-biospheres that can be created by the students in the classroom and a sampling of other hands on activities. In an effort to encourage a generation of individuals who understand their relationship to the environment, we must begin to show students that there truly is a direct connection between how they live and the life support systems of the earth. They must begin right now to work towards saving their environment.

After the first day of school this year I noticed all the litter on the school grounds that had been left behind by the anxious students who had just begun another year at Helene Grant. I could still see the green grass and the flowers that had welcomed them that morning but the litter disturbed me. I wondered if it bothered any one else, the students, their parents, the staff? Were they angry at what was happening? Did they realize that this was just a small taste of the attitude toward our environment that was causing so much of the destruction of the biosystems of the world? As I drove to the highway past several other schools the situation was the same, in fact the more I looked it was the same everywhere. The litter wasn’t restricted to those academic campuses where small children might unconsciously drop a paper or two, it spread through the downtown area where there were very few children, and many adults. In fact, when I got back to my own small environment 45 miles north, the litter was bad there too.

I realized that I, like the children, their parents and the rest of the staff was so accustomed to this situation that we hardly noticed what was happening. The litter was there in the deeper backgrounds of our consciousness. We had adapted to the situation so completely that we were no longer consciously oppressed

by these conditions. I guess what bothered me even more was the fact that this carried over into everything we do. We are wasteful with no consideration as to the consequences, we rarely carpool, we rarely recycle and worst of all, we rarely notice.

The question of what could be done about the situation surely had been asked many times, with the frustrated answer of, “very little, if anything.” Any changes or regulations enacted would disturb the entire life system. Whatever the forebodings of the present citizenry or our children, the situation was a product of our own activities. Any change would require total commitment, and this was too much to ask.

Thus does “adaptation,” the basic instrument of our survival, become the source of our peril? We adapt to our addictions. We do not change until some event shocks us so profoundly that we finally decide that the remedy is less to be feared than the addiction. Such a shock we have begun to experience from the toxic elements in our food supply, air pollution, our need to drink bottled water rather than the uncertain or tainted water that flows in our water systems, problems of waste disposal, the climatic changes taking place as a result of our use of fossil fuels, and the prevalence of cancer throughout our society. There is also the brooding sense of guilt when we think of the damaged world that we are handing on to our children.

One of the basic values of this unit is its clarity in presenting the consequences of our present activities on the biosystems of the planet and the urgent need to deal with these addictions. This altering of our conduct has three phases:

1. increasing our awareness of the impending disaster;
2. cessation of our harmful activities;
3. healing the damage already done.

These are universal obligations. Everyone can contribute to these efforts to ensure the survival of the planet, and thereby give ourselves and our children a context for continued human existence.

We can take much encouragement from certain events of recent years. Through the work of many organizations we have attained a new clarity as regards to our present situation. The media has raised environmental issues. The shock needed to bring about a recovery is now being felt throughout all levels of society. The consciousness of danger now exists, the rate of devastation begins to diminish, the healing is begun.

The director of the United Nations has stated that the issue of the environment is at the top of the international agenda, and it was the foremost concern at a recent meeting of the Organization for Economic Cooperation and Development. This year marks the twentieth anniversary of the Stockholm Conference, the first of the major international conferences on the environment. Whereas prior to this conference there were no environmental protection agencies in our governments, the delegates went home from this conference and established such agencies in almost ninety percent of the nations that attended.

From these and a multitude of other events that have taken place we can conclude that a pervasive consciousness now exists of the plight of the planet. We now recognize that a thousand things need to be done, all the way from recycling our paper and our metal containers to completely transforming our lifestyles, especially by reducing our use of (and possibly eliminating) the gas driven automobile. For our students who will suffer the most we can teach through example by reducing paper waste, water waste, the hazards of littering, and recycling.

Beyond all the particular things that need to be done there is a general need to transform our basic values. This applies especially to our religious and educational establishments, which have been terribly negligent in dealing with this situation. Our religious institutions have long ago developed ways of dealing morally with such issues as suicide, homicide, and genocide; yet they are totally lacking in moral principles for dealing with biocide and geocide—evils at least as disastrous.

So too with education. We educate our children for efficiency in running our commercial—industrial institutions, precisely those establishments that are tearing the planet to pieces and saturating it with toxic wastes, especially the petrochemical industries. Even though we have developed organic agriculture to a newly efficient degree, our universities continue to teach reliance on chemical based agriculture. Similarly, despite the vast amounts of toxic waste from our nuclear industry that we cannot dispose of, we remain negligent in committing our energies and our finances toward the development of solar energy. We are still not giving our students basic information on the dangers of fossil fuels and the destruction of our forests in building up the blanket of greenhouse gases in the atmosphere.

Everyone can make a significant contribution. We must begin to recognize the dangers of a consumer society. We can revise our lifestyles to reflect the needs and activities of the planet itself.

There was a time, prior to our use of the automobile and the development of the petrochemical industry, when we did not need to know a great deal about the earth or how it functioned in relation to our human activities. That is no longer true. Today all of us urgently need to know the implications of using polystyrene cups, dishes, or fillers, or plastic linings for diapers. As automobile owners we need to know that each year we put an amount of carbon dioxide into the atmosphere equal to the weight of the car itself.

By teaching some of the specific forms of our present situation, I hope to clarify not only the reality of our present situation but help offer specific remedies that can be applied to the issues. You should be able to bring the issues before your class in its actual urgency, but also help them to come up with directions as to how they can meet the difficulty. While there is no single answer to the problem, the suggestions given here will work for almost everyone.

Use this unit and your students will no longer live in deadly innocence, nor will you feel so frustrated as to what you can do with your knowledge. The students in my classroom have already committed themselves to limiting their polluting activities. If these students can become aware of their situation and commit themselves to change it, then all of us should be able to rethink our present condition and proceed with the radical transformations that are needed.

AN ACTIVITY: GET YOUR STUDENTS READY

Objective

To create a vision for the earth and pursue it.

Materials

None.

Procedures

Tell your class about John Muir, Sigurd Olson, Aldo Leopold, and Rachel Carlson. Ask them to consider in either written or oral form: What dreams do you have about the outdoors? About discovering your sense of wonder? Listen to your inner voice. Identify your personal interests or concerns about the earth. (Do this before you begin the unit and again when you have completed it. See if their attitudes have changed. Many students don't even realize how much their habits are affecting the earth in a negative way until you show them.)

Ask them to make a commitment to changing their own habits to ensure a better environment for those who come next.

Have your classroom make an earth pledge of things they can do while at school to make it a better earth. (Some examples you can suggest are white paper recycling, using both sides of paper, composting with worms from the recycling center). Invite them to share suggestions about what they can do at home.

THE OZONE LAYER

Brightening the abyss of space as it spins in a mass of swirling colors is the earth. Beyond the ashen craters of the moon rises our planet, its surface a marbled canvas of blue and white. A delicate "skin" of water and gases envelopes the earth. This moist cushion extends from the deepest point of the ocean floor to the outer reaches of the atmosphere, several hundred miles above the ground. The water, air, and soil systems of the globe work together to sustain life, and to renew and purify themselves. A constant recycling of the chemical elements necessary for life—water, minerals, oxygen, phosphorous, and carbon, among others—must take place, because no elements enter or leave the ecosphere.

The ozone layer is a fragile swath of gas that absorbs almost all of the harmful ultraviolet (UV) radiation emanating from the sun. It shields our planet like a blanket. Found in its densest concentrations at altitudes ranging from 7Ð15 miles above the earth, the ozone layer is only a few parts per million thick. Indeed, if all of the ozone in the stratosphere, a region 12Ð31 miles high, were condensed to our own atmospheric pressure, our precious ozone layer would be but the width of a dime.

Why should the condition of a canopy of molecules far above the globe concern us? The answer is that the ozone layer is a vital link among the physical components necessary to sustain life on Earth. A damaged Ozone layer allows lethal ultraviolet radiation to reach the planet. The effects of that radiation will be manifested in higher incidences of skin cancer, wide-scale depression of immune systems, increased level of smog, lower crop yields, deterioration of marine harvests. Perhaps even more significant than these sobering predictions is the relationship between ozone depletion and global warming, and the destruction of the ocean's phytoplankton, the organisms that form the very basis of the food chain.

A documented hole in the ozone layer exists. It materializes over Antarctica each September, and scientists have noted that it has worsened each year since 1979. In the late 1980's the gap was two times the size of the continental United States. Scientific opinion varies on the reason why the hole keeps reappearing. The reason why it exists at all, however, is clear: It can largely be blamed on the presence of chloroflourocarbons (CFC's) in the atmosphere.

Ozone losses have been documented in other areas of the world as well. An average yearly loss of three

percent of ozone has been noticed above Arosa, Switzerland, for at least 10 years. Seven hundred miles from the North Pole, Norway, a hole one-third the size of Antarctica's has been pinpointed.

A prominent drop in ozone has been verified at three out of five Australian ozone-monitoring locations. Whether or not the loss was due to the Antarctic depletion stretching over Australia is still unknown.

CFC's are found most commonly as the propellant in spray cans, coolant in refrigerators and air conditioners, in foam and plastic insulation, and in industrial solvents. Widespread agreement exists in the scientific community that Antarctica's ozone loss is triggered by chlorine, from the use of CFC's, and bromine, a component of fire retardants.

What is it about CFC's that makes them so perilous to the ozone layer? The CFC class of molecules, ironically, was developed by industrial chemists who were seeking nonflammable substance—one that would "safely" propel deodorant out of a can, for example. These molecules are comprised of one or more carbon atoms, to which are attached chlorine and/or fluorine atoms. When the spray button on a can is pushed, the molecules enter the air, bounce off the walls and eventually find their way outside—a journey that may take days or weeks. Continuing to ricochet off trees and telephone poles, the CFC's are lifted by wind currents and they "fly" ever upwards. Several years later, they arrive in the high atmosphere, most without having broken down or combined chemically with any other molecules along the way.

In that high atmosphere, where ozone prevails, a CFC molecule will remain for a century before it surrenders its chlorine. The chlorine, upon encountering the ozone molecule, destroys it—without destroying itself. And therein lies the truly frightening nature of the CFC: It will take years before the chlorine reenters the lower atmosphere and is removed via rainwater. During that time, one atom of chlorine can demolish 100,000 molecules of ozone.

It was in 1973 that atmospheric chemists F. Sherwood Rowland and Mario Molina of the University of California at Irvine postulated the connection between ozone depletion and CFC's. When their report appeared in the June 1974 issue of *Nature* , shock waves reverberated through the $3 billion a year fluorocarbon industry. How could a product that had contributed so much to the ease of modern life be exposed as a hazard to populations worldwide?

Dozens of applications for CFC's had been discovered during the World War II era. "Freon," the trademark for CFC-12, became an internationally popular refrigeration coolant. Production increased by 4,000 percent between 1931 and 1945. Aerosol propellants against malaria were made with CFC's 11 and 12 during the war; afterwards, hair spray and softer carpet pads, sofa and auto cushions all evolved from the wonders of CFC's. From 1945 to 1950, the total production of CFC's doubled when Dow Chemical Company began manufacturing Styrofoam.

As a result of the energy crisis of the 1970s, homeowners and businesspeople began looking for more efficient means of heating and insulating their residences. The fabrication of rigid foam insulation, blown with CFC-11 and CFC-12, skyrocketed. In 1985, two thirds of the insulation placed in new commercial buildings in the United States was rigid foam, as was half of the insulation in new, single family homes, and a third of the entire home reinsulation market.

Today, shoppers strolling the aisles of giant malls and employees working in skyscrapers are kept comfortable by enormous chilling units that utilize CFC's. Families are more inclined to travel in the summer, because most of the cars sold in the United States are equipped with air conditioners. The scope of CFC use even extends to

the food we buy in the supermarket. Three fourths of the American diet is refrigerated at some point before it is consumed.

The versatility of the CFC family of chemicals explains why they have pervaded our culture so thoroughly. The fastest growing CFC in use worldwide is number 113. It can clean computer microchips as well as cloths that would normally be subjected to more immediately toxic dry cleaning solutions. As a solvent, it also removes grease, glue, and dried solder from metals and plastics.

On a personal level, who hasn't sighed gratefully when cooled by an air conditioner on a hot day? But evidence is mounting that this CFC-based form of relief has a hidden cost: our health. Illness is directly related to the ozone layer's decline.

The NASA Ozone Trends Panel reported on the efforts of more than 100 scientists who spent almost a year and a half re-analyzing every bit of information collected from satellite and groundbased ozone data. Their conclusions?

1. The hole in the layer over Antarctica was caused by the presence of CFC's.
2. The poles are not the only places where the ozone is missing; losses are occurring around the planet.
3. Ozone has consistently decreased by over one-and-a-half to three percent in the last 20 years, in the area where most of the world's population lives. The decreases were most noticeable in the winter, depending on the latitude.

NASA further reports that the ozone layer has already declined more than two percent on a global scale. It is proceeding to degenerate far more rapidly than computer models have anticipated. Moreover, a further deterioration is imminent; tons of chemicals still being released into the atmosphere have not yet reached the ozone layer.

The effects of increased amounts of UV radiation on bacteria, soil, and mammals are not well known. However, it is known that increased exposure to humans can bring about a surge in skin cancers and an impairment of the body's immune system. Light skinned peoples are most vulnerable to the threat of skin cancers. Scientist Carl Sagan has already written that light skinned people may need to wear protective clothing and strong sun-block ointments just to perform ordinary outdoor tasks.

Melanoma, a form of skin cancer that causes the most fatalities, is connected with extreme UV radiation exposure, as in cases of severe sunburn. It is responsible for more than half of all skin cancer deaths. Frighteningly, incidences of melanoma have sharply increased around the world within the last few years.

The AIDS virus has demonstrated all too well the inability of damaged immune systems to cope with the ravages of opportunistic disease. In the scenario of ozone depletion, increased exposure to UV-B rays (wave lengths that inflict the most biological harm on humans, animals, and plants) is expected to lower the body's resistance to invading organisms. Although a jump in skin cancers would primarily affect the light skinned population, an immuno-deficiency caused by degraded ozone could affect virtually every single person on earth.

The threat to human health from a diminishing layer of high-atmosphere ozone is further complicated by the phenomenon known as "photochemical smog," or ground level ozone. Stratospheric ozone guards the earth from the dangerous effects of UV radiation, and is a factor in the balance of worldwide climate. Ground level ozone is caused when atmospheric air pollutants react with hydrocarbons and nitrogen oxides under the influence of sunlight. (Hydrocarbons, organic compounds containing carbon and hydrogen, emerge from

burned or somewhat burned gasoline. They are also formed in the evaporation of industrial solvents, as from refineries. Nitrogen oxides are pollutants produced by the reaction of nitrogen and oxygen when high temperatures are generated in internal combustion engines and furnaces.) The main component of smog is ground level ozone. As the high altitude ozone layer continues to erode, more UV radiation bathes the earth's surface, quickening the photochemical process.

At ground level, ozone is a destructive gas that can burn the inner lining of the lungs. World Resource Institute claims that $4 billion worth of crops are destroyed in the United States every year by ozone at ground level. Some of these crops, such as cotton, soybeans, wheat, and corn, are global staples of clothing and diet. Tree growth is also impaired by the gas. Damage to the trees is continuing at a startling rate. It is estimated that half of the trees in many European countries suffer blight from ground level ozone as well as from acid rain.

The legacy of acid rain—ruined crops, corroded buildings, and gradual deaths of lakes and fish—is enhanced by ground level ozone. As the upper ozone layer decreases, a greater volume of hydrogen peroxide is believed to collect in the lower atmosphere, where 95 percent of our air exists. Hydrogen peroxide is one of the ingredients capable of producing acid rain .

Attitudes and Appreciations to Be Considered

- ¥ The interaction of living and nonliving things is exceedingly complex; an action of one may affect another seemingly unrelated, or a long distance away, or even after a long time.
- ¥ The natural resources that are available in any practical way to people are limited in amount and confined to a very thin layer of the earth.
- ¥ No one person or group has any more right, by destiny or decree, to the basic necessities of life than any other person or group.
- ¥ Some basic resources such as water are used by all living things, and recycled, so that what is used today has already been used many times by forms no longer living.
- ¥ Because space on earth is limited, and some discarded materials are slow to decompose or are even harmful, people must exercise increasing care in what they discard and accumulate.
- ¥ "Away" usually is just some other place on earth.
- ¥ "Take nothing but pictures; leave nothing but footprints!"
- ¥ How someone else left it for me is his or her responsibility; how I leave it for someone else is my own responsibility.
- ¥ Some environmental changes can be reversed, but others never can be.
- ¥ When the environment is affected by something, people are affected, too, because they are a part of the environment.

Skills and Habits to Be Developed

- ¥ Minimizing waste at home or school by efficient, thoughtful use of materials.
- ¥ Taking care of both personal and public equipment to make it last.
- ¥ Sorting discarded materials efficiently so that items suitable for recycling can be recycled.
- ¥ Declining a carrying container at the store for an item that is already packaged.
- ¥ Deciding not to use aluminum foil when a biodegradable substitute will do.
- ¥ Pointing out alternative points of view, with reasons, when organisms are described as bad or good.
- ¥ Exhibiting a sympathy for living things through care of organisms borrowed for study.
- ¥ Observing carefully and keeping accurate records of changes in one or more objects or conditions in the environment.

AN EXPERIMENT: A LITTER BIT LESS

Objectives

Students will collect litter from an environment close to them. They will discuss possible sources of the litter and list possible solutions to the problem. Students will test the biodegradability of some of the litter found.

Materials

plastic gloves trash bags
paper plastic bag (small)
pencils

Thoughts and Ideas to Consider Before You Begin

What does the phrase “throw away society” mean?

List some phrases and slogans that are products of our current throw away society.

ie... “Chuck it”, “One use only”.

Would people be more or less likely to litter if the area was already clean?

How does litter effect the soil?

Where does it eventually go?

Procedures

Divide the class into teams of about four students. Give each team a plastic bag, and every student plastic gloves. (remind them that they should not pick up any broken glass or syringes.) Send them away to collect for 20Ð30 minutes. When they return ask them to move the garbage from one bag to another and make a list of what they have collected.

They can then return to the classroom to answer the following questions:

1. What are the most common objects and materials in the litter that was collected?
2. How should these kinds of things have been disposed of?
3. Where is the nearest trash container in which they could have been placed?
4. What can be said to people who litter that might make them change their ways about litter?

Evaluation

Go back to the area where you collected trash a few days later. As a group you should have the students answer the following questions:

1. What is your reaction to what you observe?
2. Where is the problem the worst?
3. Where is the container for trash?
4. Is the location an effective one?

5. How can the container be made more attractive?

WATER

The utter magnitude of the ocean signifies that we live on a “water planet.” For just as the ocean envelopes 71 to 73 percent of the earth, our own bodies are 70 percent water. It is water that makes life possible. If the earth was positioned farther away from the sun, all its water would freeze. If the planet was closer to the sun, the heat would vaporize the water. But the planet’s precise location allows the conditions for water, and life, to exist. Solar energy and gravity shift water from the oceans to the atmosphere, where it evaporates. (Water from lakes, rivers, soils, and plants is also carried upward.) The water in the atmosphere falls upon the land and ocean as fresh water. Finally, water on the land is returned to the ocean. This process, known as the hydrological cycle, is repeated continuously to distribute water and sustain life.

The immensity of the ocean can be deceiving. One glance from land’s end could lead us to believe that there is a plentiful supple of usable water on the planet. Although 97.1 percent of the world’s water is found in the ocean and in saline lakes, it cannot be used for agriculture or drinking. In fact, only .003 percent of the total amount of water on earth is considered fresh and usable. Glaciers, ice caps, the atmosphere, and deep soil hold another 2.9 percent of the earths fresh water in lakes, rivers, and some underground deposits. Yet 99 percent of these sources are eliminated by pollution, unavailability, and remote locations. Thus the amount from which the world’s people must draw is .003 percent.

It is also easy to misconstrue the distribution of life within the sea. Nearly all of it is concentrated along the coastal margins, or continental shelves. This zone represents less than 10 percent of the total area of the ocean, yet 90 percent of all marine life dwells there. Ninety percent of the world fish catch occurs within 200 miles of land. Tragically, it is in these critical habitats near the shelves, upon which we depend for food and recreation, that most of our polluting has taken place.

The size of the sea has historically been the justification for filling it with every kind of unwanted debris—from explosives and radioactive waste to sewage sludge and ammunition. The reasoning behind ocean dumping is that the ocean is so vast that it can never be saturated to the point where it will cease to function. During the industrialization of America, factories were planned near rivers for a source of power. The coasts became targets for factories too, because of shipping. The next step was that these waterways became the logical sites for dumping.

Today we know that 85 percent of all ocean pollution begins on the land. Whatever is flushed from the land will make its way, ultimately to the sea. How can our rivers, streams, and bays be clean if our soils are contaminated with pesticides, chemical lawn applications, and air pollution residues? If our pathways to the oceans are fouled, so is the ocean itself.

Nevertheless, the myth persists that any body of water as huge as the ocean must be able to recover from whatever is poured into it. But the poisonous quality and vast quantity of what we are dumping is beyond the ocean’s capacity for self cleaning.

Attitudes and Appreciations to Be Encouraged

- ¥ Without water, there could be no life as we know it, since water is the major constituent of cells and tissues.
- ¥ Clean water is not unlimited; hence, no person has the right to pollute or waste it.
- ¥ All the water used by a person or a community must eventually be used by others; so every user should be considerate of downstream neighbors and of future generations.
- ¥ As a burgeoning population demands increasing amounts of fresh water, people must look to the sea for extracting additional amounts.
- ¥ Some of nature's most beautiful and awesome displays—rainbows, seascapes, waterfalls, clouds and thunderstorms—depend on water or on the energy released during the recycling of water.
- ¥ Evaporation from the sea and subsequent precipitation over land is the means of replenishment of fresh water for drinking, sanitation, recreation, and irrigation, and of falling water for hydroelectric power plants.

Skills and Habits to be Developed

- ¥ Keeping streams, lakes, and oceans free of litter and pollution.
- ¥ Taking care not to waste tap water, even though the supply may seem limitless.
- ¥ Using to advantage the buoyant force of liquids to float objects or to decrease their weight.
- ¥ Remembering to give water to pets, household plants, farm animals, and even wild birds as they need it.
- ¥ Using correct terms such as fluid, displacement, buoyancy, vapor, condense, pollution, immerscible, sewage, and conservation.

An Experiment: Bringing Water to Your Home

Objective

The student will demonstrate an understanding of the many steps it takes to deliver drinking water to the consumer and the importance of filtering and disinfecting drinking water.

Materials

2 liter plastic soda bottles with bottoms cut off	sand
old panty hose or knee highs	water
elastics	pebbles
plastic containers for drainage	charcoal

Thoughts and Ideas to Consider Before You Begin

How do you think the time of year affects how much water is processed at the treatment plant?

Suppose you went to a foreign country where you were told not to drink the water because it wasn't disinfected. What other things would you have to avoid in order not to get sick from the water?

Procedure

1. Remove the cap and put the nylon screen over the opening. Secure it with elastic.
2. Pour in a layer of gravel. Pour a layer of sand over that to create a sand layer. Use charcoal to create another layer.

3. Turn the bottle upside down into a container to drain.
4. Scoop some dirt containing twigs, grass, etc. Mix with 2-3 cups of water. Pour into the wide end of the bottle. Let it filter through. DO NOT DRINK THIS WATER, IT HAS NOT BEEN DISINFECTED.
5. Observe the water as it passes through the filtering process. Is the water coming through the filtering process cleaner than when it entered? Why?

Additional Questions and Activities

1. What would happen if you rearranged the order of the filtering system? Try it.
2. What other kinds of things can be used for filtration?
3. Have a contest to see who can create the filtration system that is most effective.

BIOSPHERE II

Scientists have built a miniature earth in Oracle, Arizona. They have created a 2.5 acre, self supporting environment enclosed by glass and steel called Biosphere 2. Students will learn about Biosphere 2, the largest totally sealed environment in the world, and will design and conduct their own experiments with mini-environments. In the process, they'll discover facts about the delicate balance of nature and the environment. A biosphere is a region where life can exist. It must have everything a living organism needs to survive. Scientists call earth "Biosphere 1," likening it to a cocoon. In this cocoon, plants and animals live together in a fragile, life-supporting balance.

Biosphere 2 is the largest totally sealed environment in the world. Closed to the air by a double pained glass dome and sealed off from the soil by a stainless steel underground plate, Biosphere 2 encompasses six geographical regions having different climates, plants, and animals. These regions known as biomes, include a rain forest, a savannah, a salt water marsh, a fresh water marsh, an ocean, and a desert. Biosphere 2 houses plants, animals, even people.

You might think that animals would die and plants would dry up in a closed environment. But that won't happen if the right balance is maintained. If more nutrients are constantly generated for food production, and the water supply and atmosphere are constantly regenerated, the environment will continue to sustain life.

Biosphere 2 will give environmental scientists their first opportunity to work with a control. Using a control, scientists can compare what happens in a normal situation to what happens in a test situation. Because Biosphere 1 (earth) is regularly exposed to and tested by pollution, oil spills, toxic waste, droughts, floods, and so on it will be the test environment in this experiment. Biosphere 2 is the control environment because it is sealed.

By designing, building, controlling, and monitoring life in Biosphere 2, scientists hope to learn more about earth's ecological balance and how we can protect it. Someday, this mini-world might also be the model scientists use to build habitats for people on the Moon or on Mars. When choosing the occupants of Biosphere 2, scientists imitated nature. For example, some plants and animals were carefully chosen to create food chains. Others were selected because of the jobs, like pollination, they perform.

A permanent population of lady bugs and praying mantises, for example will take the place of pesticides.

Technology assists nature in Biosphere 2. Computer operated shutters control temperature and sunlight. In

all, nearly 2,000 computer sensors constantly monitor conditions in Biosphere 2. Should nature need an assist, the computers regulate adjustments to air pressure, air temperature, air circulation, and water supply. Water, air, and waste are recycled.

In September, eight scientists joined more than 3,000 different types of plants and animals for a two year stay in Biosphere 2. The four men and four women will grow grains, fruits, and vegetables and will raise animals and fish.

AN EXPERIMENT: MINI BIOSPHERES (BOTTLE BIOLOGY)

(Step by step instructions for specific experiments can be ordered from The Bottle Biology Program, University of Wisconsin—Madison, Department of Plant Pathology, 1630 Linden Drive, Madison, WI 53706, (608) 263-5645. **It's free!** What I am including here works very well in a grow lab in your classroom. It always works if you consider that even when the plants die it can be a learning experience. I have had a great deal of success, and my students have learned a great deal from it.)

Objective

Students will document growth in an enclosed system.

Materials

2 liter plastic soda bottles with tops water
soil seeds
anything from their environment they may want to add.

Thoughts and Ideas to Consider Before You Begin

How will this mimick life on earth and in Biosphere 2?

Why won't the bottle need to be watered?

What would happen if you put living things in the environment (worms)?

If you were going to be closed away from the world and your family for two years what would you take?

What would concern you about being away for so long?

Procedures

Clean out the soda bottles. Remove any labels.

Put about 2 inches of soil in the bottle. You can use dirt from outside or potting soil.

Put in seeds or sticks or whatever the students choose.

Put in a few teaspoons of water. Your bottles will not have to be watered again.

Put the tops back on.

Watch to see what happens. The bottles will begin to grow. You should chart the growth by measuring with rulers, or documenting visual changes within the bottle.

You may want to try some variations. Use a green bottle. Put in a worm or a slug or ants, consider what they will need to survive. Try anything you or your students can come up with, consider the things you would take with you into Biosphere 2.

EARTH SUMMIT 1992

More than 100 world leaders and 10,000 delegates and observers took part in the Earth Summit, in Rio de Janeiro, Brazil, the largest international gathering in United Nations history, organized by the UN Conference on Environment and Development (UNCED). But while the Summit offered a reassuring vision of global cooperation, it convened with serious problems. For one thing, all the players were not sitting on the same side of the table. On one side is "The North" (as the developed world is commonly called in UN parlance)—the United States, Japan, and much of Europe—and on the other side are the poorer, less developed countries of the Third World, "The South." Adding to the confusion, barely 25 miles from the conference hall just outside of Rio where the official delegates gathered, an alternative summit dubbed the '92 Global Forum assembled. An expected 20,000 environmental activists from around the world took part in the '92 Global Forum to ensure that Rio was more than "just a big global photo opportunity."

The interests of the two sides represented at the official Summit may prove to be irreconcilable. The North called for global restrictions on carbon dioxide emissions; the South, struggling to develop an economic base to improve the standard of living of it's people, responded that it is Northern overconsumption and inefficient energy systems that are the major contributors to toxic emissions. There was little actual negotiating in Rio; most of the rough and tumble took place at preparatory conferences held in Geneva, Nairobi, and New York that ran through last April. At those conferences, Third World delegates cited UN figures showing that the average person in the North consumes 10 times as much energy, and one-and-a-half times as much food, while producing 16 times as much air pollution as the average person in the developing world. The Northern countries must cooperate in narrowing that disparity, according to the Group of 77 who represent the Southern countries, before they are willing to cooperate on such matters as deforestation, limiting carbon dioxide emissions, and other measures necessary to contain the global environmental threat.

The very idea of Western economic growth, fueled by industries that pollute and products that deplete irreplaceable resources, was under heavy fire.

Some do try to find common ground. The point is obviously not to put the North against the South, but to show how interrelated we are. We are not the new enemy. We are trying to demonstrate that ecology is the permanent economy. The only way to organize a secure economy is ecologically.

Senator Al Gore, the author of a new book called *Earth in the Balance* , and the leader of the U.S. Senate delegation to the Earth Summit, commented in an interview that it is time to replace the old bipolar division of the planet with a new ideology of the earth. Just as fighting communism was the central organizing principle of the Western democracies over the past half-century, now that Communism has collapsed, the new organizing principle must be the effort to save the global environment. The scope and ambition of the discussions at Rio were staggering, touching upon every facet of the world's ecology. From the reduction of chloroflourocarbon

emissions that erode the ozone to the fate of dolphins in the ocean to the rights of indigenous peoples—all are slated for inclusion in an Earth Charter of general principles, a menu of proposed actions known as Agenda 21, and in separate treaties, covering climate change and biodiversity as well as a set of new principles for logging of the world's forests.

Conclusion

Whether you are just learning what a CFC is, or are a seasoned environmental activist, it's hard not to feel overwhelmed by the facts. You may be wondering, "What's the use? The pollution and destruction are too rampant to ever be halted." It's not too late, however. You are alive in the 1990s, the "decade of the environment." The National Wildlife Federation claims that if you convinced two people to do something for the environment, and the next day they convinced two people, and so on, less than a month would pass before everyone in the United States would be alerted to take action. You can make a difference.

You have tremendous power as a teacher. You can think. Your students can think. You can educate yourself and your students about a situation, and then act and teach accordingly. Follow the path of your actions. Discuss and share with the class.

It may be convenient to stop at a fast food restaurant for a hamburger, but all of us will experience climatic changes from diminishing rain forests.

You can make a decision not to consume fast food. The ivory trade causes 80,000 elephants a year to be slain for their tusks. If the slaughter continues, every wild elephant will be killed in five years—but we will have plenty of tie clips and earings to remember them by—unless you decide not to buy ivory.

Must destruction be the legacy of our species? Are humans incapable of appreciating the flora and fauna of a given ecosystem for their contributions to the entire scheme of life without profiting from the abuse of our resources?

We have exploited the earth's resources for our comfort and vanity, regardless of the cost. Now, the fact that we haven't taken responsibility for our actions is catching up with us. It is reflected in the degraded state of our planet. If we don't immediately decide to live in a sustainable manner, nature will simply continue to make the decision for us by providing a habitat less and less habitable.

To stop and think about a product before we buy it may seem like a loss of freedom, but it is the only way to ensure and acceptable quality of life for ourselves and future generations. You, your children, and their children deserve to see the ocean brimming with fish and seashells, not sewage and hypodermic needles. This means we have to think about what we buy and how we dispose of it.

Even if you can't find the time or space to get into the actual experiments, let your students know. Both you and your students have tremendous power as consumers. Read labels. Can the package be recycled? Does the product contain harmful ingredients? Why spend money on products that will pollute the environment—and ourselves—as we use them? Take a moment to drop a postcard in the mail to the manufacturer saying why you didn't buy the product. Realize the power that you have to remove wasteful packaging and harmful products from the shelves simply by not buying them!

Every action we perform can be likened to a footstep on the earth; it will leave an imprint. Therefore, step lightly.

ENVIRONMENTAL FACTS FOR STUDENTS

Air

Air pollution can affect people all over the earth because polluted air does not stay in one place. Dirty air can block out the sun and create gloomy, unhealthy places to live.

The threat of global warming comes from the greenhouse gases in the air which prevent more than the natural amount of the earth's heat from escaping into space.

Major sources of air pollution are power plants, factories, cars and trash burning. The wasted fuel makes smoke, soot, and gases, which are worse when the sources are inefficient.

Greenhouse gases that contribute to global warming are water vapor, carbon dioxide, methane, CFC's, ground level ozone and nitrous oxide.

Too much acid rain hurts trees, lakes, rivers, soil and living things. Most acid rain is caused by too much sulfur dioxide and nitrogen oxide in the air, from fossil fuel burning factories, plants, and motor vehicles.

Carbon dioxide accounts for about half of all greenhouse gases and has increased to record levels. In the U.S., burning coal, oil and natural gas to heat homes, produce power and operate cars and trucks produces vast amounts of carbon dioxide.

The ozone shield in the upper atmosphere screens out the sun's harmful ultraviolet rays. The "ozone hole" over Antarctica, and lower ozone levels globally, are caused mainly by man made chloroflourocarbons used in refrigeration and air conditioning. Ozone depletion can cause skin cancer, cataracts and other damage to people animals and plants.

Trees absorb lots of carbon dioxide in order to grow. Trees also produce oxygen that we breath. Cutting down more trees than we plant increases global warming.

People

Poverty affects 1.2 billion people on earth. Poverty is a primary cause of pollution worldwide.

45% of the world's population lives in urban areas, most of which are still growing rapidly. Three quarters of the U.S. population lives in urban areas.

In the poorest countries, where people are struggling to survive, they often are forced to damage their environment in order just to have food and shelter.

The largest cities are having more and more trouble providing essential services for their people.

Every day, nearly 40,000 children in the world die of starvation and disease. Most are where people have very little or no money and medical care.

The growing gap between rich and poor throughout the world, as well as in the United States, means that some people consume far more than they need, while others live in extreme poverty and homelessness.

The total population of the world, now 5.4 billion, doubled between 1950 and 1987, it will increase by about a billion during the nineties. It will quite probably double again in the next century. The population of the U.S. is 254 million, or only 5 percent of the world's total.

In order to protect the global environment, rich countries need to help poor countries develop in ways that do not harm the environment.

WATER

70% of the world's surface is covered with water. 3% of the earths water is fresh water, but 2% is locked in glaciers and the polar ice cap, leaving just 1% available for human and other uses.

Only 12% of ocean oil pollution comes from tanker accidents. Most of it comes from deliberate disposal into the waterways by car owners, cities and factories. Ships pollute the oceans when they dump plastic bags, oil, sewage and garbage.

Around the world, cities are growing rapidly. People, animals and plants all share increasingly crowded spaces. Cities like New York and Los Angeles must find better ways to save water.

In many cities in poor nations, there is not enough clean water for drinking and bathing. Children get diseases from polluted water.

Water Pollution can be caused by sewage, garbage, chemicals, radioactive wastes, and runoffs of chemical fertilizers and pesticides.

Water evaporates into the air and rains back down to the earth. Keeping it clean and using it wisely will help make sure we have safe water in the future.

The average price for water in North America is $1.27 for 1,000 gallons. One penny buys 126 eight ounce glasses of water.

LAND

Soil erosion is caused by water run off and the wind blowing on bare soil.

In parts of the world, tropical rainforests are cut down to make farmland and provide special kinds of wood.

Soil erosion can occur when forests are cut down and water floods land used for farming. Topsoil is washed away and crops cannot grow.

In some poor countries, the population is growing so fast that the good soil is used up because the people cannot afford to put vital nutrients back into the land. They then must cut down forests for new farmland. Sometimes this causes land to become degraded.

Soil erosion can also occur if farmers let the soil lie bare part of the year. They need to keep the right kinds of crops planted year round, to bind the soil together.

“Backyard mechanics” in the U.S. generate more than 324 million gallons of used oil, and dispose most of it improperly.

The U.S. has always had so much farmland that farmers produce more food than the country needs. The extra food is sold to other countries. However, in some cases, U.S. farmers are not taking care of the farmland and we are losing tens of millions of tons of topsoil each year.

U.S. homeowners use up to 2 1/2 times more pesticides per acre to keep lawns weed free than farmers do to keep crops weed free.

ACTIVITIES

There are a variety of activities these facts can be used for. Many will depend on the grade level of your students.

1. Use one each week and coordinate a science experiment to go along with it.
2. Put one fact on the board each week, write an essay about how they can do their part to help.
3. Write letters to your local and national elected officials. Watch how they vote on issues that effect the environment.
4. Assign a specific fact to an individual or group of students for individual research.
5. Ask students to prepare material on a fact for presentation to the classroom.
6. Decide which of the facts affect the U.S.
7. Decide which of the facts are caused by the U.S.
8. Decide which facts affect the city or town where you students live.
9. Look at what they can do to begin to change the way we are treating the environment.
10. Create a game like Jeopardy or Hollywood Squares. It would be great to play in the beginning of the year and again at the end to see how much the class gained in environmental awareness.

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