

V. TEACHER INFORMATION

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A. CHARACTERISTICS OF ECOSYSTEMS

References: Janet Abramovitz, 1997⁴⁴; Nathan Keyfitz, 1995⁴⁵, 1993⁴⁶; William R. Catton Jr., 1994⁸, 1982⁴⁷

An ecosystem is made up of a community of plants and animals which develops within an interrelated physical and chemical environment.

It took millions of years for each of the forms of life in an ecosystem to evolve. Each species is adapted to its particular physical-chemical environment and to its relationships with other species. Ecosystems can have various identities ranging from “desert,” “deciduous forest,” “coral reef,” “tundra” etc., to a more local identity such as the “lower Sonoran Desert,” “coastal grass-brush,” and “tall grass prairie.”

Ecosystems are characterized by the consistency of certain species and their interaction over a period of time. The length of time may vary, but the ecosystem remains viable if there is a stability that lasts through repeated life cycles of most of the species and through various changes in its physical-chemical environment.

Rapid or catastrophic changes in an ecosystem can have unpredictable and destructive results. This is because of the intricate interdependence between all elements of the system and a very slow ability to adapt to new conditions through natural selection.

There can be particular groups of species or physical factors necessary to keep an ecosystem viable such as the pollinators needed for fertilization of plants. Extreme constant temperature change can destroy an ecosystem. In either case, if pollinators are killed by pesticides or the average temperature increases, another very different ecosystem would evolve over a long period of time with other species becoming dominant.

Political Concerns about Ecology and Ecosystems

Ecology, ecologist, ecosystem, and life-support ecosystems are basic terms which must be fully understood by all disciplines and by politicians in today’s environmental/population crisis. Members of two disciplines in need of understanding the impact of ecological parameters are sociologists and economists.

Demographer Nathan Keyfitz⁴⁵ points out the problems of making political decisions when the disciplines vary in their understanding of the concepts of ecology and carrying capacity:

A part of the difference is that biologists, geologists, cosmologists, and earth scientists take a longer view than economists. ... The notion of carrying capacity, so congenial to agriculturalists, is an irritation to social scientists.

Sociologist William Catton Jr.⁸ joins Keyfitz by criticizing some sociologists who view that “*a social fact can be explained only by another social fact*” which ignores or greatly subdues ecological factors. Catton continues:

The social sciences, in effect, practiced a denial of the possibility that humans might fail to adapt to changing environmental conditions, including changes brought about by human impact. Cultures have died.

Catton calls this “overshoot.”⁴⁷ This happens when a population exceeds its carrying capacity and continues to deplete the resources, and the population endures increased social stress. This has led to extermination of the population as happened on Pitcairn Island and disintegration of other cultures (see page 38).

Catton⁸ quotes sociologist Robert Wisniewski:

As Wisniewski lamented, when social scientists neglect carrying capacity’s time dimension, it changes the meaning of the

concept, depriving it of an essential component as developed among biological scientists. Instead of ‘the maximum population that a given resource base can sustain indefinitely, sociologists have focused,’ he said, ‘on the maximum that can be achieved in the short run.’

How Ecosystems Serve Us

Short, quotable definitions of “ecosystems” do not adequately relate their importance and our dependence upon them. Janet Abramovitz relates clear facts and concepts about ecosystems.⁴⁴

Nature’s ecosystem services include producing raw materials, purifying and regulating water, absorbing and decomposing wastes, cycling nutrients, creating and maintaining soils, providing pollination and pest control, and regulating local and global climates. Forests, for example, do much more than supply timber. They provide habitat for birds and insects that pollinate crops and control disease-carrying and agricultural pests. Their canopies break the force of the winds and reduce rainfall’s impact on the ground, which lessens soil erosion. Their roots hold soil in place, further reducing erosion. A forest’s watershed protection values alone can exceed the value of its timber. Forests also act as effective water pumping and recycling machinery, helping to stabilize the local climate. And through photosynthesis, plants generate life-giving oxygen and hold vast amounts of carbon in storage, which stabilizes the global climate.

Nature synthesizes and produces food, fiber, fuel, fertilizers, building materials, medicines, and objects of aesthetic value. Providing this service requires healthy ecosystems, which are in increasingly short supply.

In the United States, 25 percent of all prescriptions dispensed between 1986 and 1990 and 60 percent of nonprescription medicines contain active compounds extracted from natural products, primarily plants. The heart

medicine *digitalis*, antimalarial quinine, antibiotics and aspirin are among the drugs that originated in nature. All told, medicines from natural products are worth about \$40 billion a year worldwide.

Eighty percent of the world’s 1,330 cultivated crop species (including fruits, vegetables, beans, and legumes, coffee and tea, cocoa and spices) are pollinated by wild and semiwild pollinators. . . . In the United States, more than half the honeybee colonies have been lost in the last 50 years, with 25 percent lost within the last 5 years alone.

Soil is more than just a place where plants can put down their roots. It is also home to an incredible array of valuable microorganisms who are the workers in nature’s ‘underground economy.’ Insects, worms and microorganisms in the soil provide the priceless services of decomposing organic material, making nutrients available to plants, controlling diseases, and improving the texture and water holding capacity of the soil.

Many of nature’s services arise from its ability to regulate and recycle water, nutrients, and waste. But human disruptions have impaired this ability to filter and regulate water, to recharge groundwater supplies, and to move nutrients and sediments—indeed to support life.

Combinations of the above services of nature along with others make up the life-support ecosystems which we depend upon for our existence. These include: the hydrological cycle of rain, ground water, transpiration of plants and evaporation forming clouds, etc.; the carbon dioxide-oxygen balance of the atmosphere and ocean waters; the integrity of the ozone layer; the soil ecosystem including many of the items listed above; the atmosphere cleansing chemicals which eliminate toxic natural compounds; and the forest ecosystems of the world which supply many of the vital needs for humans (see pages 36–37 for the effects of deforestation).

B. CULTURE AND POPULATION DIE-OFFS

1. THE END OF SEVEN CULTURES

Researchers report numerous examples of cultural deterioration due to environmental degradation and overpopulation. To give an example of some of these, the following is a brief description of cultures in Mesopotamia; The Mediterranean; the Maya in Mesoamerica; and four small Pacific island cultures which either totally disappeared or ended up with a few survivors.

a. Mesopotamia—The Mediterranean—Mesoamerica

Reference: Clive Ponting, 1991¹¹, 1990⁴⁸

Clive Ponting's book *A Green History of the World* reveals what has been the basic human condition over three million years of existence. Food is a primary limiting factor, and through all historic periods humans have constantly reached the carrying capacity of food. Through our ingenuity we have managed to break out of starving situations. But these survival strategies have not been without their problems. In fact, these past strategies of survival have led us to a crisis situation. We have reached the limits of many resources and our population is still exploding.

Ponting gives examples of three cultures which broke out of the restrictions of natural ecosystems to reach a new level of society where more food and amenities became possible. These cultures went through their glory and contribution of technology and discovery only to fall victim to humans' inability to foresee that they were destroying their new way of life. Ponting takes us through the development and demise of the Mesopotamian, Mediterranean, and Mesoamerican cultures. They broke out of the hunter-gatherer culture which was controlled by natural ecosystem constraints. Here are excerpts from his book and an article by him in the November, 1990, *Environment* magazine.⁴⁸

Mesopotamia. Among the first civilizations to embark on the Agricultural Revolution were the

villages in the Tigris and Euphrates river basins. The Sumerian society started about 5000 B.C.E (Before Common Era or B.C.) in an unlikely place where the summer growing period became hot and dry and the only water at that time of the year for crops was by irrigation. Wheat was the primary grain crop along with barley. Here is Ponting's account of what happened to the society:

In summer, temperatures were high ... which increased evaporation from the soil surface and, consequently, the amount of salt in the soil. Water retention in the deeper layers of the soil and, hence, the likelihood of water-logging increases because of two factors: very low soil permeability and the slow rate of drainage caused by the very flat land.

The best way to alleviate this type of land deterioration is to leave fields in fallow (to not farm or irrigate) and wait for the water table to fall. However, Ponting points out:

...internal pressures (see below) within Sumerian society made that impossible and brought about a disaster. The limited amount of land that could be irrigated, along with a rising population and increasing competition among the city-states increased the pressure to intensify the agricultural system.

As salting became more severe, the wheat crops dwindled because wheat is not salt tolerant. Barley is, and by 2300 B.C.E wheat was no longer grown in the Sumerian city-state of Agade. By 2100 B.C.E., Ur also had abandoned wheat production. The end of the society came about by the classic internal weakness and vulnerability due to environmental degradation and wars. Ponting:

The consequences for a society so dependent on a food surplus were predictable. The size of the bureaucracy and the army that could be fed and maintained fell rapidly, making the state very vulnerable to external conquest.

The Mediterranean. In this area it was not entirely crop deterioration which led to the end of

the Greek city-states and the Roman Empire, but elimination of a forest ecosystem which had kept the area lush and moist. Ponting gives the environmental description of the area:

The natural vegetation of the Mediterranean basin was a mixed evergreen and deciduous forest of oak, beech, pine and cedar. Because sheep, cattle, and goats grazed on the young trees and shrubs that sprang up after clearing, the forests did not regenerate. ...Overall, it is estimated that no more than 10 percent of the original forests that once stretched from Morocco to Afghanistan even as late as 2000 B.C.E., still exist.

In Greece, the first signs of widespread environmental destruction began to appear about 650 B.C.E., as the population grew and settlements expanded. The root of the problem was overgrazing on the 80 percent of the land that was unsuitable for cultivation. ...the pressure from a continually rising population proved too great.

The growth of the Roman Empire increased the pressure on the environment in other areas of the Mediterranean as the demand for food increased. The Romans occupied Northern Africa and:

Today, the Roman ruins lie surrounded by vast deserts, a memorial to widespread environmental degradation brought about by human actions.

The Maya. The settlements started out about 2500 B.C.E. and reached a high point about 450 B.C.E. In Mesopotamia the problem was irrigation in the desert; in the Mediterranean the lush forests were destroyed and the hillsides highly overgrazed and eroded; in the Maya we have a jungle forest where overpopulation and warfare necessitated removal of the forest leading eventually to the demise of the culture. Ponting describes the situation:

Warfare increased in the Maya cities, and the elite demanded construction of more and larger ceremonial buildings, requiring huge amounts of labor. Population continued to

rise steadily, and a higher proportion lived in the cities where they were available to fill the armies and work on construction projects. Cultivation became even more intense. The ecological basis to support such a massive infrastructure was simply not there. The soils in tropical forests are easily eroded once the tree cover is removed.

In short, the Maya ended up destroying the environment upon which they relied for food and hence, for the whole complex social structure that had developed.

Ponting sums up with his analysis of these three examples with this statement:

Now, with the creation of a global economy to exploit resources, humanity for the first time must contend with damage to the global mechanisms that make life on Earth possible—the ozone layer and the concentration of carbon dioxide in the atmosphere. Given the 2 million year history of humans on Earth, it is still an open question whether the 10,000-year-old development of agriculture and settled societies and the more recent dependence on nonrenewable fossil fuels constitute an ecological sustainable strategy.

b. Polynesian Ecological Disasters

References: Jared Diamond, 1995⁴⁹, 1997⁵⁰; William Catton Jr., 1994⁸, 1982⁴⁷, Clive Ponting, 1991¹¹

Easter Island. The Polynesians arrived on Easter Island (Polynesian name Rapa Nui) from the Marquesas Islands between 400 and 500 C.E. They found a lush temperate forest with a few species of animals, some grass and brush, and large nesting areas for several species of sea birds. They brought chickens and rats and plants to cultivate including taro, sugar cane, coconut palms, breadfruit, and sweet potatoes.

Unfortunately, the island climate was too cool for the tropical plants. The primary foods were sweet potatoes and chickens. Fishing was marginal

because of the steep shoreline, but there was a small uninhabited island 260 miles away where they obtained fish while they had boats. In their later stages, porpoise bones (common dolphins which they harpooned) made up 30 percent of the animal remains in kitchen middens. Easter Island is 64 square miles.

The population increased rapidly, reaching a maximum around 1550 of from 7,000–12,000 inhabitants. During this time they had destroyed the habitat. All the forest trees were gone, the native animals depleted, mostly extinct. The largest tree was the Chilean wine palm which became extinct on the island. It was used to make boats.

When they could no longer go to sea, a social and ecological disaster took place. They had removed all of the forest to haul the giant rock statues, and also for heating and cooking. The soils were now deteriorated and erosion took place on the cultivated areas, and water was not held in the soil.

Since the Easter Islanders could not leave in boats, they turned to war and to cannibalism. Clive Ponting relates:

Slavery became common and as the amount of protein available fell the population turned on cannibalism. Against great odds the islanders painstakingly constructed, over many centuries, one of the most advanced societies of its type in the world. For a thousand years they sustained a way of life in accordance with an elaborate set of social and religious customs that enabled them to flourish. It was in many ways a triumph of human ingenuity and an apparent victory over a difficult environment. But in the end the increasing numbers and cultural ambitions of the islanders proved too great for the limited resources available to them. When the environment was ruined by the pressure, the society very quickly collapsed with it leading to a state of near barbarism.

The end result of deforestation on Easter Island:

Eventually the island was taken over by Chile and turned into a giant ranch for 40,000 sheep by a British company, with a few remaining inhabitants confined to one small village.

Pitcairn, Henderson, and Mangareva Islands.⁵⁰ These islands are 1,250 miles west of Easter Island and about 1,000 miles southeast of Tahiti. They were each smaller than Easter Island (Henderson was the largest at 14 square miles), and could not hold a large population. In the case of Pitcairn and Henderson, small populations had thrived for some time but in each of these cases, the islands were uninhabited when discovered. They had gone through a similar ecological deforestation as happened at Easter Island. The small number of people remaining on Mangareva were starving when the island was discovered in 1797.

2. FAMINES IN IRELAND AND THE SAHEL

References: Douglas, 1996²³; Kinealy, 1996⁵¹; IUCN Sahel Report, 1986⁵²

The potato arrived in Ireland in 1580, reportedly on Sir Walter Raleigh's property. It was brought to Europe from the Andes area of South America by the Spanish in 1565. After the potato was introduced into Ireland, the population rose from about three million in 1580 to over 8 million at the time of the famine in 1845. Just before the famine, the average per capita consumption of potatoes was four- five pounds a day, with large adult males eating up to 12 pounds per day. They had little else but mutton to eat with the potatoes.

The potato famine in Ireland, called the Great Hunger, lasted from 1845-52. It was brought on by "late blight", a fungus disease, *Phytophthora infestans* which originated in Mexico. The fungus arrived in Europe first and reached Ireland in 1845. Since the potato came from the Incan

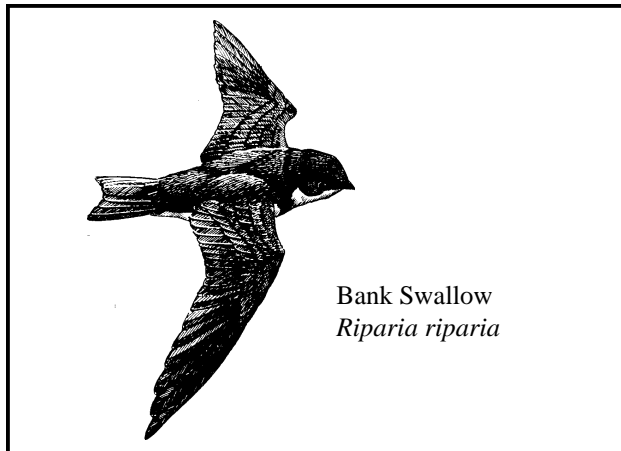
Empire in the Andes Mountains, it had no resistance to the fungus with which it had not evolved. The fungus spread rapidly by spores carried in the air, up to 50 miles a week during the worst infestation in 1847. The potato leaves would sometimes turn black overnight killing the plants. The famine resulted in starvation and sickness for the Irish population which was going through serious political and economic problems at the time.

By 1900, the population had dropped to 3-4 million. About 2 million died from starvation and disease, mostly typhus. About 3 million migrated, mostly to the United States. The population in Ireland today is 3.7 million compared to 8 million at the time of the famine.

Britain controlled Ireland at that time. During the famine period, food to feed about one million people was exported. Merchants in England and Ireland “lobbied” to continue to export food in spite of the starvation taking place.

The policy to export food while people starved was repeated in Ethiopia and Somalia and other Sahelian countries (the Sahel is the semi-arid area between the Saharan Desert and the tropical forests of Africa). In these poor African countries, they exported food to maintain their infrastructures. There was little other foreign exchange. From the 1986 IUCN Sahel Report⁵² we read:

Throughout the famine, Sahelian countries continued to export both food and cash crops—Local food consumption is thus sacrificed to the need for foreign exchange.



3. SPANISH FLU AND THE BLACK DEATH

Why discuss these events in more detail?

Even though there have been massive die-offs from diseases, wars, and famines throughout history, there is a great ability for the humans to survive and rebuild a population quickly after disasters. For instance, twenty million people (10 percent of the USSR population) were killed in the USSR during WWII. Yet in one generation after the war, the population nearly reached pre-war levels. Recovery from war and famine have rarely resulted in prolonged population decline.

Plagues however, have been devastating to populations, and there is growing concern about the future. Plagues occur mostly in crowded conditions due to population increase in cities, and are associated with hunger and poverty.

Today, 43 percent of the world’s population live in cities, but by 2050, that figure will be 69 percent, with billions living in squalid conditions. Outbreaks of especially virulent viruses could happen again in many poor overpopulated countries. Recent occurrences of viruses such as Ebola, Marburg, dengue, Legionnaires, Machupo, Lassa and Hanta viruses have been contained due to worldwide attention and the medical means to stop them from becoming widespread. However, there is growing concern about stemming these viruses in the future especially in developing countries which may have poor medical responses to plagues.

Spanish Flu, 1918–20. Reference: McGrew, 1985⁵³.

This very deadly influenza was most virulent in 1918, with the last cases reported in 1920. It is called the “Spanish Flu” but most likely it originated in the United States where the first cases were recorded. One billion cases were reported worldwide. This means that since the world’s population was about 2 billion at that time, half of all the people on Earth may have been infected. Of these, 22 million died and approximately 650

thousand in the United States. It was highly virulent with people who had little resistance to viral infections such as Native Americans. For example, a Navajo family that went out to gather pinon nuts in the morning did not return that night. When found, they were dead.

The Black Death

References: McGrew, 1985⁵³; Herlihy, 1997⁵⁴; Garrett, 1994⁵⁵.

This bubonic plague (forming bubos or swelling of lymph glands) was caused by the bacterium (a bacillus) *Yersinia pestis*. The bacillus was carried by fleas on rats in Central Asia (near China) where the plague started about ten years before it arrived in Europe. When the rats died, the fleas would leave and infect humans. Infected humans moved Westward along the Mongolian trade routes to the Caspian Sea, then to Western Europe. It could also be spread through the air on droplets of saliva. The deaths were mostly in cities, and when the plague would start in an area, those who could would move to the countryside where there was less contagion. Death could occur within three days after contracting the bacillus.

The bacillus spread in Europe from port to port by rats on ships. It arrived in Europe in 1346, and continued as an epidemic until 1352 when it reached Moscow. It killed 75 million people, 20 percent of the world's population. In some countries in Europe, up to 60 percent of the people died. During its peak in 1348, 800 died of the plague in Paris each day and 300 per day in Venice. It was most virulent in the warm spring and summer months. No deaths were reported in the Pyrenees and Balkan Mountains of Europe and in the Atlas Mountains of northern Africa.

Part of the problem of high deaths among the poor was that there was the "Great Hunger" in Europe from 1314–1317 and another famine in 1337. People had little resistance to diseases and lived in crowded unsanitary conditions. There were continued lesser outbreaks of the plague in the world, especially in 1665-1666, until the source and cure were found in 1894.

C. SURVIVAL STRATEGIES FOR TWO SPECIES AND A COUNTRY

1. SEA OTTER AND THE APHID

Sea Otter Reference: Dan Miller, California Department of Fish and Game, ret.

There is probably no other animal as controlled by the food limiting factor than the sea otter, *Enhydra lutris*. It spends its entire life in the ocean where it gets all its food, gives birth to its young, and rests. Because it is clumsy and slow on land, it rarely hauls out.

It has no blubber as do the other sea mammals. Instead, it has two survival adaptations: the most dense fur of all mammals, and a high metabolic rate to replace heat loss to the water. It must consume about 25 percent of its weight to maintain its temperature and physical ability. The largest may weigh 100 pounds. An animal this size must eat about 25 pound of meats a day. In California it rarely eats fish. Its food is primarily, abalone, urchins, clams, crabs, and squid.

Shark predation is common and helps keep the otter population healthy. The white shark is protected in California waters to keep a balance in the marine ecosystem. This helps protect the overall health of sea otter, sea lion, elephant seal and harbor seal populations.

The sea otter population (which is fully protected) is naturally culled in the winter when food becomes scarce, usually in February and March. Sea otters can have young any time of the year but mostly do so in spring and summer. If a mother otter is nursing a pup in the winter when food becomes scarce and she starts to starve, she will abandon the pup. An abandoned pup will not be fed by another otter.

This is an example of the survival process of a species population when times are severe. Each species has evolved behaviors that cause the healthiest and most experienced members to survive. In nearly all species the members lost first

are the very young and the old, those least able to survive by themselves.

The Garden Aphid

This little green insect sucks the sap out of plants, especially the tender leaf parts. It reproduces very fast and can soon cover a plant. A population of aphids on a plant usually does not have wings and can reproduce without mating. However, if the population gets so dense that an aphid just hatched from the egg is stepped upon by another aphid, the newly hatched aphid will grow wings and fly away. The population is thus lowered and spreads to other plants.

2. REPUBLIC OF CHINA POPULATION POLICIES

References: Lester Brown, 1994⁵⁶; Paul and Anne Ehrlich, 1990³; Griffith Feenney, 1993⁵⁷; Lea Goodstadt, 1982⁵⁸

Thirty million Chinese died during the 300 year Mongol occupation of China starting in 1234. Another 30 million died from starvation and disease during the 1959–61 economic upheaval and famine. The last disaster took place after the government took emphasis away from food production to undertake massive heavy industrial development, neglecting the basic needs of the people.

After the 1959–61 famine, the government made studies of their population and food production. They concluded that the carrying capacity of China was from 650-750 million people. By this time they were nearing one billion. In the 1960s and early 1970s they instituted the voluntary “later-longer-fewer” campaign through education. **Later** meant not getting married until age 24, **longer** meant spacing children three years apart, and **fewer** meant to stop at two children. The program was working. Total fertility fell from 6.1 to 3.1 children per woman from 1970 to 1977, but it was not fast enough to reach sustainable population levels needed to insure the success of their social and economic programs.

In 1979, the government instituted the one-child policy. There was fair compliance in the cities, but not in the country where 80 percent of the Chinese people live. “Many sons” has always been the traditional goal of Chinese rural families—to supply farm work and to insure the religious ancestral lineage through male members of the family.

Briefly, in the cities where the government controls industry and jobs, if a married couple chooses to remain childless or to have only one child they will receive a bonus, get a better place to live and retire with higher pay. If the wife gets pregnant after having one child and she does not have an abortion, they may have to pay back the bonus, may lose the larger home, and have less on retirement. If they have a third child, they may be fined.

In the country it is different. Now that the farms are privately owned, there is no government coercive control of family size as mentioned above. In the country, they may have two children, but if they have more, there may be fines and they may not be able to send the children born after the second child to government schools.

Even though the average number of children per woman is 1.8 in China, the population is increasing at an alarming rate due to demographic momentum of a young population. There are still more births than deaths. Government policies responded to the traditional social values of rural families who need sons for ancestral reasons and cheap labor.

On the private farms it is cheaper to have your children do the work for no salary than to hire one of the 100 million migrant workers who roam the countryside. The immigrant workers are mostly outside the government family restrictions and have larger families. Also, the government has continued the traditional policy that the amount of land allotted to a family depends upon the size of the family, creating the desire to have larger families to gain more land and profit from the farms.

It is not known how successful the fertility program will be in the long term. There are about 400 million fewer people in China today because of the one-child policy. However, with the trends of modernization, it is not known whether family size will drop when opportunity increases and people choose to consume rather than have children as in Taiwan or Hong Kong. There might be an increase in family size due to euphoria about the future as happened in the post WWII prosperity era in most industrialized countries.

In Taiwan and Hong Kong, there have been social changes which stimulate very small family size. This is especially so in Hong Kong (1.1 children per family) where most of the population is urban. If rural traditions prevail on mainland China, there will be serious problems.

These population trends are serious enough. Difficult times are ahead for the Republic of China because of declining water supplies, less land for cropland due to urbanization and erosion, the desire to have automobiles in every family, and other economic "gains."

The Republic of China is the only country which uses coercive economic methods to lower family size. Zero Population Growth, Inc. and other population action groups consider it unnecessary and improper to implement such programs.

D. SEVERE ENVIRONMENTAL CHANGES

1. OZONE LAYER DEPLETION

References: Al Gore, 1992⁵⁹; Paul and Anne Ehrlich, 1996⁶⁰; Molina and Rowland, 1974⁶¹; Clive Ponting, 1991¹¹

Ozone (O₃) is a form of oxygen formed by three oxygen atoms connected to each other. Oxygen (O₂) necessary for all animals to breathe, has two atoms.

Before there was life on Earth, there was very little free oxygen gas, not enough for life to exist on land. About 4 billion years ago the first living organisms, bacteria, appeared in the ocean. Those which developed chlorophyll, called phytoplankton, broke down carbon dioxide gas in the water into oxygen and sugars. After about 1.5 billion years, enough oxygen was released into the atmosphere to reach the stratosphere, where at about 13-15 miles up, ozone was formed by the sun's ultraviolet rays.

Until this time, life could exist on earth only below several feet in water because of deadly ultraviolet sun rays, namely UVB and UVC. Water blocks UV rays, UVA close to the surface, and the others at deeper levels. UVA rays (with the longest length) are not lethal to animals, although they can give bad sunburns and activate skin cancer in humans and injure tender plants. About 2.5 billion years ago, the ozone layer surrounding the earth became thick enough to block nearly all the UVB and UVC, and life could now evolve and move onto land.

The atmosphere is one of the life-support ecosystems vital to our existence. There are natural chemicals which neutralize naturally produced lethal gases keeping the biosphere within livable limits. The lethal effects of UVB and UVC are damage to DNA, cancer, blindness, and loss of immunity to diseases.

Human technology can do "wondrous" things. This includes making compounds which cannot

be broken down by the “cleansing” chemicals of the atmosphere. These are synthetic or “artificial” human made products. Included are CFCs (C = chlorine, F = fluorine, C = carbon), and methyl bromide. These chemicals, when they reach the stratosphere (it takes about 5–15 years to do so), interact with ozone and other chemicals to break down the ozone molecules.

This is happening over Antarctica where the winter temperatures are extremely cold and there is no sunlight. Al Gore summarizes what happens to the ozone layer and gives three basic reasons why it takes place over Antarctica⁵⁹:

First, since the ozone layer above Antarctica is much colder than anywhere else on earth, clouds form at much higher altitudes, putting tiny particles made of nitric acid and water into the stratosphere, where the ozone layer is found. The chlorine from the CFCs can destroy ozone molecules much more effectively in the presence of these ice crystals than in free-floating air. Second, above Antarctica strong winds form a circular pattern that resembles a vortex... This holds the frigid chemical brew—chlorine, bromine, ozone and ice crystals—tightly in place, as if in a bowl, until the sun comes up. Third, when the sun finally does come up (starting in September), it ends the six-month darkness of the Antarctic night. ... When the first rays of that long-awaited dawn strike the icy bowl of ozone and chlorine, they trigger a chain reaction of ozone destruction until virtually all of the ozone inside the bowl has been eaten by the chlorine and bromine. ... In the process, the concentration of ozone in the rest of the world’s air is diluted by ozone-poor air flowing out of the bowl and mixing with the ozone-rich air outside.

As the atmosphere warms up, the ozone layer will again form from the sun’s rays and from ozone floating in from around the hole, slightly decreasing the ozone layer around the world. The hole extends over the entire Antarctica—the edge of the hole reaching the southern tips of Argentina, Chile, and New Zealand.

There are now international laws to eventually eliminate CFCs, and methyl bromide is hopefully next to follow. The ozone layer may take a hundred years to return to “normal.”

Ozone layer depletion is a prime example of the dangers of new technology. There was no way to predict what the CFCs were doing until 1974 when Molina and Rowland⁶¹ published an article that warned about the possibility. In 1985, suddenly, the concentrations of chlorine and bromine over Antarctica became so dense that the ozone depletion became massive.

It took 2.5 billion years to produce enough ozone layer to protect life on land, and human technology, within a thousandth of a second on the geological time scale, came close to eliminating all life on land. Let’s hope scientists found the mistake in time.

Events like the ozone layer depletion and global warming take time to be noticed. It takes many years for the buildup to take place and then the critical point arrives with surprise. Dangerous amounts of CFCs accumulated in the stratosphere before the ozone layer loss was detected. Carbon dioxide from burning fossil fuels had been accumulating in the troposphere long before temperature changes could be measured.

2. GLOBAL WARMING

References: Paul and Anne Ehrlich, 1996⁶⁰; S. Rasool and Stephen Schneider, 1971⁶²; Stephen Schneider and Lynn Mesriow, 1976⁶³; Michael Soule, 1995⁶⁴; David Chandler, 1998⁶⁵

Causes of the present global warming are greenhouse gases released through human activity. The primary ones are carbon dioxide (CO₂) from fossil fuels, wood burning and rotting, nitrous oxide (NO₂) from fossil fuels and chemical fertilizers, and methane (CH₄) emitted from croplands, cattle, coal seams, and decaying matter. Other greenhouse gases include Chloro-Fluoro-Carbons (CFCs), and water vapor.

The sun's rays pass through the earth's troposphere through these gases, but when the rays hit the earth's surface they increase in length and cannot escape. They are absorbed into the atmosphere. Over the past hundred years, carbon dioxide has increased by 30 percent, nitrous oxide by 15 percent, and methane by 145 percent.

Carbon dioxide has contributed to 66 percent of the total global warming so far, making up 350 parts per million in the atmosphere (in 1980). Methane makes up only 1.7 parts per million of the atmosphere, but is responsible for 17 percent of the greenhouse effect. Methane is about 25 times more potent than CO₂. CFCs are trace gases, but still make up 12 percent of the greenhouse effect. CFCs are a thousand times more potent as absorbers of infra-red than CO₂. Nitrous oxide is at a low level but contributes to about 5 percent of the greenhouse affect. It is 120 times more potent than CO₂.

There has been opposition to the fact that there is a serious global warming taking place. The opposition comes from people and organizations who do not want to change their way of life or their occupation. The fact that oil and gas reserves will run out within 40 to 50 years (see page 46) greatly disturbs the public for they know that substitutes are far from available at this time.

Some people also believe that there is plenty of coal and oil shale. Others still have hopes that nuclear power will be usable. Some, especially those making profits from fossil fuels, want to exploit the reserves they control and try to refute scientific warning, about global warming.

True, there is enough coal, oil shale, and nuclear power for hundreds of years, but the environmental damage and cost of retrieving these fuels is prohibitive. It is unwise economically and is environmentally unacceptable. The answer to energy production lies in renewable power either directly or indirectly from the sun. These will not cause global warming.

However, there is much money invested in using fossil fuels as long as it is economically profitable. The results of continued use include environmental damage to habitat, use of scarce water to retrieve oil from shale, and serious atmospheric warming, and pollution (especially from nuclear power).

The Brownlashers

The brownlashers want to continue to use fossil fuels for business purposes. They discredit environmental concerns and state that global warming is not due to burning of fossil fuels or is not as serious as scientists claim.

Paul and Anne Ehrlich's book *Betrayal of Science and Reason*⁶⁰ gives a good example of an attack on the credibility of scientists who are trying to solve global warming. Some scientists were saying that we may be coming into an "ice age;" that there is information that the earth is cooling off. Later, when other scientists offered evidence that the earth was warming, it was confusing to the public. As all good scientists do, the proponents of the "ice age" concept, including Stephen Schneider, conducted more research. They soon agreed that the earth was warming, not cooling.

It was not apparent in 1971 that nitrous oxide, methane, and CFCs were also greenhouse gases

(Schneider and Mesirov⁶³). Stephen Schneider is now a strong proponent of the fact that greenhouse gases from human activities are the basic cause of global warming. Yet, some brownlash people still refer to Schneider's original "cooling" remarks to discredit the environmental movement.

At this time there is a very serious concern among atmospheric scientists. Methane (CH₄) is around 25 times more effective than CO₂ as a greenhouse gas. There are trillions of tons of methane locked in the frozen tundra.⁵⁹

If the atmosphere warms up to the point where the permafrost in the tundra starts melting, there could be a runaway global warming that humans could not stop. Scientists do not know what the average global atmospheric temperature must be before this happens.

This will be a serious problem for the world to solve in the future. If the permafrost starts melting, what will humanity do? Will people using fossil fuels to make energy ignore the permafrost melt and continue to use fossil fuels? Or will there be a serious effort to stop release of greenhouse gases from fossil fuels?

This is a clear case where caution must prevail and governments must not delay curbing fossil fuel use until positive proof is available. When the permafrost starts melting and there is an increase of methane in the atmosphere, action must be taken to stop a runaway disastrous global warming. Hopefully the environmental movement and elected officials who are aware of the dangers will prevail.

Here are some quotes to think about:

Michael Soule, UCSC, 1995⁶⁴:

Our species is engaged in an uncontrolled experiment in planetary heating. Each decade the concentration of CO₂, methane and other greenhouse gases in the atmosphere is increasing by about 4 percent. ...Many plant

and animal species living in natural ecosystems will perish because they will be unable to keep up with shifting climate zones. Warming exacerbates another problem—the influx of alien animals, plants and pathogens. These introduced species, many from the tropics, will increase the variety and incidence of tropical diseases.

David Chandler, 1998⁶⁵:

By using a combination of written records and information in tree rings, ice cores, and coral reefs, researchers at the University of Massachusetts have been able to build a record of the world's climate that extends back 600 years. The record revealed that the warmest years in that whole span of time were 1997, 1995, and 1990.

3. THE COMING FUEL CRISIS

by Stuart Johnson

Converting society to a solar age is likely to bring intense social conflict and violence.

Society has moved through a petroleum based spurt of technological growth.

After World War II, worldwide oil production grew at a rapid rate. The largest petroleum reserves were located in Middle East countries, including Saudi Arabia, Iran, Iraq, and Kuwait. The United States enjoyed unbroken growth in its oil-based standard of living until hostilities broke out in the Middle East.

During October of 1973 Egyptians and Syrians attacked Israel. Arab oil ministers resolved to totally cut off oil supplies to America and the Netherlands. This embargo was called the First Oil Shock. The Second Oil Shock arrived as Islamic fundamentalists replaced the Shah of Iran (see oil production, Figure 10, below).⁶⁶

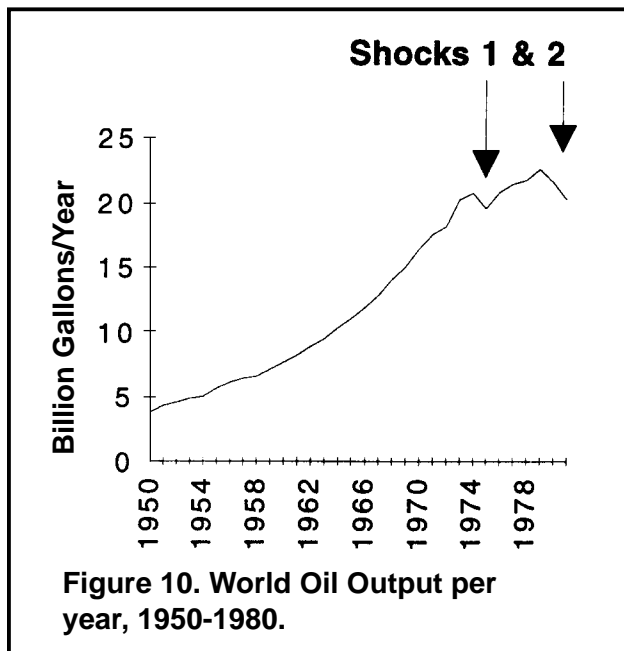


Figure 10. World Oil Output per year, 1950-1980.

Note the long continual rise in oil production from 1950. What effects would you have expected from the small reductions in 1973 and 1979? The results were frightening.

People died from fights in US gasoline lines. National Guard soldiers were mobilized to deal with violence in the trucking industry. The government cut rail service, then asked the public to switch from private automobiles to public transportation. A 1979 NBC/AP poll indicated that two-thirds of the nation believed that an oil company conspiracy caused the shortages.⁶⁷ Gasoline was rationed. Some argued for government seizure of the big oil companies.

Recent studies predict imminent shortages of oil as we rapidly use up US and overseas supplies.

A Harvard business group⁷⁰ warned that the US is rapidly using up its own oil supplies. Thus we become more and more dependent on oil from the Middle East. We will soon import three quarters of the oil upon which the US now depends. If the Middle East countries become unstable, their leaders could cut off our oil supplies. The curve (Figure 11) shows actual world oil production from 1950 through the 1973 and 1979 oil shocks to the present (see 'You are here'). Future supplies are estimated from 2000 to 2030.

Scientists at the University of New Hampshire Complex Systems Research Center estimated that oil shortages would cause a slowdown of US manufacturing toward the end of this century.⁶⁸ Geologists have calculated a strong downward turn in oil production shortly after the year 2000.^{66,69}

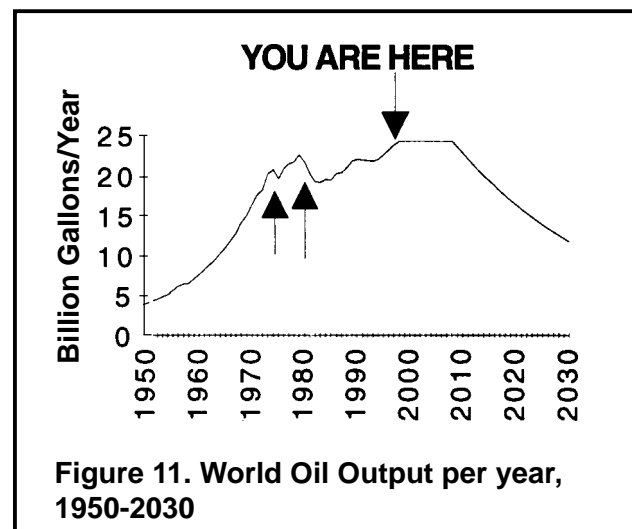


Figure 11. World Oil Output per year, 1950-2030

Scientists expect drastically reduced productivity in agriculture and industry.

Since population growth continues while oil production decreases, the amount of oil available per person is less as time passes.

The US Gross National Product (GNP) depends upon fuels to drive industrial, manufacturing, and transportation processes. Loss of oil will affect all the products and processes that make up our standard of living.

Agriculture will be especially hard hit with less gasoline and diesel fuels for the manufacture and operation of agricultural machinery. Processing, refrigeration, and transportation of food will be affected. Food travels an average of 1,300 miles before it is consumed. Less petroleum means reduced fertilizer, pesticides, herbicides, and other petrochemicals. Less food will be available for local use and for overseas exports.

Can alternative fuels replace oil?

For the last few dozen years, the US has used efficient oil and gas fuels to produce goods and services. Replacing those with less efficient alternative fuels will reduce the goods and services produced.

Obtaining fuel from so-called “oil shales” would leave enormous waste deposits and use huge quantities of water. Also, more energy may be required than is produced.

Converting from oil to coal will cause heavy atmospheric pollution and acid rain. The energy required to mine coal will increase over time and the net yield of a ton of coal will go down.

Nuclear energy plants are producing radioactive waste pollution that is likely to leak into the environment in the future. Decommissioning of nuclear facilities and long-term storage of waste will require very large quantities of energy. Thus, more energy may have been put into the development of nuclear reactors than they have yielded.⁶⁸

Fuel alcohol prepared from corn also requires nearly as much energy as it yields. Increasing corn crops for alcohol would increase soil erosion and would reduce food production. Although solar energy will certainly be used extensively in the future it cannot replace the energy now obtained from oil.

Society is likely to become more harsh with increased population and loss of oil supplies.

Americans cherish their individual rights. But these rights evolved during a period of growth and abundant food. By now, that growth has used up our stores of petroleum. People are likely to compete more strongly for reduced food and necessities. We may become less concerned for the well-being of people and for the biological systems that feed and clothe us.⁴⁷

A publication of the American Association for the Advancement of Science⁶⁷ (AAAS) predicts a long-term return to land-based power. Current power is based on holes in the ground from which minerals, coal, oil, and water are obtained and the technologies these resources support. Power is also increased when “phantom acreage” is created in agriculture by increasing crop yields per acre with fertilizer, herbicides, pesticides, and mined ground water.⁴⁷ By contrast, available solar power is based on the area of land held on which the sun shines.

Social movements are emerging that involve decentralization and a shift toward land-based power. These include bioregionalism, environmentalism, local self-reliance, libertarianism, and solar energy. Linguistic, ethnic, and geographic chauvinism may divide groups and their lands. Other territorial or “turf-defense” trends involve militias, survivalists, urban street gangs, and immigration resistance.

The AAAS study also predicts a return toward theocracy. As examples, the author points to the growth of charismatic religions, increased intrusion of religious pressures into politics, and the world-wide surge of Islamic fundamentalism.

We may hope that our society turns to appropriate technologies rather than reverting to the stifling dark ages of anti-intellectualism and suppression of science. We need desperately to bring the behavioral sciences and social and humanistic disciplines into the planning of domestic energy policy. Scarcely any parts of our social system will escape drastic impacts. All aspects of social policy and planning are affected by the certainty of reduced fuels.

Education, housing, and health care delivery will be reshaped due to the loss of fuel for busing and central heating. Networks and vehicles for transporting people and products are likely to shrink. Loss of fuel will slow all aspects of economic development and will accentuate the search for new sustainable agricultural and other human support services.

Human welfare depends on the number of people among whom life's necessities must be divided. Therefore the limits imposed by a loss in fuel supplies will even control the rate at which humans can reproduce and survive on this finite earth.

4. THE SIXTH EXTINCTION

References: Richard Leakey and Roger Lewin, 1995¹²; Paul Martin, 1984⁷¹; National Geographic, 1999²⁶; Jean-Claude Carriere, 1995⁷².

The title of the book by Leakey and Lewin, *The Sixth Extinction*, does not imply that humans will become extinct, but rather that humans may **cause** the sixth major extinction of species on Earth.

There have been five previous periods when most of the species became extinct. These were 440, 365, 225, 210, and 65 million years ago. At least 65 percent of all species became extinct in each of these periods. Ninety-five percent of the marine species vanished in the Permian period, 225 million years ago.

It is not known why these extinctions occurred, but in the last extinction 65 million years ago in which the dinosaurs quickly vanished, it is pretty well agreed that it was a huge meteor or comet which struck the Earth in the Caribbean Sea north of the Yucatan Peninsula. This explosion hurled massive amounts of dust into the air blocking the heat from the sun and caused a sharp global decline in air temperature. This condition lasted long enough to exterminate the dinosaurs.

However, today's birds have a similar bone structure and locomotion by walking on their hind legs, and some scientists believe that birds are actually "dinosaurs" which evolved from a bird-like warm blooded dinosaur that survived the cold.

Today, estimates are that up to 10,000 species are eliminated each year globally, mostly insects in the tropical forests. If our destruction of ecosystems continues as in the past 100 years, we could indeed initiate the sixth extinction.

About two hundred years ago humans were removing or destroying about one percent of the net primary productivity (photosynthesis) each year. Today we are removing about 40 percent of all the net primary productivity (NPP) on land. This leaves only about 60 percent of the energy, food, and habitat available to other land species.

Number of State and Federally Listed Endangered and Threatened Animals of California. April, 1999

Source: California Department of Fish and Game, Sacramento.

www.dfg.ca.Endangered/animals.html

Gastropods (snails)	2
Crustaceans (shrimp and crayfish)	8
Insects	20
Fishes	29
Amphibians	10
Reptiles	13
Birds	29
Mammals	28
Total	139

This is why the Dalai Lama⁷² states that human overpopulation is the most serious problem on Earth today. The Buddhists for whom he leads protect all animals. For our species to remove 40 percent of the NPP each year from all other animals is not tolerable to the Dalai Lama. He states that our “*population must be lowered.*”

Extinction is a fact of the evolutionary process.

The average life span of a species is only about four million years⁷¹. It is estimated that “*30 billion species have lived since the first multicellular species evolved.*” Today there are about 30 million species on earth meaning that 99.9 percent of all species that have ever lived are extinct. Leakey presents a good discussion on the theories why these extinctions took place including the effects of changes in ocean height, blocking of earth rays by volcanic dust, increase of CO₂, decline of atmospheric oxygen by half, and other possibilities.

The existence of any species is very fragile, and the most important thing we can do for ourselves and for all other species is to avoid destroying the stability of our life-support ecosystems (see page 35).

We have the technology and presently the desire to convert all organisms and resources into human use far beyond what we need to live comfortably at a sustainable level. Had we caused the destruction of the ozone layer, we would have created a great extinction on earth—all land species including ourselves.

If we, by causing global warming, release the trillions of tons of methane now trapped in the permafrost, we will create extreme temperature conditions. This might lead to disruption of the fragile balance within all earth’s ecosystems. The **speed** of changes in the environment has been the cause of extinction. When environmental changes are faster than the adaptive rate of mutations, extinction occurs.

5. CHILDREN, LAMBS, COLTS **An Example of Pastoral Attitudes**

Easter Island is a unique example of an ecological disaster and demise of a flourishing culture. However, overshoots of carrying capacity (see page 34) have taken place throughout the world. The disappearing pastoral society of the Navajo is an example in our own backyard.

The following is a statement by a female Navajo elder to an anthropologist studying the Navajo religion. The interview was taken about 100 years ago.⁷⁴

We do not have grass enough. Even if we had grass enough, the land is not broad enough. My people work both night and day, the men and women creating children, my flocks and herds making young. The Americans are always clamoring for more land; so are my people. I long for enough land to stretch my limbs. From here (Keams Canyon on the Hopi Reservation) you can see the San Francisco Mountains at the west. By riding a short distance to the north you can see Navajo Mountain, a short way to the south are the White Mountains, and at the east is Mt. Taylor. Remember what a small patch of ground this really is. Think how much effort will be made this very night to increase the number of children, lambs, colts. We do not have enough land.

This statement was made a short while after the Navajos were allowed to return to their grazing lands on their new reservation. Most of the Navajos had been incarcerated for several years (late 1860s) at Bosque Redondo on the Pecos River in New Mexico. They did not want to become farmers, so the US government gave them herds of livestock, primarily sheep. The Navajos thus continued the pastoral culture they had developed since 1582 when the Spaniards introduced livestock to the Navajos.

The US policy toward Native Americans was to place them on reservations, whenever possible on

arable lands so they would become farmers. The Navajo were horticulturists as were the traditional Pueblos, but did not want to become agriculturalists. The anthropological definition of horticulture is the tilling of land by hand with hoe or digging sticks. Crop growing becomes agriculture with the use of plows and mechanisms other than hand held objects.

Pastoralism is an economy that obtains the bulk of the food from domesticated animals. Traditional pastoralists typically ate few plant products, those they traded for or bought. The traditional Navajos did have small crop areas in the summer, but relied heavily on their livestock for food. They sold the meat, wool and hides to purchase other foods and equipment.

This decision to continue pastoralism by the US government was a mistake. The fragile semi-desert was no place to establish a large scale pastoral society based on sheep and goats. There were no controls over the use of the area to prevent overgrazing which eventually caused desertification and erosion.

The principle of the “commons” described by Garrett Hardin⁸¹ became a devastating reality. Navajos, who had developed an efficient unique culture with small numbers of people, were soon to be overwhelmed with a mass of their own people which the land could not support.

In a commons situation, when a piece of land is being used for grazing by more than one user, if each user acts independently for short-term advantage, the result in the long-term is the deterioration of the resource.

Estimates of the carrying capacity at the formation of the Navajo Reservation was about 30,000 people existing as pastoralists. The population grew rapidly from less than 20,000 in 1900 to nearly 200,000 by 1980. It is now 250,000.

The Navajos are an Athabascan people. They were the last wave of immigrants from the Siberian area

to come across the Bering Strait. Some of them continued to wander southward as hunter-gatherers through the plains area east of the Rocky Mountains until they settled near the Pueblo Indians around the year 1400.

They split into two tribes, the Navajo and the Apache. The principal difference was that the Apache ate their raided livestock as they obtained them, whereas the Navajo kept most of them and developed a pastoral society. The Navajos were very adaptive to the various Pueblo cultures they adjoined, and then to the ways of the Spaniards, Mexicans, and Americans.

They had both negative and positive relationships with their neighbors. Some Navajos and Hopis intermarried and had good relationships; others raided Hopi crops or took over Hopi land. However, when the Spaniards were at war with the Pueblos, members of several Pueblo tribes took refuge for several years with the Navajo living in the hinterlands. At this time, the Navajos learned the growing of corn and other crops, and weaving and sand painting from the Pueblo Indians. Later, when some of the Navajos were fleeing from US troops, the Hopi secreted them on their land for safety.

The close interaction with their neighbors yielded a rich Navajo culture including arts and crafts. They became superb weavers of cloth and saddle makers, reliable railroad workers, and were the stone masons who built the kilns for charcoal making near Death Valley. Nevertheless, the necessity for the Navajo to have large families eventually caused the demise of their pastoralism.

The Navajo needed large families for several reasons. The primary one was to graze and tend the large flocks. This was usually by the children. The Navajo culture required families spread over large areas, necessitating large family groups and clans for protection from other indigenous raiding tribes, the Comanches to the east and the Paiutes and Utes to the north.

The Navajo population grew exponentially from 1900 to 1990. During this time their large reservation environmentally deteriorated and they occupied most of the Hopi Reservation. By the time the land dispute was resolved in the courts in the 1970s, the Navajo occupied 84 percent of the Hopi Reservation. Court orders and legislative acts dictated that half of the Hopi land occupied by the Navajos was to be given back to the Hopi, and the other half was to be added to the Navajo Reservation.

Around 4,000 Navajos lived on the portion to be returned to the Hopi Reservation. They had a choice to move to any community or city in the United States receiving a free house and some funding to train themselves for employment. They could also move back onto the original Navajo reservation lands with a new home, or move to the New Lands and a new home. The New Lands were grazing lands purchased for the relocatees south of the original Reservation.

Almost 400 Navajo families moved to the New Lands where tribal and government personnel established a well managed livestock raising program. They put up fences and Relocation Commission hired professional range management personnel.

This new grazing area has been so well managed on a sustainable level that several years ago when there was a severe drought in the Southwest, the New Lands was one of the few areas in which there was plenty of food and water for the livestock, and the people were not affected by the drought. The drought is continuing.

Economist Philip Reno of Navaho Community College,⁸² made a report on the economic status of the Navajos in 1981. One problem was that government officers who managed the Navajo Reservation had not included projections of the needs of people for future population levels.

Reno's purpose was to evaluate a proposed 10-year development plan. He revealed clearly the plight of the Navajos. They had been caught for a hundred years in the intricate web of rapid population growth, technological impact, and economic short-term exploitation of resources encouraged by the US government.⁸²

The Navajo experience, like that of tribesmen in the wide stretches of Africa, Asia, and Latin America, leaves little doubt that a land ethic cannot by itself save the land from demands of a *growing population on a fixed land and technological base*. The American and industrial experience generally, on the other hand, leaves no doubt at all that technology becomes a Frankenstein monster in a simply acquisitive society, a society without an ethic of the place of humankind in the universe of nature. In the absence of such an ethic, *economics simply shows how to maximize technology's short-run output; and its long-run devastation* (emphasis added).

The Navajo elder in the first quote above was expressing the survival attitude of pastoralists and other land users over the world for thousands of years. Today this attitude is rapidly changing. Many of the livestock grazers from the Black Sea to Korea now have small families.

Both the pastoral attitude for more "children, lambs, colts," and the present short-term exploitative use of resources for natural capital in the free market must now be kept within ecological limits.

E. WORLD POPULATION DATA

1. Average family size, doubling time and population of 201 countries and major population areas of the world, 1999, by average family size (FR).⁵

FR = fertility rate (live births/female)

DT = population doubling time in years

P = population in millions

npg = negative population growth

NATION/AREA	FR	DT	P
Monaco	–	239	0.03
Bulgaria	1.1	npg	8.2
Latvia	1.1	npg	2.4
China, Hong Kong	1.1	161	6.9
San Marino	1.2	165	0.03
Italy	1.2	npg	57.7
Spain	1.2	1980	39.4
Estonia	1.2	npg	1.4
Slovenia	1.2	npg	2.0
Russia	1.2	npg	146.5
Macao	1.2	78	0.4
Czech Republic	1.2	npg	10.3
Germany	1.3	npg	82.0
Austria	1.3	2310	8.1
Romania	1.3	npg	22.5
Greece	1.3	6931	10.5
Belarus	1.3	npg	10.2
Georgia	1.3	217	5.4
Ukraine	1.3	npg	49.9
Hungary	1.3	npg	10.1
Japan	1.4	318	126.7
Lithuania	1.4	npg	3.7
Taiwan	1.4	102	22.0
Slovakia	1.4	845	5.4
Portugal	1.5	770	10.0
Switzerland	1.5	277	7.1
Belgium	1.5	693	10.2
Netherlands	1.5	180	15.8
Canada	1.5	162	30.6
Poland	1.5	1155	38.7
Sweden	1.5	npg	8.9
Armenia	1.5	128	3.8
Liechtenstein	1.6	105	0.03
Bosnia-Herzegovina	1.6	141	3.8
Korea, South	1.6	70	46.9
Cuba	1.6	103	11.2
Singapore	1.6	69	4.0
Croatia	1.7	990	4.6
Antigua and Barbuda	1.7	46	0.1
France	1.7	210	59.1
Luxembourg	1.7	187	0.4
Denmark	1.7	472	5.3
Finland	1.7	459	5.2
United Kingdom	1.7	423	59.4

NATION/AREA	FR	DT	P
Australia	1.7	107	19.0
Martinique	1.7	81	0.4
Yugoslavia	1.7	365	10.6
Moldova	1.7	990	4.3
Trinidad and Tobago	1.7	103	1.3
Andorra	1.7	85	0.1
Barbados	1.8	130	0.3
China	1.8	73	1,254.1
Macedonia	1.8	107	2.0
Norway	1.8	224	4.5
Kazakstan	1.8	151	15.4
Ireland	1.9	122	3.7
New Zealand	1.9	83	3.8
Dominica	1.9	61	0.1
Bahamas	2.0	45	0.3
Guadeloupe	2.0	64	0.4
Malta	2.0	136	0.4
United States	2.0	116	272.5
Iceland	2.0	81	0.3
Thailand	2.0	61	61.8
Cyprus	2.0	107	0.9
Mauritius	2.0	67	1.2
Albania	2.0	58	3.5
Puerto Rico	2.1	78	3.9
Azerbaijan	2.1	62	7.7
Netherlands Antilles	2.2	59	0.2
Sri Lanka	2.2	57	19.0
Seychelles	2.2	61	0.1
Reunion	2.3	48	0.7
Korea, North	2.3	48	21.4
Brazil	2.3	45	168.0
Uruguay	2.4	85	3.4
Chile	2.4	49	15.0
Lebanon	2.4	43	4.1
St. Vincent & Grenadines	2.4	49	0.1
Palau	2.5	68	0.02
Saint Lucia	2.5	44	0.2
St. Kitts-Nevis	2.6	82	0.04
Suriname	2.6	39	0.4
Turkey	2.6	46	65.9
Argentina	2.6	58	36.6
Turkmenistan	2.6	46	4.8
Guyana	2.7	40	0.7
Panama	2.7	39	2.8
Costa Rica	2.7	38	3.6
Mongolia	2.7	50	2.4
Vietnam	2.7	46	79.5
Jamaica	2.8	40	2.6
Indonesia	2.8	42	211.8
Kyrgyzstan	2.8	47	4.7
New Caledonia	2.8	42	0.2
Tunisia	2.8	44	9.5

NATION/AREA	FR	DT	P	NATION/AREA	FR	DT	P
Bahrain	2.8	37	0.7	Cambodia	5.2	29	11.9
Israel	2.9	45	6.1	Cameroon	5.2	26	15.5
Venezuela	2.9	34	23.7	Swaziland	5.2	22	1.0
Colombia	3.0	34	38.6	West Bank	5.2	21	1.9
Mexico	3.0	32	99.7	Cape Verde	5.3	24	0.4
Iran	3.0	38	66.2	Gabon	5.4	32	1.2
French Polynesia	3.1	40	0.2	Ghana	5.4	24	19.7
Morocco	3.1	41	28.2	Solomon Islands	5.4	21	0.4
Dominican Republic	3.2	32	8.3	Togo	5.4	26	4.5
Malaysia	3.2	33	22.7	Mauritania	5.5	25	2.6
Kuwait	3.2	32	2.1	Bhutan	5.6	22	0.8
Tajikistan	3.2	36	6.2	Gambia	5.6	29	1.3
Uzbekistan	3.2	35	24.4	Laos	5.6	26	5.0
Fiji	3.3	39	0.8	Mozambique	5.6	32	19.1
Bangladesh	3.3	38	125.7	Pakistan	5.6	25	146.5
Ecuador	3.3	33	12.4	Guinea	5.7	29	7.5
Egypt	3.3	35	66.9	Iraq	5.7	25	22.5
South Africa	3.3	43	42.6	Senegal	5.7	25	9.2
Brunei	3.4	32	0.3	Tanzania	5.7	28	31.3
India	3.4	37	986.6	Djibouti	5.8	30	0.6
Guam	3.5	29	0.2	Maldives	5.8	32	0.3
Peru	3.5	32	26.6	Equatorial Guinea	5.9	27	0.4
El Salvador	3.6	30	5.9	Guinea-Bissau	5.9	32	1.2
French Guiana	3.7	28	0.2	Malawi	5.9	41	10.0
Philippines	3.7	31	74.7	Madagascar	6.0	24	14.4
Grenada	3.8	30	0.1	Rwanda	6.0	33	8.2
Myanmar (Burma)	3.8	35	48.1	Afghanistan	6.1	28	25.8
Belize	3.9	27	0.2	Côte de Ivoire	6.1	26	15.8
Nicaragua	3.9	22	5.0	Eritrea	6.1	23	4.0
Qatar	3.9	41	0.5	Zambia	6.1	35	9.7
Zimbabwe	4.0	57	11.2	Liberia	6.2	23	2.9
Algeria	4.1	29	30.8	Nigeria	6.2	23	113.8
Botswana	4.1	59	1.5	Sao Tome & Principe	6.2	20	0.2
Libya	4.1	28	5.0	Benin	6.3	23	6.2
Bolivia	4.2	34	8.1	Sierra Leone	6.3	24	5.3
Vanuatu	4.2	29	0.2	Saudi Arabia	6.4	23	20.9
Western Samoa	4.2	29	0.2	Burundi	6.5	28	5.7
Lesotho	4.3	33	2.1	Chad	6.6	21	7.7
Honduras	4.4	25	5.9	Congo Dem. Rep.(Zaire)	6.6	22	50.5
Jordan	4.4	28	4.7	Burkina Faso	6.7	24	11.6
Paraguay	4.4	26	5.2	Mali	6.7	22	11.0
Nepal	4.6	28	24.3	Marshall Islands	6.7	19	0.1
Sudan	4.6	32	28.9	Yemen	6.7	24	16.4
Fed. States/Micronesia	4.7	27	0.1	Angola	6.8	23	12.5
Kenya	4.7	33	28.8	Somalia	6.8	25	7.1
Syria	4.7	25	16.0	Western Sahara	6.8	24	0.2
Haiti	4.8	33	7.8	Uganda	6.9	24	22.8
Papua-New Guinea	4.8	29	4.7	Ethiopia	7.0	28	59.7
United Arab Emirates	4.9	32	2.8	Gaza	7.0	16	1.2
Central African Repub.	5.1	32	3.4	Oman	7.1	18	2.5
Comoros	5.1	25	0.6	Niger	7.5	23	10.0
Congo	5.1	31	2.7				
Guatemala	5.1	24	12.3				
Namibia	5.1	42	1.6				

Five countries are at zpg: Austria, Greece, Spain, Poland, and Portugal.

WORLD POPULATION DATA

1. Average family size, doubling time and population of 201 countries and major population areas of the world, 1999, in alphabetical order.⁵

FR = fertility rate (live births/female)

DT = population doubling time in years

P = population in millions

npg = negative population growth

NATION/AREA	FR	DT	P
Afghanistan	6.1	28	25.8
Albania	2.0	58	3.5
Algeria	4.1	29	30.8
Andorra	1.7	85	0.1
Angola	6.8	23	12.5
Antigua and Barbuda	1.7	46	0.1
Argentina	2.6	58	36.6
Armenia	1.5	128	3.8
Australia	1.7	107	19.0
Austria	1.3	2310	8.1
Azerbaijan	2.1	62	7.7
Bahamas	2.0	45	0.3
Bahrain	2.8	37	0.7
Bangladesh	3.3	38	125.7
Barbados	1.8	130	0.3
Belarus	1.3	npg	10.2
Belgium	1.5	693	10.2
Belize	3.9	27	0.2
Benin	6.3	23	6.2
Bhutan	5.6	22	0.8
Bolivia	4.2	34	8.1
Bosnia-Herzegovina	1.6	141	3.8
Botswana	4.1	59	1.5
Brazil	2.3	45	168.0
Brunei	3.4	32	0.3
Bulgaria	1.1	npg	8.2
Burkina Faso	6.7	24	11.6
Burundi	6.5	28	5.7
Cambodia	5.2	29	11.9
Cameroon	5.2	26	15.5
Canada	1.5	162	30.6
Cape Verde	5.3	24	0.4
Central African Repub.	5.1	32	3.4
Chad	6.6	21	7.7
Chile	2.4	49	15.0
China	1.8	73	1,254.1
China, Hong Kong	1.1	161	6.9
Colombia	3.0	34	38.6
Comoros	5.1	25	0.6
Congo	5.1	31	2.7
Congo Dem. Rep.(Zaire)	6.6	22	50.5
Costa Rica	2.7	38	3.6
Côte de Ivoire	6.1	26	15.8
Croatia	1.7	990	4.6

NATION/AREA	FR	DT	P
Cuba	1.6	103	11.2
Cyprus	2.0	107	0.9
Czech Republic	1.2	npg	10.3
Denmark	1.7	472	5.3
Djibouti	5.8	30	0.6
Dominica	1.9	61	0.1
Dominican Republic	3.2	32	8.3
Ecuador	3.3	33	12.4
Egypt	3.3	35	66.9
El Salvador	3.6	30	5.9
Equatorial Guinea	5.9	27	0.4
Eritrea	6.1	23	4.0
Estonia	1.2	npg	1.4
Ethiopia	7.0	28	59.7
Fed. States/Micronesia	4.7	27	0.1
Fiji	3.3	39	0.8
Finland	1.7	459	5.2
France	1.7	210	59.1
French Guiana	3.7	28	0.2
French Polynesia	3.1	40	0.2
Gabon	5.4	32	1.2
Gambia	5.6	29	1.3
Gaza	7.0	16	1.2
Georgia	1.3	217	5.4
Germany	1.3	npg	82.0
Ghana	5.4	24	19.7
Greece	1.3	6931	10.5
Grenada	3.8	30	0.1
Guadeloupe	2.0	64	0.4
Guam	3.5	29	0.2
Guatemala	5.1	24	12.3
Guinea	5.7	29	7.5
Guinea-Bissau	5.9	32	1.2
Guyana	2.7	40	0.7
Haiti	4.8	33	7.8
Honduras	4.4	25	5.9
Hungary	1.3	npg	10.1
Iceland	2.0	81	0.3
India	3.4	37	986.6
Indonesia	2.8	42	211.8
Iran	3.0	38	66.2
Iraq	5.7	25	22.5
Ireland	1.9	122	3.7
Israel	2.9	45	6.1
Italy	1.2	npg	57.7
Jamaica	2.8	40	2.6
Japan	1.4	318	126.7
Jordan	4.4	28	4.7
Kazakstan	1.8	151	15.4
Kenya	4.7	33	28.8
Korea, North	2.3	48	21.4
Korea, South	1.6	70	46.9
Kuwait	3.2	32	2.1
Kyrgyzstan	2.8	47	4.7

NATION/AREA	FR	DT	P	NATION/AREA	FR	DT	P
Laos	5.6	26	5.0	Saint Lucia	2.5	44	0.2
Latvia	1.1	npg	2.4	San Marino	1.2	165	0.03
Lebanon	2.4	43	4.1	Sao Tome & Principe	6.2	20	0.2
Lesotho	4.3	33	2.1	Saudi Arabia	6.4	23	20.9
Liberia	6.2	23	2.9	Senegal	5.7	25	9.2
Libya	4.1	28	5.0	Seychelles	2.2	61	0.1
Liechtenstein	1.6	105	0.03	Sierra Leone	6.3	24	5.3
Lithuania	1.4	npg	3.7	Singapore	1.6	69	4.0
Luxembourg	1.7	187	0.4	Slovakia	1.4	845	5.4
Macao	1.2	78	0.4	Slovenia	1.2	npg	2.0
Macedonia	1.8	107	2.0	Solomon Islands	5.4	21	0.4
Madagascar	6.0	24	14.4	Somalia	6.8	25	7.1
Malawi	5.9	41	10.0	South Africa	3.3	43	42.6
Malaysia	3.2	33	22.7	Spain	1.2	1980	39.4
Maldives	5.8	32	0.3	Sri Lanka	2.2	57	19.0
Mali	6.7	22	11.0	St. Kitts-Nevis	2.6	82	0.04
Malta	2.0	136	0.4	St. Vincent & Grenadines	2.4	49	0.1
Marshall Islands	6.7	19	0.1	Sudan	4.6	32	28.9
Martinique	1.7	81	0.4	Suriname	2.6	39	0.4
Mauritania	5.5	25	2.6	Swaziland	5.2	22	1.0
Mauritius	2.0	67	1.2	Sweden	1.5	npg	8.9
Mexico	3.0	32	99.7	Switzerland	1.5	277	7.1
Moldova	1.7	990	4.3	Syria	4.7	25	16.0
Monaco	-	239	0.03	Taiwan	1.4	102	22.0
Mongolia	2.7	50	2.4	Tajikistan	3.2	36	6.2
Morocco	3.1	41	28.2	Tanzania	5.7	28	31.3
Mozambique	5.6	32	19.1	Thailand	2.0	61	61.8
Myanmar (Burma)	3.8	35	48.1	Togo	5.4	26	4.5
Namibia	5.1	42	1.6	Trinidad and Tobago	1.7	103	1.3
Nepal	4.6	28	24.3	Tunisia	2.8	44	9.5
Netherlands	1.5	180	15.8	Turkey	2.6	46	65.9
Netherlands Antilles	2.2	59	0.2	Turkmenistan	2.6	46	4.8
New Caledonia	2.8	42	0.2	Uganda	6.9	24	22.8
New Zealand	1.9	83	3.8	Ukraine	1.3	npg	49.9
Nicaragua	3.9	22	5.0	United Arab Emirates	4.9	32	2.8
Niger	7.5	23	10.0	United Kingdom	1.7	423	59.4
Nigeria	6.2	23	113.8	United States	2.0	116	272.5
Norway	1.8	224	4.5	Uruguay	2.4	85	3.4
Oman	7.1	18	2.5	Uzbekistan	3.2	35	24.4
Pakistan	5.6	25	146.5	Vanuatu	4.2	29	0.2
Palau	2.5	68	0.02	Venezuela	2.9	34	23.7
Panama	2.7	39	2.8	Vietnam	2.7	46	79.5
Papua-New Guinea	4.8	29	4.7	West Bank	5.2	21	1.9
Paraguay	4.4	26	5.2	Western Sahara	6.8	24	0.2
Peru	3.5	32	26.6	Western Samoa	4.2	29	0.2
Philippines	3.7	31	74.7	Yemen	6.7	24	16.4
Poland	1.5	1155	38.7	Yugoslavia	1.7	365	10.6
Portugal	1.5	770	10.0	Zambia	6.1	35	9.7
Puerto Rico	2.1	78	3.9	Zimbabwe	4.0	57	11.2
Qatar	3.9	41	0.5				
Reunion	2.3	48	0.7				
Romania	1.3	npg	22.5				
Russia	1.2	npg	146.5				
Rwanda	6.0	33	8.2				

Five countries are at zpg: Austria, Greece, Spain, Poland, and Portugal.

F: ACTIVITIES FOR STUDENTS

Zero Population Growth has a well established student activities program by Pamela Wasserman of the National Office. The latest edition of their program, *Earth Matters*, is described in the Suggested Reading section, page 70. Included in this syllabus is one of the activities from *Earth Matters*, and an interactive game, **Two Children or Four Children**, designed by ZPG Chapter school lecturer Dr. Bruce Bridgeman.

TWO CHILDREN OR FOUR CHILDREN

This version of the activity is by Dan Miller who adapted the game to his lecture material.

CONCEPT: A population remains stable when each couple (or woman) has two children on the average. The average children per family must remain at 2.1 or less for several generations to reach zero population growth (zpg), or below 2.1 for negative population growth (npg). If each couple has four children on the average, the population doubles in every generation. Before long, the population would outstrip its resource base.

OBJECTIVE: Students will play the parts of several generations in a population—first with two-child families and then with four-child families. They will see how quickly a population explodes with large families.

SUBJECT AREAS: All, especially mathematics and social studies.

INTRODUCTION: The growth of a population depends strongly on the average numbers of children that each couple raises. In countries such as the Sweden the average is around two children, and the population size will eventually stabilize at that fertility rate (excluding migration). The dynamics of population growth are easier to understand in a small imaginary island environment, the “locale” of this interactive game.

MATERIALS: The students themselves, at least 12.

PROCEDURE

1. Ask for two volunteers, one boy and one girl assuring them that their only job will be to stand in front of the class. They do not have to say anything or touch anyone.
2. Once they are in front of the room, explain the scene. Here is where you get your message to them about intelligent people who know that having only two children on the average will prevent overpopulation.

Describe this imaginary scene:

We have a shipwreck. We are in the old days in the Pacific Ocean when there were still uncharted islands, and this boat hit one of them. They noticed immediately there were no large trees to make another boat so they knew they were stranded.

There was just enough food and safe places to live for about the same number of people who were on the boat, all of them being adult married couples. In other words, they were already at carrying capacity of the land. Since this island was uncharted, they did not know if they would ever be discovered so they planned to make sure they could live there for many years. To do this they all agreed to have no more than two children per family average. Some did not want any children and others felt they would like to have two or more.

Tell the couple standing that:

You are having two children. (to the girl)
Pick out a girl from the class as your daughter (and to the husband), pick out a son and have him come up here.

After they are up front with their “parents,” tell the parents that since life is rugged there everyone dies early. Tell the parents. “*You are now dead and you may sit down.*”

This may sound unpleasant, but the students like

to be “dead” and sit down, with the rest of the class encouraging them.

Now say you are a magician and that students standing there are no longer brother and sister, but husband and wife from two unrelated families. They then are instructed again to pick a son and a daughter from the class, and when all four are standing, again tell the parents to sit down.

At this time, point out to the class that as long as there are only two children per family, the population does not increase. You could go all day long without more than two children standing.

3. Again, with these two students tell them that you are a magician and they are now a married couple, not brother and sister. But, in this case tell them of the new situation:

We have the same island and the same time of history but a different boat. This boat has about the same number of married couples, but they are a different kind of people than in the previous boat. These people trust that they will soon be discovered or that they will come up with some way of getting more food. Also, this group is from a farming community and when they are discovered, they want to have a large family to do the work on the farm when they get back home. In those days they needed large families on the farm. So, they plan to have an average of four children per family.

Tell the wife to pick out two daughters and the husband to pick out two sons to come to the front of the class. As before, tell the parents to sit down, leaving four children.

You become a magician again and tell them they are two married couples and for each parent to pick two children. There will now be eight children standing when they sit down. Do this one more time and there will be 16 children standing. If you are in a hurry, you can stop the game here, but one more generation will have the entire class standing at the end. It is always impressive to re-

mind them that it takes only ? number of generations more and the entire school would be standing. Find the number in the school and see how many doublings of two would yield that number. It is usually about 5 to 7 more generations.

Then tell them that this increase (pointing to the 16 or 32 people standing) is going on in many nations today. Ask them to sit down, thanking them for doing such a good job.

4. You may then end up asking them what will happen to the people on the island who have four children on the average if they are never discovered and begin to starve. The first response is cannibalism, the next is usually wars. They usually cannot think of what else they would do.

Now is your chance to remind them of the most important thing. Over the past five years only two students voiced it: **Stop having children until the population is staying the same or decreasing and then maintaining a two-child family.**

Depending upon the maturity of the class, You may also relate examples of what has happened in the past, including wars, starvation, and cannibalism (Easter Island). Make sure you tell them that this does not have to happen today because contraceptives can be used.

VI. GLOSSARY

Acid Rain: The end product of the release of sulphur and nitrogen oxides into the atmosphere by heavy industry and auto emissions. These chemicals are transformed into acids and fall back to earth with rain, sleet, or snow.

Affluence: An abundance of riches and wealth. Having much more than is required for basic needs.

Agriculture: Production of crops, livestock and poultry.

Anthropologist: A person who studies the ways of living, behavior, physical and cultural characteristics, and distribution of humans.

Aquifer: See **groundwater** below.

Atmosphere: The mass of air surrounding the earth. The troposphere is from the surface to 9 miles; the stratosphere extends beyond 9 miles.

Biodegradable: A substance that will decay into a simple compound and be absorbed by the environment.

Biodiversity: The great variety of species and plants and animals on earth interacting with each other and providing the “balance of nature.” The greater the number of species, the greater the biological diversity.

Birth Rate: See page 6.

Canopy: The covering of limbs, branches, and leaves of forest trees.

Carbon Emissions: Gases released from combustion engines or deterioration of wood and other compounds containing carbon. For global warming, principally carbon dioxide (CO₂), and methane (CH₄).

Carrying Capacity: See pages 9–12.

Conservation: Use, management, and protection of resources so that they are not degraded, depleted, or wasted.

Contraceptive: Physical, chemical, or biological methods used to prevent pregnancy.

Culture: The ideas, customs, behavior, language, art, and skills of a people in a given area; civilization.

Death Rate: See page 8.

Deforestation: Removal of trees and other vegetation in an area.

Demography: The study of the size, density, growth, and distribution of human populations.

Depletion: Gradual reduction or destruction of resources.

Desertification: The transformation of formerly good land into desert through deforestation, water or wind erosion, and overgrazing.

Developing Country: A nation with mostly a rural population with low levels of income, education, literacy, and usually high fertility.

Development: In population and environmental terms this usually refers to new use of lands such as changing croplands to subdivisions, usually referred to as “growth” (see urban sprawl). Development is necessary to build schools and other needs of people, but must be limited to protect necessary habitat and values of the citizens.

Discipline: In this discussion, the word stands for different professions or fields of study such as sociology, biology, mathematics, economics, etc.

Ecology: The study of the physical and biological environment, and the relationship of species to it (see page 34 for discussion on ecological terms).

Endangered Species: A species which is so low in numbers or its entire habitat is deteriorated resulting in danger of extinction.

Environment: The total of all one's surroundings.

Estrous Cycle: Period when a female animal with a placenta will accept mating. This does not include humanoid animals who have menstrual periods. Each species with an estrous cycle have periods when they will mate. This is determined by hormones made in the brain. For instance, female dogs have a recurrent estrous cycle when they will mate which is 6 to 12 days every 21 days.

Evolution: Development over time with small (occasionally large) changes from a simple form to a more complex form. Can be species of animals or plants, ideas, mechanical things such as autos, etc. Scientists and the great majority of people worldwide consider biological evolution and natural selection to be fact, not theory.

Exponential Growth: see page 7.

Exploited: Used or utilized productively. The term can refer to "exploitative use" which may imply "unethical" use, or excessive, wasteful use.

Extinction: The permanent loss of a species.

Family Planning: Providing information, clinical services, and contraceptives to assist people in choosing the number and spacing of children. This includes information for not having children or for adopting a child.

Famine: Scarcity of food causing mass hunger and starvation.

Feedlot: An enclosed area where animals, especially livestock, are kept to be fed special foods for fattening for the market.

Fossil Fuels: Burnable chemicals produced by the remains of prehistoric plants and animals. Coal comes from the plants buried in the mud of swamps in freshwater. Oil comes from ocean

organisms, primarily phytoplankton, which fall to the bottom. It takes millions of years for liquid oil to form under extreme pressure within rock and gravel areas.

Global: Same as all the Earth's area.

Green Revolution: see pages 24–25.

Groundwater: Water that sinks into the ground and flows slowly through sand, gravel, and porous rocks called aquifers.

Habitat: An area that provides enough food, water, shelter, and space for a species to survive.

Hectare: 1,000 square meters or 2.471 acres.

Human: Refers primarily to present human species, *Homo sapiens*. Also used to discuss ape-like humans (humanoid species) which were developing longer arms and legs, standing and walking upright, making tools and with changes in brain size and head shape. This occurred from 3.5 to 4 million years ago in Central Africa.

Humanitarian: A person promoting the welfare of other humans, especially eliminating pain and suffering.

Hunter-Gatherer. People who lived from day-to-day gathering food items or hunting animals. They stored little food and did not plant crops to harvest later. Their only tamed animal was the dog. There are still a few of these tribes in Africa, south Asia, and Australia.

Inherited Traits: Behaviors a living organism has which are determined by genes in the DNA. These are also called "instincts" which are inherited rather than learned from others. A bird, through instinct, can build its particular nest without having seen one being made.

Islam: The religion of Moslems (Muslims).

Kilogram (kg): In metric measure one kilogram (1,000 grams) equals 2.2046 pounds.

Limiting Factor: A factor is something that brings about a result. A population limiting factor is something that limits the size of the population. For instance, food is the major “limiting factor” in nearly all animal populations.

Mortality: death.

Natural Gas: Gases found in underground deposits of 50% to 90% methane (CH₄) and smaller amounts of heavier gases such as propane (C₃H₈) and butane (C₄H₁₀).

Natural Resources: Soil nutrients, minerals, water, plants, animals, air and other resources produced by Earth’s natural processes. Renewable resources are those which replace themselves such as trees and birds. Ground water tables, which are recharged by rainfall, are also renewable. Nonrenewable resources include metals, minerals such as oil and coal, and rocks which do not increase in time. When used up, they are gone.

Nomad Behavior: To move about either with intent or to wander to find food or desired living space. Hunter-gatherer nomads usually took seasonal journeys to known food supplies as they became available.

Nutrition: Food or food energy.

Malnutrition is poor quality food which can gradually lead to hunger and loss of immunity to diseases.

Undernutrition occurs when there is insufficient food to remain alive, resulting in famine, if continued.

Overpopulation: See pages 8–12.

Ozone Layer: See pages 42–43.

Photosynthesis: Chemical process in cells of green plants in which light allows carbon dioxide and water to combine producing atmospheric oxygen and organic nutrient compounds such as sugars.

Polygamy (polygyny): Having more than one wife.

Poverty: Inability to meet basic needs of water, food, and shelter. Today, poverty is also identified with unemployment, lack of education, and lack of health care.

Predator: An animal that eats another animal.

Prey: An animal that is eaten by another animal.

Residential: An area where homes are or can be built. This is also called an urban or suburban area.

Sink: In global warming chemistry and physics, a sink is an area where certain elements or compounds are accumulated in the earth’s surface or in plants. These elements, when in the sink, are not affecting or interacting with other elements and chemicals in the atmosphere. The primary carbon dioxide sinks of the world are the oceans and in vegetation such as the tropical forests. Methane sinks are in the permafrost, the shallow ocean waters along the Arctic coastline, and the shallow ocean bottoms of Central America.

Solar Energy: *Direct* radiant energy from the sun such as electricity generated by solar collectors. Also, *indirect* forms from the sun’s heat are biomass (burning organic matter), wind, and falling or flowing water (hydro energy).

Species: A genetically similar population of individuals that look alike and can interbreed to produce fertile offspring. Horses and donkeys can have offspring. But, since they are different species, their hybrids (mules) are sterile and cannot reproduce.

Sustainable: Continuing in existence; to maintain a constant number or condition; to maintain the continued use or availability of.

Third World Country: This term is uncommonly used today. *First World* countries are rich industrialized countries such as the United States and France. The *Second World* was the cooperating countries called the USSR controlled by Russia. This alliance has been abandoned. The *Third World* is the poorer countries (see *developing* country above). This group is sometimes referred to as the *South* because most poor countries are south of the equator.

Topsoil: The surface layer of soil (usually darker) that is rich in decaying plants, bacterial material and many other organisms, and chemical nutrients.

Urban Sprawl: When cities or towns extend their development (growth) beyond the city limits to build homes, businesses, roads, factories, etc. Action to stop urban sprawl occurs when the land is valuable cropland, wetlands, important aesthetic scenery, or habitat for protected animals.

Waterlogged: Saturated with water. In soils, this means that the water table is near the surface and the plant's roots are drowned. Can be caused by continual irrigation in heavy soils.

Watershed: A sloping vegetated area supplying water to streams, rivers, and lakes. The protective cover slows water movement so it can sink into the ground without causing erosion.

Wildlife, and Tamed and Domesticated Animals: **Wildlife** refers to animals that are not tamed or domesticated. A **tamed** animal was made less wild than it usually is, and can be approached. A **domesticated** animal has been bred to create a new form or color of animal or one with a certain behavior (see page 15). Domesticated animals depend upon humans to survive. Horses, sheep, cattle and chickens are domesticated animals. A tamed zebra, elephant, raccoon, or coyote is not a domesticated animal. Animals that will not breed in captivity cannot be domesticated.

Women's Rights: Women are denied their rights when they are not allowed by custom, law, religion, and race or gender bias to do the things men can do, or to do things they want to do in order to fulfill their potential for accomplishments.

Zero Population Growth (ZPG): When capitalized, Zero Population Growth represents an incorporated organization. Address: 1400 Sixteenth Street, NW. Suite 320. Washington D.C. 20036.

Zero population growth (zpg). A condition in which the population remains fairly constant with birth and death rates remaining close. In-migration must be about equal to out-migration for a zpg condition to exist. Recently, as countries in Europe reached zpg, they remained that way only for about a year or two then continued to decline in population. The population then experienced negative population growth (npg) which is necessary for a period of time for any country which is above its carrying capacity.

VII. REFERENCES

1. Vogt, William. 1948. *Road to Survival*. William Sloane, NY.
2. Ehrlich, Paul R. 1968. *The Population Bomb*. Ballantine Books, NY.
3. Ehrlich, Paul R, and Anne H. Ehrlich. 1990. *The Population Explosion*. Simon and Schuster, NY.
4. Deevey, Edward S. Jr. 1960. The Human Population. *Scientific American* 203 no. 9 (September).
5. Haub, Carl, and Diana Cornelius. 1999. *World Population Data Sheet*. Population Reference Bureau, Washington D.C.
6. Cohen, Joel E. 1995. *How Many People Can the Earth Support?* W. W. Norton & Co., NY.
7. Abernethy, Virginia D. 1993. *Population Politics: The Choices that Shape our Future*. Insight Books, Plenum Press, NY.
8. Catton, William R. Jr. 1994. Carrying Capacity and the Death of Culture. *Wild Earth* (summer).
9. Pimentel, David. 1994. Lecture. American Association for the Advancement of Science. Annual meeting, San Francisco.
10. Daily, Gretchen C. and Paul Ehrlich. 1992. Population, sustainability, and Earth's carrying capacity. *BioScience* 42 no. 10 (November).
11. Ponting, Clive. 1991. *A Green History of the World: The Environment and the Collapse of Great Civilizations*. St. Martin's Press, NY.
12. Leakey, Richard, and Roger Lewin. 1995. *The Sixth Extinction: Patterns of Life and the Future of Mankind*. Anchor Books, Doubleday, NY.
13. Linton, Ralph. 1956. *The Tree of Culture*. Alfred A. Knopf, NY.
14. Mansfield, Terry. 1994. What We've Learned About Lions. *Outdoor California: special issue 57 no.3*. Calif. Dept. Fish and Game, Sacramento.
15. Orr, Robert. 1970. *Animals in Migration*. The Macmillan Co., NY.
16. Hansson, Lennart. 1989. The Lemming Phenomenon. *Natural History* (December).
17. Hrdy, Sarah Blaffer, and C. Sue Carter. 1995. Hormonal Cocktails for Two. *Natural History* (December).
18. Potts, Malcolm. 1999. The Bashful Ape. *Population Press* 5 no. 2. Population Coalition, Claremont, Calif.
19. Kroeber, Alfred L. 1925. *Handbook of Indians of California*. Bureau of American Ethnology. Bull. 78.
20. Hirschhoff, P.M., and N.G. Kotler, eds. 1989. Completing the Food Chain: Strategies for Combating Hunger and Malnutrition. *Smithsonian Institution Press*, Washington D.C.
21. Thompson, Laura. 1950. *Culture in Crisis*. Harper & Brothers, NY.
22. O'Hara, Sarah L., Falaune Street-Perrott and Timothy P. Burt. 1993. Accelerated soil erosion around the Mexican highlands lake caused by prehistoric agriculture. *Nature* 362 no. 6415 (4 March).

23. Douglas, Daly C. 1996. The Leaf That Launched a Thousand Ships. *Natural History* (January).
24. Fusfeld, Daniel R. 1977. *The Age of the Economist*. Scott, Foresman & Co., Glenview, Illinois.
25. Meadows, Donella, Dennis L. Meadows, Jorgen Randers, and William W. Behrens III. 1972. *The Limits to Growth*. A Potomac Associates Book.
26. Morell, Virginia. 1999. The Sixth Extinction. *Natural Geographic* 195 no. 2, Millennium Supplement: Biodiversity, The Fragile Web (February).
27. Wilson, Edward O. 1992. *The Diversity of Life*. Harvard University Press, Cambridge, Mass.
28. Zeide, Boris. 1994. Ecological Research and Environmental Problems: Reflections on the National Biological Survey. *Bulletin Ecological Society of America* 75 no. 1 (March).
29. Dasgupta, Partha S. 1995. Population, Poverty, and the Local Environment. *Scientific American* (February).
30. Tambiah, S. J. 1973. Dowry and Bridewealth, and the Property Rights of Women in South Asia. in Goody, Jack and S.J. Tambiah, *Bridewealth and Dowry*. Cambridge Paper in Social Anthropology, no. 7. Cambridge University Press.
31. Brown, Lester R., and 12 others. *State of the World 1998*. W.W. Norton, NY.
32. Myers, Norman. 1993. The Big Squeeze. *Earthwatch* (November/December).
33. Boulding, Kenneth. 1977. (Quote from a misplaced article—the message is still good).
34. Brown, Lester R. and 11 others. *State of the World 1995*. W. W. Norton, NY.
35. Walker, Brian. 1993. God's Problem. *Earthwatch* (November/December).
36. Zwingle, Erla. 1998. Women and Population. Millennium supplement: Population. *National Geographic* no. 4 (October).
37. Scaff, Marilee. 1998. Microcredit for Women. *Population Press*. Claremont, Calif. 4 no. 3 (January/February).
38. Brown Lester R. and 13 others. *State of the World 1999*. W.W. Norton, NY.
39. Kates, Robert W., et al. 1988. *The Hunger Project*. Alan Shawn Feinstein World Hunger Program. Brown University (March).
40. Brown Lester R. 1998. Struggling to Raise Cropland Productivity. *State of the World 1998*. W. W. Norton, NY.
41. Brown, Lester R., Gary Gardner and Brian Halweil. 1998. *Beyond Malthus: Sixteen Dimensions of the Population Problem*. Worldwatch Paper 143. Linda Starke, ed. Worldwatch Institute, Wash. D.C.
42. Tuxill, John. 1998. *Losing Strands in the Web of Life: Vertebrate Declines and the Conservation of Biological Diversity*. Worldwatch Paper 141. Jane Peterson, ed. Worldwatch Institute, Wash. D.C.
43. Brown, Lester R., Gary Gardner and Brian Halweil. 1999. *Beyond Malthus: Nineteen Dimensions of the Population Challenge*. Environmental Alert Series, Linda Starke, ed. Worldwatch Institute, Wash D.C.
44. Abramovitz, Janet N. 1997. *Valuing Nature's Services*. State of the World 1997. Worldwatch Institute, Wash. D.C.

45. Keyfitz, Nathan. 1995. Contradictions between Disciplines and their Influence on Public Policy. *Journal of the Federation of American Scientists* 48 no.3 (May/June).
46. Keyfitz, Nathan. 1993. Population and Sustainable Development: Distinguishing Fact and Preference Concerning the Future Human Population and Environment. *Population and Environment* 14 no. 5 (May).
47. Catton, William R. Jr. 1982. *Overshoot: The Ecological Basis of Revolutionary Change*. University of Illinois Press, Urbana.
48. Ponting, Clive. 1990. Historical Perspectives on Sustainable Development. *Environment* (November).
49. Diamond, Jared M. 1995. Easter's End. *Discover* (August).
50. Diamond, Jared M. 1997. Paradises Lost. *Discover* (November).
51. Kinealy, Christine. 1996. How Politics Fed the Famine. *Natural History* (January).
52. Report of IUCN's Task Force on the Sahel and other Drought-affected Regions of Africa. 1986. *International Union for Conservation of Nature*. Switzerland (May).
53. McGrew, Roderick E. 1985. *Encyclopedia of Medical History*. McGraw & Hill.
54. Herlihy, David. 1997. *The Black Death and the Transformation of the West*. Harvard University Press. Cambridge, Mass.
55. Garrett, Laurie. 1994. *The Coming Plague*. Farrar, Straus, and Giroak, N.Y.
56. Brown, Lester. 1994. Who Will Feed China? *World Watch* magazine 7 no. 5 (September/October) Worldwatch Institute, Wash. D.C.
57. Feeney, Griffith and Wang Feng. 1993. Parity Progression and Birth Intervals in China: The influence of Policy in Hastening Fertility Decline. *Population and Development Review* 19 no. 1 (March).
58. Goodstadt, Leo F. 1982. China's One-Child Family: Policy and Public Response. *Population and Development Review* 8 no. 1 (March).
59. Gore, Al. 1992. *Earth in the Balance: Ecology and the Human Spirit*. Houghton Mifflin, NY.
60. Ehrlich, Paul and Anne Ehrlich. 1996. *Betrayal of Science and Reason*. Island Press. Washington D.C.
61. Molina, Mario and Sherwood Rowland. 1974. Stratospheric Sink for Chloflouromethanes: Chlorine Atom Catalyzed destruction of ozone. *Nature* 249.
62. Rasool, S. and Stephen Schneider. 1971. Atmospheric Carbon Dioxide and Aerosols: Effects of Large Increases on Global Climate. *Science* 173 no. 3922 (9 July).
63. Schneider, Stephen, and Lynn Mesirov. 1976. *The Genesis Strategy: Climate and global survival*. Plenum, NY.
64. Soule, Michael. 1995. Health implications of global warming and the onslaught of alien species. *Wild Earth* (summer).
65. Chandler, David L. 1998. New Figures Show Recent, Dramatic Global Warming. *Population Press*. Claremont, Calif. 4 no. 6 (summer).
66. Campbell, C.J. 1997. The Coming Oil Crisis. *Multi-Science*. Brentwood, Essex. England.

67. Perelman, Lewis J. 1981. Speculations on the Transition to Sustainable Energy. *in* Energy Transitions: Long-Term Perspectives. *American Association for the Advancement of Science*. Westview Press, Boulder.
68. Gever, John, et al. 1991. *Beyond Oil: The Threat to Food and Fuel in the Coming Decades*. 3rd. ed. Colorado University Press. Niwot, Colo.
69. Youngquist, Walter. 1982. *GeoDestinies: The Inevitable Control of Earth Resources over Nations and Individuals*. Portland National Book Co.
70. Stobaugh, Robert and Daniel Yergin. 1983. Energy Wars. *in* Stobaugh and Yergin, *Energy Future: Report of the Energy Project at the Harvard Business School*. Vintage Books, NY.
71. Martin, Paul. 1984. Prehistoric Overkill: The Global Model. *in* *Quaternary Extinction: A prehistoric revolution*. Paul Martin and Richard G. Klein, eds. University of Arizona Press, Tuscon.
72. Carrier, Jean-Claude. 1995. Facing the Future. A screenwriter confronts the Dalai Lama with the central questions of our time. *New Age Journal* (November/December).
73. Kremer, Michael. 1993. Population Growth and Technological Change: One Million B.C. to 1990. *Quarterly Journal of Economics* (August).
74. Reichard, Gladys. 1974. *Navajo Religion: A Study of Symbolism*. Princeton University Press.
75. Weiskel, Dr. Timothy. 1994. Interview published in Zero Population Growth Fact Sheet: *Living in a Material World*.
76. Boulding, Kenneth E. 1990. In Forward of *Future Worlds* by Norman Myers. Anchor Books, NY.
77. Dorn, Harold F. 1962. World Population Growth: An International Dilemma. *Science* 135 no. 3500 (26 January).
78. Homer-Dixon, Thomas F. et al. 1993. Environmental Change and Violent Conflict. *Scientific American* (February).
79. Leopold, Aldo. 1953. *Round River*. Oxford University Press, NY.
80. Daily, Gretchen C. (ed). 1997. *Nature's Services: Societal Dependence on Natural Ecosystems*. Island Press. Wash. D.C.
81. Hardin, Garrett. 1968. The Tragedy of the Commons. *Science* 162:1243-1248.
82. Reno, Philip. 1981. *Navajo Resources and Economic Development*. University of New Mexico Press, Albuquerque.
83. Gore, Rick. 1997. The First Europeans. *National Geographic* 192 no. 1 (July).
84. Weidensaul, Scott. 1999. Tracking America's First Dogs. *Smithsonian* 29 no. 12 (March).

VIII. ADDITIONAL INFORMATION

A. Suggested Reading

The Sixth Extinction. 1995. Richard Leakey and Roger Lewin. Evolution of humans, extinction of large mammals by hunter-gatherers, global ecosystem damage, and humans causing sixth extinction of species. Eighth grade up. Anchor Books. pb \$11.20. Libraries: Aptos, Central, Live Oak, Watsonville.

Nature's Services: Societal dependence on natural ecosystems. 1997. Edited by Gretchen Daily. Comprehensive, readable and thorough book for adults. Papers by 32 authorities on many aspects of ecosystems. References cited for each paper with subject index for all sections. High school, and excellent for teachers as resource information. Biology and social studies. Island Press. pb \$24.95.

Ishmael. Daniel Quinn. 1997. Ecological fiction. A gorilla learns to speak English and suggests how humans may be able to survive. Sixth grade and up. Good for English class to use for writing a book report. Bantam Books. pb \$19.95. Libraries: Aptos, Scotts Valley, Central, Live Oak, Watsonville.

Earth in the Balance. 1992. Al Gore. When he was a US Senator, his son had a near death accident and needed constant attention. Gore spent the time studying the population-environmental crisis, and then visited many countries. The book is not politicized, and is valuable for high school. The text is in three parts: Balance at Risk, The Search for Balance, and Striking the Balance. Houghton Mifflin, NY. pb. \$14.95. Libraries: Aptos, Boulder Creek, Branciforte, Scotts Valley, Watsonville.

The Population Explosion. Paul Ehrlich and Anne Ehrlich. 1990. This book revived public interest about the severity of the population and environmental crisis. It is full of facts and figures and may be a little hard for students. It is one of the more important books on the subject for teachers.

Some figures are outdated because this is a very dynamic subject. The basic problems are clearly revealed. Simon and Shuster. pb \$17.95. Libraries: Aptos, Boulder Creek, Central, Felton, Watsonville.

National Geographic has published a Millennium Supplement of two issues. The first is on ***Population*** issued in October, 1998; the second is on ***Biodiversity*** issued in January, 1999. There is an exceptional article in the October issue titled ***Women and Population*** by Eria Zwingle. In all libraries.

A Green History of the World. Clive Ponting. 1991. Penguin Books. This book is by an historian who interprets human cultural evolution from the viewpoint of an environmentalist. He has an awareness that cultures as well as species become extinct due to rapid "habitat" changes. In the case of humans, we are degrading not only our own environmental-social "habitat" but the physical and biological habitat of many other species. Ponting's is a refreshing approach to history with examples demonstrating that cultural disintegration has three basic components: food and resource scarcity, overpopulation, and warfare. pb \$14.95. Libraries: Watsonville.

B. Population Data

State of the World. Published by the **Worldwatch Institute**, Washington D.C. This annual report is submitted in January each year updating the key environmental issues of the world. It is read worldwide, translated into 30 languages. This statement appears on the cover: "Written in clear and concise language, with easy-to read charts and tables, *State of the World* presents a view of our changing world that we cannot afford to ignore." W.W. Norton, NY. pb \$13.95.

World Population Data Sheet. Published by the **Population Reference Bureau**. The data for the tables on population data on pages 52–55 of this syllabus are from this annual summary which appears in May or June each year. There are 18 categories of data including: population numbers,

birth and death rates, natural increase, doubling time, infant mortality, total fertility rate, life expectancy, percent of population which is urban, GNP per capita, percent of women 15-19 giving birth each year, percent of population under 15 and over 65.

Address: 1875 Connecticut Ave., NW, Suite 520. Washington D.C. 20009. Phone 202-483-1100; FAX 202-328-3937; e-mail: popref@prb.org

C. Source of ZPG Teacher-Student Activities

Earth Matters: Studies for our global future. 2nd ed. Pamela Wasserman, ed. A teacher's guide of interactive games and projects for students. Includes 34 activities in 13 categories: population dynamics, climate change, air pollution, water resources, deforestation, food and hunger, waste disposal, wildlife endangerment, energy issues, rich and poor, population and economics, the world's women, and finding solutions. One of these activities appears on pages 58-60 in the Teachers Information section. 209 pages; pb \$30.00.

Zero Population Growth Education Program, 1400 16th St. NW., Suite 320. Washington D.C. 20036. Phone 1-800-767-1956; FAX 202-332-2302; e-mail: PopEd@zpg.org

D. California Regional Environmental Education Coordinators (CREEC) Library

CREEC is a new State Department of Education program on environmental education. Region V of CREEC includes Santa Cruz, Santa Clara, Monterey and San Benito Counties. Part of their activities was to set up the Professional Environmental Education Resource Library for K through 12 teachers. The library is at Shoreline Middle School, 855 17th Avenue. The hours of operation are Wednesdays and Thursdays, 3:00-5:00 pm.

It has more than 3,000 curriculum guides, state compendia and activity modules. All Materials can be checked-out for a two-week time period. For

more information contact Bill Lovvorn, CREEC Coordinator, Santa Cruz Office of Education, 831-477-5483.

E. Internet Web Sites:

Zero Population Growth, Inc. ___ www.zpg.org
Click on Population/Education Buttons

Population Reference Bureau ___ www.prb.org

US Census Bureau _____ www.census.gov

IX. QUOTES

America is sauntering through her resources, and through the mazes of her politics with an easy nonchalance; but presently there will come a time when she will be surprised to find herself grown old—a country, crowded, strained, perplexed— when she will be obliged to pull herself together, husband her resources, concentrate her strength, steady her methods, sober her views, restrict her vagaries.

Woodrow Wilson

We expanded upon the things of nature and came to believe that expansion was in the nature of things. ... We need to realize that no ecosystem in the natural world has ever existed for the unique benefit of just one of its constituent species.

Dr. Timothy Weiskel, Harvard Divinity School. 1994⁷⁵

Environmentalism, which looks like the coming major ideology of the next century, involves our having an image of the earth as a total system and loving it.

Economist Kenneth E. Boulding, in Norman Myers, Future Worlds. 1990⁷⁶

Scarcity of renewable resources are already contributing to violent conflicts in many parts of the world. These conflicts may foreshadow a surge of similar violence in coming decades, particularly in poor countries where shortages of water, forests, and, especially, fertile land, coupled with rapidly expanding populations, already cause great hardship.

Thomas Homer-Dixon. 1993⁷⁸

Today, the population problem is no longer a private matter. In a world of nearly four billion people increasing by 2 percent, or 80 million more every year, population growth and how to restrain it are public concerns...it is quite clear that one of the major challenges of the 1970s...will be to curb the world's fertility.

George H. Bush, as a member of the House of Representatives

One of the penalties of an ecological education is that one lives alone in a world of wounds. Much of the damage inflicted on land is quite invisible to laymen. An ecologist must either harden his shell and make believe that the consequences of science are none of his business, or he must be the doctor who sees the marks of death in a community that believes itself well and does not want to be told otherwise.

Aldo Leopold (Great Naturalist). 1953⁷⁹

Even when family planning and other reproductive health services are widely available, the social and economic status of women affects individual decision to use them. The ability of women to make decisions about family size is greatly affected by gender roles within society in sexual relationships. Ensuring equal opportunity for women in all aspects of society is crucial.

Population Summit of the World's Scientific Academies. Fifty-eight academies were represented at the 1993 conference in New Delhi.

Interestingly, the nature and value of Earth's life-support systems have been illuminated primarily through their disruption and loss. Thus, for instance, deforestation has revealed the critical role of forests in the hydrological cycle—in particular, in mitigating flood, drought, and the forces of wind and rain that cause erosion. Release of toxic substances, whether accidental or deliberate, has revealed the nature and value of physical and chemical processes, governed in part by a diversity of microorganisms, that disperse and break down hazardous materials. Thinning of the stratosphere ozone layer sharpened awareness of the value of the service in screening out harmful ultraviolet radiation.

Gretchen Daily. 1997⁸⁰

In our every deliberation, we must consider the impact of our decisions on the next seven generations.

From the Great Law of the Iroquois Confederation, an Eastern United States horticultural and hunting culture.

For many people the world "overpopulation" conjures up an image of Bangladesh, but a truer definition of overpopulation might lead us to think of Britain instead. While Bangladesh's population is growing 12 times faster than Britain's, Britain's population growth, in conjunction with its profligate lifestyle, contributes 3.5 times as much carbon dioxide to the global atmosphere and hence to global warming. People in Britain do not live on an island nearly so much as they like to suppose. They depend on an overseas "shadow ecology" several times their country's size for one one-third of their food. Each time a British citizen lifts a forkful of food made with groundnuts, he or she lends a hand to hoes spreading desertification thousands of kilometers away.

Norman Myers³²

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