ENVIRONMENTAL ECONOMICS A TEACHER'S GUIDE

Sandra Allmond Bagley

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ENVIRONMENTAL ECONOMICS
A TEACHER'S GUIDE

by

SANDRA ALLMOND BAGLEY

A Thesis submitted To The Faculty of
Longwood College
in partial Fulfillment of the Requirements for the Degree of
Master of Science
Environmental Studies
Longwood College
December 2001

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Date Approved
Abstract

The purpose of this thesis is to incorporate economics into lectures on environmental issues. This guide introduces several environmental issues, discusses the laws and regulations governing these issues, and discusses the economic instruments that have been incorporated into laws to reduce environmental degradation. The economic instruments discussed in this guide are those that have been incorporated into environmental laws. These instruments allow environmental protection goals to be met at the least cost. Economic instruments are more flexible than command and control regulations and allow firms to choose the least cost method of reaching goals. Economic instruments also encourage advances in new technology. Students will be more receptive to the concept of using economics to help solve environmental problems if economic solutions are presented with environmental issues. This guide provides teachers with an understanding of the complex issues surrounding environmental protection and economic development.
Environmental Economics: A Teacher’s Guide

Sandra Allmond Bagley

Dr. Melanie Marks, Director

Acknowledgements

I would like to thank the following people who have provided guidance and support to me during my work on this thesis.

First, I would like to thank Dr. Melanie Marks who introduced the world of Environmental Economics to me. Dr. Marks has always encouraged me to be my very best, not only as a graduate student, but also as a wife and mother. Thank you for your guidance and patience.

Special thanks to Dr. Raymond Brastow for his patience and continued support during my research. Dr. Brastow has always been available to answer questions or explain economic concepts to me during my research.

I would also like to thank my dear friend, Danette Carlton for supporting me during this time. Danette has been a true friend.

I would like to thank my family: my parents and in-laws, and very special thanks to my husband, Raleigh, and our sons, Ron and Matt. Thank you for standing by me and encouraging me to see this project through to the end. I could not have done this without your encouragement and love. I love you all!

And last, but not least, I give all praises to my Heavenly Father for sustaining me and giving me the courage to accomplish this goal.
ENVIRONMENTAL ECONOMICS

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Sandra Allmond Bagley
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CHAPTER 1

Human Population Growth

In this chapter we examine the following:

- History of population growth
- Population dynamics
- Current trends in population growth
- Arguments on population growth
- Population growth and environmental issues
- Population growth and economic issues
Key Words – Chapter 1

- Growth rates
- Crude birth rate
- Crude death rate
- Doubling times
- Rule of 70
- MDCs
- LDCs
- Cornucopians
- Marxists
- Malthusians
- Carrying capacity
- Consumption patterns
Introduction

- It is important to begin any lecture on environmental issues with a discussion on human population growth. It is a widely held belief that population growth is the basis of all environmental problems. Rapid human population growth is viewed as a serious problem with environmental as well as economic consequences.

- Destruction of natural habitats, loss of biodiversity, global warming, air and water pollution, and resource scarcity are just a few of the problems believed to be the result of a rapidly increasing human population.

- Although population growth is not the only cause of our environmental problems, it is a factor that cannot be ignored.

- In this guide we have dedicated the first chapter to human population growth. In this chapter, students will be exposed to the dynamics of population growth as well as the history and the different views on this important topic. This chapter will also help students understand the intricate relationship between human population growth, economic health, and the environment.

- Human population growth is a complex and controversial issue. It is not within the scope of this chapter, or even this book to establish what the causes and effects are of the rate of population growth that the world is experiencing today. The purpose of this chapter on population is to present information that will allow the students to analyze the issues and to decide for themselves the impact that rapid population growth has on the environment and the world's ability to protect our precious resources.
Population Dynamics

If there is one factor that is believed to contribute to every environmental problem that we are facing, it has to be human overpopulation. It is almost mind-boggling how fast the human population is growing. Eighty million people are added to the earth every year. Eighty million more people who will need homes, food, fuel, clean water, transportation, education, and a host of other resources that humans need. In this chapter we will examine the dynamics of human population growth, which includes birth rates, death rates, doubling times, and population growth rates.

Let’s begin by looking at human population statistics in time units. Below is a chart showing how many births are taking place in various time units. Just think, every minute 251 people are born in the world!

World Vital Events Per Time Unit: 2002
(Figures may not add to totals due to rounding)

<table>
<thead>
<tr>
<th>Time unit</th>
<th>Births</th>
<th>Deaths</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>131,903,973</td>
<td>55,647,865</td>
<td>76,256,108</td>
</tr>
<tr>
<td>Day</td>
<td>361,381</td>
<td>152,460</td>
<td>208,921</td>
</tr>
<tr>
<td>Hour</td>
<td>15,058</td>
<td>6,352</td>
<td>8,705</td>
</tr>
<tr>
<td>Minute</td>
<td>251</td>
<td>106</td>
<td>145</td>
</tr>
<tr>
<td>Second</td>
<td>4.2</td>
<td>1.8</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Source: U.S. Bureau of the Census, International Data Base(1)
History of Human Population Growth

To understand why the present trends in human population growth are a concern, we need to look at the history of How and Why our population has grown. Figure 1.1 shows how much more rapidly the population is growing today than in the past.

<table>
<thead>
<tr>
<th>World Population Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Population reached:</td>
</tr>
<tr>
<td>1 billion in 1804</td>
</tr>
<tr>
<td>2 billion in 1927          (123 years later)</td>
</tr>
<tr>
<td>3 billion in 1960          (33 years later)</td>
</tr>
<tr>
<td>4 billion in 1974          (14 years later)</td>
</tr>
<tr>
<td>5 billion in 1987          (13 years later)</td>
</tr>
<tr>
<td>6 billion in 1999          (12 years later)</td>
</tr>
<tr>
<td>World Population may reach:</td>
</tr>
<tr>
<td>7 billion in 2013          (14 years later)</td>
</tr>
<tr>
<td>8 billion in 2028          (15 years later)</td>
</tr>
<tr>
<td>9 billion in 2054          (26 years later)</td>
</tr>
<tr>
<td>10 billion in 2183         (129 years later)</td>
</tr>
</tbody>
</table>

Source: United Nations Population Division. (2)

Notice that it took from the beginning of time until 1804 for the population to reach its first billion and only 183 years to reach 5 billion. Clearly the growth in population is getting larger and larger and should be of concern.

There are three periods in history that demonstrate the changes that have occurred in human population growth; the 100,000 year period where men lived as Hunter-Gatherers, the Neolithic Period where farming and agriculture began, and the Industrial Revolution which led to increases in population growth. This latter period became the most powerful threat to the natural world.
Hunter-Gatherers

For 100,000 years, man lived as *hunter-gatherers*. They were extremely nomadic which means that they were constantly moving and only living in an area for a few days at a time. Hunter-gatherers hunted wild animals and gathered wild plants, and would move from place to place to secure food. They lived off the land and respected the environment, giving the land time to heal and replenish itself before returning again.

The nomadic life did not lend itself to having a large population. The women gathered wild plants (while the men hunted) and had to carry their children with them, usually on their backs. This style of living limited the family to one or two children. Therefore, by necessity, human population was kept under control.

Neolithic Period

Around 10,000 years ago, climate changes forced a new way of life for man. The amount of rainfall decreased, which meant less food was available. Man looked for and settled in areas that had adequate amounts of rainfall, rather than wandering from place to place. It was during this Neolithic Period that people began gathering and planting seeds; animals were also domesticated. When people began to settle down and women no longer had to carry their children, the population increased. Thanks to agriculture and farming, men were no longer nomadic and the exploitation of the earth began.

Industrial Revolution

The Industrial Revolution began in England over 200 years ago and created the modern world, as we know it. The Industrial Revolution created factories, industries, consumer wealth, and environmental pollution. The Industrial Revolution touched every corner of the earth.

With the increase in factories and manufacturing, there was one asset that was in great demand—workers. As the population grew, it was good for the Industrial Revolution. Workers became prosperous and were able to afford a higher standard of living. In England, it was a common practice that a couple did not get married until they could afford to buy their own home. The factory jobs provided the means to acquire financial independence. More people married, had families, and the population grew even more.
The Industrial Revolution not only had an impact on population growth, but also on the natural world. This period marks the beginning of rapid population growth as well as a global impact on the environment.

Current Trends

The total World population reached 6 billion on October 12, 1999. Over the past year almost 80 million people have been added to an already immense number of people inhabiting the earth. China leads the world in population numbers with over 1.2 billion, India with over 1 billion, followed by the United States with 283 million (3). There are more people living in less developed countries (LDCs) than in more developed countries (MDCs); LDCs also have the highest growth rates. LDCs are characterized as those countries that have low levels of living, high rates of population growth; low income per capita and economic dependencies on more developed countries (MDCs). LDCs and MDCs will be discussed in more detail later in this chapter.

Even though the population is growing more slowly, it could still reach 9.4 billion by 2050 (4). The Population Division of the Department for Economic and Social Information and Policy Analysis in a report released in November 1996 reported that currently we are adding 97 million people each year to the population.

Population Dynamics

Growth Rates

It is not only important to know how large the human population is getting but to also know how fast it is growing. The population \textit{growth rate} tells us at what rate the population is growing. Knowing population growth rates provides vital information that allows demographers (people who study population statistics) to predict social and economic trends.

To calculate natural growth rates, use the following formula:

\[(A/1000 - B/1000) \times 100 = \text{natural population growth rate (expressed as \%)}\]

Where: \(A = \# \text{ live births} \)
\(B = \# \text{ of deaths} \)
To calculate natural growth rates, we use what is called the *crude birth rate* and *crude death rate*. The crude birth rate is the number of live births divided by the total midyear population then multiplied by 1000. The crude death rate is the number of deaths divided by the total midyear population multiplied by 1000. Below is an example of how to calculate growth rates using current figures for the United States:

<table>
<thead>
<tr>
<th>Births per 1000</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths per 1000</td>
<td>9</td>
</tr>
</tbody>
</table>

\[
\frac{14}{1000} - \frac{9}{1000} \times 100 = 0.5\%
\]

It is more important to note that crude rates do not give information on other factors such as fertility, age, and sex, and therefore does not give a complete picture of future population growth. Also, these figures do not take into consideration emigration and immigration. For instance, in a country like the United States where many people immigrate to, using crude rates does not give a true measure of increase in the increasing population in this country.

### Doubling Times

Another important measurement of population growth is *doubling times*. This is the number of years it will take the population to double its current number. Doubling times are closely related to population growth rates. For instance, those countries with higher population growth rates will have shorter doubling times. To calculate doubling times, we use the "rule of 70". By dividing the current population growth rate into 70, we can estimate the number of years it will take the population to double. The following example uses the current population growth rate for Yemen, whose current population is 16,388,000; population growth rate 3.3.

Use the formula: \(70 / \text{growth rate} = \text{number of years for population to double}\)

\[
\frac{70}{3.3} = 21.2
\]

Therefore, the country of Yemen will double its population to over 32 million in just 21 years if the current rates of growth continue.
LDCs vs. MDCs

Less developed countries (LDCs) have larger populations and higher growth rates as compared to more developed countries (MDCs). Presently, 80% of the world’s population lives in the LDCs, and it has been estimated that over the next few years that figure will increase to 90% (4). These figures show a trend that will be discussed in more detail later in this chapter, but we will briefly mention it here.

LDCs are by definition the poorest countries in the world. Currently over 4.7 billion people live in the poorest countries in the world (the total population of the MDCs is just over 1.2 billion). These poor countries possess only 20% of the economic resources of the world. These statistics should raise questions about the quality of life achievable in LDCs if their population growth rates continue to rise.

Population growth rates in MDCs have remained fairly low and are expected to fall even lower than the current rate of 0.4%. Figure 1.4 compares the average annual increase between LDCs and MDCs. Notice that between the years 2020 – 2025 there is expected to be little or no growth in the MDCs. Almost 100% of the growth in population is expected to be in the LDCs, the poorest countries in the world.
Different Views on Population Growth

It is an understatement to say that there are many different views on the human population growth issue. Not everyone believes that population growth, rapid or otherwise, is a problem. The three main points of view, Malthusian, Cornucopian, and Marxism are the only views that we will discuss here, but understand that there are varying degrees of each of these views.

Malthusian

Malthusians follow the teachings of Thomas Malthus, an eighteenth century parson and economist who believed that it is human nature to reproduce excessively. Malthus wrote *Essay on the Principle of Population* in 1798, in which he discussed the relationship between population increase and food suppliers. Malthus pointed out that the human population increases geometrically, while food supplies increase arithmetically. Therefore, the population would grow faster than the earth's capability to feed it. Malthus' conclusion was that we are destined to a future of famine and poverty. To the Malthusians, population growth is a serious problem that will eventually lead to the extinction of the human species if it is not brought under control.

Cornucopians

The term Cornucopian means "overflowing, abundant, or productive." This clearly explains the Cornucopian view of population growth. Cornucopians believe that there is no population problem because technology can solve any problems that population growth may cause. This is a good time to point out that Thomas Malthus predicted in 1798 that the world would run out of food in 50 years, but industrialization and technology increased our food supplies tremendously and the predicted famine of 1848 did not occur.

Marxists

Marxists also do not believe that there is a population problem. They believe that the problem is not population growth, but the inequality in the distribution of resources. Marxists believe that efforts should not be focused on reducing population growth rates, but rather on a more even distribution of wealth.

Population growth is a complex and controversial issue. It is important to note that excessive population growth is viewed as a problem with environmental and
economic consequences. In the next sections of this chapter we will look at the impact that excessive population growth appears to have on these important issues. It is not within the scope of these chapters, or even this book to establish what the causes and effects are of the rapid population growth that the world is experiencing today. The purpose of this chapter is to simply explain population issues as a pretext to the other environmental issues that we will discuss in this book.

Population Growth and Environmental Problems

An increase in human population means that there are more resources being consumed, more pollution being released, and more species habitat being lost. A rapidly increasing human population is putting stress on the environmental resources that sustain us. Signs of environmental stress have many asking the question, “How many people are too many?”

Humans and the environment are connected. Everything that we do to live from day-to-day affects the earth and our environment. And we cannot live without the earth and the resources that it provides. The air that we breathe, the water that we drink, the food that we eat, the fuel that keeps us warm in the winter and cool in the summer, all come from the earth’s resources. We take these resources for granted, assuming that they will always be there for us. This section focuses on the effects that the current rate of human population growth has on the environment and the resources that it provides for us.

Carrying Capacity

Is there a limit to the number of people that the earth is able to support? The answer to that question is probably yes. Many of our earth’s natural resources are limited. Fossil fuel supplies are finite. We will run out someday. While water and air are renewable, we can only add so many pollutants to those resources before they are no longer fit for human consumption. All of these statements lead us to one question. What is the Earth’s carrying capacity? Carrying capacity refers to the maximum number of a species (here, that species is us) that an environment can support without causing severe environmental degradation. In other words, how many people can we add to the earth without depleting its resources beyond repair? The rapid population growth that we are experiencing is having a tremendous effect on our environment and the resources that we rely on to sustain us. Air and water pollution, over-harvesting of resources, destruction of natural habitat, land degradation, and biodiversity loss are just a few of the environmental problems
resulting from human population growth. These environmental problems are leading many biologists and environmentalists to believe that the carrying capacity of the earth has already been exceeded.

Rapid population growth would not be a problem if the earth's resources were unlimited. The problem is that there is only so much land, fossil fuel, and freshwater available for each of us to consume. We add 80 million people to our population every year. Eighty million more people who will need food, water and shelter. It is important to note here that it is not only the number of people that inhabit the earth that causes environmental degradation; our lifestyles contribute to the problem as well. The population growth rate in the more developed countries (MDCs) are the lowest in the world, yet we consume over 80% of the earth's natural resources. Let's examine the effects that rapid population growth has on the environment and the earth's ability to sustain itself and us.

Human activities begin its noticeable assault on the environment during the Industrial Revolution. A species of the peppered moth was common in England. Ninety-eight percent of these moths were light; 2% were dark. When the dark moths landed on the bark of trees they were easily spotted by birds and eaten. Over the course of a few years the trees became covered with soot from factories and darkened. The white moths then became more visible to the birds and were eaten; the population of dark moths began to increase (95%) and the white moths decreased. The Industrial Revolution not only had an impact on population growth, but also on the natural world. This period marks the beginning of rapid population growth as well as a global impact on the environment. Air and water pollution, water scarcity, deforestation, and biodiversity loss are all environmental issues that are a direct result of human activities.

Deforestation

Human population growth is a direct cause of deforestation, the cutting and removing of forest cover. The World Resources Institute reports that ½ of the world’s forest cover has been lost, much of it within the last three decades (5). The majority of the land that is being deforested is converted to agriculture and pastureland to feed a rapidly increasing human population. Human demand for food, fuel, timber, paper, and highways is forcing the destruction of the forests.

Forests have been called the lungs of the Earth. Forests regulate carbon, nitrogen, and oxygen cycles. For example, forests absorb carbon from the atmosphere. When the trees are removed, carbon is released as carbon dioxide into the atmosphere. Carbon dioxide is a major greenhouse gas. Forests also regulate temperature and rainfall. Trees in the forest hold the soil in place and prevent soil erosion.
especially the tropical rainforests, are home to the greatest variety of species; some estimates are as high as 30 million different species (6).

Deforestation leads to a multitude of environmental problems. Soil erosion occurs when trees are removed and the soil no longer has anything to hold it in place. Soil erosion is a major cause of water pollution; soil is washed into the rivers and lakes and the weight of the sediment kills aquatic life. Deforestation also increases flooding. Trees and the soil absorb water from the ground. Once trees are removed, there is a greater chance of flooding in the area because not only are the trees gone but so is the topsoil that helps to absorb the water. Deforestation also results in lower crop production. Once trees are removed, the land loses nutrients and the fertility of the land drops, which eventually results in declining crop yields. Deforestation decreases rainfall. Rain is generated by a cycle of evaporation and transpiration, which occurs in the leaves of trees. Without forests, this cycle does not occur efficiently and total rainfall is diminished. Loss of species habitat is another result of deforestation. Loss of habitat is the number one cause of biodiversity loss. Even though no one knows the actual rate of extinction in the rainforests (we can’t know what we have lost if we don’t know what we have had) it has been estimated that 50,000 species have been estimated in the last 35 years (7). This averages out to about 1,500 species per year. In an effort to house, clothe, and feed an ever-growing population, we are using forest and other areas that have been rich in diversity to grow food, build malls and homes, changing the natural habitats to accommodate man.

Air Pollution

Increases in population growth also affect a resource that we cannot possibly live without: air. Air is vital to all living things. More people means more energy used, more vehicles on the roads, more factories to produce goods, and more pollutants released into the air. Since the beginning of the twentieth century human population has increased from 1.6 billion to 6.1 billion. During the same period carbon dioxide, a greenhouse gas has increased from 534 million metric tons (1900) to 6.59 billion metric tons in 1997 (8). Air pollutants such as carbon dioxide, carbon monoxide, nitrogen oxides, and chlorofluorocarbons (CFCs) are responsible for such health problems as respiratory disease and cancer. There are many sources of air pollution, the majority of which are from human activities. Although there are natural sources of air pollution such as volcanoes, soil erosion, and forest fires, the contribution of these natural sources to our air pollution problems are minimal compared to human activities. The pollutants that enter the air from natural sources only remain in the air for a short period of time and therefore do not have a major contribution to air
quality problems. Air pollution from human activities has a much greater effect on the atmosphere as well as the health of the population.

One human activity that is the major source of air pollution is the burning of fossil fuels such as coal, oil, and natural gas. It is projected that the number of avoidable deaths from air pollution caused by the burning of fossil fuels alone could reach 8 million between the years 2000 and 2020 (9). We rely heavily on these fossil fuels to power our everyday lives. Factories, cars, home furnaces and air conditioners, stoves, refrigerators, computers, and virtually every technological advance we have made since the beginning of the Industrial Revolution requires energy to operate. Increased human population requires more energy, and therefore requires more fossil fuel. Supplying energy for over 6 billion people requires a lot of fossil fuel, and contributes significantly to air pollution.

Automobiles are responsible for over 50% of air pollution, power plants 21%, and factories 16%. A growing population has increased the number of vehicles on the roads and increased the amount of pollutants entering the atmosphere. Automobiles release carbon monoxide, nitrogen oxides, particulates, and hydrocarbons into the atmosphere. Between 1950 and 1994, the number of vehicles on the world’s roads has increased from 70 million to 630 million. Automobiles release carbon monoxide, nitrogen oxides, particulates, and hydrocarbons into the atmosphere. These and other pollutants not only pose health problems for humans, but also contribute to another environmental problem called global warming. Global warming is caused by an increase in greenhouse gases. Greenhouse gases are gases such as carbon dioxide, CFCs, ozone, methane, and nitrous oxide. Increases in greenhouse gases are a direct result of rapid population growth. The effects of global warming are not fully understood. The best scientific data suggest that we can expect more extreme weather including more rain during rainy seasons, longer droughts, and an increase in storms, including hurricanes and tornadoes. Warmer temperatures could also melt the polar ice caps, resulting in coastal flooding. Some areas may become completely covered with water.

Water Pollution and Scarcity

Water supplies are feeling the pressure of our growing numbers in two ways: pollution and scarcity. Water, like air, is a necessity for life. Water pollution, like air pollution, is a common pool problem. No one owns it (unless it is on private property), therefore without regulations, no one is held accountable to make sure that it is used in a responsible manner. Over the last 50 years increases in population, agriculture, and industry have put a tremendous strain on water supplies leading to not only pollution, but also a shortage of this precious natural resource.
Without water all life would cease to exist. Yet, over 1.1 billion people lack access to clean water. Water pollution makes our rivers, streams, lakes, and oceans unpleasant to be near; it also contaminates and poisons the seafood that many of us love to eat. Ingesting polluted water causes cancer, and birth defects in unborn children. Water pollution occurs in all countries, but it is especially a concern in LDCs. It is estimated that approximately 95% of water in LDCs are polluted. LDCs discharge 95% of their untreated sewage directly into surface waters that are used for drinking, cooking, and other uses. In the United States, 37% of our lakes are not fit for swimming and other recreational activities. Runoff of pesticides, fertilizers, and soil all contribute to the water pollution problems that we experience in this country. These pollutants enter our water supplies through human activities such as deforestation and other agricultural activities that humans do to feed and house an ever-increasing human population.

The World Watch Institute reports that the number of people living in water-stressed countries is projected to climb from the current 470 million to 3 million by the year 2025. Rapid human population growth, decreased rainfall, man-made engineering systems (such as dams), and depletion of groundwater resources all contribute to our current water crisis. Overall water supplies are abundant, but are not distributed evenly throughout the world. Currently twenty-six countries fall into the water scarce category. China, the world's most populous country, is home to 22% of the world's total human population, but has access to only 7% of the world’s freshwater supply. Beijing's water tables are falling 5ft. per year. The Yellow River, China's main source of water, first ran dry in 1972 for 15 days. For the last 10 years, the Yellow River has completely dried up before reaching the sea for an average of 70 days per year. In 1997, the river ran dry for 226 days, more than one half of the year. China's fresh water supplies are estimated to supply only 1/2 of the over 1 billion people with fresh water.

World water usage has tripled over the last 50 years. Over 70% of all water withdrawn from rivers or underground sources is used for irrigation of crops to feed a rapidly increasing human population. It is estimated that worldwide underground sources of water are being over pumped by 160 million tons each year. We add another 80 million people each year. 80 million more people who will need water. Water is renewable, but it is not infinite. Water use in agriculture will have to increase even more to keep up with the demand for food. Most of the increase demand for food will be in the LDCs, where the highest population growth rates exist.

These are only a few of the environmental problems that world is facing today. Man has had, and continues to have, a tremendous effect on our natural world. We are contributing to the degradation of the Earth and its resources at an unprecedented
rate. It is necessary that we learn to control the damage that we are causing not only to other creatures, but also to ourselves. Many believe that like others in the animal kingdom, lack of resources will be the limiting factor to human population growth. Clearly the human population cannot keep growing indefinitely. Lack of clean water, lack of adequate food and housing, and diseases, are all results of a population that is outstripping the Earth’s ability to support it.

**Population Growth and Economic Development**

Does rapid human population growth have an affect on the economic health of a country or region? One thing is clear; population growth and economic growth are related. In this section we will look more closely at less developed countries (LDCs), more developed countries (MDCs), the population growth rates of LDCs and MDCs, consumption patterns, and the effect that population growth appears to have on economic health.

Less developed countries (LDCs) are those countries that have low standards of living, low income per capita, and high population growth rates. LDCs also have low economic growth rates, high illiteracy rates, high birth rates, and high death rates. LDCs also depend on more developed countries (MDCs) for economic support.

MDCs are those countries that are highly industrialized and have moderate to high Gross National Product (GNP) per capita. GNP is an indicator of a nation’s economic health. MDCs enjoy a much higher standard of living than LDCs. More developed countries, under UN classification, are those countries of Europe and North America, Australia, Japan, and New Zealand. All other countries are classified as less developed countries (10).

LDCs have the highest population growth rates in the world. The population growth rate in LDCs is 1.6%, compared to the population growth rate of 0.1% in MDCs. It is estimated that over the next few decades 90% of the population growth that the world will experience will be in LDCs. In other words, more people will be added to those countries that are already struggling to provide basic services such as health care, clean water and sanitation, and education. Population pressures in LDCs have economic and social impacts. Hunger, poverty, and disease many times are results of uncontrolled population growth in LDCs. When populations grow faster than the resources that are available, scarcity occurs. Food supplies, clean water and sanitation, and housing are basic necessities of life. Currently, 4.4 billion people live in LDCs; 1.2 billion live on less than $1 a day. Nearly 60% of the 4.4 billion people in LDCs lack basic sanitation, 1/3 does not have access to clean water, and 1/4 lack adequate housing. Another 1.1 billion are malnourished. (11)
Table 3.1 lists the 10 countries with the highest GNP per capita and Table 3.2 lists the 10 countries with the lowest GNP per capita for 1999 (12), and their percentage of natural increase in population (13).

### Highest GNP per Capita (US Dollars)

<table>
<thead>
<tr>
<th>Country</th>
<th>GNP per capita (US Dollars)</th>
<th>% Natural Increase in Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Luxembourg</td>
<td>$34,200</td>
<td>.34%</td>
</tr>
<tr>
<td>2. United States</td>
<td>$33,900</td>
<td>.55%</td>
</tr>
<tr>
<td>3. Singapore</td>
<td>$27,800</td>
<td>.86%</td>
</tr>
<tr>
<td>4. Switzerland</td>
<td>$27,100</td>
<td>.14%</td>
</tr>
<tr>
<td>5. Monaco</td>
<td>$27,000</td>
<td>-.33%</td>
</tr>
<tr>
<td>6. Norway</td>
<td>$25,100</td>
<td>.28%</td>
</tr>
<tr>
<td>7. Belgium</td>
<td>$23,900</td>
<td>.06%</td>
</tr>
<tr>
<td>8. Denmark</td>
<td>$23,800</td>
<td>.11%</td>
</tr>
<tr>
<td>9. Iceland</td>
<td>$23,500</td>
<td>.77%</td>
</tr>
<tr>
<td>10. Austria</td>
<td>$23,400</td>
<td>-.01%</td>
</tr>
<tr>
<td>Japan</td>
<td>$23,400</td>
<td>.17%</td>
</tr>
</tbody>
</table>

**Table 3.1**

### Lowest GNP per Capita (US Dollars)

<table>
<thead>
<tr>
<th>Country</th>
<th>GNP per capita (US Dollars)</th>
<th>% Natural Increase in Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sierra Leone</td>
<td>$500</td>
<td>2.59%</td>
</tr>
<tr>
<td>2. Tanzania</td>
<td>$550</td>
<td>2.67%</td>
</tr>
<tr>
<td>3. Ethiopia</td>
<td>$560</td>
<td>2.68%</td>
</tr>
<tr>
<td>4. Somalia</td>
<td>$600</td>
<td>2.89%</td>
</tr>
<tr>
<td>5. Cambodia</td>
<td>$710</td>
<td>2.25%</td>
</tr>
<tr>
<td>Congo</td>
<td>$710</td>
<td>3.09%</td>
</tr>
<tr>
<td>Dem. Republic of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Rwanda</td>
<td>$720</td>
<td>1.28%</td>
</tr>
<tr>
<td>8. Comoros</td>
<td>$725</td>
<td>3.02%</td>
</tr>
<tr>
<td>9. Burundi</td>
<td>$730</td>
<td>2.58%</td>
</tr>
<tr>
<td>10. Eritrea</td>
<td>$750</td>
<td>3.05%</td>
</tr>
</tbody>
</table>

**Table 3.2**
Let's examine Table 3.1 and Table 3.2 more closely. The tables show that those countries with the highest GNP per capita have population growth rates much lower than the World population growth rate of 1.3%, and that those countries with the lowest GNP per capita have growth rates that are considerably higher than that of the World's. For example, Eritrea, located on the west coast of West Africa, has a population growth rate of twice that of the world's population growth rate, and had a GNP per capita income of $500, the world's lowest. Luxembourg on the other hand enjoys the world's highest GNP per capita income of $34,200 and population growth rate of .34%. Population growth rates clearly affect the per capita income of nations—population growth rate for MDCs is 0.1%, while that of LDCs is 1.6%

It is difficult for a country such as Eritrea, or any of those listed in table 3.2, to experience substantial economic growth while providing basic services such as health care and education to a rapidly increasing population. Money that could be used to encourage economic growth is instead used to provide basic services.

Before we move on, there is one more important point to be made about the rapid population growth in LDCs; age distribution. When a population increases at the rates that we see in LDCs, the increase means a large, young population who will not be able to contribute to the economic health of the nation for many years. The percentage of the population under the age of 15 in LDCs is 33%; the percentage of the population under the age of 15 in MDCs is 18%.

Consumption Patterns

There is great concern about the environmental impact of the rapid human population growth, especially in LDCs. While it is important to the economic health of those countries, we cannot blame the population growth of these countries alone for the world’s environmental problems. We have spent considerable time discussing the environmental impact of population growth, but there is another factor to environmental degradation that we have yet to discuss; that factor is consumption patterns. There are very few, if any, human activities which do not place demands on natural resources. These demands play a major role in the stress that humans exert upon the environment.

A huge consumption gap occurs between the richest countries (MDCs) and the poorer countries (LDCs). Each person living in the wealthiest countries in the world consumes and pollutes as much as fifty people living in the poorest countries in the world. We have established that population growth rates are highest in LDCs; currently
80% of the world’s population lives in those countries. But, the population in those countries only consumes 20% of the world’s resources. MDCs, the wealthiest countries in the world, are home to only 20% of the world’s population, but consume 80% of the world’s resources. Only one-fifth of the world’s population live in MDCs, but that small number of people is responsible for over half of the carbon dioxide emissions that are released into the atmosphere; the United States alone, with only 4.6% of the world’s population is responsible for over 25% of greenhouse gas emissions. The United States also consumes 25% of the world’s total fossil fuel use each year.

While population growth increases demand for resources, levels of consumption may have an even greater effect on the depletion of these resources. As more and more countries try to attain the living standards of the more affluent nations, we will continue to see an even greater demand placed on our natural resources. Increases in population growth, as well as increases in level of consumption per person, are pushing the limits of the Earth’s carrying capacity. High population growth rates in LDCs make it nearly impossible for these countries to experience any serious economic growth. These countries are exploiting the natural resources to simply survive from day to day. High consumption rates in MDCs are depleting natural resources faster than the Earth can replenish itself. While the population growth rates in MDCs are the lowest in the world, overconsumption is placing an enormous strain on the Earth.

Human population growth is a controversial issue. Population growth alone is not responsible for our environmental problems. Population growth interacts with consumption patterns to increase environmental degradation. It is important to note however that population growth is viewed as a problem with environmental and economic consequences. In a speech before the International Conference on Population Development in September of 1994, Vice President Al Gore made the following comments:

"But the solution – like the solution to the population challenge – will not be found in any single simplistic answer. It will be found in a comprehensive approach that combines democracy, economic reform, low rates of inflation, low levels of corruption, sound environmental stewardship, free and open markets at home and access to markets in the developed countries alike – the connection between those of us alive today and future generations that will inherit the results of the decisions we make. Indeed, a major part of the spiritual crisis we face in the modern world is rooted in our obstinate refusal to look beyond the immediacy of our own needs and wants and instead invest in the kind of future our children’s children have a right to expect. And it should
be obvious that we cannot solve this lost sense of connection to our future merely through appeals to reason and logic.”

Well said, Mr. Gore.
Population Activities for Students

- To illustrate the economic consequences of high population growth rates on limited resources, divide students into groups of 2, 6, 12, etc. Give each group 6 jellybeans and tell them to divide the jellybeans evenly among their group. The group with 2 students will have more than enough for 2 people. The group with 6 students will have just enough to give each student 1 jellybean. The largest group will have to divide each jellybean to make sure everyone has some, or some people will have some or some will have none. Ask students to explain how excessive population growth affects the standards of living.

- To illustrate population density, place the student’s desks into groups. The areas should be equal with at least one group of desks crowded into the area (these students should have a problem getting in and out of their desks). Ask students how this situation impacts the environment as well as the well being of humans.

- Ask students to research countries with high population growth rates. Find out what types of policies (if any) that these countries have in place to reduce population growth rates. For instance, China has a policy in place that encourages couples to have only one child. Couples who have one child are given government benefits that allow them to have a higher standard of living. There is information on several government sites (United Nations, World Bank, Population Info, etc.,) that give information on these policies.

- Overconsumption is a major factor in environmental issues. Ask students to take a tour of their homes and make a list of things that are needs, and another list of things that are wants. There should be very few things, if any, on the needs list. We need food, water, and shelter. Almost everything else is wants.
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CHAPTER 2

Economic Tools for the Environment

In this chapter we examine the following:

- Privatization
- Pricing
- Externalities
- Markets
Key Words – Chapter 2

- Tragedy of the commons
- Positive externalities
- Negative externalities
- Economic cost
- Economic value
- Private property rights
- Markets
Introduction

- The purpose of this chapter is to introduce the student to the economic concepts that we will use to help "fix" our environmental problems.

- We will introduce several sound economic principles and concepts that we will use in later chapters to analyze and provide possible solutions to many environmental issues. These principles will help students understand and appreciate the complex issues surrounding environmental protection and economic development.
Why Use Economic Instruments in Environmental Protection?

There are several reasons why economic instruments are being used to achieve environmental protection goals. These instruments allow environmental protection goals to be met at the least cost. Economic instruments are more flexible than command and control regulations and allow firms to choose the least cost method of reaching goals. Economic instruments also encourage advances in new technology. The flexibility of these instruments encourage firms to develop new, more cost-effective ways to reduce pollution and other environmental problems. The use of these instruments are being incorporated into many of our environmental laws, with amazing results. Let's look at four economic instruments that we will use in this guide to discuss environmental issues and solutions.

Private Property Rights

The idea of private property rights is not an easy concept for many people to accept when it comes to environmental issues. Many people believe that natural resources such as water and air belong to everyone and no one has the right to own it. Even though this is an admirable concept, it is one of the major causes of environmental degradation. When no one owns a resource, there is no one to insist that it be used in a reasonable manner. This problem is commonly referred to as the tragedy of the commons. Most of our natural resources are owned by no one, but used by everyone. People are more inclined to take care of a resource if they bear the cost or benefit of that resource.

In this guide, we will examine how allowing private ownership of resources can help solve the problem of abuse of many of our natural resources. By allowing property rights, the resource is given an economic value. A person would have incentives to protect that resource in a beneficial manner.

Pricing

Appropriate pricing is another economic principle that we will use to help solve some of our environmental problems. This principle appears to be logical; surely the price of a resource should reflect its cost, if not its value, right? Not necessarily. As we will see in later chapters, many of our environmental problems are a result of the underpricing of resources. Underpricing encourages overconsumption and misuse rather than efficiency and conservation. Underpricing creates an illusion of plenty, and we value it less. The price of a resource should reflect the entire cost of providing that resource.

One example of underpricing leading to overconsumption of a resource is water. If you were to ask someone what were three things he/she needed to live, water
would be on the list. Yet, it is one of the least expensive resources that we use. The price that we pay does not reflect the entire cost of providing that water. Instead, most cities are highly subsidized to build the infrastructure to provide water, and the consumers pay very little for it.

Until pricing reflects the full recovery of total costs, many of our resources will continue to be used carelessly and inefficiently.

Externalities

In the previous section we discussed costs and benefit analysis and determined that most people make decisions based on the costs and benefits to themselves. But, what if we could make decisions that had no costs or benefits for us? In other words, the costs or benefits were “external” to our actions.

The concepts of externalities can be extremely useful in understanding many of our environmental problems.

Externalities arise when a person or firm does not have to make decisions based on costs /benefits. If making the decision does not cost anything, or will not be beneficial, there is no incentive to try to make a good decision.

There are two types of externalities: negative externalities and positive externalities.

A negative externality is one in which the result of the decision or action is a cost in which the firm or person does not take into account. Air pollution from factories would be an example of a negative externality (if there are no laws regulating air pollution, therefore no cost).

A positive externality is one in which the result of a decision or action is a benefit which the firm or person does not take into account. For instance, let’s say that a student plays the violin. His mother demands that he practice 2 hours everyday. The student does not realize that the elderly lady who lives next door loves to hear his music and looks forward to it everyday. She benefits from the decision he made to practice (even though reluctantly).

We will use the concepts of externalities to show that firms are more likely to make more environmentally sound decisions if they have to internalize the costs and benefits of those decisions.

Markets

A market is where an economic change takes place. Economic does not necessarily mean monetary, although many times it does involve money. An economic exchange occurs when two parties, the buyer and seller (or consumer and supplier), makes a voluntary exchange of goods and services. For example, each time a consumer goes to a drink machine to purchase a drink (especially on a hot summer
day), and drops $.50 into the machine, a market transaction takes place. The owner of the drink machine was willing to supply the drink for a price of $.50 and the thirsty consumer was willing to purchase at the same price. The supplier is $.50 wealthier and the consumer is wealthier because his thirst is quenched. Markets are essential to an economy for one simple reason; markets increase the wealth and well-being of those who participate in them.

Markets can be valuable tools in solving many of our environmental problems. As we will see in later chapters, creating markets for water and tradeable pollution permits, is extremely effective in helping to reach our goal of having a healthy environment.

To understand how markets can play an important role in solving environmental problems, we need to first understand how markets work. Let’s first look at two important concepts of Economics: the law of demand and supply and demand.

The Law of Demand

The Law of Demand states that “the lower the price of a good, the larger the quantity consumers will purchase.” Of course there are factors that must be held constant, such as preferences and incomes. But for the purpose of applying this law to environmental issues it is not necessary to discuss those factors here. To understand the law of demand, let’s look at Table 4.1.

Table 4.1 shows the quantity of televisions that consumers will be willing to purchase at various prices. Notice that at a price of $200, the consumer is willing to only purchase five televisions. At $150, consumers are willing to purchase ten. But look at the quantity purchased at $50. The consumer is willing to purchase twenty televisions at this price.

<table>
<thead>
<tr>
<th>Price Per Television</th>
<th>Televisions Purchased</th>
</tr>
</thead>
<tbody>
<tr>
<td>$250.00</td>
<td>0</td>
</tr>
<tr>
<td>$200.00</td>
<td>5</td>
</tr>
<tr>
<td>$150.00</td>
<td>10</td>
</tr>
<tr>
<td>$100.00</td>
<td>15</td>
</tr>
<tr>
<td>$50.00</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 4.1
Figure 4.1 shows the law of demand in action. This graph demonstrates the consumers' willingness to buy at each price. Notice that once the points at each price are connected, we have a downward sloping curve. This is known as the demand curve. The downward slope represents a negative relationship between price and the quantity purchased, when price goes up, the quantity that consumers are willing to purchase goes down. The demand curve tells us how much the consumer is willing to purchase at each price along the curve. In other words, the demand curve simply demonstrates the law of demand.

There will be movement along the demand curve when quantity demanded changes in response to price. Movements along the demand curve are responses to a price change.

If we represent the actions of the consumer, it is also necessary to represent the supplier (remember, there are two parties in the market). Suppliers participate in the market with one simple goal; that goal is to maximize profits. One way to maximize profits is to sell goods at the highest price that consumers are willing to buy. This is why the supply curve slopes upward. The supplier wants to sell at the highest price possible to increase earnings for the firm. If consumers are willing to pay more, the
supplier is willing to produce more. Table 4.2 shows the quantity that suppliers are willing to supply at various prices.

<table>
<thead>
<tr>
<th>Price Per Television</th>
<th>Televisions Supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td>$250.00</td>
<td>20</td>
</tr>
<tr>
<td>$200.00</td>
<td>15</td>
</tr>
<tr>
<td>$150.00</td>
<td>10</td>
</tr>
<tr>
<td>$100.00</td>
<td>5</td>
</tr>
<tr>
<td>$50.00</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4.2

Figure 4.2 is the graphical representation of this table. We represent the supplier by using the supply curve. The supply curve tells us what quantities the supplier is willing to supply at various prices. Notice in figure 4.2 that the supply curve slopes upward; *this represents the positive relationship between price and quantity supplied*. In other words, as the price increases, so will the quantity that the suppliers are willing to supply.
There are also "shifts" in the demand and supply curves. These shifts do not occur because of changes in price. Shifts in the demand or supply curve (a movement of the curve itself) occur because of factors such as changes in income (demand) or changes in technology (supply). Using our television example, if the consumers' income increases, more televisions will be bought. If the supplier can find technology to reduce the cost of manufacturing the televisions, more televisions will be supplied.

When a demand curve shifts, there will be more (shifts to right) or less (shifts to left) of a good bought at each price.

When there is an increase in demand, the entire demand curve shifts to the right causing prices to rise; if there is a decrease in demand, the curve shifts to the left causing prices to fall. Figure 4.3 demonstrates the shift in demand curve. Notice that at a price of $250 per television, the quantity purchased is zero, but when the demand curve shifts to the right (because of higher incomes or some other factor) the quantity sold at this price increases to five.
Figure 4.4 demonstrates a similar shift in the supply curve. At a price of $50 suppliers are not willing to produce any televisions. Once the curve shifts (because technology has made it less expensive to produce), suppliers are willing to supply 5 televisions at this price.
Now that we understand how price affects supply and demand, let's look at how they work together to create a market system. Figure 4.5 shows the supply and demand curves in a given market. Remember, the demand curve (D) represents the consumer's willingness to buy and the supply curve (S) represents the supplier's willingness to supply at given prices.
Notice that there is a point where the demand curve and the supply curve intersect, the quantity supplied and the quantity demanded is equal. This is known as market equilibrium. When a market is in equilibrium, the quantity demanded and the quantity supplied are equal. The price at this point is the equilibrium price; it is the price that markets strive to achieve. Any other points along the curve would create either a shortage or a surplus. Therefore, the equilibrium price for televisions in this market is $125.00; the equilibrium quantity is 13 televisions. When the market is in equilibrium, there is no incentive for prices to increase or decrease; each party in the market is supplying or buying the quantity that is wanted. In fact, when changes occur in the market to create a surplus or a shortage, the market will eliminate each through the force of supply and demand.

We will apply these four basic economic principles to find possible solutions to environmental problems throughout the following chapters. These principles will not solve all of our environmental problems, but we will examine how they have been applied and worked in many situations.
CHAPTER 3

Environmental Laws and Regulations

In this chapter we examine the following:

- History of the Environment Protection Agency (EPA)
- How Laws and Regulations are created
- Brief summaries of major Environmental Laws
Key Words – Chapter 3

- Command and control
- Laws
- Regulations
- NEPA
- CWA
- CAA
- CERCLA
- Environmental Protection Agency (EPA)
Introduction

Environmental protection is a complex and controversial issue. While most people would agree that clean water, clean air, and protection of endangered species are important, there is however disagreement on how to obtain these goals. Time and again regulations that are positioned to protect the environment place restrictions on businesses and industries, as well as individuals and their rights as private citizens. At a time when many people feel that the government already invades their lives, environmental protection sometimes seem to interfere with economic progress for individuals as well.

Environmental protection is more than just cleaning up the environment. There are issues that arise from environmental protection that affect all of our lives, either directly or indirectly. Directly through limitations on use of private property, or indirectly through increased prices to cover compliance costs for business and industry.
Before we begin our discussion on the laws and regulations governing environmental protection, we should first distinguish between the two.

**Laws**

Congress and only Congress enact laws. All laws can be found in the U.S. Code. Laws are always a higher authority than regulations. How does a law become a law? The flow chart below shows us how. (1)

1. **Member of Congress Proposes a Bill**
2. **Both Houses of Congress must approve the proposed Bill**
3. **Presidential approval of Bill after passing both Houses of Congress**
4. **Bill becomes an Act (examples: Clean Air Act, Clean Water Act)**
   - Published in U.S. Code
Laws are not effective if they are not enforced. Laws are general documents that do not give details. After a law is passed, Congress gives certain agencies the power to create the regulations of the law, and in the case of the Environmental Protection Agency, the power to enforce them.

Regulations

Federal administrative agencies and departments write federal regulations. All federal regulations can be found in the Code of Federal Regulations (also known as CFR).

Proposals from federal agencies are listed in the Federal Register. The public is encouraged to read the proposal and send comments to the agency. If the agency believes that revisions need to be made, the necessary regulation is issued. After the regulation is finished, it is given a code and published in the CFR.

It is important to note that during the process of creating a regulation, the public is notified through every stage of the process. The Federal Register furnishes details about the proposed regulation meetings that will be held.

Environmental laws and regulations go through the same process of that of laws and regulations. These laws and regulations are created to protect the environment and man. The process allows each of us to become a part of it.

Summaries of Environmental Laws

In this section we will briefly summarize several major U.S. environmental laws. These laws were chosen because they address fundamental issues that provide a basis to understanding environmental protection.

National Environmental Policy Act of 1969
Clean Air Act (CAA)
Clean Water Act (CWA)
Endangered Species Act (ESA)
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

National Environmental Policy Act of 1969
42 U.S.C., Section 4321-4347

The National Environmental Policy Act (NEPA) of 1969 has been described as the most far-reaching environmental law ever written. NEPA is the national charter for protecting the environment. NEPA mandates federal agencies to consider and document environmental impacts of proposed actions and legislation. These
documents are known as Environmental Impact Statements (EIS). EIS are comprehensive documents that must be prepared if the action is “major” and will significantly affect the quality of the environment. In other words, NEPA mandates that all forms of government research and report any harm that it may cause to the environment. (2)

Clean Air Act (CAA)
42 U.S.C., §§ 7401 et seq. (1970)

The Clean Air Act (CAA) regulates air emissions from several different sources. The CAA authorizes the EPA to set standards for air pollution. These standards are known as the National Ambient Air Quality Standards. The initial goal of the plan was to have every state reach the standards by 1975. This goal was not reached. The CAA was amended in 1977 and 1990. The 1977 amendments set new goal dates; the 1990 amendments address other air quality problems such as ozone depletion and acid rain. (3)

Clean Water Act (CWA)
33 U.S.C., §§ 1251 et seq. (1977)

The 1977 Clean Water Act (CWA) is actually an amendment to the Federal Water Pollution Control Act of 1972. The FWPCA is the basis for controlling water pollution, and the CWA of 1977 gives the EPA the authority to set the standards for controlling water pollution. The CWA also established the NPDES program, the National Pollution Discharge Elimination System. The NPDES program is a program that requires industries and businesses to obtain permits to discharge pollutants into waters. (4)

Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act (SDWA) was established in 1974 to protect human health from contaminants in drinking water or water that will be used as drinking water (including groundwater). The SWDA authorizes the EPA to set and enforce standards for acceptable levels of contaminants such as lead. All owners or operators of public water systems are required to meet the EPA standards. The SDWA was extensively amended in 1986 and 1996.
Endangered Species Act (ESA)

The Endangered Species Act of 1973 provides federal protection for species of plants and animals that are in danger of becoming extinct. The ESA prohibits government agencies, industries, businesses, and individuals from any action that constitutes "taking" of an endangered species. A "taking" is any action that would harm the species, including but not limited to modifying its habitat. (5)

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as Superfund)
42 U.S.C. § 9601 et seq. 1980

The 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), gives the EPA the authority to clean up hazardous waste. The EPA identifies and prioritizes areas that need to be cleaned up. CERCLA also holds the party responsible for the hazardous waste and the cleanup of that waste. (6)

Later we will take a more in depth view of laws and regulations in the chapters dealing with specific environmental issues, but at the present, let's take a closer look at the Environmental Protection Agency (EPA) and its role in protecting the environment.

History of the Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) was established in 1970 under the Presidency of Richard M. Nixon. During this time a new awareness had been raised concerning environmental problems. The book *Silent Spring* by Rachel Carson was published in 1962, and brought the dangers of environmental pollution, especially the use of DDT, to the forefront(7). The nation's attention was captured, and the environmental movement as we know it began.

The EPA is the regulatory and enforcement agency mandated to protect the environment. The EPA sets standards, goals and policies for environmental protection. Let's take a closer look at the EPA, its history, mission, and goals.

The newly created EPA was actually a consolidation of duties from four existing government agencies (listed below). President Nixon believed that the functions of these agencies would be more effective if they were combined into one
agency. This consolidation established one of the most powerful agencies in the U.S. government.

Department of Interior
- Pesticide Research
- Federal Water Administration

Department of Health, Education and Welfare
- National Air Pollution Administration
- Bureau of Water Hygiene
- Bureau of Solid Waste Management
- Bureau of Radiological Health
- Pesticide Tolerances and Research

Department of Agriculture
- Pesticide Registration

Executive of the President
- Federal Radiation Control
- Environmental Radiation Standards of the Atomic Energy Commission
- Environmental Systems Studies of the Council in Environmental Quality

EPA Seal

The EPA Seal is a flower with a bloom with the colors blue, green, and blue green. The blue represents the sky, the green represents the land, and the blue green represents the water. The white circle in the middle represents the sun and moon. The Seal is symbolic of a clean environment. (8)

The EPA's Mission Statement is "to protect human health and to safeguard the natural environment – air, water, and land – upon which life depends" (9).
Growth of the EPA

The EPA has grown tremendously over the past 30 years. The fiscal year budget for the EPA in 1970, the year that it was established was $1,003,984,000 with a workforce of 4,084 employees. The proposed budget for fiscal year 2001 is $7,256,599,000, with a workforce of 18,050 employees (10).

Thanks to government regulations, the nation is cleaner today than it was 30 years ago. Regulations are needed to hold polluters responsible for the damage that they cause to the environment and to humans as well. Over the past few years, the EPA has incorporated many market-based programs into environmental laws to encourage environmental protection. These programs will be discussed throughout the following chapters. Environmental protection is one of the most important tasks that this nation faces. Through effective regulations and the use of economic instruments, we can have a clean, healthy world to live in.
Environmental Laws and Regulations Activities

Assign students different Environmental Laws and Regulation to research.

- Research what duties were transferred to the EPA and from what agency.

- Divide students into two groups, Houses of Congress, and the President. Have students to go through the process of introducing a Bill and trying to become a Law. (Pull the President aside and tell him/her to not give approval the first time.)

- Make a list of past administrators of the EPA. What were their previous jobs? Were any of these administrators economists? If not, how might environmental regulations evolve differently if they had been economists?
1. USGS Guide to Federal Environmental Laws and Regulations

2. U.S. Environmental Protection Agency. National Environmental Policy Act

3. U.S. Environmental Protection Agency. Clean Air Act
   http://www.epa.gov/region5/defs/html/CAA.htm

   http://www.epa.gov/region5/water/cwa.htm

5. U.S. Environmental Protection Agency. Endangered Species Act
   http://www.epa.gov/region5/defs/html/esa.htm

   http://www.epa.gov/region5/defs/html/rcra.htm


   http://www.epa.gov/history/org/origins/seal.htm

   http://www.epa.gov/history/org/origins/mission.htm

    http://www.epa.gov/history/org/resources/budget.htm
Chapter 4

Air Pollution

In this chapter we examine following:
- The causes and effects of Air pollution
- Laws and Regulations
- Economic solutions of Air pollution
Key Words – Chapter 4

- Ozone
- Ozone depletion
- Smog
- Acid rain
- Greenhouse gases
- Global warming
- Greenhouse effect
- Primary pollutants
- Secondary pollutants
- Tradeable permits
- Local pollution
- Global pollution
- CAA
Introduction

- Air Pollution affects not only the air that we breathe, but also the quality of everyday life. Air, like water, is essential to life. Although it is vital to life, air is not something that we think about unless it is polluted and of poor quality. In this chapter we will discuss the causes and effects of air pollution, the air quality problems that arise from air pollution, current regulations regarding pollutants and economic instruments that are being used to control air pollution.
Air Pollution

Clean air is a necessity for life. Air is something that we do not think about unless it is polluted and we are affected by it. Air pollution causes many health and breathing problems. Air, like water, is common property. Air is part of the commons; it is owned by no one, but available to everyone. This situation leads to what is called the "tragedy of the commons." Commons refers to any resource that is shared among a group of people, but owned by no one. Water is another example of a common resource. Each person has a right to use (and abuse) the resource, but no one is responsible for making sure that it is used in a reasonable manner. This is one of the major reasons that air pollution exists. Without regulations, no one will assume the responsibility of protecting the quality of the air that we breathe.

Air Pollution

A pollutant is any substance that is introduced into a natural system that has a negative effect on that system. A pollutant adversely affects the biological and/or physical quality of the system and threatens the well being of organisms that depend on that system. Air pollution has negative effects on the air that we breathe as well as the health of humans, animals and plants. Air pollution causes health problems in humans such as respiratory illness, birth defects and cancer, and also contributes to problems in both plants and animals due to the changes in the earth's atmosphere. Let's look at some of the causes of air pollution and the effects that it has on life.

Causes

Air pollution is caused by the introduction of harmful substances into the atmosphere. The leading cause of air pollution today is the burning of fossil fuels from industries and motor vehicles. Coal, oil and natural gas are all fossil fuels. Burning fossil fuels releases several chemicals into the air that are classified as pollutants such as sulfur dioxide, nitrogen oxide, and carbon monoxide. These chemicals are released into the air through emissions from motor vehicles and manufacturing processes from industries. It is important to note here that although motor vehicles have come a long way in reducing pollution (cleaner fuels, more efficient engines), an ever-increasing human population means that there are more
vehicles on the road, which increases the pollution from vehicle emissions; which are responsible for 50% of air pollution (1).

Types of Air Pollution

There are two categories of air pollutants, primary and secondary. A primary pollutant is one that is emitted directly into the air. There are six primary pollutants: carbon monoxide, carbon dioxide, sulfur oxides, nitrogen oxides, hydrocarbons, and particulates (tiny particles of solids or liquids that are light enough to be carried through the air). Sources of primary pollutants are burning of fossil fuels and industrial processes. Secondary pollutants are those that are formed from a reaction of two or more primary pollutants, or with compounds that are already in the atmosphere such as water vapors. Examples of secondary pollutants are ozone and acid precipitation. Ozone, which occurs naturally in the stratosphere and protects us from UV rays, is considered a pollutant when it is near ground (troposphere) level. It is formed by combining sunlight and volatile organic compounds, which react with nitrogen dioxide. Acid precipitation is formed when sulfur dioxide and nitrogen oxides (which are primary pollutants) undergo chemical reactions and form sulfuric and nitric acids.

Air pollution can be local or global. Local air pollution occurs in the lowest level of the atmosphere. Smog is an example of local pollution. Smog is a dense haze that usually contains soot, ash, and gaseous pollutants such as sulfur dioxide and carbon dioxide. Smog causes headaches, dizziness, and breathing problems. In 1952 in the city of London, England, 4,000 people died during what is known as the London Fogs (2). Burning coal in factories and homes caused the smog that was responsible for these deaths. In 1956, a Clean Air Act was passed banning the burning of coal in London. Global pollution occurs in the stratospheric level. In the stratosphere, ozone (O3) forms a protective layer that shields the earth from ultraviolet rays. Pollutants that reach the stratosphere attack the ozone layer and cause thinning. In some areas of the world, such as the Antarctic, the ozone layer completely vanishes for a few weeks each year.

Global Warming

Another example of global pollution is global warming. Global warming is caused by an increase in greenhouse gases. Greenhouse gases are gases such as carbon dioxide, CFCs, ozone, methane, and nitrous oxide. These gases trap heat close to the earth’s surface and contribute to the Greenhouse Effect. The Greenhouse Effect is produced when these gases allow radiation from the sun to pass through into the
Earth’s atmosphere but prevents infrared radiation from escaping. It is important to note that there is a natural greenhouse effect that keeps the Earth’s temperature at an average that is possible to sustain life. The problems that we are experiencing are from an increased level of concentrations of the greenhouse gases, which lead to global warming. Since the industrial revolution concentrations of CO$_2$ have increased 30%, methane by 100% and nitrous oxide by 15% (3). Remember, increases in greenhouse gases are a direct result of rapid population growth. Increases in the number of motor vehicles, the distances that are driven (people commuting to and from work), and factories needed to produce goods for an exploding population all contribute to the increase in greenhouse gases.

The effects of global warming are not fully understood. The best scientific data suggest that we can expect more extreme weather including more rain during rainy seasons, longer draughts, and an increase in storms, including hurricanes and tornadoes. Warmer temperatures could also melt the polar ice caps, resulting in coastal flooding. Some areas may become completely covered with water.

Ozone Depletion

The region of the atmosphere 6-30 miles above the surface of the Earth is called the Stratosphere. Ozone (O$_3$) naturally occurs in the stratosphere and protects the Earth’s surface (and humans) by absorbing UV radiation from the sun. Most ozone (O$_3$) occurs in the lower layer of the stratosphere and this layer is known as the ozone layer. This layer protects plants, animals, and humans from harmful UV radiation. UV radiation has been linked to skin cancer and cataracts. About 90% of the planet’s ozone occurs in the ozone layer.

The ozone is being depleted due to human activities—mainly through the use of chemicals known as chlorofluorocarbons (CFCs). CFCs have been used in refrigerants, solvents, and production of foams (such as Styrofoam). CFCs were also used as propellants in hair sprays and deodorants. CFCs were considered extremely useful chemicals. They are extremely stable, nonflammable and were able to be used in a variety of products.

The very characteristics that have made CFCs useful are also the characteristics that make them damaging to the ozone layer. In the 1970’s scientists began research on the effects of CFCs on the environment. Researchers found that because CFCs were so stable, there were no natural processes that destroyed or even removed CFCs from the troposphere (the lowest level of the atmosphere), therefore, the CFCs would move into the stratosphere.

Once the CFCs enter the stratosphere, they are exposed to strong UV radiation; UV radiation is the only means that CFCs can be broken down. When this
happens the CFCs release chlorine. One atom of chlorine can destroy 100,000 molecules of ozone. The chlorine destroys the ozone faster than it can regenerate itself. Ozone depletion has been linked to increased rates of skin cancer, cataracts, and other diseases.

Under Title VI of the Clean Air Act, a complete ban on production of CFCs along with other ozone depleting chemicals was enforced as of January 1, 1996(4).

Acid Rain

Acid rain is rain that has a pH of less than 5.0. About 62% of acid rain comes from sulfur dioxide (SO2) which, when dissolved in water (rain) becomes sulfuric acid. Thirty two percent of acid rain is from nitrogen oxides (NOx), which forms nitric acid when dissolved in water (rain). The remaining 6% of acid rain is hydrochloric acid. These gases that produce acid rain are from burning fossil fuels in industry and motor vehicles.

Acid rain has created a host of environmental problems. Acid rain falling in lakes and rivers causes the water to become acidic, killing fish and other aquatic life. The acidic conditions also react with and release toxic metals that would usually remain bound in rocks. Release of these metals affects not only the fish, but also the humans who consume the fish.

Acid rain also affects trees and buildings. The acid in the rain reacts with nutrients that trees need, reducing the uptake of those nutrients. The affected trees are then more susceptible to diseases and breakage. Acid rain can also damage buildings, especially those made of limestone. The acid dissolves the calcium carbonate in the stone. The reaction causes the stone to break apart, and the building or statue begins to crumble.

Humans are also affected (although indirectly) by acid rain. Acid rain can also release heavy metals from the soil, which easily travels to water supplies. Once the acid reaches the pipes of a drinking water system, the acid reacts with lead and copper pipes. Lead and copper ingestion leads to serious health risks, especially in children.

Laws and Regulations

Without regulations, most common pool resources such as air would have higher levels of pollution than what we see now. Air, like water, is common property. Government regulations are needed to protect common pool resources because individuals and firms have no incentives to do so. Individuals and firms will not incur the costs of polluting common pool resources unless the government forces them to
internalize the costs. Creating laws and regulations and enforcing those laws and regulations are needed to protect us from pollution of common pool resources.

The Clean Air Act

The Clean Air Act (CAA) is the Federal law that regulates emission from area, stationary, and mobile sources. The CAA authorizes the EPA to establish National Ambient Air Quality Standards (NAAQS). The NAAQS are the standards set by the EPA that limits the quantity of pollutants that may be emitted into the air by specific sources such as factories. The CAA was passed in 1970 and amended in 1977 and 1990. The CAA of 1970 was actually an update of the previous Air Pollution Control Act of 1955 (APCA). The APCA was an act to bring national attention to the problem of air pollution. The Act simply identified the problem and acknowledged that steps needed to be taken to improve air quality.

In 1963, the CAA of 1963 was passed. This act focused on setting standards from sources such as power plants and industries (this act did not take into consideration pollution from mobile sources such as automobiles). Amendments to the CAA of 1963 were passed in 1965, 1966, 1967, and 1969.

Even with the almost yearly amendments, the CAA of 1963 was still inadequate. By 1970, the same year the EPA was established, Congress decided to give the Act a major revision. The Clean Air Act of 1970 set new and tougher regulatory standards. The CAA of 1970:

- Set National Ambient Air Quality Standards
- Regulated emissions from new sources by setting New Source Performance Standards
- Set standards for hazardous emissions from motor vehicles
- Provided $30 billion dollars for research
- Gave citizens the right to sue any organization or agency who violated standards
- Set a goal for all states to reach the NAAQS by 1975

Clean Air Act Amendments of 1990

The Clean Air Act Amendments (CAAA) of 1990 addressed three major air pollution problems: acid rain, urban air pollution, and air emissions. The CAAA of 1990 encouraged the use of economic incentives such as emissions trading. The amendments also encouraged the formulation of cleaner, more environmentally
friendly fuels, the use of low sulfur coal and natural gas, and promoted energy conservation. Many of the economic based incentives programs that are in place today are a result of the CAAA of 1990.

Economic Instruments to Reduce Air Pollution

The Clean Air Act Amendments of 1990 authorized various market-based programs to help reduce air pollution. Market based programs in general are more effective than traditional regulations; market based programs provide rewards for reducing or preventing pollution. Market based programs not only result in pollution levels lower than traditional methods of regulations, but usually result in even lower levels than the specified goals.

Traditional methods of regulations are called command- and control regulations. Command- and control regulations are usually inflexible. These regulatory approaches usually operate through one of three means: source specific emissions limits, output specifications, or technology requirements. Source specific emissions limits tell the polluter what quantity of pollutant that he is allowed to release into the air. An example of source specific emissions limits would be factories. Output specifications apply to those products that consumers will purchase such as cars, or gasoline. Finally, technology requirements are those that specify to industries or businesses specific equipment that they have to use.

Traditional methods of regulations are not always the most effective way to reach pollution goals for several reasons. First, they do not allow companies to decide what method of controlling pollution is most cost effective for the business. Secondly, regulations such as technology requirements do not encourage companies to create technologically advanced products to help curb air pollution. As for technology requirements, unless the regulatory agency is willing to spend the time and money testing each new advance in equipment, many firms will be using outdated equipment rather than the most advanced.

Traditional methods of regulations have been somewhat successful in reducing air pollution. In the Emissions Trends Report (EPA, 1998b), EPA reports that emissions are down in many cases over 50%, and in the case of lead, over 95%(6). But traditional methods of regulations do not encourage industries to further reduce pollution. Let's look at several economic instruments used to control air pollution and how they work.
Economic Instruments:
- Pollution charges, tax, fees
- Tradable allowances
- Subsidies for reducing air pollution
- Fines and Penalties

Pollution charges, tax, fees

These economic incentives are simply charges for polluting. Emission charges, taxes, and fees are designed to reduce the amount of pollution that is emitted. These charges are usually per unit of pollution that is emitted. The incentives are effective because most companies are concerned with minimizing costs, and each unit of pollution that is not emitted is money saved. By charging per unit of pollution, most firms will lower their emissions at least to a level where the cost of controlling the pollution is equal to the emission charges that they must pay. The firm will make necessary changes to control pollution as long as the changes are less expensive than the pollution charges would be. Charges also encourage polluters to further reduce pollution because every unit that is not emitted is money saved. The purpose of charges, taxes, and fees is to make polluting an expensive activity, thereby encouraging polluters to reduce the number of units of pollution that it releases. It is important to note that there is no magic amount or rate at which to charge polluters. It is usually through trial and error that the right charge is found to encourage a reduction in emissions.

Charges, taxes, and fees can also encourage technological advances to reduce emissions. More technologically advanced equipment means fewer emissions and that means lower costs to the firm.

Marketable Permit Systems (Tradeable Allowances)

The Marketable Permit System, also known as Tradeable Allowances, is probably the most innovative economic incentives program used to control air pollution. The idea of marketable permits is not a new one. Thomas Crocker first suggested it in 1966(7). The marketable permits system creates a market for the buying and selling of pollution permits. Each firm, or company, is allowed a fixed
number of emission credits. Each credit is worth a certain number of units of pollution. To understand how the system works and how it creates a market among firms that generate air pollution, let's look at the Acid Rain Program. The program was created under the Clean Air Act of 1990 and is being hailed as a model program for reducing environmental pollution.

The Acid Rain Program

The Acid Rain Program is the most innovative of the marketable permit programs. The financial incentives that the program presents to power plants in the Midwest and South to reduce sulfur dioxide emissions have encouraged a 30% reduction below what is allowed by law(8). Under the Acid Rain Title (Title IV) of the 1990 of the Clean Air Act Amendments (CAAA), a new “tradeable allowance” system was mandated. The tradeable allowance system is part of an overall effort to reduce emissions of sulfur dioxide, a major cause of acid rain. The implementation of the tradeable allowances provides economic incentives to industries by allowing flexibility in compliance options that reduces compliance costs, increases economic efficiency and encourages economic growth. The flexibility allows individual firms to select the most cost effective approach to reduce its emissions. Let's examine how the tradeable allowance program works and how effective it has been.

The CAA's allowance trading program is a type of quantity rationing program(9). The EPA sets a predetermined total allowable level of emissions of certain pollutants for an area or region. The purpose of setting the levels is to control the amount of pollution in that area. Once the acceptable levels of emissions have been determined, “permits” or “allowances” are distributed among polluters based on economic formula.

Once the allowances are distributed, the holder of the allowance has three choices:

- use the allowances
- hold the allowances to use in the future
- sell the allowances

How does the firm decide what to do with the allowances? To make this decision, the firm will do a cost-benefit analysis. In other words, the firm will compare the cost of reducing air emissions to the financial gain that it will receive if it sells the allowance. For example, if the firm can reduce its pollution emissions for a cost of $2,500.00, and the market price for the allowances that the firm holds is $5,000.00, the firm will reduce its emissions and sell its allowances. The firm has earned $2,500.00 over the cost of reducing its emissions. On the other hand, if the cost of reducing pollution emissions is high, most firms will use the allowances instead of
making an effort to reduce those emissions. The firm will choose the most cost
effective way to comply with regulations and reduce costs to the company.

The firm has one more choice; it can hold the allowances for future use. The
firm may choose to hold its allowances for several reasons. First of all, the firm may
have plans to increase production in the future; by holding the allowances, the firm
will be able to cover the future cost of emissions. Firms may also hold allowances to
sell when the number of allowances supplied in the market is down, and the price that
it can get for the allowances rises.

Now let's look at supply and demand among the firms participating in a market
for tradeable allowances. The agency in charge of the program determines how many
allowances are available. As we stated earlier firms with higher compliance costs will
choose to buy permits and firms with lower compliance costs will choose to sell. The
law of demand tells us that if prices of the permits fall, the firm will hold more permits
and control less pollution, and if the price rises, the firm will buy fewer permits and
control more pollution. But what happens if the supply of allowances is reduced?
Reducing the number of allowances will further reduce air pollution, which is the goal
of the EPA. The following graph (fig 6.1) illustrates how the market is affected by a
decrease in supply.

![Decrease in Supply of Tradeable Allowances](image)

**Figure 6.1**

A decrease in supply ($S_1$) causes the supply curve to shift to the left ($S_2$). The result is
a higher equilibrium price ($p_1$) for the allowances, and a reduced quantity ($Q_1$).
supplied at that price. Again, the firm will compare its emissions reduction costs to the cost of purchasing permits (which is higher now with a decrease in supply). Many firms will find ways to reduce emissions instead of buying more permits.

Initially the EPA will allot a certain number of allowances to each firm. Based on the total number of allowances allocated, a percentage is held for auction. The EPA authorizes an agency (currently the Chicago Board of Trade) to conduct the auction. The allowances are auctioned and sold to the highest bidder until there are no allowances left. Any person, organization, firm or industry can bid for the allowances. Many environmental organizations retire or remove the allowances from trading. By retiring the allowances, pollution is reduced because that allowance (which currently is equal to 1 ton of sulfur dioxide) is no longer on the market to be traded or sold.

It is important to note here, that tradeable allowances do not increase pollution. The maximum levels of pollution for a specific area are set, and the number of permits or allowances do not exceed that level. Regardless of how many allowances a firm holds, that firm is not allowed to pollute over the limits that have been set. In fact, the tradeable allowances program could encourage firms to lower their emissions so that they can sell their allowances. If a firm can lower its emissions for less money than it will receive for its allowances, it will make the necessary improvements and sell the allowances.

Subsidies

Subsidies encourage firms to prevent pollution by offering cash payments for reducing emissions. Subsidies are usually grants or loans. Subsidies are effective instruments in reducing pollution. Subsidies encourage polluters to reduce pollution because subsidies pay for some or all of the cost of the pollution reduction. For example, farmers are encouraged to use innovative, new farm equipment to reduce soil degradation and agricultural runoff. There are many times that farmers are not willing to incur the costs associated with the improved technology unless it benefits him/her in some way (increased crop yield, etc.). A subsidy will encourage the farmer to use the new equipment because the costs are now either fully or partially incurred by the government. By subsidizing the purchase of the new equipment, society benefits through a reduction in pollution, which means cleaner resources for everyone.
Voluntary Programs

Voluntary Programs have proven to be an effective tool in reducing air pollution. In the article “Why Do Firms Volunteer to Exceed Environmental Regulations?”(10) Arora and Cason examine participation among firms in the EPA’s voluntary 33/50 program. The program was designed to allow firms to volunteer to reduce emissions of seventeen toxic chemicals by 33% in 1992, and by 50% in 1995.

Arora and Cason examined the incentives that companies would have to participate in a program such as the 33/50 program, one that would be costly to the company. Arora and Cason believed that those firms that were in closer contact with consumers would be more willing to participate; the firms would have to receive some benefit from improving their environmental image, and those firms with the highest advertising cost had the most gain from projecting an “environmentally conscious” image.

The data collected showed that voluntary programs might be an alternative to more costly mandatory government regulations. Between 1988 (the base year for the program) and 1992, the 8,000 firms invited to join reduced their total releases of the 17 target chemicals by 40.1%, while reducing 300 other chemicals by 33.6%.

The study confirmed several of Arora and Cason’s beliefs. Those firms that were in closer contact with the consumers were more likely to participate; by projecting an environmentally friendly image to consumers the firms believed that it would be good for business. The firms with the highest advertising cost also were more likely to participate.

This study shows that companies are willing to clean up the environment voluntarily if the benefits outweigh the costs. The firms believed that consumers generally care about the environment and would be willing to pay a little more for products to help cover the costs.

The article states: “Economics has traditionally focused on the cost side of environmental regulations and has for the most part disregarded the benefits that a firm might derive from a clean environmental record”(12). Companies will be willing to spend the additional money to clean up its environmental image if by doing so it projects a positive image to consumers. People will choose an environmentally friendly firm over one that is not (especially if prices are the same) possibly making the additional benefit greater than the additional cost. The study does show that many firms believe that the benefit gained from an “environmentally clean” image is worth the cost of cleaning up.
Fines and Penalties

Holding polluters financially responsible for pollution and the harm that it causes is another effective economic solution to combat air pollution. If polluters are held accountable for pollution, they will find ways to reduce it, or prevent it altogether. One of the more recent examples of holding polluters financially responsible for pollution is the recent settlement of a hazardous waste case against ExxonMobil. A case was filed in 1996 against Mobil Oil Corporation alleging that the company had mishandled benzene-contaminated waste in Staten Island, NY. The case was settled one week before the case was to go to trial. The settlement was one of the largest in history: $11.2 million. In addition to the settlement, Exxon Mobil must perform cleanup at the site; the cost of cleanup is in addition to the cost of the settlement.

It is important to note that people in management positions are now held responsible for their firm’s pollution. Criminal charges can now be brought against management in corporations, even though the decisions to pollute were made further down the chain of command. Ignorance of the illegal actions no longer protects a person from prosecution.

Fines and penalties force polluters to make better decisions about the release of pollution. Through civil and criminal lawsuits, damaged parties are able to force polluters to pay for the damages that pollution causes.

These economic incentives are proving to be effective tools in reducing air pollution. The EPA has made great strides in reinventing environmental regulations to include economic incentives. Over the last decade, many policies and programs have been put into place to not only meet reduced pollution goals, but also to allow more flexibility in the way firms meet those goals. Fortunately, air pollution is decreasing where many economic incentives are being introduced. Releases of toxic chemicals decreased by 5.3% in 1999 from 1998 levels and by half from the 1988 levels, just two years before the CAAA of 1990 were established. As we will see in later chapters, laws and regulations governing other environmental problems are not as flexible as the Clean Air Act (CAA).
Air Pollution Activities

1. Students should make a list of the sources of pollution (car, factories, etc.) in the area in which they live. Use the information to create a pie chart of which sources the students chose. Compare it to the pie chart of sources nationwide. (Chart can be found at epa.gov)

2. Instruct students to interview at least one adult about air pollution issues (types of air pollution, causes, effects, laws, etc.). Students should write a 2 page paper on misconceptions that the person may have had and explain facts pertaining to those misconceptions.

3. “A Plain English Guide to the Clean Air Act” is located on the EPA website. Students should visit this website to clearly understand the Clean Air Act, it’s missions, and it’s programs. Write a brief summary

4. The EPA website has a list of the names of who bought allowances at the last auction. Have students visit the website. Who bought the most allowances? What environmental groups bought allowances? What other groups participated (For instance, a college club bought at least one allowance from the auction)?

5. To illustrate the effects that air pollution can have on a person’s ability to breathe, give each person ½ of a plastic straw. Have students to put the straws in their mouths and hold their noses. If they are doing the procedure correctly, they will only be breathing through the straw. Ask the students before they get started how long do they think that they will be able to breathe through the straw! Time the students; some will stop before others. Explain to students that many breathing problems result from air pollution. This experiment simulates what it is like to have asthma.
1. EPA Office of Air Quality Planning and Standards. *Plain English Guide To the CAA...Mobile sources.*
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2. TORRO. *British Weather Extremes.* http://www.torro.org.uk/extremes.htm

3. EPA. *Global Warming: Climate.*
   http://www.epa.gov/globalwarming/climate/index.html


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http://Yosemite.epa.gov/opa/a
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CHAPTER 5

Water Pollution

In this chapter we examine following:

- The causes of water pollution
- Point sources and non-point sources of water pollution
- Different types of water pollutants
- Effects of water pollution on man and the environment
- Laws and regulations governing water pollution
Key Words – Chapter 5

- Point source
- Non point source
- Pathogens
- Organic waste
- Chemical pollutants
- Sediment
- Nutrients
- 1899 Rivers and Clean Harbors Act
- Water Quality Act of 1965
Introduction

- Over 70% of the earth's surface is covered with water; 97% in the oceans and seas, and 3% is found in glaciers, lakes, rivers and ground water.

- Water is one of the few necessities of life. Water from the earth's sources also sustains commerce (the fishing industries), agriculture (farming), recreation, as well as our overall quality of life.

- A 1997 "Money" magazine survey found that clean water ranked second on its list among top factors Americans use to choose a place to live.

- Water pollution causes diseases, fish kills, and deformities in marine life. Clean water is essential to our quality of life.
Water Pollution

Water is literally the liquid of life. Without it all life would cease to exist. Yet, over 1.1 billion people lack access to clean water. Over the last decade, most of us have watched in horror the images of marine animals exposed to water pollution: frogs with abnormalities such as six legs or two heads, the dead fish washing up on shores with no reasonable explanation why, or the fish that are found with holes eaten through its body by parasites. Water pollution makes our rivers, streams, lakes and oceans unpleasant to be near; it also contaminates and poisons the seafood that many of us love to eat. Ingesting polluted water causes cancer, and birth defects in unborn children. Protecting water supplies from pollutants, managing irrigation and chemical use, and curbing industrial air pollution are vital steps to improving water quality.

Water Pollution Sources

There are 3 major classifications of water pollution sources: industrial, municipal, and agricultural.

Examples of industrial sources are chemical manufacturers, food processing plants, and product manufacturers. Municipal sources are usually publicly owned water sewage treatment plants. Agricultural sources are those sources that are related to crop production, pastures, feedlots, and animal operations.

Industrial sources are usually point sources; they discharge directly into the waters. Industrial facilities may also be considered non-point sources if their manufacturing process can contaminate rainwater or storm water and be carried into the water supplies.

Municipal sources are also known as publicly owned treatment works (POTWs). POTWs receive sewage from homes and commercial facilities. The POTWs receive and treat the sewage wastewater before discharging it into waters. POTWs are point sources of water pollution.

Agricultural sources are usually non-point sources and are regulated differently than point sources. Pesticides, chemicals, sediment, nutrients, and other pollutants are washed into water sources by rain, or melting snow and ice. We will later see that not only are agricultural sources regulated differently than other sources, but that the economic instruments used to control agricultural sources of pollution are also different.
Point and Non-Point Sources of Water Pollution

The sources of pollution are categorized as point or non-point sources. Point sources are those sources that are easily recognized; point sources discharge pollutants directly into the water such as pipes from factories or even oil spills in the ocean. The Clean Water Act defines a point source as any discernable, confined, and discrete conveyance from which a pollutant may be discharged (1). Non-point sources of pollution are not as easily identified as point sources, and are more difficult to regulate. Examples of non-point sources are runoff from golf courses, city streets, parking lots, and pesticide runoff from farms. With non-point sources, the actual pollutant may be easily identified, but its source is not. For example, the pollutant may be easily recognized as a pesticide, but which farm did it come from? Let's examine the pollutants that these sources are discharging into our oceans and the problems that they cause. We will discuss point and non-point sources of water pollution again when we discuss regulations and economic instruments.

Major Water Pollutants

The major water pollutants are chemical, biological, or physical. These pollutants are generated by a great number of human activities usually from the production of waste. It is important to note the seriousness of water pollution.

To better understand water pollution; let's examine the major types of pollutants and their sources. The major pollutants are usually divided into the following categories: pathogens or water borne diseases, organic waste, chemical pollutants (inorganic or organic), sediments, and nutrients.

Pathogens

Pathogens are the most serious water pollutants. These are disease causing bacteria, viruses, and parasites. Pathogens usually enter water supplies from the excretions of humans or animals infected with the pathogen. The pathogen containing waste contaminates drinking water, food, or swimming areas and is passed to other humans and animals. Epidemics such as typhoid fever and cholera were the results of water borne diseases.
Organic Waste

Organic waste is the waste from human and animals. If this waste is untreated and enters the water supply, which is used by humans, it can cause serious health risks. Another problem with organic waste is that bacteria in the water decompose the waste and in the process removes dissolved oxygen (DO) from the water. The process depletes the oxygen that aquatic organisms need to live. Many fish cannot survive if the DO drops below 2ppm (parts per million). Organic waste can have detrimental effects on water supplies.

Chemical Pollutants

Chemical pollutants consist of inorganic chemicals (heavy metals such as lead, acids, and salts) and organic chemicals (petroleum products such as oil). Other organic products such as pesticides, cleaning products, and solvents also pose serious risks to animals and humans. Chemical pollutants are toxic at even low levels and can make water unfit for consumption.

Sediments

Sediments enter water supplies through erosion of farmlands, deforestation, and overgrazed rangeland. Sand, silt, and clay interfere with the natural flow of water and in some cases reduce the flow altogether. Eggs of aquatic organisms perish because they cannot survive the weight of the sediment. Water pollution from sediment usually takes a backseat to other pollutants, but the U.S. Natural Resources Conservation Agency estimates that sediment damage costs the U.S. over $6 billion dollars per year (2).

Nutrients

Nutrients are essential for healthy animal and plant growth but in excess can cause severe problems in water supplies. An overabundance of nutrients, such as nitrogen and phosphorous, can cause excessive growth in algae and other water vegetation. This excessive growth blocks the light needed for other aquatic life, and uses up the dissolved oxygen that is needed. Nutrients usually enter the water supplies from non-point sources such as runoff from farms.
Laws and Regulations

The first federal legislation to protect the nation’s waters was the “1899 Rivers and Harbors Act.” The purpose of the Rivers and Harbors Act was to promote commerce and addressed the issue of navigability.

In 1948, the Federal Water Pollution Control Act (FWPCA) was passed and provided technical assistance and funding to states and local governments to improve water quality. By this time, the government had recognized the seriousness of the water pollution problem. The FWPCA was amended in 1956 and strengthened enforcement of the Act.

Two other Acts, the Water Quality Act of 1965, and the Water Quality Improvement Act of 1970, expanded federal authority by allowing provisions of water quality standards that were state and federally enforceable and established a state certification program to prevent water degradation.

By 1972, it was obvious that the effort to control water pollution was at best piecemeal. In 1972, the Clean Water Act (CWA) placed the task of cleaning up the nation’s water to the newly organized Environmental Protection Agency (EPA). The Clean Air Act of 1972 establishes the NPDES permit program (which requires permits for any pollution discharge), strengthens water quality standards, and provides billions of dollars for construction of sewage treatment facilities.

The CWA was amended again in 1977. The new amendments allowed states to assume responsibility for programs under the federal government and also strengthened regulations on toxic pollutants.

The 1987 amendments addressed urban stormwater runoff and non-point sources of water pollution. Section 319 established the NPS Pollution Management Program, which placed control in the hands of individual states.

The CWA requires major industrial sources to meet performance standards. The Act also gives states the authority to set water quality standards and goals, and creating the programs to meet those goals. The CWA also provides financial support to states to help meet the goals of the CWA.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) was passed in 1974 and amended in 1986 and 1996. The SDWA of 1974 focused on treatment to provide clean drinking water. Under the SDWA, the EPA sets national standards for drinking water, as well as maximum levels of contaminants. Requirements for water systems to test for and
treat water contaminants are also set forth in the SDWA. The SDWA requires that the public is notified of any water systems' violation and that customers receive an annual report on levels of contaminants found in their drinking water. The Act requires disinfection and filtration of surface water supplies, and establishes a multi-billion dollar loan fund for water systems upgrades.

Point Source Regulation

Point Source pollution is more readily regulated than non-point sources. All point source dischargers are required to have a permit to discharge into any waters in the U.S. The National Pollutant Discharge Eliminator System Permit Program (NPDES) regulates point sources of pollution by requiring that those sources have a permit to discharge directly into waters. Federal Water Pollution Control Act (FWPCA) Amendments of 1972 required a discharge permit for discharges and the amendment limited the amount of pollutants that could be discharged.

Discharger fees under the NPDES system vary according to discharge volume and toxicity. The fees are to discourage polluters by making it expensive to pollute. One of the complaints about the NPDES system to control pollution is that the permit fees are modest in comparison to control cost. There is more incentive to pay the fees than to control pollution.

The NPDES Permit consists of:

- Cover page - contains name, location of permittee, specific discharge and location of discharge

- Effluent limits - gives limits amounts for pollutant that is being discharged

- Monitoring (reporting requirements) – gives requirements for monitoring and reporting discharges (usually due on a monthly basis)

- Special and standard conditions – special conditions are those in addition to effluent limit guidelines (standard conditions) (3)

The NPDES program regulates point sources of pollution from industrial and municipal sources. The program establishes effluent limits to protect water supplies. The NPDES excludes irrigated agriculture and agricultural storm water runoff.
The noncompliance fines under NPDES can be staggering. Civil fines can range up to $25,000 per day for each day that the discharger is not in compliance. Maximum punishments are $500,000, thirty years in prison, or both (4).

Non-point Source Regulations

The Clean Water Act Amendments of 1987 concentrated heavily on the need to control non-point sources of water pollution. The amendments of 1987 required states to develop “non-point source management programs” (5). Section 319 of the CWAA of 1987 holds states responsible for the control of non-point sources of pollution. Under Section 319 of the amendments, states are required to submit an assessment of waters within the state that, without further action to reduce pollution from non-point sources, could not reach acceptable water standards. In other words, the 1987 amendments placed the burden of controlling non-point sources of water pollution on the states. Under Section 319 states receive grant money to help implement non-point pollution control programs.

Economic Instruments to Control Water Pollution

Taxes, Charges, and Fees

Taxes, charges, and fees are effective in reducing water pollution for both point and non-point sources of pollution. They are especially effective for reducing non-point sources. Remember, non-point sources are harder to control because the sources are dispersed and are therefore harder to identify and regulate. These instruments make polluting more expensive and encourage the polluter to control pollution. For example, if a tax is added to a fertilizer that is known to affect water quality, the tax makes that product more expensive to use. The farmer will be encouraged to cut operating costs and will try to find a less expensive fertilizer. Remember the law of demand; the lower the price of a good, the more consumers will consume. Figure 7.1 demonstrates the demand for the fertilizer. At a price of $50 per bag, consumers will purchase 60 bags of fertilizer. But look at what happens when a steep tax is added on to the cost of the fertilizer. Let’s add a tax that doubles the price to $100. (Our tax is an increase of 100% here; the tax should be large enough to change the behavior of the polluter.) The quantity demanded drops to 50 bags.
The tax will encourage farmers to find a lower cost fertilizer to use, and it reduces the use of the fertilizer that has a negative effect on water quality. Taxes, charges, and fees force the polluter to internalize the cost of his/her actions. These instruments are especially effective for non-point sources of pollution. Non-point sources of pollution are more difficult to regulate because the sources are harder to identify. By taxing input products (the fertilizer in this case), the polluter pays for the damage that the actions are known to cause, even if the damage cannot be traced back to him/her.

**Effluent Trading**

Effluent trading is similar to the emissions trading that we discussed earlier in the air pollution chapter. Unfortunately, the practice of effluent trading has not been as widespread as emissions trading and therefore has not had the same success. Effluent discharges and the regulations governing them are very different than air emissions. These differences make it more difficult to create an effective program for effluent trading.

The first national effort to encourage effluent trading was a result of the "Reinventing Environmental Regulation" program that President Clinton started in 1995 (6). The state of Wisconsin began its first effluent trading pilot program in 1997.
The program allowed point source trading between discharges with permits. Those sources (discharges) that were able to control waste at levels lower than the permit allowed, sold its permit. Those sources that controlled less than what the permit required bought permits. There were restrictions placed on who could participate; buyers must be a new facility, an existing facility increasing production, or a facility that through optimal operation still could not meet permit limits.

Pollutant trading can take place between point sources. Point sources are easier to monitor and require a permit to discharge, and are easier to trade. The sources have permit limits, therefore through monitoring the sources can determine the amount of pollutant that each source is discharging into a given body of water. Point/Non-point trading is not as clear-cut. There is no permit for non-point sources of pollution, therefore the amount of pollutant is harder to pinpoint. The non-point source will have to be willing to reduce their pollutant load by such actions as reducing or eliminating input products, which contribute to water pollution.

Let's look at the Tar-Pamlico Nutrient Reduction Trading Program. It is considered an effluent trading success story.

The Tar-Pamlico River is in an area of North Carolina where the majority of the land is used for agriculture and livestock operations. In the late 1980s increased algae blooms and fish kills resulted from nutrient loading of nitrogen and phosphorus into the river. In 1989, the Tar-Pamlico was designated as Nutrient Sensitive Waters (NSW) and required under state law implementation of management plans for point and non-point sources. The dischargers in the area formed the Tar-Pamlico Association. In 1989, the association proposed nutrient trading between point and non-point sources to reach the nutrient goals. Nutrient concentration limits were set and in 1992, nutrient trading among point and non-point sources began. Under the program dischargers are allowed to implement cost effective ways of pollution reduction through trading. At the end of Phase 1, nutrient discharges had been reduced by 28% (7). It has been estimated that without trading, this reduction would have cost approximately $7 million; through trading reduction goals were met for $1 million (7).

Subsidies

To control non-point sources of pollution, farmers have to be included in the overall scheme of providing economic incentives to reduce water pollution. Cost-sharing and incentive payments (subsidies) are used to encourage farmers to adopt practices. Through cost sharing, federal or state governments cover some or all of the cost of implementing better management practices for farmers. The government for all or part of the cost reimburses farmers. Incentive payments are designed to encourage farmers to use new technologies to help reduce pollution; incentive payments reduce the financial burden of installing the new technologies. One point
needs to be made about subsidies such as cost sharing and incentive payments; the subsidies must continue to encourage the use of new technological advances as they become available. Subsidies such as these can become very expensive. One example is a program to retire cropland and plant grasses to reduce soil erosion. Farmers are paid to not cultivate their land, and are paid as long as they keep the land out of use. Over the years, programs such as this can become very expensive. It is estimated that costs to encourage improved management practices on 176 million acres of cropland has cost $3.6 billion (8).

Clean water is a necessity for life. Through regulations such as the Clean Water Act and its amendments, and more recently the economic incentives that have been incorporated into these laws, our waters are becoming cleaner. Economic incentives are being used to control sources of water pollution that cannot be controlled strictly through regulations. Hopefully, programs such as the effluent trading program will become a major tool in reducing water pollution.
Water Pollution Activities

1.) Each year "E" Environmental Magazine lists the 13 most endangered rivers in America. The list for 2001 follows:

- The Missouri River
- The Canning River
- The Eel River
- The Hudson River
- The Powder River
- The Mississippi River
- The Big Sandy River
- The Snoqualmie River
- The Animas River
- The East Fork Lewis River
- The Paine Run River
- The Hackensack River
- The Catawba River

Assign one river to each student (or group of students) to research. Report should include: why is the river considered endangered? What has been the cause (industry, soil erosion, agricultural run-off, etc.)? Is the source a point or non-point source of pollution? What programs are being implemented to clean up the river? What economic instruments would the student recommend to clean up the river?

2.) The EPA website has a summary of several effluent trading programs throughout the U.S. Students should visit the website, choose a program to report on, and write a short summary. The summary should include:

- Body of water that is affected
- State where water is located
- Problem addressed by the program (sediment nutrient loading, metals, etc.)
- Is the program between non-point sources, point sources, or both
- When was the program started
- What group oversees the program
3.) Divide students into three groups. Each group should design (in words) a town or city that they would like to live in. The town should have all of the businesses and manufacturers that it needs to supply the town with the resources that it needs to function. For example, the town would need farms, a water treatment facility, schools, shopping centers, laundromats, car manufacturers, factories, homes, paving companies, etc. Include population numbers. What is the main source of income for the town? Encourage students to be creative.

Once students have finished describing their town, exchange the descriptions with the other groups. Each group should have one description from another group. Instruct the students to create water quality problems for the town using the industries, farms, and other entities of that town. For example, agricultural run-off from the farms is creating algae blooms in the rivers. The algae blooms are reducing oxygen for the fish. Dead fish are washing up on the riverbank. Students should create several water quality problems from different sources.

Once the students have finished creating water quality problems, give those problems to the students who originally created the town. Now the students need to decide how to solve their water quality problems. The solutions should include economic instruments designed for each specific source of pollution. For example, is the source a non-point or point source? How are those sources regulated? What economic incentives are used to reduce the pollution? What is more effective for each particular source (taxes, subsidies, effluent trading, etc.)? Why? Encourage students to be creative.
Literature Cited
Chapter 5


CHAPTER 6

Water Scarcity

In this chapter we examine following:

- Natural and human factors contributing to the water crisis
- Examples of areas with severe water shortages
- Adequate pricing of water
- Creating private property rights for water
- Creating markets for trade of water
Key Words – Chapter 6

- Illusion of plenty
- Tragedy of the commons
- Commons
- Underpricing
- Water markets
Introduction

- Over the last 50 years increases in population, agriculture, and industry have put a tremendous strain on water supplies leading to a shortage of this precious natural resource. In this chapter we will examine the causes of water shortages, areas that are hardest hit by these shortages, and economic solutions to solve this crisis.

- Most people do not realize that there is a water crisis. The good news is that water shortage is one of the environmental problems that can be easily “fixed” through economic tools such as privatization, appropriate pricing, and markets.

- Please note that we do not have a section in this chapter on regulations. There are no Federal laws and regulations governing the issue of water supplies. Those regulations that are in place are issued by each state and are too numerous to cover here.
Water is a necessity for life. It sustains us and everything else on Earth. The World Watch Institute reports that the number of people living in water-stressed countries is projected to climb from the current 470 million to 3 million by the year 2025. (1). Rapid human population growth, decreased rainfall, man-made engineering systems (such as dams), and depletion of groundwater resources all contribute to our current water crisis. Overall water supplies are abundant, but are not distributed evenly throughout the world. Currently twenty-six countries fall into the water scarce category.

The tables below (table 8.1 and 8.2) list the ten countries with the most renewable water resources and the ten countries with the least renewable water resources. Those countries whose annual supplies are at least 1,000 – 2,000 cubic meters per person are considered water stressed. Those countries with less than 1,000 cubic meters per person are considered water scarce. Notice that the ten countries with the least renewable resources are considerably under the levels to be considered water scarce. We will also see later that many of the nations that are water scarce have rapid human population growth, which puts even more pressure on water supplies.

### Countries With Most Renewable Water Resources (2)

<table>
<thead>
<tr>
<th>Country</th>
<th>Cubic Meters Per Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland</td>
<td>606,498</td>
</tr>
<tr>
<td>Suriname</td>
<td>452,489</td>
</tr>
<tr>
<td>Guyana</td>
<td>281,542</td>
</tr>
<tr>
<td>Papua–New Guinea</td>
<td>174,055</td>
</tr>
<tr>
<td>Gabon</td>
<td>140,171</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>107,194</td>
</tr>
<tr>
<td>Canada</td>
<td>94,373</td>
</tr>
<tr>
<td>New Zealand</td>
<td>88,859</td>
</tr>
<tr>
<td>Norway</td>
<td>87,691</td>
</tr>
<tr>
<td>Republic of Congo</td>
<td>78,668</td>
</tr>
</tbody>
</table>

Table 8.1
Countries with Least Renewable Water Resources (2)

<table>
<thead>
<tr>
<th>Country</th>
<th>Cubic Meters Per Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuwait</td>
<td>11</td>
</tr>
<tr>
<td>Egypt</td>
<td>43</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>64</td>
</tr>
<tr>
<td>Libya</td>
<td>100</td>
</tr>
<tr>
<td>Jordan</td>
<td>114</td>
</tr>
<tr>
<td>Mauritania</td>
<td>163</td>
</tr>
<tr>
<td>Singapore</td>
<td>172</td>
</tr>
<tr>
<td>Moldova</td>
<td>225</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>232</td>
</tr>
<tr>
<td>Yemen</td>
<td>243</td>
</tr>
</tbody>
</table>

Table 8.2

To illustrate the severity of the water crisis, let’s look at some areas that are experiencing problems with lack of water.

High Plains, USA

The Ogallala Aquifer is the largest aquifer in North America, underlying 174,000 miles from Texas to South Dakota. The water in the Ogallala has been held there for thousands of years and if completely depleted, would take 6,000 years to replenish. Currently the aquifer is the subject of much controversy due to rapid depletion of its water supply. The water from the aquifer is used to irrigate millions of acres of crops in the High Plains area, much of which is to feed livestock.

The area that the Ogallala supplies water to has had a history of repeated droughts. The soil is fertile but dry. Technological advances in the early 1900’s allowed drilling to access water in the aquifer and turned the region into an agricultural miracle.

Currently the aquifer is being depleted at a much faster rate than it is being replenished. As of 1999, 24% of the Texas portion had been depleted. In some places depletion had reached 95% in 1982(3). The State of Texas has estimated that at the current rate of use and without imported water, 60% of the acreage that is irrigated will have to be abandoned by the year 2020 (4).
Middle East

The Middle East has some of the highest human population growth rates in the world. Water is a big concern for the nations in this region. After signing the peace accords with Israel, Egyptian President Anwar Sadat stated, "the only matter that could take Egypt to war again is water." In 1990, King Hussein of Jordan stated that water was the only issue that could take Jordan to war with Israel (5). Israel, Jordan, and the occupied West Bank all share the water of the Jordan River basin. Israel's annual use already exceeds its renewable supply of 15 percent. Jordan's population grows by 3.4 percent annually, which also puts a strain on the river's water supply. Among these problems, there is also a conflict between Israel and the countries of Jordan and Syria over a plan by the latter countries to build a dam on the Yarmuk to increase their supplies of water. Israel fears that the dam will interfere with the flow of water into the Jordan River, reducing its water supply. Israel has been able to block the plan for now, but again, it is an issue that could bring these countries to war.

China

China, the world's most populous country, is home to 22% of the world's total human population, but has access to only 7% of the world's freshwater supply. Beijing's water tables are falling 5ft. per year. The Yellow River, China's main source of water, first ran dry in 1972 for 15 days. For the last 10 years, the Yellow River has completely dried up before reaching the sea for an average of 70 days per year. In 1997, the river ran dry for 226 days, more than one half of the year (6). China's freshwater supplies are estimated to supply only ½ of the over 1 billion people with fresh water.

World Water Usage

World water usage has tripled over the last 50 years. 70% of all water withdrawn from rivers or underground sources is used for irrigation of crops to feed a rapidly increasing human population. It is estimated that worldwide underground sources of water are being over pumped by 160 million tons each year (7). In the United States the average use per person per day is 120 gallons. In less developed countries average use is less than 5 gallons per day per person.
Factors contributing to the World’s Water Crisis

In the book *The Last Oasis*, Sandra Postel begins by comparing and contrasting the daily use of water in the lives of two children, one in the city of Phoenix, Arizona, the other in the east African town of Lodwar, Kenya. The child in Phoenix has the luxury of having water at his disposal at the touch of a tap and probably uses an excessive amount because it is so readily available. The child in Lodwar, on the other hand, has to walk several hours to a spring just for a couple of jugs of water. His family uses only about 5% of the water that the family in Phoenix uses. At first a person may think "well, of course there would be less water available to the child in Lodwar than the child in Phoenix". What is surprising about this scenario is the fact that both cities only receive 16-18 centimeters of rainfall each year, limiting the amount of water that is available. Also both cities have high populations that put an even more forceful strain on the water supply. The scarcity of water and overpopulation are the only things these cities have in common. In Lodwar, the water crisis is an everyday fact of life; one that is not only noticeable but permeates through every part of their lives. Phoenix on the other hand, gives what Postel refers to as an "illusion of plenty". This illusion causes more damage in the long run for water scarce areas like Phoenix. It leads to over consumption and abuse of a resource that may be renewable but depends on natural sources, such as rain, that are beyond our control. Areas that have what seems to be an abundance of water this year may be in a water crisis in 5 years.

The story above illustrates that the water crisis is affecting us globally. The children in Kenya, like many African nations, are suffering from lack of rainfall and severe droughts. Our freshwater supplies are replenished through rainfall; so obviously, in periods of drought freshwater supplies decrease. Namibia, a country in sub-Saharan Africa is the driest country in that region. Nearly 83% of all rainfall evaporates as soon as it falls. The rivers that are accessible to the country are seasonal flowing rivers and run dry several months of the year.

Droughts can be devastating to the economy, especially in less developed countries (LDCs). A large percentage of the population in LDCs depends on agriculture as a way of life. These people literally live off the land. Their food, water, and fuel all come from farming the land. Droughts devastate crops and livestock; lack of water can bring these areas to their knees.

Natural factors contributing to water scarcity currently seem to have a greater effect on LDCs than the more developed countries. MDCs have the means to manipulate water supplies to provide water to areas that need it.
Human factors have played a major role in creating the current water crisis. Rapid population growth is without a doubt the major factor in water shortages. Rapid population growth puts a tremendous strain on freshwater supplies. Over 70% of all water drawn from rivers and underground sources is used for irrigation to feed the over 6 billion people living in the world today (8). We add another 80 million people each year. 80 million more people who will need water. Water is renewable, but it is not infinite. Water use in agriculture will have to increase even more to keep up with the demand for food. Most of the increase demand for food will be in the LDCs, where the highest population growth rates exist.

California is a good example of how natural and human factors (population growth) affect water supplies. California is in a water crisis, and it is expected to rival the power shortages that California has been experiencing. The population in California has increased by almost 6 million people in the past 10 years. That is an annual growth rate of 1.3% (the natural rate of increase for the U.S is .55%). The population growth in California is expected to produce a shortage of 4.2 million acre-feet of water by the year 2020 (9). To fuel the water crisis even further, is the drought that California has been experiencing. Like many other areas in the U.S., California has not received as much rainfall as it has in the past.

Economic Factors & Instruments to Solve the Water Crisis

There are several economic factors that contribute to over-consumption and abuse of water. First of all, water is part of the commons; there are very few places where people actually have property rights to water. Secondly, water is grossly under priced, which leads consumers to value it less and continue to consume additional units that have low marginal value. And last, but not least, there is not a system of exchange for water except in those areas where people do have property rights to water. Correcting these economic problems is the first step in easing the strain that we are placing on our water supplies.

Tragedy of the Commons and Property Rights

In most areas water is part of the commons; it is owned by no one, but available to everyone. This situation leads to what is called the “tragedy of the commons.” Commons refers to any resource that is shared among a group of people, but owned by no one. Air and water are examples of commons. Each person has a right to use (and abuse) the resource, but no one is responsible for making sure that it is used in a
reasonable manner. Garrett Hardin coined the phrase “tragedy of the commons” in a 1968 article for *Science* (10). Today tragedy of the commons is used to describe a major reason for many of our environmental problems. Water scarcity is no exception. By assigning private property rights, owners are more likely to take care of and protect water supplies especially if they are receiving the costs and benefits of protecting it. Lack of property rights is one of the reasons that it is hard to use economics to solve water shortage issues. Property rights to water would allow markets to be created for the selling and buying of water.

**Adequate Pricing**

In Chapter 4, we discussed how the law of demand and low pricing affects the demand for goods. By raising the price of any good, including water, we make it more expensive to consume. For instance, if water prices were to triple, more households and businesses would use less water. Under pricing of water gives an illusion that there is plenty of water and leads to over consumption of resources. If you were to ask someone what three things that they had to have to live, water would be on that list. And yet, water is probably one of the least expensive resources that we use. Under-pricing not only gives us the illusion that there is plenty of water, but because it is so cheap we tend to value it less. Heyne points out in his book *Microeconomics*, that “the incentive to economize is weak when the cost of using is low” (11).

Let’s look at how inadequate pricing encourages a shortage of water supplies. When prices are set lower than equilibrium price, the price where quantity demanded is equal to quantity supplied, consumers are encouraged to use more of the resource. Point A on the graph below (Fig. 8.1) represents market equilibrium; the quantity demanded is equal to the quantity supplied. But look what happens when the price is set lower (P1) than the equilibrium price. At the lower price, consumers will consume at point B or Quantity Q1. Please note that increased demand alone does not cause the shortage. Supply also plays a role. Point C on the graph represents the quantity supplied when prices are below the equilibrium price; it is considerably lower than the quantity supplied at the equilibrium price (A).
What would happen if the price of water were raised to represent its true value? At first, it is easy to think that the response would be minimal; water is a “necessity”; we all have to have it. Presently the price of water represents a very small portion of most of our incomes. There are few, if any substitutes for water. Raising the price should not make people use or buy less. But this is not necessarily true.

If the cost of Consumer A’s water usage was usually $40.00 per month and the price doubled to $80.00, Consumer A will take steps to consume fewer units. While there are some uses of water that cannot be cut back, such as cooking or showering, there are many uses of water that would be reduced. For example, any leaky faucets would be repaired, wash loads of clothes would probably be larger and less frequent, and a brick may be placed in the back of the toilet to use less water when flushing. Raising the price of water will help conserve water and may force consumers to place a higher value on it.

Adequate pricing would also impact the biggest consumers of water: those who irrigate crops. Remember, 70% of water consumed is used to irrigate crops. Yet, water used to irrigate crops is the least expensive water to purchase. Excessive use of water for irrigation is encouraged through a type of subsidy. Most of us do not pay the full cost of water; through water subsidies farmers pay even less than we do. For example, in the city of Santa Barbara, California, water costs $1600 per acre-foot; farmers in the surrounding area pay only $100 per acre-foot (12). The result is the same for land irrigation as our example in the previous graph; prices below the equilibrium price.
encourage higher consumption. If the farmers in the Santa Barbara had to pay full price, their water usage would decrease. Many of these farmers would grow less water intensive crops, or find more efficient ways to use water. Note that many of these “farmers” are multimillion dollar corporations; taxpayers are picking up the tab for their water bills.

Markets

Water markets are increasing throughout the world to solve water shortage problems. In areas such as the High Plains region of the U. S., the residents who have property rights to water are able to sell the use of their water to other residents. This exchange not only increases the wealth among residents, but it also helps to conserve water. The opportunity cost of keeping water that could otherwise bring a handsome income convinces many residents to sell their water. For example, in those cities where water is scarce, there is an active market, which allows cities to pump water from rival areas into the cities. The result is that cities get the water that they need and the rural areas, which are generally poorer, are wealthier by selling the water. This exchange benefits both parties.

Examples of successful markets that have been created:

In 1991, California established the Emergency Drought Water Bank (EDWB) to purchase water from farmers at $125 per acre – foot. The EDWB sold the water to municipalities and other agricultural users for $175 per acre – foot. By midyear, the EDWB had purchased 750,000 acre – feet of water.

The Northern Colorado Water Conservation District allows thousands of acre – feet of water to be traded through private transactions. This program operates with virtually no interference from the government. The result has been one of the most developed water markets in the nation. The market provides water for agriculture as well as citizens in Denver.

Water markets are more common in the west than other areas of the U.S. Utah, Nevada, Oregon and other states are using markets in innovative ways to supply needed water, and protect our most precious natural resource.

Chile has one of the most notable water market systems in the world. Through price reforms and the creation of water markets, water used for irrigation has dropped over 26% (13). Chile grants existing water users property rights and auctions new water rights. Rights can be sold or traded at any price; these rights can also be used to secure bank loans.

Many states are beginning to put water market systems into place to satisfy the water needs of its people. More markets exist today than ten years ago. Creation of
markets for buying and selling of water could have a tremendous impact on the way water is valued.

Many states and countries have water markets in place to satisfy the water needs of its people. In the U.S., especially the West, more markets exist today than ten years ago. Appropriate pricing and creation of markets for the buying and selling of water could have a tremendous impact on the way water is valued. Conserving water and encouraging a more sound pattern of water use requires major changes in the way water is valued. Appropriate pricing, assigning property rights, and creating markets that operate without government interference are the first steps in achieving those goals.
Water Scarcity Activities

1.) Have students to keep a log of water consumed (drinking, shower, cooking, washing the car, etc.) for one week. After one week, the students should calculate the estimated water usage. Tell students to keep a log of water consumed for a second week. During class help the students calculate their water usage using the following figures for that week. Each American uses an average of 120 gallons per day.

- drinking/cooking: 10 gals
- toilets: 100 gals
- bathing: 80 gals
- laundry: 40 gals
- watering lawns: 100 gals

If the student ate a fast food hamburger, fries, coke, add 1500 gals. (this includes raising the beef, growing the potatoes and producing coke)

What is the difference between the estimated water usages for the two weeks?

Explain to the students that we all consume more water than we think. Americans use more water per day to flush their toilets than many people use in the entire day for all their water needs.

Tell students to record their water usage for one more week. For the third week, students should try to reduce their water usage. After the third week, have the students to share with the class how what usages they were able to do without.

2.) When students come to class, there should be several cups of water in the front of the class. Place a sign on the front door that reads “Water Auction Today”. Divide students into groups and give each group an equal amount of play money. The purpose of this activity is to demonstrate to the students how valuation of resources and the price we are willing to pay for those resources are connected. If a resource is scarce and we value that resource, we will be willing to pay more for it. Students should not be told what each cup of water represents until it is time to bid on that cup of water. Explain to the students that the cup is enough to last them for the rest of their lives.
Here are some suggestions for the auction:

1st cup of water—represents the last available water on earth to wash the car (or the dog if the students are too young to drive; be creative). There will probably be few, if any, bids for this cup of water.

2nd cup of water—represents the last available water on earth to use for baths, showers, toilet, etc.

3rd cup of water—represents the last available water on earth to use for growing food.

4th cup of water—represents the last available water on earth to use for drinking water, cooking.

3.) Visit the National Oceanic and Atmospheric Administration website (noaa.gov). The site has a drought monitor and drought information center.

4.) The USGS Waterwatch website (usgs.gov/waterwatch) has maps with color-coded areas for measuring water resources. Assign students different states to report on.

5.) National Drought Mitigation Center Website (drought.unl.edu) has color-coded drought information.

Students should visit these sites and write brief summaries. Include the following information:

Which areas are the driest?
Are the majority of the areas considered drought or drought watch areas?
What are the drought conditions in Virginia? California?
Literature Cited
Chapter 6


13. World Resources Institute. *WRI study reveals how cheap water causes scarcity, ecosystem decline.*
http://www.wri/press/cheapwater.html
CHAPTER 7

Biodiversity Loss/ Endangered Species

In this chapter we will discuss the following:

- Causes of Biodiversity Loss/Endangered Species
- The Endangered Species Act (ESA) and controversies
- Current economic approaches to protecting endangered species
Key Words – Chapter 7

- Biodiversity
- Endangered species
- Endangered Species Act (ESA)
- Section 7
- Section 9
- “Take”
- “harm”
- Economic Value
- Safe Harbor Agreements
- Candidate Conservation Agreements with Assurances
- Campfire Program
Introduction

- Endangered Species Protection is a controversial issue in this country. Species are becoming extinct faster than any other time in history.

- Currently over 1200 species are listed as endangered or threatened. Only 27 species have been recovered since the ESA was passed in 1973.

- The Endangered Species Act (ESA) was passed in 1973, and provides Federal protection to endangered species.

- Many people feel that the protection of endangered species denies citizens their 5th Amendment Rights to own private property and to "just compensation" when property is restricted.
Biodiversity Loss/Endangered Species

What is biodiversity?

Biodiversity loss, most commonly understood as endangered species, is one of the most crucial (and controversial) environmental problems facing the world today. Exploding population growth, destruction of natural habitats, global warming, and air and water pollution are driving many species to extinction at an unprecedented rate. Reducing biodiversity loss has proven to be a very unpopular task. Often times it results in what many consider an obstruction of their Fifth Amendment rights. As we will see later in this chapter, protecting the environment sometimes means that the government places restrictions on a citizen's right to use his land in a way that is most beneficial to that citizen.

The term biodiversity is easy to define; it simply means the variety of life. Biodiversity touches every aspect of our lives, and yet most of us think of it as being "out there" in the tropical rainforest or the Galapagos Islands. We do not realize that the aspirin that we take was derived from the willow tree, or that the coffee plant that so many of us need for that morning jolt would not be possible without the insects that pollinate it. Biodiversity is very much the fabric that not only holds those ecological systems such as the rainforest, oceans, and other habitats together, but it is a crucial part of man's own survival; without it we would cease to exist.

At this point, it is a good idea to explain why we chose to use the term "biodiversity loss" instead of "endangered species" to introduce this problem. Usually when someone thinks of endangered species, the bald eagle or the spotted owl comes to mind. And while species such as these are important, they are not the only ones that we have to be concerned about. There are more insects and plants at risk of extinction than the more cuddly animals that we think of when we hear the words "endangered species"; these insects and plants are extremely important to man's own survival.

Until recently, it had been believed that there were approximately 5 million different species on earth. Collections made by Terry Erwin in the Peruvian Amazon Rainforest discovered such a high number of previously unknown insects that the estimate was raised to 30 million, taking into account all rainforests in the world (1). Currently most scientists agree that there are somewhere between 5 and 30 million species on earth. Of that number only 1.4 million have been described. There are approximately 750,000 species of insects, 41,000 species of invertebrates, and 250,000 species of plants. Species loss or extinction is difficult to estimate for the
simple reason that no one knows how many species there are. Even the estimate of 5 to 30 million is believed to be too low.

Species loss or extinction is a natural process, but overpopulation and other environmental problems have increased the rate of extinction. The natural rate of extinction is approximately 1 species per year, while the current rate is estimated to be anywhere from 10 to 1000 times higher (2). A total of 1,622 extinctions have been documented since 1600, and 26, 106 species are considered threatened. Humans contribute to the loss of species diversity by conversion of natural habitats, pollution, overfishing, and through man-made environmental problems such as global warming.

Causes of Biodiversity Loss

Loss of habitat is the number one cause of biodiversity loss, especially in the tropical rainforest, which is the richest in biodiversity of any other habitat. Tropical rainforests are the centers of biodiversity. Although rainforests comprise only 7% of the earth's surface, they contain over half of the species in the world. Rainforests are inhabited by 45% of all plant and animal species, including 30% of all bird species and 96% of all anthropoid species (3). Wilson points out in his book Biodiversity that while visiting Peru he recovered forty three species of ants belonging to twenty six genera from a single tree (4). A river in Brazil contains more species of fish than all the rivers in the United States. Rainforests are rich in flora diversity too. In one study, 300 tree species were found in single 2.5-acre plots in Peru; there are only 700 species in all of North America.

The tropical rainforests are being destroyed at an unprecedented rate, causing a mass extinction of species. It has been predicted that if present levels of destruction continue, there will be a loss of 12% of the 704 bird species in the Amazon basin and 15% of the 92, 000 plant species in South and Central America (5). Destruction of rainforest habitats is the main cause of biodiversity loss. Even though no one knows the actual rate of extinction in the rainforests (we can't know what we have lost if we don't know what we have had) it has been estimated that 50, 000 species have been lost in the last 35 years (6). This averages out to about 1,500 species per year.

Most people, especially in this country, tend to see biodiversity loss due to the destruction of the habitat as only occurring in the tropical rainforest. And while deforestation in these areas is a major threat to biodiversity, the United States has its share of the blame. The difference is that our contribution to biodiversity loss isn't as simple as cutting down trees or human population growth. It is also the result of poor land management (drive through any town and look at the sprawling development of shopping centers, neighborhoods, and parking lots) and technological advances such as automobiles and mass transit. The conflicts between environmental protection and urban development are a fact of life in most parts of
this country. These conflicts develop between environmentalists and developers when protection of a species interferes with housing or economic development.

Protection of biodiversity/endangered species

Protecting biodiversity has been a goal of international law for quite some time. The first wildlife treaty dates back to 1902; it was called the Convention for “The Protection of Birds Useful to Agriculture.” Today there are several dozen international treaties as well as international organizations whose main goal is to preserve biodiversity. In 1992, the Convention on Biological Diversity was opened at the United Nations Conference on Environmental and Development in 1992 after concerns were raised from organizations like the WWF.

Federal intervention to protect endangered and threatened species began with the Lacey Act, which placed restrictions on interstate trade and transport of wildlife. Congress intervened in 1966 and 1969 by passing endangered species preservation acts. The Endangered Species Act is a powerful law that makes an effort to protect biodiversity/endangered species. But how well is it working? Let’s look at the economic issues that surround protection of endangered species. We will also look at programs and organizations that have used economic incentives to accomplish the goal of species protection, usually with exceptional results.

The Endangered Species Act states that economic factors are not to be considered when placing a species on the list; only biological factors are to be considered. Critical habitat should also be determined. Critical habitat simply means areas that are necessary to the conservation of a species (Amendments to the Act in 1978 do allow some consideration for economic factors). But is it realistic, not to mention fair, to make regulations without considering the economic consequences? Let’s take a closer look at this controversial law and the impact that it has had, both on protecting species from extinction and the private property rights of citizens.

The Endangered Species Act of 1973

In 1973, a new Endangered Species Act (ESA) was enacted and created a renewed awareness in environmental legislation. The ESA combined and strengthened the previous Endangered Species Preservation Act of 1966 and The Endangered Species Conservation Act of 1969. The Act states as its purpose to “provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide for a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth...” (Endangered Species Act, Section 2) (7).
Species are placed on the list in several ways. Government agencies such as the U. S. Fish and Wildlife Service or the National Marine Fisheries Service may recommend placement of species on the list. Private citizens and private organizations may also recommend species for the list. As of December 31, 2000, 1244 US species were listed, of which 508 are animals and 736 are plants (8).

Species can also be classified as "candidate species" while waiting to be listed. Presently there are more than 3,600 candidate species. Classification of candidate species is either Category I or Category II. Category I species are those that agencies have enough information to warrant listing. Category II species may warrant listing but more information needs to be gathered.

The US Fish and Wildlife Service (FWS) and the National Marine Fisheries Service administer the ESA. Once a species is placed on the Endangered Species List, the U. S. Fish and Wildlife Service (USFWS) is responsible for developing a recovery plan. The plans include implementation schedules, which give priority to recovery tasks, identify cost and length of time, and identify agencies responsible for recovery. Once a species is no longer considered threatened or endangered, it is taken off of the list. There have not been many that have been removed from this list; usually once a species is endangered, its chances for survival are marginal. There have only been 27 species removed from the list since the inception of the ESA. Considering that there have been over one thousand species listed, many believe that the ESA is not working.

Controversy and the ESA

There is probably no other environmental law that provokes more passion than the Endangered Species Act (ESA). For over 28 years the ESA has been the subject of much controversy and conflict. The conflict is between Environmentalists who want to protect biodiversity/endangered species at any cost to economic growth, and private property owners and developers who believe that they should be allowed to use their land without government restrictions which forces them to protect species. The ESA appears to be a powerful law that is administered in a way to make it ineffective for species protection, while at the same time having power to affect the land use of private property.

The controversy with the ESA is that it restricts private landowners from using their land in ways that would benefit the landowner. In other words, the ESA tells citizens what they can and cannot do with private property. Under the 5th Amendment, the government cannot "take" a person's property without "just compensation." The problem with the ESA is that the property is not actually taken, it is only restricted. The property owner cannot develop or in many cases use the land that is habitat for the endangered species. Therefore no compensation is made.
Over 50% of endangered species occur on land that is privately owned (9). To encourage protection of these species, it is imperative that the government agencies that are mandated to protect endangered species implement programs that encourage private landowners to protect species habitat rather than destroy it. Under the current ESA, landowners have more economic incentives to destroy species habitat, which is not the goal of the ESA. This is one reason why many people feel that the ESA is not effective in protecting endangered species, and in fact, may increase the decline of species. To understand how the ESA discourages species protection, let’s look at the two main sections of the ESA that address private property issues. We will then look at examples of economic hardships that the ESA sometimes imposes.

**ESA: Sections 7 and 9**

Section 9 of the ESA covers what actions are deemed “unlawful” with respect to endangered species. This section basically states that it is prohibited to “take” (not the same meaning as stated above), any endangered species. The definition of “take” in the ESA covers a group of actions: possessing, selling, and includes any act that will adversely affect the species. In a final ruling printed in the Federal Register on November 8, 1999, the rule defines the term harm (which is one of the definitions of take) to include habitat modification or degradation(10). Therefore, under the ESA “take” (harm) includes any act that can impair behavior patterns (habitat modification) is illegal. Section 9 often restricts private property owners from using their land in ways that are economically beneficial. Not all of the private property owners affected by the ESA are wealthy businessmen who are developing land for another mall or condominium complex. Often the ESA prohibits everyday people like you and me from building homes and farming land.

Section 7 mandates to Federal agencies that they ensure that any action authorized, funded, or carried out by any agency...is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction, or adverse modification of habitat of such species...(11).

On the surface it appears that this Section only pertains to government agencies. Section 7 affects private property rights because it provides government agencies the power to refuse permits to develop or modify habitat. By regulating land use to accommodate listed species, the FWS tells the landowner what he /she can or cannot do on the property including developing, farming, building a home, and even walking on the property. This regulatory aspect of the ESA is what makes an enemy out of the very species that the law is trying to protect and in the process makes the
law ineffective in protecting endangered species. The ESA unfairly penalizes landowners who own property suitable for species habitat.

There are several ways that the private landowner incurs economic losses under the ESA. First of all, the value of the land decreases. Once an endangered species is found on private property, many times restrictions are placed on the land and it can no longer be developed; the value of the land decreases. Not many people are willing to invest money in property that cannot be developed or sold later at a higher price. Another economic loss that occurs under the ESA is the loss of income. For example, many landowners sell the timber off their land to support their families. Another example is farming. Many times farmers are not allowed to use their farming equipment because it may disturb the endangered species either physically, or through the noise from the equipment. Other ways landowners suffer economic losses are through loss of investment income, delays for permits to develop, and the costs of studies required by the ESA. The landowner is usually the one who funds the costs of the studies to determine if the land could possibly be developed without harming the species. Often, the costs of such studies can be extremely expensive, especially for the small landowner.

"Shoot, Shovel, and Shut Up"

Under the current ESA, endangered species have become unwanted by many private landowners and encourage the landowners to get rid of the species or its habitat. This is known as "shoot, shovel, and shut up" (12). Because of restrictions placed on the use of land, many landowners would rather destroy the habitat than face the economic losses that accompany harboring endangered species. Managing and conserving land that is deemed suitable for endangered species is crucial for species survival; it should be rewarded, not punished. To illustrate the economic costs sometime incurred by private landowners, the following are just a few cases to demonstrate the effect that the ESA can have on landowners.

Riverside Fires (13)

In 1992 homeowners in Riverside, California were told by the FWS that they could not disc (create firebreaks) around their homes. Discing is a method used to prevent fires from neighboring forest from spreading into housing areas. The area had been identified as critical habitat for the Stephens' kangaroo rat. Discing carried penalties of prison time and/or fines of 100,000 dollars. Serious fires developed in October of 1993, and 29 homes were destroyed. Micheal Rowe, a resident of the area,
disregarded the FWS warnings when he saw the fire approaching his home. Rowe got on his tractor and disced around his property, saving his home. Even though Rowe was not penalized, the threat of penalization caused 29 other homes to be lost to fire.

Taung Ming Lin (14)

Taung Ming Lin, an Asian farmer, bought a farm in Bakersfield, California to grow vegetables to sell to Asian markets in the area. The land was zoned for farming and no permit was needed. When Lin began plowing, he disturbed the habitat of the endangered Tipton kangaroo rat. Lin was charged with federal and civil violations under the ESA.

Margaret Rector (14)

Margaret Rector bought 15 acres of land on a busy highway in Austin, Texas in 1973. In 1990, the Golden Cheek Warbler was listed as endangered and Rector’s land was classified as suitable habitat for the bird. The property, which had an assessed value of $831,000 dollars in 1991, was assessed at $30,000 dollars in 1992. The property, located in the fastest growing area of Austin, was no longer valued as highly because it harbored an endangered species and could not be developed.

These are just a few examples of how the ESA has affected individuals. There are countless examples of how the ESA has affected entire industries in areas. Probably the most notable is the Pacific Northwest Timber industry. In 1990, the Northern Spotted Owl was added to the Endangered Species List. The owl’s habitat was old growth forest, and millions of acres of land were set aside and protected under the ESA. The forests were protected in an area of the country where logging was the major source of jobs. Jobs were lost, and the economic impact on the community from the protection of the owl was devastating.
Economic Instruments

The Endangered Species Act is easily the most controversial environmental law that we have today. Private property owners affected by the law believe that the government puts the rights of animals above the rights of its citizens. Others believe that the law puts innocent species in a position to be detested.

Another controversial issue surrounding the ESA is the question: “Is the government in a position to save these endangered species?” There are many programs that have been established that appear to be doing a much better job, and without infringement on the rights of property owners. Many states have initiated programs to help property owners maintain their property, giving the owners economic incentives to protect the endangered species. Programs like Zimbabwe’s Campfire Program make the elephant private property for the villages and brought the elephant back from near extinction. Let’s look at a few of these programs and how they often work successfully to protect endangered species and provide incentives to land owners to participate in the programs.

Safe Harbor Agreements

The Fish and Wildlife Service (FWS) has created a program under the ESA that encourages private landowners to restore and conserve natural habitats on private property for species listed as threatened or endangered. The Safe Harbor Program provides protection for the owner of the property while protecting the endangered species.

Under this program, the private property owner agrees to permanently improve and maintain habitat for any endangered species that were on the property prior to the agreement. In return, the landowner will not be subject to further land restrictions to accommodate other species (threatened or endangered) that may be attracted to the property. The FWS also provides technical assistance to the landowners to help maintain the habitat. The incentive to private property owners to enter into the Safe Harbor Agreement is clear: as long as the owner maintains the property for the endangered or threatened species, he/she will not be subjected to further land use restrictions. In other words, the landowner only has to maintain habitat for the number of species that were on the property when the Safe Harbor Agreement was signed. Remember, one of the major flaws in the ESA is that many times citizens are punished, not rewarded, for having endangered species on their property. Through land use restrictions imposed by the ESA, many landowners are encouraged to destroy habitat that would be suitable for many of the endangered species that the law is trying to protect.

The Safe Harbor Agreements seem to be working. Since its inception in 1995, over 2 million acres of land (private land) have been enrolled in the program (15).
The first Safe Harbor Agreement was in North Carolina to protect the red-cockaded woodpeckers. As of 1996, there were 47 groups of woodpeckers present on safe harbor lands; that number is expected to double within 10 years (16).

The incentives created by the Safe Harbor Agreement encourage landowners to become good stewards of natural resources. Economically, the incentives give reassurances that in the future, the landowner will be able to develop the property without the fear of land restrictions, which devalue his property.

Possible Markets for Safe Harbor Agreements

Under Section 10 of the ESA, the FWS can grant permission to develop property that is habitat for an endangered species, but the landowner must establish critical habitat for the endangered species. Markets can be created through this section that would allow one landowner to pay a fee to another landowner who may already have a Safe Harbor Agreement. For example, if landowner 1 could convince (through payment) landowner 2 to set aside an additional portion of land (it must be a suitable habitat for the endangered species), landowner 2, under the guidelines of the ESA could develop his/her property and maintain habitat for the ESA. All parties involved are better off. Landowner 1 has earned money through the transaction; Landowner 2 can develop his/her property, and the endangered species has its habitat.

Candidate Conservation Agreements with Assurances

The Candidate Conservation Agreements with Assurances (CCAA) is a program similar to the Safe Harbor Program, with the exception that the species being protected are not yet listed as threatened or endangered. The species concerned under the CCAA are declining in numbers and the purpose of the program is to try to prevent the need for listing these species. These "candidate" species are not given any protection under the ESA because they are not listed.

The CCAA, like the Safe Harbor Agreements, guarantees participants that by protecting existing species populations on their property restoring and or enhancing habitats, the property owners will not be faced with further land use restrictions later, even if the species is later listed as endangered or threatened. The only condition that the landowner has to agree to is to maintain the property to accommodate the baseline number of the species, or the number that was present on the property when the agreement was signed.
The Safe Harbor Agreements and the CCAA are proving to be useful tools in conserving habitat for endangered species. These programs are both voluntary and encourage private landowners to protect wildlife without the fear of being punished. Many states and countries have initiated programs to help property owners maintain their property, giving the owners economic incentives to protect the endangered species. One such program, Zimbabwe’s CAMPFIRE Program, has been successful bringing the elephant back from near extinction by giving villages economic incentives to protect the elephants. Let’s take a closer look at this program and how it has worked.

CAMPFIRE Program

The Communal Areas Management Program for Indigenous resources (CAMPFIRE) can be considered the classic example of how economic incentives and private property rights can provide protection for endangered species. CAMPFIRE gave the endangered African elephant economic value for the people of Zimbabwe, which provided an incentive to Zimbabweans to protect and preserve the elephant and the land.

Zimbabwe, like much of Africa, receives little to no rainfall in several of its regions. Rural areas of Zimbabwe in general have poor soil. Food production in these areas is difficult. Areas such as this are best suited for the wildlife of Zimbabwe.

Almost 12% of Zimbabwe’s land area is wildlife reserves or national parks. For a country that is only the size of California, this leaves very little land for the people of Zimbabwe to live. In these rural areas, much of the country’s wildlife can be found outside of the reserves and parks, especially in the rural commercial areas. In these communal areas, people and wildlife such as elephants, compete for land.

In Zimbabwe, hunting wildlife had always been a matter of survival. People hunted animals for uses such as food, clothing, and shelter. Once the parks and reserves were established, Zimbabweans were not only forced from their lands, but were also banned from hunting wildlife. These same animals ruined what crops the Zimbabweans were able to raise and killed their livestock. The people of Zimbabwe began to see the wildlife as a nuisance. The wildlife was ruining their livelihood and in some cases their lives (countless times elephants and other large animals killed the communal people). Many of the residents resolved to illegal hunting and poaching to survive (wildlife such as the elephant). These animals were seen as dangerous and destructive. Their only value to the communal tribes was the tusks that could be sold.

Elephants are valued in international markets for their tusks. Hong Kong and Japan have been the primary consumers for the ivory trade. In 1960, raw ivory was worth $3-10 dollars per pound; by 1987 it was valued at $125.00 per pound. Exploitation of the elephant drove it to near extinction and in 1989, the Convention
of International Trade in Endangered Species (CITES) made the trade of ivory illegal. Once the ban was in place, a pound of ivory was worth thousands of dollars. Although illegal, dead elephants now had economic value. The ban forced the communal people of Zimbabwe to harvest the ivory illegally. By killing the elephants, the Zimbabweans were solving a two-fold problem; they were earning money and they were eradicating a dangerous and destructive enemy.

Needless to say, under the CITES ban, the number of African elephants began to dwindle. Although Zimbabwe’s elephant population did not fall to the same levels of some other African countries, such as Kenya, there was a decrease in the elephant population.

In 1989, the CAMPFIRE program was started. The CAMPFIRE program conserves wildlife by giving it economic value to the communal tribes who have to live with this wildlife on a day-to-day basis. CAMPFIRE uses economic incentives to encourage wildlife protection. Ecologists working in the parks system created the program. The communes raise incentives through CAMPFIRE in several ways:

- Leasing trophy concessions. 90% of the money generated by CAMPFIRE comes from foreign hunters (usually from the U. S., Europe, and Japan). The community and others determine the quota that can be hunted. Hunting permits can cost as much as $40,000.

- Tourism - Now local communities benefit from tourism, leasing land for tourism, running tourism facilities, and acting as guides. All of these generate income for the community.

- National Resource Harvesting - Sales of crocodile eggs, timber, etc.

- Animal Sales - Sales of wildlife whose numbers are high. (17)

It is important to note that no individual or businesses collect the money from this program. The money raised is used to improve the community as a whole through projects such as hospitals, schools, agricultural equipment, etc.

The communal people of Zimbabwe now have a reason to protect the wildlife of their region. The tribes directly benefit from the protection of the wildlife and natural resources. CAMPFIRE has made the natural resources of Zimbabwe “private property” for its people. Any benefits that are gained through the use of these resources encourage the protection of those resources and the preservation of wildlife.

Through the use of the CAMPFIRE program, the communal people of Zimbabwe are given the authority to manage their wildlife resources. This authority
gives the people control over their resources, and makes the wildlife that had once been a threat to Zimbabwean’s lives now economically valuable.

To make the Endangered Species Act effective in protecting biodiversity, major changes will have to be made in the way that the law is administered. Economic considerations when placing land restrictions on private landowners would be a good place to start. To encourage landowners to protect endangered species, the ESA has to be administered in a way that also protects the landowner from losses that he/she may incur through protection of the species. Sometimes that protection is through agreements to not restrict further land use, and other times it may be necessary for the government to compensate the landowner for loss of use of the property. There are several ways to accomplish the goal of species protection while also protecting the private landowner. Considering the fact that over 50% of habitat for endangered species is on private property, it is imperative that the government gives the landowner the incentives to protect, not destroy, endangered species habitat.
Endangered Species Activities

1.) Role Play: Students should be divided into three groups: developers, environmentalists, and town council. The developers and the environmentalists will go before the town council to express their views and concerns relating to the land the developers wish to develop. An endangered species has been found on the property, and the environmentalist want the project stopped at any cost. In their presentation to the town council, the students should express environmental and economic consequences of developing and not developing the land.

- Is the development really needed? (Is it a needed housing area, or is it another shopping mall among many?)
- What is the environmental impact?
- Is it possible to build the project in another area of town?
- Do the developers have a plan to relocate the endangered species?
- Why is the endangered species valuable? (Is it a plant that medicines are derived from? Is it an animal or a plant that is crucial to the ecosystem in which it lives? For example, does it keep another species in check?)
- Town council should be able to use sections 7, 9, and 10 of the ESA to render a decision. (When does the ESA allow incidental takes? Have the developers clearly shown that they can continue the project without harming the species? Have the environmentalist shown through scientific proof that this is the habitat for this particular species? Do the environmentalists approve or disapprove of the habitat that the developers have planned for the species?)

2.) Assign each student, or group of students an endangered species to report on. The report should include the following: natural habitat (ex. forest range of forty acres, pine trees at least thirty years old); reasons why the species is endangered (ex. Loss of habitat due to population growth).

(USFWS's website has a listing of endangered or threatened species)

3.) There are many environmental groups that are working to protect endangered species, many times with more success than the government. Students should research these groups and report on at least one program. Some examples are:

- Nature Conservancy
- Audubon Society
- Defenders of Wildlife
- Environmental Defense
- World Wildlife Foundation
4.) The following is a list of federal and private incentives programs. Students should research and report on one of the following, and include the following information in their reports:
   - What group or agency administers the program?
   - When was it started?
   - What are the basics of the program?
   - What are the incentives for the private landowner?

Partners for Fish and Wildlife  
Wildlife Habitat Incentives Programs  
Environmental Quality Incentives Program  
Forest Stewardship Program  
Wetland Reserve Program  
Conservation Reserve Program  
North Carolina Herpetological Society Bog Turtle Program  
Environmental Defense’s Landowner Conservation Assistance Program  
Northern Aplomado Falcon Safe Harbor Agreement  
Virginia Red- Cockaded Woodpecker Safe Harbor Agreement  
Texas Songbird Safe Harbor Agreement

5.) Most people think of animals such as the spotted owl or the bald eagle when someone speaks of endangered species. Many people do not realize that there are rats, plants, insects, and weeds on the list of endangered species. Instruct students to visit the FWS website and report on what they feel are the strangest endangered species listed.

6.) Student should visit FWS website and do brief summary of at least one endangered species listed from their state.
Literature Cited
Chapter 7


Resources for Teachers

The Cleaner and Greener Program for Schools
http://www.cleanerandgreener.org/schools/

Education Planet
http://www.educationplanet.com

NYS Department of Environmental Conservation
http://www.dec.state.ny.us/website/education/edinfo.html

Texas Natural Resource Conservation Commission
http://www.tnrcc.state.tx.us/air/monops/lessons/lesson_plans.html

EPA’s IAQ Tools for Schools
http://www.epa.gov/iaq/schools/curricula.html

Air Quality Lesson Plans and Data
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