Environmental Quality

The 24th Annual Report of the Council on Environmental Quality

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Acknowledgements

This is the 24th annual Environmental Quality Report of the Council on Environmental Quality. The report is prepared pursuant to Section 201 of the National Environmental Policy Act of 1969 (Public Law 91-190, U.S.C. 4321). The report discusses the status and condition, and trends of environmental quality using information and data through December 31, 1993.

In an attempt to help readers understand the latest data on the health of the environment, this year's report is data-driven. Our goal was to not only present one-dimensional information, but to include interpretation by national experts regarding what trends the data may show.

The 24th annual Environmental Quality Report was prepared under the direction and management of Ray Clark. The primary author is Carroll Curtis, and the editor is Barry Walsh. CEQ contributing editors are Elisabeth Blaug, Wendell Stills, and Lara Bernstein. Other CEQ staff who contributed to this report are Kathleen Gallagher, Anne Jenkins, Holly Welles, and Corrine Van Dalen.

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The President's Message on Environmental Quality

To the Congress of the United States:

The United States has always been blessed with an abundance of natural resources. Together with the ingenuity and determination of the American people, these resources have formed the basis of our prosperity. They have given us the opportunity to feed our people, power our industry, create our medicines, and defend our borders-and we have a responsibility to be good stewards of our heritage. In recent decades, however, rapid technological advances and population growth have greatly enhanced our ability to have an impact on our surroundings-and we do not always pause to contemplate the consequences of our actions. Far too often, our short-sighted decisions cause the greatest harm to the very people who are least able to influence them-future generations.

We have a moral obligation to represent the interests of those who have no voice in today's decisions-our children and grandchildren. We have a responsibility to see that they inherit a productive and livable world that allows their families to enjoy the same or greater opportunities than we ourselves have enjoyed. Those of us who still believe in the American Dream will settle for no less. Those who say that we cannot afford both a strong economy and a healthy environment are ignoring the fact that the two are inextricably linked. Our economy will not remain strong for long if we continue to consume renewable resources faster than they can be replenished, or nonrenewable resources faster than we can develop substitutes; America's fishing and timber-dependent communities will not survive for long if we

destroy our fisheries and our forests. Whether the subject is deficit spending or the stewardship of our fisheries, the issue is the same: we should not pursue a strategy of short-term gain that will harm future generations.

Senators Henry Jackson and Ed Muskie, and Congressman John Dingell understood this back in 1969 when they joined together to work for passage of the National Environmental Policy Act. At its heart, the National Environmental Policy Act is about our relationship with the natural world, and about our relationship with future generations. For the first time, the National Environmental Policy Act made explicit the widely-held public sentiment that we should live in harmony with nature and make decisions that account for future generations as well as for today. It declared that the Federal Government should work in concert with State and local governments and the citizens of this great Nation -to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.'

Over the past 25 years, America has made great progress in protecting the environment. The air is cleaner in many places than it was, and we no longer have rivers that catch on fire. And yet, this year in Milwaukee, more than one hundred people died from drinking contaminated water, and many of our surface waters are still not fit for fishing and swimming. One in four Americans still lives near a toxic dump and almost as many breathe air that is unhealthy.

In order to continue the progress that we have made and adequately provide for future generations, my Administration is ushering in a new era of common sense reforms. We are bringing together Americans from all walks of life to find new solutions to protect our health, improve our Nation's stewardship of natural resources, and provide lasting economic opportunities for ourselves and for our children. We are reinventing environmental programs to make them work better and cost less.

My Administration is ushering in a new era of environmental reforms in many ways. Following is a description of a few of these reforms, grouped into three clusters: first, stronger and smarter health protection programs such as my proposed Superfund reforms and EPA's new common sense approach to regulation; second, new approaches to resource management, such as our Northwest forest plan, that provide better stewardship of our natural resources and sustained economic opportunity; and third, the promotion of innovative environmental technologies, for healthier air and water as well as stronger economic growth now and in the future.

Stronger and Smarter Health Protection Programs. Throughout my Administration, we have been refining Government, striving to make it work better and cost less. One of the best places to apply this principle in the environmental arena is the Superfund program. For far too long, far too many Superfund dollars have been spent on lawyers and not nearly enough have been spent on clean-up. I've directed my Administration to reform this program by cutting legal costs, increasing community involvement, and cleaning up toxic dumps more quickly. The reformed Superfund program will be faster, fairer, and more efficient-and it will put more land back into productive community use.

Similarly, EPA is embarking on a new strategy to make environmental and health regulation work better and cost less. This new common sense approach has the potential to revolutionize the way we write environmental regulations. First, EPA will not seek to adopt environmental standards in a vacuum. Instead, all the affected stakeholders-representatives of industry, labor, State governments, and the environmental community-will be involved from the beginning. Second, we will replace one-size-fits-all

regulations with a focus on results achieved with flexible means. And at last, we're taking a consistent, comprehensive approach. With the old piecemeal approach, the water rules were written in isolation of the air rules and the waste rules, and too often led to results that merely shuffled and shifted pollutants-results that had too little health protection at too great a cost. With its new common sense approach, EPA will address the full range of environmental and health impacts of a given industry-steel or electronics for example-to get cleaner, faster, and cheaper results.

Better Stewardship of our Natural Resources. Just as representative of our new approach to the environment-and just as grounded in common sense-is the Administration's commitment to ecosystem management of the Nation's natural resources. For decades ecologists have known that what we do with one resource affects the others. For instance, the way we manage a forest has very real consequences for the quality of the rivers that run through the forest, very real consequences for the fishermen who depend on that water for their livelihood, and very real consequences for the health of the community downstream. But until recently, government operations failed to account adequately for such interaction. In many cases, several Federal agencies operated independently in the same area under different rules. In many cases, no one paused to ponder the negative consequences of their actions until it was too late.

Often, these consequences were catastrophic, leading to ecological and economic train wrecks such as the collapse of fisheries along the coasts, or the conflict over timber cutting in the Pacific Northwest. When I convened the Forest Conference earlier this year I saw the devastating effects of the Federal Government's lack of foresight and failure to provide leadership. Here, perhaps more than anywhere else, is a case study in how a failure to anticipate the consequences of our actions on the natural environment can be devastating to our livelihoods in the years ahead. Our forest plan is a balanced and comprehensive program to put people back to work and protect ancient forests for future generations. It will not solve all of the region's problems but it is a strong first step at restoring both the long-term health of the region's ecosystem and the region's economy.

Innovative Environmental Technologies. Environmental and health reforms such as EPA's common sense strategy and natural resource reforms such as the forest plan provide an opportunity, and an obligation, to make good decisions for today that continue to pay off for generations to come. In much the same way, sound investments in environmental technology can ensure that we leave to future generations a productive, livable world. Every innovation in environmental technology opens up a new expanse of economic and environmental possibilities, making it possible to accomplish goals that have eluded us in the past. From the very beginning, I have promoted innovative environmental technologies as a top priority. We've launched a series of environmental technology initiatives, issued a number of Executive orders to help spur the application of these technologies, and taken concrete steps to promote their export. Experts say the world market for environmental technology is nearly $300 billion today and that it may double by the year 2000. Every dollar we invest in environmental technology will pay off in a healthier environment worldwide, in greater market share for U.S. companies, and in more jobs for American workers.

Innovations in environmental technology can be the bridge that carries us from the threat of greater health crises and ecological destruction toward the promise of greater economic prosperity and social well-being. Innovation by innovation, we can build a world transformed by human ingenuity and

creativity-a world in which economic activity and the natural environment support and sustain one another.

This is the vision that Jackson, Muskie, and Dingell articulated more than two decades ago when they wrote in the National Environmental Policy Act that we should strive to live in productive harmony with nature and seek to fulfill the social and economic needs of future generations. We share a common responsibility to see beyond the urgent pressures of today and think of the future. We share a common responsibility to speak for our children, so that they inherit a world filled with the same opportunity that we had. This is the vision for which we work today and the guiding principle behind my Administration's environmental policies.

PART I: Environmental Issues

Chapter 1: Air Quality and Climate

We must take the lead in addressing the challenge of global warming that could make our planet and its climate less hospitable and more hostile to human life. Today, I reaffirm my personal and announce our nation's commitment to reducing our emissions of greenhouse gases to their 1990 levels by the year 2000. I am instructing my administration to produce a cost-effective plan that can continue the trend of reduced emissions. This must be a clarion call, not for more bureaucracy or regulation or unnecessary costs, for American ingenuity and creativity, to produce the best and most energy-efficient technology.

President Bill Clinton

The composition of the atmosphere is a primary determinant of global temperature and climate. In turn temperature and climate establish conditions and limitations for life on earth. There was a time, not long ago, when air quality and climate would not have been included in the same chapter. Today, however, evidence strongly suggests that pollutants emitted into the air from anthropogenic (human-made) sources have the potential to change the climate of the planet.

Air Quality

The good news is that, between 1983 and 1992, auto emissions were down because of pollution control; the bad news is that Americans are driving more miles each year. The nation cannot afford to rest on its air quality laurels.

Conditions and Trends

As a world leader in air pollution control, the United States continues to work toward air quality goals using advanced technologies and innovative policies such as market-based regulation. The Clean Air Act Amendments of 1990 called for achieving air quality goals in a more flexible, cost-effective, market-based manner than had been the case in prior years. These amendments, now in early stages of implementation, will have their major impact in the coming years. Meanwhile in some parts of the nation, exceedances of health-based national ambient air quality standards (NAAQS) set by the U.S. Environmental Protection Agency (EPA) continue to pose risks to human health and the environment.

Americans and Their Cars

The technology that has improved the emission rates of new automobiles is contributing to improvements in air quality. For example 1990-model vehicles emit hydrocarbons and carbon monoxide at only one-third the rate of 1975-model vehicles. In the near future, the nation can expect further reductions in emissions as older vehicles are retired and replaced by newer, cleaner ones. Even with these technological improvements, however, the total vehicle emissions could once again increase if vehicle miles of travel continue to rise.

Various trends are contributing to the continued rise in vehicle miles of travel:

. Increase in the number of workers,

. Increase in vehicle ownership,

. Decrease in vehicle occupancy rate,

. Decrease in use of public transportation,

. Longer average trip length,

. Growth in suburb-to-suburb travel, and

. Low per-mile driving costs.

The real cost of gasoline, for example, is now lower than it was in 1950. Efforts to reduce travel in single-occupant vehicles and total vehicle miles of travel face difficult challenges in light of these trends.

NAAQS Pollutants

Over the past decade, air quality levels in the United States have shown continued improvement. The six pollutants for which the EPA sets NAAQS are carbon monoxide, lead, nitrogen dioxide, ozone, particulates, and sulfur dioxide. Levels tracked by monitoring stations document progress in reducing air levels for each pollutant.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless, and poisonous gas produced by the incomplete burning of carbon in fuels. Elevated carbon monoxide levels can enter the human bloodstream and reduce normal delivery of oxygen to organs and tissues. In areas where levels exceed the NAAQS, the health threat is most serious for persons who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease, although healthy individuals also can be affected. Such exposure is associated with impairment of visual perception, manual dexterity, learning ability, and performance of complex tasks.

Two-thirds of the nationwide emissions of carbon monoxide are from transportation sources, with the largest contribution coming from highway motor vehicles (such as light-duty gas vehicles and motorcycles, light-duty and heavy-duty gas trucks, and diesels). Long-term trends indicate that emissions for all types of highway vehicles nearly tripled from 1940 through 1970. From 1970 to 1980, emissions from highway vehicles increased only 11 percent, largely because the nation implemented the Federal Motor Vehicle Control Program that regulates emissions from new vehicles. This program has resulted in widespread use of catalytic converters on automobiles to reduce carbon monoxide, nitrogen oxides, and volatile organic compound emissions. Another result has been the use of unleaded gasoline for vehicles with these converters. Since 1980 carbon monoxide emissions have decreased 37 percent as a result of pollution control and retirement of older vehicles without converters.

Ambient atmospheric concentrations of carbon monoxide have recorded a general long-term improvement. The 10-year period, 1983-1992, showed a 34-percent improvement, which agrees with the estimated 30-percent reduction in highway vehicle emissions. These reductions, largely attributable to vehicle emission controls, occurred despite a 37-percent increase in vehicle miles of travel in the United States during the reporting period. The environmental and transportation communities are

concerned that rising vehicle miles of travel could overtake the emission improvements realized over the last decade.

Despite these improvements the EPA designated 42 areas as nonattainment for carbon monoxide in November 1993. These areas failed to meet the carbon monoxide NAAQS of 9 ppm in an 8-hour period. Based upon the magnitude of carbon monoxide concentrations, 41 areas were classified as moderate, with Los Angeles alone classified as serious.

Air Quality Success Stories

Prior to 1993 the EPA had designated Syracuse, New York, as moderate nonattainment for carbon monoxide; Knoxville, Tennessee, as marginal nonattainment for ozone; and Greensboro, North Carolina, as moderate nonattainment for ozone. The EPA, in 1993, was able to redesignate these areas as attainment.

First the EPA Administrator had to determine that the areas had attained the national ambient air quality standard and that the improvement in air quality was the result of permanent and enforceable reductions in emissions. In addition other NAAQS criteria had to be met. Each area was required to have an approved applicable implementation plan describing the measures used to reduce emissions and achieve attainment and a maintenance plan showing that the ambient air standard would be maintained for at least ten years after redesignation. These plans are designed for a particular area but draw on national guidance concerning applicable controls for certain types of pollution sources.

Syracuse helped achieve attainment with the carbon monoxide standard through a combination of measures including a traffic management plan for major events in the downtown area (such as concerts and athletic events) and institution of a ride-share program. Knoxville applied reasonably available control technology (RACT) to major emission sources in its efforts to attain the ozone standard. Greensboro, in addition to applying RACT for major sources, adopted an inspection/maintenance (I/M) program in two counties in the nonattainment area.

In September 1993 Syracuse became the first area in the nation to be redesignated by the EPA as attainment.

Lead

The major sources of atmospheric lead emissions are lead gasoline additives, nonferrous smelters, and battery plants. Transportation contributes more emissions than any other sector of the U.S. economy. Exposure to lead can occur through multiple pathways, including inhalation of air and ingestion of lead in food, water, soil, or dust. Lead accumulates in the body in blood, bone, and soft tissue. Because it is not readily excreted, lead also affects the kidneys, nervous system, and blood-forming organs. Exposure in adults to lead levels exceeding the NAAQS can cause seizures, mental retardation, and behavioral disorders. Fetuses, infants, and children are most susceptible to lead, which can cause central nervous system damage; however, individuals as well. Studies show that lead may be a factor in high blood pressure and subsequent heart disease in middle-aged white males.

Lead emissions from highway sources decreased sharply from 1970 to 1986 as a result of the Federal Motor Vehicle Control Program. Gasoline consumption increased 16 percent between 1970 and 1975, but because of the reduced lead content of gasoline, lead emissions from highway vehicles actually decreased 24 percent. Since 1984 lead emissions from transportation sources have decreased 96 percent, brought about by increased use of unleaded gasoline in catalyst-equipped cars, which made up 99 percent of the gasoline market in 1993. In 1984, the unleaded share of the gasoline market was about 60 percent. In addition to the use of unleaded gasoline, the decrease can be attributed to the reduced lead content in leaded gasoline, which went from an average of 1.0 gram per gallon to 0.1 grams per gallon in January 1986.

Programs are also in place to control lead emissions from stationary sources. Lead emissions from fuel combustion by industry and lead smelters, which contribute to total lead emissions, have decreased over the past two decades. The reductions reflect utility and industrial lead-emission controls and some plant closures.

Ambient lead concentrations in urban areas, where most lead- monitoring stations are located, decreased 89 percent since 1984. This improvement has been evenly distributed over the entire network of 204 monitoring sites. Over the past decade, ambient lead concentrations at 66 monitoring sites near such industrial sources of lead as smelters and battery plants improved 63 percent. Most areas in the United States meet national air quality standards for lead. Those that do not are industrial areas impacted by point sources of lead. In 1993 these areas were Cleveland, Ohio; Indianapolis, Indiana; Memphis, Tennessee, and parts of Alabama and Mississippi; Omaha, Nebraska, and parts of Iowa; Philadelphia, Pennsylvania, and parts of New Jersey; and St. Louis, Missouri, and parts of Illinois.

Nitrogen Dioxide

Nitrogen dioxide is a yellowish brown, highly reactive gas present in the urban atmosphere. Formed by the oxidation of nitrous oxide, it is emitted when fuels burn at high temperatures. Nitrogen dioxide plays a major role, together with volatile organic compounds, in the atmospheric reactions that produce harmful, ground level ozone. It is also a precursor to acidic deposition and contributes to environmental nitrogen loading that can affect both aquatic and terrestrial ecosystems.

Nitrogen dioxide can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections such as influenza. Continued or frequent exposure to concentrations exceeding the NAAQS can cause pulmonary edema.

The two main sources of nitrogen dioxide are transportation and stationary fuel combustion from electric utilities and industrial boilers. Emissions from all sources have increased since the turn of the century. Since 1984 reductions have occurred in emissions from many sources, although total 1993 emissions were 1 percent higher than 1984 figures. Fuel combustion emissions have remained relatively constant during the last five years. Most decreases in mobile-source emissions occurred in urban areas. The Federal Motor Vehicle Control Program and the New Source Performance Standards recently set by the EPA have helped reduce the growth of nitrogen dioxide emissions from electric utilities and highway sources.

Ambient concentrations of nitrogen dioxide increased significantly during the first two-thirds of the century as a result of increased fuel consumption. Since 1984, however, concentrations have declined by 12 percent. Los Angeles, the only urban area in the past ten years with recorded violations of the annual average nitrogen dioxide standard, in 1992 for the first time had air quality levels that met this standard and continued to improve in 1993.

Ozone

Trospheric (Ground-level) ozone is a major component of smog. While ozone in the upper atmosphere (stratosphere) benefits life by shielding the earth from harmful ultraviolet radiation from the sun, concentrations of ozone at ground level in excess of the NAAQS are a major health and environmental concern. Ozone is not emitted directly into the atmosphere but is formed through complex chemical reactions between precursor emissions of volatile organic compounds and nitrogen oxides in the presence of sunlight. These reactions are stimulated by light intensity and temperature so that peak ozone levels occur typically during the warmer times of the year, especially under dry, stagnant conditions.

The reactivity of ozone causes health problems because it damages lung tissue, reduces lung function, and sensitizes the lungs to other irritants. Ambient levels of ozone not only affect persons with impaired respiratory systems but healthy adults and children as well. Several hours of exposure to ozone in doses that exceed the NAAQS can reduce lung function in normal, healthy people during exercise. This decrease in lung function generally is accompanied by symptoms including chest pain, sneezing, and pulmonary congestion. Ozone also can damage forests and crops.

Transportation and industrial sources emit volatile organic compounds (VOCs) and nitrogen dioxide, which are the precursor chemicals of ozone. Emissions of VOCs from fuel combustion have declined steadily since 1900, with the exception of a recent peak caused by residential wood combustion. Emissions from industrial processes increased from 1900 to 1970, but emission control devices and process changes have helped limit these increases. Decreases in emissions after 1970 are also attributed to the substitution of water-based emulsified asphalt for asphalt liquefied with petroleum distillates.

Emissions from transportation sources increased from 1900 to 1970, first from railroads and later from highway vehicles. By 1970 railroads were contributing only 1 percent of total emissions, while highway emissions had risen to 41 percent. Since then highway emissions from diesel and gasoline-powered vehicles have declined by 50 percent from the 1970 level as a result of the Federal Motor Vehicle Control Program and national limits on fuel volatility. Overall total emissions of VOCs are estimated to have declined by 9 percent since 1984.

Ambient concentrations of ozone improved nationally by 12 percent from 1983 to 1992. The 1993 composite average is higher than the 1992 level, but it is noteworthy that 1992 ozone levels were the lowest of the past ten years. Since 1984 the expected number of exceedances of the ozone NAAQS also has decreased by 60 percent.

Particulates

Air pollutants called particulates include dust, dirt, soot, smoke, and liquid droplets. Particulates are emitted directly into the air by sources such as factories, power plants, cars, construction activity, fires, and natural windblown dust. Particles also form in the atmosphere from the condensation or transformation of emitted gases such as sulfur dioxide and volatile organic compounds.

The major effects on human health from concentrations of particulates that exceed the NAAQS often are associated with sulfur dioxide. They include breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissues, carcinogenesis, and premature mortality. Individuals with chronic obstructive pulmonary or cardiovascular disease, influenza, or asthma as well as children and the elderly are most likely to be sensitive to the effects of particulates. Particulate matter also soils and damages building materials and impairs visibility in many parts of the country.

In 1987 the EPA promulgated annual and 24-hour standards for particulate matter, using a new indicator, PM-10, which includes only those particles with aerodynamic diameter smaller than ten micrometers. These smaller particles are more likely to be responsible for adverse health affects because of their ability to reach the lower thoracic region of the respiratory tract. The new standards specify an expected annual arithmetic mean not to exceed 50 micrograms per cubic meter. They also specify that expected 24-hour concentrations greater than 150 micrograms per cubic meter per year may not exceed one occurrence per year.

PM-10 particulates are emitted by point and nonpoint sources:

. Point Sources. These include fuel combustion by electric utilities and industry; industrial processes involving chemicals, metals, and petroleum; and transportation.

. Nonpoint Sources. Among these are fugitive dust from agriculture, construction, mining, quarrying, paved and unpaved roads, and wind erosion.

Over the 9-year period, 1985-1993, total PM-10 emissions from point sources decreased almost 3 percent. PM-10 emissions by highway vehicles and off-highway vehicles decreased by 7 percent between 1985 and 1993, while emissions from a category entitled, Fuel Combustion, decreased 14 percent. Emissions in this category are produced predominantly by residential wood combustion'-the in-home use of fireplaces and woodstoves. Several innovative approaches to controlling residential wood combustion are responsible for the large decrease in this emission category.

Fugitive dust contributes six to eight times more PM-10 particulates than point sources; it is consistently emitted by construction activity and unpaved roads. Among road types, emissions from unpaved roads have remained fairly steady, while emissions from paved roads are estimated to have increased 30 percent since 1985, most likely due to increased vehicle traffic. Emissions from construction sites have decreased an estimated 13 percent since 1985. Mining and quarrying, sources estimated to be a relatively small contributor to total fugitive particulate matter emissions at the national level, can be major factors in local areas.

A minor contributor to the national total, agricultural tilling is a major source of particulates in specific regions of the country, such as the Great Lakes, Upper Midwest, and Pacific Northwest. Over the 9-year period, 1985-1993, fugitive dust emissions showed no significant change in these areas. PM-10 emissions caused by wind erosion are very sensitive to regional soil conditions and year-to-year changes

in total precipitation. Accordingly estimated emissions from wind erosion were extremely high for the drought year of 1988.

Measured ambient air PM-10 concentrations decreased by 20 percent between 1988 and 1993. Declines in particulate levels are attributable to the installation of pollution control devices in electric utilities and to reduced activity in some industrial sectors, such as iron and steel.

Sulfur Dioxide

Ambient sulfur dioxide results largely from stationary source coal and oil combustion, steel mills, refineries, pulp and paper mills, and from nonferrous smelters. The largest and most consistent source of these emissions has been coal-burning electric power plants.

Human exposure to concentrations of sulfur dioxide exceeding the NAAQS can affect breathing and aggravate existing respiratory and cardiovascular disease. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly. Sulfur dioxide is a primary contributor to acidic deposition (acid rain), causing acidification of lakes and streams and damaging trees, crops, historic structures, and statues. In addition sulfur compounds in the air contribute to visibility degradation in large parts of the country, including some national parks. The conversion of sulfur dioxide to sulfate aerosols in the atmosphere could impact global climate change.

Historic emissions of sulfur dioxide from fuel combustion and industrial processes increased steadily from 1900 until 1925 and then decreased during the 1930s primarily because of the Great Depression, only to increase sharply from 1940 to 1970. During the 1970s and early 1980s, emissions decreased by 25 percent as the result of several factors:

. Coal cleaning and lower sulfur coal blending by electric utilities;

. Reduction in coal burning by industrial, commercial, and residential consumers;

. Increased use of emission control devices by industry, especially

sulfuric acid manufacturing plants; and

. Byproduct recovery of sulfuric acid at nonferrous smelters.

Emissions have declined slightly in recent years. Nationally the long-term trend in ambient sulfur dioxide concentration shows a 26-percent reduction over the 10-year period, 1984-1993, although the annual rate of decline has slowed over the last few years. Currently there are 47 areas in the United States do not meet national air quality standards for sulfur dioxide.

Air Quality Population Estimates

Although ambient air quality improvements in the 1984-1993 period are encouraging, population estimates suggest that 59 million people live in counties where pollution levels failed to meet one or more air quality standards in 1993. Such estimates provide a relative measure of the extent of the problem for each pollutant. As an indicator, however, they have limitations. For example, an individual living in a county that violates an air quality standard may not actually be exposed to unhealthy air.

Smog

Urban, ground-level ozone (smog) continued to be the most pervasive air quality problem, with an estimated 44.6 million people living in counties that did not meet the ozone standard. This figure, however, the lowest for the 10-year period, represents a substantial decrease compared to the 112 million people thought to live in areas that did not meet ozone NAAQS in 1988 when hotter, drier meteorological conditions prevailed and contributed to more ozone formation. The decrease is also partly because of new emission control programs.

Pollution Standards Index (PSI)

The EPA developed the Pollution Standards Index (PSI) as an air quality indicator for describing urban air trends. The PSI has found widespread use in the air pollution field for reporting daily air quality to the general public. The index integrates information from many pollutants across an entire monitoring network into a single number that represents the worst daily air quality experienced in an urban area. It is computed for carbon monoxide, nitrogen dioxide, ozone, particulates (PM-10), and sulfur dioxide. The index is based on short-term National Ambient Air Quality Standards (NAAQS), Federal Episode Criteria, and Significant Harm Levels.

Index Range Health Effects Categories

0 to 50 Good

51 to 100 Moderate

101 to 199 Unhealthful

200 to 299 Very Unhealthful

300 and Above Hazardous

The impact of hot dry summers in 1983 and 1988 in the eastern United States can be measured by examining total PSI data along with PSI data for selected metropolitan areas. Pittsburgh is the only city where a significant number of PSI days greater than 100 are caused by pollutants other than carbon monoxide or ozone; the Pittsburgh pollutants are sulfur dioxide and PM-10 particulates.

Sulfur Dioxide/Nitrogen Dioxide

The year 1992 marked the first time since the EPA began making population estimates that the agency recorded no monitoring violations of either sulfur dioxide or nitrogen dioxide NAAQS.

Program Accomplishments

The nation continues to experiment with innovative programs to reduce motor vehicle emissions that cause smog and industrial emissions that release air toxics and cause acid rain.

Motor Vehicle Emissions

Cleaner fuels and cleaner engines, sophisticated emissions testing, and rethinking of intermodal transportation systems can help increasingly mobile Americans clean up unhealthy air.

Cleaner Fuels

National limits on gasoline volatility-its tendency to evaporate-already have contributed to lower ozone levels, as observed during the summers of 1991 and 1992. Oxygenated fuel was introduced during the winter of 1992-1993, becoming the first major fuel measure authorized by the Clean Air Act Amendments of 1990 to take effect. Increasing the oxygen content of gasoline reduces carbon monoxide emissions by improving fuel combustion, especially in colder temperatures where fuel combustion is less efficient at the beginning of the driving cycle. As a result, oxygenated fuels contributed to a reduction in exceedances of the carbon monoxide standard in the 35 cities implementing the program. Some motorists have complained that pumping the new fuel at self-service pumps caused dizziness or headaches. EPA studies into these effects concluded that substantial risk of acute health symptoms among healthy members of the public receiving typical environmental exposure is unlikely. Although chronic developmental, cancer, and non-cancer effects from oxygenated gasoline cannot be precisely quantified, they are likely to be no more serious than effects from non-oxygenated gasoline. Nonetheless, the EPA has provided waivers in some very cold areas (such as Alaska) while assessing other solutions to reduce emissions.

New Quality Standards. In 1993 new quality standards took effect, limiting the sulfur content of diesel fuel. The limits will reduce particulate emissions from in-use diesel engines and pave the way for particulate-control technology in new diesel engines. The existing technology is not as effective with high-sulfur fuel.

Cleaner Fuel Regulations. In December 1993 the EPA finalized regulations that call for a new generation of cleaner, reformulated gasolines to reduce hydrocarbon and toxic emissions by at least 15 percent by 1995 and by over 20 percent by 2000 in the nine cities most polluted with ozone.

Cleaner Cars, Trucks, and Buses

Tighter emission standards requiring exhaust hydrocarbon emission reductions of 30 percent and nitrogen oxide emission reductions of 60 percent from new cars and light trucks will be phased in beginning with the 1994 model year. In March 1993 the EPA also finalized rules requiring a 90-percent reduction in particulate emissions from new urban buses by 1996.

Inspection and Maintenance

Enhanced vehicle inspection and maintenance (I/M) may make the largest contribution toward improved urban air quality of any measure in the Clean Air Act. The 1990 Clean Air Act has resulted in the implementation of stricter vehicle tailpipe and evaporative emission controls that increasingly will benefit all areas over the next two decades. Enhanced I/M uses high technology testing on an annual or

biennial basis along with supplemental on-road emissions testing to ensure that vehicles meet these standards. Maintenance is required to bring nonconforming vehicles into compliance. The EPA estimates that enhanced I/M, now required in approximately 100 urban areas, can yield a 28-percent emissions reduction. During 1993 the states took the first steps toward implementing the enhanced I/M program, which will be phased in during 1995.

Transportation

While emissions from new vehicles on a per-mile basis are a fraction of the levels of 20 years ago, the number of miles driven has doubled over that period and continues to rise. The Clean Air Act of 1990 and the Intermodal Surface Transportation Efficiency Act of 1991 together require states and local areas to rethink traditional approaches toward planning and providing transportation services. In 1993 the EPA finalized a transportation conformity rule requiring that transportation and air-quality planning be conducted in concert to maintain air-quality goals. The EPA and Department of Transportation (DOT) worked together to develop innovative transportation strategies outlined in a 1993 report, Clean Air Through Transportation: Challenges in Meeting National Air Quality Standards. These strategies provide guidance and technical assistance to state and local governments in reconciling environmental and mobility goals.

Fleet Vehicles

Beginning in 1998 in 22 cities, the EPA will require new fleet vehicles, such as taxis and delivery vans, to meet tailpipe standards more stringent than those required for conventional vehicles. New EPA guidelines provide incentives for fleet owners to purchase Inherently Low-Emitting Vehicles (ILEV) fueled with natural gas, propane, pure alcohol, or electricity (see Chapter 7).

Air Toxics

Toxic pollutants -those known or suspected to cause cancer or other serious health effects- are released into the air in many areas of the United States. Two EPA programs serve as primary sources of information on air toxics:

. Toxics Release Inventory. The TRI covers air toxics emissions, and

. National Volatile Organic Compound Database. The database, in conjunction with field studies, covers air toxics concentrations.

According to estimates of those industries participating in the TRI, more than 2 billion pounds of toxic pollutants were emitted into the air in 1991. This is a reduction from 1990, when 2.2 billion pounds were emitted. Among the top-ten air toxics in terms of quantities reported, TRI emissions showed a downward trend for all but one of the pollutants listed. The EPA projects that, with implementation of the Clean Air Act Amendments, this downward trend will continue.

The EPA is implementing a comprehensive program to reduce routine emissions of hazardous air pollutants to doses below their known or suspected levels of causing cancer or other serious health effects such as birth defects. The Clean Air Act Amendments of 1990 require the EPA to establish

standards over a 10-year period to regulate emissions of 189 chemicals listed in the legislation. In 1993 the EPA took steps to reduce emissions of hazardous air pollutants in the following industries:

Dry Cleaners. In September 1993 the EPA issued a final rule requiring technology controls and/or improved work practices for 25,000 industrial and large commercial dry cleaners. These popular businesses are a major source of perchloroethylene, one of the air toxics that Congress listed for control in the Clean Air Act. The rule is expected to result in a national reduction of as much as 35,600 tons per year of perchloroethylene emissions.

Coke Ovens. In October 1993 the EPA issued a final rule sharply reducing emissions from coke oven batteries. Coke is used in blast furnaces for the conversion of iron ore to iron in the process of making steel; the conversion is performed in coke oven batteries. Coke oven emissions are among the most toxic of all air pollutants, with preregulation maximum individual risks of contracting cancer running as high as 1 in 100 in some cases. The EPA developed the final rule through a formal regulatory negotiation that included representatives from the steel industry, state and local agencies, environmental groups, and the Steel Workers Union. The rule will result in overall reductions of 82 to 94 percent of total emissions from coke ovens.

Industrial Cooling Towers. In August 1993 the EPA issued a proposed rule to eliminate emissions of chromium, a highly toxic chemical, from industrial process cooling towers. The proposed rule requires substitution of nonchromium-based chemicals for chromium. The result will be a 100-percent reduction in chromium emissions from these cooling towers.

Halogenated Solvent Cleaners. In November 1993 the EPA issued a proposed rule to reduce emissions from solvent cleaning machines of halogenated solvents including methylene chloride, perchloroethylene, trichloroethylene, 1,1,1-trichloroethane, carbon tetrachloride, and chloroform. Major industries using halogenated solvents include the aerospace industry, motor vehicle manufacturing facilities, the fabricated metal products industry, and the electric and electronic equipment industry. The proposed rule, a combination of equipment standards with work practices, will result in a reduction of hazardous air pollutant emissions of 88,400 tons per year.

Chromium Electroplating and Anodizing Operations. In November 1993 the EPA issued a proposed rule that will require the application of maximum achievable control technology for about 5,000 chromium electroplating and anodizing operations. These operations are a major emission source of highly toxic chromium compounds listed for control in the Clean Air Act. The rule is expected to result in a national reduction of as much as 173 tons per year of chromium emissions.

Indoor Air Quality

During the past 20 years, as outdoor air pollution decreased, indoor air pollution increased because of the following factors:

. Construction of more tightly sealed buildings,

. Reduction of ventilation to save energy,

. Use of synthetic building materials and furnishings, and

. Use of chemically formulated personal care products, pesticides,

and household cleaners.

Indoor air pollutants include tobacco smoke, radon, volatile organic compounds, biological contaminants, combustion gases, respirable particulates, lead, formaldehyde, and asbestos. Diseases such as asthma, chronic bronchitis, emphysema, and lung cancer-all of which have increased in the United States over the past two decades-have been linked to these indoor air pollutants. While a difference exists in sensitivity from person to person, the following indoor air pollutants are areas of special concern:

Secondhand Smoke

Environmental tobacco smoke (ETS), often called secondhand smoke or passive smoke, is a major concern. In a December 1992 report, Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders, the EPA estimated that ETS causes over 3,000 lung cancer deaths a year among nonsmokers and may be responsible for serious respiratory illness in hundreds of thousands of children. As public awareness of the hazards of ETS exposure increases, businesses and communities across the nation are taking actions to prevent involuntary exposure through prohibiting smoking indoors or limiting smoking to specially designated, separately ventilated smoking rooms. In July 1993 the EPA released a brochure, -What You Can Do About Secondhand Smoke,- which summarized preventive actions.

Radon

Studies by the National Academy of Science estimate that the naturally occurring gas, radon, is the cause of 7,000 to 30,000 lung cancer deaths nationwide each year. Most of these deaths occur among people who smoke cigarettes. The 1992 Radon Risk Communication and Results Study, conducted by the State Conference of Radiation Control Program Directors and sponsored by the EPA, found that 67 percent of Americans show some awareness that radon is a potential concern; 9 million U.S. homes have been tested for radon; and 300,000 of the 6 million homes estimated to have radon problems have been treated to mitigate the gas. The study, which yielded statistics for each state and for target areas within each state, found greater action to address radon in states with higher radon potential. Public and private sectors are using the study to establish a baseline for tracking and improving bottomline environmental results.

Sick-Building Syndrome

Initially reports of mild symptoms in people working in sealed, usually recently constructed, office buildings were discounted. Now scientific experts are reaching agreement that degassing of certain building materials can cause significant health effects. The following reasons have led to this conclusion:

Similarity of Symptoms. A remarkable concordance exists among the kinds of complaints made by workers in different locations and in different countries. Complaints include headaches, fatigue, inability

to concentrate, and mild inflammation of the eyes and pharynx. Diary data comparing complaints of symptoms that arise from working in new office buildings show a remarkable similarity.

Identification of Volatile Organic Compounds. Among the volatile organic compounds identified as commonly present in buildings where complaints of symptoms occur are formaldehyde, toluene, and trichloroethylene. Controlled-exposure studies of these compounds, such as a recent Danish study of n-decane exposure, find them to be common in building materials.

Asthma and Other Respiratory Problems

During the past several decades, knowledge of factors related to asthma and other respiratory problems has expanded greatly. Exposures to a wide range of substances-more than 200 have been implicated-can induce airway responsiveness. In addition to outdoor exposure to ozone and sulfur dioxide, these include indoor exposure to environmental tobacco smoke, toluene, anhydrides, platinum salts, and some acids and aerosols. Recent data have demonstrated a correlation between summer pollutant levels and respiratory morbidity as indicated by hospitalization admissions. Hospital admissions for asthma have been increasing, along with increases in asthma mortality. While hospital admissions for asthma declined for the total population in 1992, they continued to increase for blacks and other nonwhites and for children.

Indoor Air Management

A total of 20 federal agencies have responsibilities associated with indoor air quality, either through statutory mandates or as major property managers.

Committee on Indoor Air Quality. In 1993 the interagency Committee on Indoor Air Quality (CIAQ), with members from the EPA, Consumer Product Safety Commission, Department of Energy, Department of Health and Human Services, and Occupational Safety and Health Administration, coordinated control efforts.

Legislative Authority. The federal government administers indoor air programs under the authority contained in statutes such as Title IV of the Superfund Amendments and Reauthorization Act (SARA), which requires the EPA to conduct research and disseminate information on the subject. The Federal Insecticide Fungicide and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA) authorize the EPA to regulate products that adversely affect indoor air quality.

EPA Radon Program

To reduce the significant health threat of radon, the EPA radon program has set the following priorities as recommended by a panel of senior EPA officials and radon experts from outside the agency:

. Target high risk geographic areas and populations that include smokers;

. Promote radon-resistant new construction techniques;

. Encourage radon testing and mitigation as part of real estate transfers;

. Sustain a national public education campaign; and

. Develop a coordinated research plan with other federal agencies.

Acid Rain and the Clean Air Act

During the last several decades, strong acids (sulfuric and nitric acids), formed when atmospheric pollutants emitted from power plants, factories, and motor vehicles combine with water in the atmosphere, have fallen as acid rain and snow on the northeastern United States and southeastern Canada. This acidic precipitation is believed to be responsible for the acidification of sensitive lakes and streams, damage to historical structures and high-elevation forests, and impaired visibility in affected areas. The following are among the technical problems that have been recognized:

. Some watersheds in regions receiving high nitrogen deposition (such as the Adirondacks and Catskills) and some old-growth forests in the Appalachians are becoming nitrogen saturated. In many cases nitrogen inputs are exceeding the capacity of the watersheds to retain nitrogen and are contributing to increased leaching of soil nutrients and/or surface water acidification.

. Declines in northeastern high-elevation red spruce forests are associated with ambient concentrations of pollutants in cloud water and rain which reduce the midwinter cold tolerance by 4 to 10 degrees Celsius compared with trees growing at the same locations but at lower elevations.

. Chemical changes in forest ecosystems and surface waters attributable to acidic deposition are reported in some national parks.

. Wet and dry acidic deposition accounts for an estimated 31 to 78 percent of the dissolution of galvanized steel and copper in outdoor exposures.

National Trends Network

The U.S. Geological Survey coordinates the operation of the National Trends Network (NTN), a 150-station, nationwide multiagency network for monitoring precipitation chemistry in the United States. In addition NTN monitors selected sensitive lakes and streams throughout the nation to document changes in water chemistry that may result from the effects of acid rain. The Network also conducts research in several sensitive watersheds to define how geochemical processes caused by acid rain affect water quality. NTN data reveal substantial differences in precipitation chemistry between the eastern and western regions of the United States. As an example, for the period 1985 through 1993, the following conclusions have been reached:

. Sulfate concentrations are two to three times higher in the East than in the West, and an apparent decreasing trend for sulfate concentrations in the East is not evident in the West;

. Nitrate concentrations are consistently higher in the East, despite the lack of an obvious temporal pattern over the summary period;

. Ammonium concentrations, uniform across much of the United States, do not exhibit any temporal pattern;

. Calcium concentrations in precipitation are higher in the West, although the difference is less than 0.01 milligrams per liter between regions;

. The combination of higher concentrations of acid anions (sulfate and nitrate) in the East and similar to somewhat higher concentrations of cations (ammonium and calcium) in the West results in a consistently lower pH (higher hydrogen ion concentration) in the East; and

. Although the pH levels are less than one pH unit lower in the East, the amount of hydrogen in precipitation is five to six times greater than in the West.

Regional differences evident in concentration data for precipitation chemistry are even more evident in concentration data for wet deposition; however, temporal patterns are not as evident. Regional differences in the amount of precipitation (for instance, the East has considerably more precipitation than the West but less year-to-year variability) and concentrations of ions help to explain the following spatial trends in ionic deposition:

. Wet sulfate and nitrate deposition tends to be four to five times greater in the East than in the West;

. Ammonium deposition is generally twice as high in the East;

. Calcium deposition is only slightly higher in the East caused by the offsetting influence of lower concentrations in precipitation; and

. The average annual difference in the amount of wet hydrogen deposition in the East relative to the West is eight-fold.

While acidic deposition continues to effect sensitive forest, soil, and aquatic ecosystems, the effect of recent, relatively small reductions in the emissions of sulfur dioxide and nitrogen oxides are difficult to detect.

Acid Rain Program

The EPA administers the Acid Rain Program, which is designed to achieve significant environmental benefits through reductions in emissions of sulfur dioxide and nitrogen oxides. To achieve this goal at the lowest cost, the program employs both traditional and innovative, market-based approaches for controlling emissions. It is designed to encourage both energy efficiency and pollution prevention. Efforts were underway in 1993 to evaluate the costs, benefits, and effectiveness of the Acid Rain Program as part of the requirement to assess the costs and benefits of the entire Clean Air Act. The Acid Deposition Standard Study under section 404 (Appendix B) of the Act will provide insight into the environmental effectiveness of the Acid Rain Program.

Rules and Guidance. The EPA implements the Acid Rain Program through an integrated set of rules and guidance:

. **Core Acid Rain Final Rules.** The agency promulgated these rules in January 1993 (see Continuous Emissions Monitoring below);

. **Final Allowance Allocation Rules.** The EPA promulgated these rules in March 1993 (Emission Allowance System below);

. **NOx Rule.** The Acid Rain Program proposed the NOx Rule for a nitrogen oxides emission reduction program in November 1992; the Clean Air Act calls for a 2-million-ton reduction in NOx emissions by the year 2000;

. **Opt-In Rule.** This rule allows sulfur dioxide emitting sources other than electric utilities to participate in the Acid Rain Program, providing the opportunity for further low-cost reductions of sulfur dioxide emissions; the final Opt-In rule for combustion sources was published in the Federal Register on September 24, 1993.

Continuous Emission Monitoring (CEMs). Implementation of the acid rain core rules was underway in 1993. All 110 sources subject to Phase I of the sulfur dioxide emissions reduction program have submitted permit applications; draft permits were issued in August 1993, and one-third of the final permits were issued in 1993. The EPA has reviewed over 100 Phase I Continuous Emission Monitoring (CEM) plans, and affected utilities have installed and tested 900 CEMS. Emissions data for Phase I sources were submitted to EPA in January 1994.

Emission Allowance System. To achieve a 10 million_ton reduction in sulfur dioxide emissions, the Acid Rain Program administers an emission allowance system, by which the EPA allocates emission allowances to electric utilities in designated amounts that reflect an overall cut in emissions. To achieve these reductions, the law requires a 2_phase reduction in emissions from fossil fuel_fired power plants. A nationwide cap of 8.95 million tons of sulfur dioxide will be maintained with individual units deciding their own plan for compliance, as long as they stay within their allowance limit. A utility can cut its emissions more than required and sell its extra allowances to another utility or bank them for future use. At the end of each year, utilities must hold enough allowances to cover their emissions. Noncompliance earns automatic penalties.

Emission Allowance Trades and Auctions.

Emisson Allowance Trades and Auctions. A limited number of two-party and brokered trades are occurring in the allowance market, with announced prices ranging from $250 to $350 per allowance. On March 29, 1993, the EPA held an auction conducted by the Chicago Board of Trade, which has been delegated the administrative functions of the allowance auction. About 150,000 allowances were sold with selling prices ranging from $122 to $450 per allowance. Private auctions are expected to occur when the EPA allowance tracking system becomes operational in 1994.

Conservation Verification Protocols. In March 1993 the EPA published Conservation Verification Protocols to provide guidance on energy conservation to the regulated community. The system, in which each ton of sulfur dioxide a utility avoids emitting means one fewer allowance retired and one more that can be sold at a profit, creates an inherent incentive for utility energy conservation.

National Acid Precipitation Assessment Program

The National Acid Precipitation Assessment Program (NAPAP) was reauthorized under Title IX of the 1990 Clean Air Act Amendments (CAAA) to monitor and assess the effects of the Acid Rain Program (Title IV, CAAA). NAPAP coordinates the federal acidic deposition research and monitoring program in addition to its new charges of evaluating the costs of Title IV and determining the reduction in deposition rates needed to prevent adverse ecological effects. As required by the CAAA, NAPAP reports

to Congress on its investigations, analysis, and assessments. The first of these reports, which was issued in 1993, summarizes the evolution of public policy, regulatory, and technical environments within which NAPAP is operating and updates the results of relevant scientific investigations and analysis. Evaluation of costs and benefits will be addressed by NAPAP under section 901 of the Clean Air Act, with reports issued every four years beginning in 1996.

Climate

Global climate change and the effect of greenhouse gases on it were the major climate issues of the year, along with temperature and precipitation extremes in the United States which varied from ice storms to heat waves and from droughts to disastrous floods.

Conditions and Trends

Climate, the average weather in an area over a long period of time, can be described in terms of temperature, precipitation, humidity, sunshine, atmospheric pressure, and wind conditions that prevail at different times of the day or year. Other factors include extremes in range, variability, and frequency of variation.

Major U.S. Weather Events

Checking the long_term record, the contiguous United States experienced lower than average temperature but higher than average precipitation during 1993.

Record Temperature Extremes

The year 1993 started out with moderate average monthly temperatures for most of the country, but, as the year progressed, large areas experienced temperatures of both extremes. By July 1993 a sixth of the country was reporting very warm conditions, while at the same time about a third of the contiguous United States was experiencing very cold conditions. The -very warm- category is defined statistically as that monthly average temperature (or warmer) occurring less than 10 percent of the time throughout the 99-year U.S. climate data record; -very cold- is similarly defined for the cold end of the scale.

Statewide temperature ranks for May-August 1993 showed very warm anomalies along the east coast and very cold anomalies in the northwestern quarter of the country. Seven states ranked among the warmest on record while four states ranked among the coldest.

Unusually cold temperatures occurred for at least a tenth of the country through mid-summer to late fall (July-November), with over a fourth of September readings and nearly a third in November unusually cold. The cold anomalies were located largely from the Central Plains to the Pacific Northwest. In 1993 despite extreme spring and summer temperatures in the Southeast, the contiguous United States as a whole had the 13th coldest year on record.

Record Precipitation Extremes

Parts of the United States experienced excessive precipitation during 1993, but other parts were exceptionally dry. The year started out wet, with more than a fourth of the country experiencing very wet conditions in January, and a sixth of the country reporting very wet conditions in February. The -very wet- category is defined statistically as that amount of precipitation (or greater) occurring less than 10 percent of the time throughout the 99-year U.S. climatic data record; -very dry- is similarly defined for the dry end of the scale. Both very wet and very dry conditions occurred during the summer months: more than a fifth of the country was very wet in June and more than a fourth was very wet in July, while over a fourth was excessively dry during July and a seventh during September.

The period May-August 1993 was characterized by extreme precipitation anomalies. Excessive rains occurred from the Northwest to the Midwest, while severe dryness occurred along the east coast. Using statewide precipitation ranks based on 1895-1993 data, the May-August 1993 period showed 14 states with among the wettest periods on record; Iowa, Montana, and North Dakota ranked as the wettest on record. Thirteen states had among the driest May-August periods on record, with North Carolina ranking as the driest. In 1993 the contiguous United States as a whole had the 13th wettest year on record.

Record flooding occurred along parts of the Mississippi River during the summer of 1993, causing record property and crop damage and closing the river to ship and barge traffic (see Chapter 2: Water Quantity and Quality). Based on 99-year data, the upper Mississippi River basin in 1993 had the wettest April-August period ever. Ironically only five years ago, ship and barge traffic was halted due to near-record dryness reminiscent of the persistent drought of the 1930s.

Much of the primary corn and soybean agricultural region is located within the Mississippi River basin. In 1993 this agricultural belt had the wettest June-September on record; this period encompasses much of the growing/harvesting season.

The Southeast region of the United States in 1993 had the driest May-August period in the 99-year record. Severe crop losses occurred in South Carolina and parts of North Carolina and Georgia because of the drought.

The dryness of summer 1993 rapidly increased the percentage of the South Atlantic-Gulf Coast drainage basins with severe to extreme drought, reaching about 10 percent of the region by August 1993, with another 50 percent of the region in the moderate drought category. The severe drought area persisted at about the 10-percent level through the end of 1993. This occurred after a 2-year respite from severe drought in the region.

In August 1993 about 43 percent of the contiguous United States suffered under severely to extremely wet conditions. By this measure, only four other wet episodes in this century (1915, 1941, 1973, and 1983) have been as severe.

Hurricanes

Only 15 percent of current U.S. coastal residents have experienced a major hurricane, but with the population in storm-vulnerable coastal counties growing rapidly, increasing numbers of people are being exposed to such risks. New residents are the least experienced with hurricanes, but because of a long absence of disastrous hurricanes along most of the coast, even longtime residents have little hurricane experience.

The total amount of real property exposed to the risk of hurricanes is staggering. Hurricane Andrew in 1992 caused estimated direct losses of $26 billion, with indirect losses to businesses of another $15 billion; yet it could have been much worse. Had Andrew struck a mere 20 miles farther north in the financial/business center of Miami, the direct damage could have been $70 billion, with even higher indirect business losses. Andrew sent shock waves through the U.S. economy when several insurance companies failed and later when wind insurance premiums increased tenfold. Each decade holds the potential for several hurricanes like Andrew or worse.

Hurricane Preparedness

During the first 90 years of this century, the United States suffered direct hits by 60 major hurricanes, an average of two out of every three years. Each of these storms now has the potential to be a multibillion-dollar event. The risk of larger hurricane disasters, in terms of loss of life and damage, is increasing. Coastal communities need to address hurricane preparedness on every possible front.

Forecast Uncertainty. The nation still faces uncertain hurricane forecasts. Increased precision in forecasting the point of impact and the strength of the hurricane could limit the population to be evacuated to a level that existing roads could handle. The simple provision of longer lead times and more targeted warnings would allow the repositioning of rolling stock-buses, trucks, recreational vehicles, airplanes, trains, and even boats-thus removing this expensive property from harm's way.

Overdevelopment. A second problem results from the overdevelopment of coastlines. More realistic land-use policies would minimize the growth of the population at risk. The nation needs policy changes to modify or eliminate federal programs that subsidize or otherwise encourage development in the vulnerable coastal zone. Communities need local planning to provide limited, targeted evacuation and last-resort refuges for those who do not evacuate in time.

Unnecessary Preparations. Improved hurricane forecasting and response offers a potential payoff by reducing unnecessary preparations. Such reductions, which could save millions of dollars, depend ultimately on more precise and targeted hurricane warnings.

Lax Building Codes. The potential savings from well-timed preparations in areas hit by a hurricane are even more impressive than savings from the reduction of unnecessary preparations. A good building code was in effect for Andrew in Dade County, Florida, but compliance was deficient. Good code enforcement and inexpensive hurricane shutters could have reduced damages by several percentage points. Such savings would have been significant, considering that 1 percent of the Andrew damage equalled $260 million. Building codes are not as good for the rest of the nation's coastal areas, and thus strict enforcement of better codes represents an area where hurricane preparedness can have a substantial impact.

A major hurricane has yet to hit a large coastal city in modern times, but with the concentration of population along the coast, such an event is inevitable. City infrastructures, including roads and bridges, have not kept pace with population increases, leaving in question the ability of cities to quickly evacuate large populations along the Atlantic and Gulf of Mexico coastlines. Despite increased emergency planning, the record of decreasing hurricane fatalities in this century could be in jeopardy.

Tornadoes

In 1993 the United States experienced 1,173 tornadoes across the country, above the long-term 30-year average of 863 but lower than the 1992 record of 1,297. State-by-state distribution shows that the majority of these storms occurred in tornado alley-that area of the central United States and Gulf coastal plain with a historically high annual probability of tornado occurrence. In 1993 several states reported record numbers of tornadoes:

State Number of Tornadoes

South Dakota 85

Minnesota 47

Virginia 28

Idaho 11

Utah 6

The 1993 death toll was below normal at 33 compared to the average of 82. In the decade ending in 1980, the tornado death toll in the United States was 953. For the 10-year period ending in 1993, that figure had decreased to 536. Several factors have contributed to this trend:

National Severe Storms Forecast Center. The NSSFC is responsible for monitoring current and projected weather patterns to alert the public of the potential for severe weather episodes. The success of this program is measured in the decline in deaths.

National Weather Service Warning Program. Improvements in the NWS warning program have allowed it to reach more citizens, helping them to take precautions for tornadoes.

Local Weather Service Offices. Preparedness efforts sponsored by local weather service offices have raised public awareness of the threat.

Emergency Managers and Volunteers. Safety and preparedness efforts by emergency managers, volunteer spotters, and ham radio operators also have produced a more enlightened public.

The frequency of tornadoes in the United States would seem to indicate a sharp increase in tornado activity in recent years. A detailed examination of the data, however, shows that this is not the case. The explanation is better detection. U.S. tornadoes dating back to 1953, if categorized by intensity-the weak ones versus the strong or violent ones-show a dominance of weak tornadoes. These account for most of the variability and rise in tornado totals that culminated in the record or near record totals for the past four years. One of the factors that has caused this phenomenon is a greater emphasis on report gathering and warning validation by the NWS. Increased populations, storm chasing, and the advent of the video camera have also contributed to the detection of weaker tornados that previously might have been missed. Since the numbers of strong and violent tornadoes have not undergone the growth exhibited by weak tornadoes, it is likely that significant tornadoes represent the true tornado climatology.

Global Environmental Change

While human activities have long influenced local environments, only since the start of the Industrial Revolution and subsequent rapid population growth have human activities begun to have a significant influence on the global environment. These activities are inducing changes in the earth system which may have major environmental consequences: long-term climate change and greenhouse warming, stratospheric ozone depletion and increased ultraviolet (UV) radiation, changes in natural seasonal to interannual climate variability, and large-scale changes in land cover and terrestrial and marine ecosystem productivity. Understanding the causes and implications of large-scale global environmental change is instrumental in determining what courses and actions must be considered now and in the future to ensure the compatibility of economic growth, protection of the global environment, and long-term sustainability of the quality of life.

Greenhouse Gases

Trace gases in the atmosphere comprise only about 1 percent of its composition but provide two vital functions: they warm the earth's surface by trapping infrared (heat) energy in the atmosphere; and they shield the planet from harmful radiation. These gases are referred to as greenhouse gases. Their warming capacity, called the greenhouse effect, is essential to maintaining a climate hospitable to all life forms.

Greenhouse gases regulate the global climate by stabilizing the balance between the earth's absorption of heat from the sun and its capacity to reradiate heat back into space. Activities that can change this balance include natural, such as changes in solar radiation and volcanic eruptions, and human-induced, arising from industrial and land-use practices that release or remove heat-trapping greenhouse gases, thus changing atmospheric concentration. Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and ozone in the lower stratosphere and troposphere. While water vapor has the largest effect, its concentrations are not directly affected, on a global scale, by human activities. Most of these gases occur naturally, the exceptions being CFCs, HCFCs, HFCs, and PFCs, but human activities'combustion of fossil fuels, deforestation, rice cultivation, mining, and the use of nitrogen fertilizers, refrigerants, and solvents'have contributed to increases in their atmospheric concentrations. Internationally accepted science indicates that increasing concentrations of greenhouse gases ultimately will raise atmospheric and oceanic temperatures and could alter associated circulation and weather patterns. Many greenhouse gases have long atmospheric residence times-several decades to centuries-which implies that the atmosphere will recover very slowly, if at all.

Since 1990 U.S. emissions of carbon dioxide have increased while emissions of other greenhouse and photochemically important gases have remained constant or have declined. A summary of trends for the main greenhouse gases follows.

Carbon Dioxide. Large natural sources and sinks of carbon dioxide function in a balanced cycle, with human activities accounting for a smaller, but increasingly important source of emissions. Global atmospheric concentrations of carbon dioxide have increased about 30 percent since the 1700s,

suggesting that the natural carbon cycle may be out of balance. This increase is responsible for more than half of the global -heat trapping- or -radiative forcing- due to human activities.

Since the 1950s observations of carbon dioxide have shown regular annual increases in both concentration and rate of concentration growth, with year-to-year variations in growth rate. During the period 1991 to 1993, the rate of increase of carbon dioxide per year slowed, substantially and inexplicably, to as low as 0.5 parts per million by volume (ppmv) per year from as high as 1.5 ppmv per year. Numerous examples exist of short periods where growth rates are higher or lower than the long-term mean. The most recent observations indicate that growth rates of carbon dioxide are increasing again.

The main anthropogenic sources of carbon dioxide are the burning of fossil fuels (with additional contributions from cement production) and land-use changes. In the United States, anthropogenic emissions are divided fairly evenly among sectors. Fossil-fuel combustion produces 99 percent of the total gross U.S. emissions. The industrial sector is the largest source of fossil-fuel carbon dioxide emissions while the transportation sector, second to industry in quantity, had the fastest growth rate in emissions during the last decade. Cement production involving the calcination of limestone, lime production, steel making, and industrial carbon dioxide production account for the remaining 1 percent of total emissions. Absorption of carbon dioxide in U.S. forests (carbon -sinks-) has increased in recent years.

The United States is the world's largest source of energy-related carbon dioxide emissions, followed by the former Soviet Union and China, India, and Germany. In 1950 U.S. fossil-fuel carbon dioxide emissions accounted for more than 40 percent of global emissions; since then, however, this share has steadily declined to 22 percent. Emissions in the developing world, while a relatively small portion of the total, continue to rise rapidly, particularly in the Far East.

Methane is a potent greenhouse gas. Considering only its heat-absorption potential, one molecule of methane has 20 times more effect on climate than one molecule of carbon dioxide. Global concentrations of methane in the atmosphere have more than doubled over the last two centuries and since 1983 have increased by 7 percent, even though the globally averaged methane growth rate declined. Recent data suggest that the growth rates started to increase in late 1993.

Scientists have concluded that atmospheric increases in methane are largely caused by increasing emissions from anthropogenic sources, such as landfills, agricultural activities, fossil fuel combustion, coal mining, the production and processing of natural gas and oil, and wastewater treatment. Landfills are the largest source of methane emission in the United States-they represent a third of U.S. methane emissions-followed by emissions from agriculture (primarily cattle production) and emissions from oil, gas, and coal production collectively.

Methane is also produced naturally via anaerobic decomposition. Wetlands provide the largest natural source, followed by termites. While termites are only a trivial natural methane source in temperate zones, they are ubiquitous in the tropics and when tropical forests are logged or burned, vast quantities of wood residue provide ideal conditions for termite population explosions.

Nitrous Oxide. Nitrous oxide, commonly known as laughing gas, is a potent, stable greenhouse gas with a long atmospheric lifetime, from 120 to 150 years. Although actual emissions of nitrous oxide are

smaller than those of carbon dioxide, nitrous oxide is approximately 270 times more powerful than carbon dioxide at trapping heat in the atmosphere over a 100-year time horizon.

The many small sources of nitrous oxide, both natural and anthropogenic, are difficult to quantify. A best estimate of the current (1980s) anthropogenic emission of nitrous oxide is 3 million to 8 million metric tons per year. Natural sources are probably twice as large. Atmospheric concentrations of nitrous oxide have increased by 8 percent over the last century, which is most likely due to human activities. The average growth rate over the past four decades is about 0.25 percent per year (0.8 parts per billion per year).

The primary source of nitrous oxide emissions in the United States is agricultural fertilizer use and soil management. Lesser sources include fossil fuel combustion by mobile and stationary sources, adipic acid production, nitric acid productions, and burning of agricultural crop residues.

Halocarbons. Halocarbons containing fluorine, chlorine, and bromine are significant greenhouse gases on a per molecule basis. Direct radiative forcing (heat trapping) due to increases in halocarbons since pre-industrial times represents about 12 percent of the greenhouse gas contribution. Chlorine from chlorofluorocarbons (CFCs), carbon tetrachloride, and methyl chloroform and bromine from halons are also linked to stratospheric ozone depletion to varying degrees. CFCs have been long and widely used as refrigerants, foaming agents, solvents, and aerosol propellants. Carbon tetrachloride and methyl chloroform are industrial solvents, and halons are used in fire suppressors. Emissions of many such ozone-depleting compounds are controlled by the Montreal Protocol and its subsequent amendments and adjustments:

. **The Montreal Protocol.** The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer calls for a 50-percent reduction in the use of chlorofluorocarbons (CFCs) by 1995, using 1986 usage levels as baseline.

. **The London Amendment.** The subsequent London Amendment calls for the complete elimination of CFC use by 2000.

. **The Copenhagen Amendment.** The proposed Copenhagen Amendment, to be ratified in 1994, accelerates the complete phaseout of CFCs to January 1, 1996.

The tropospheric growth rates of the major anthropogenic source species for stratospheric chlorine and bromine have slowed significantly in response to these international agreements. For example the 1993 CFC-11 annual growth rate was 25 to 30 percent of that observed in the 1970s and 1980s. The total amount of organic chlorine in the troposphere increased by only 1.6 percent in 1992, about half of the rate of increase (2.9 percent) in 1989. Total peak chlorine/bromine loading in the troposphere is expected to occur in 1994, but the stratospheric peak will lag by about three to five years, so stratospheric abundance will continue to grow for a few more years before declining.

Several substitutes for CFCs and other ozone-depleting substances are now being manufactured and used, including hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs). Growth in atmospheric concentrations of HCFCs has been observed for several years and is currently about 7 percent per year. The direct global warming potential of most HCFCs and HFCs are less than those of the compounds they replace, although some HFCs have substantial global warming potentials. Perfluorocarbons, which have been proposed as CFC substitutes in some applications and are by-

products of some industrial processes, including aluminum production, have very long atmospheric lifetimes (several thousand years) and are extremely powerful greenhouse gases. Because they are not harmful to the ozone layer, they are not controlled by the Montreal Protocol. Because of their greenhouse effect, however, they will be considered under the Framework Convention on Climate Change.

Ozone

Ozone is an important greenhouse gas present in both the stratosphere and troposphere. In the troposphere ozone is produced from various precursor gases (carbon monoxide, nitrogen oxides, and non-methane hydrocarbons) and as a result of chemical feedbacks involving methane. Tropospheric ozone-a key component of smog-has increased above many locations in the Northern Hemisphere over the last 30 years. This is a cause for concern because tropospheric ozone acts as a strong absorber of infrared radiation and in high concentrations causes respiratory distress in humans. In the Southern Hemisphere, a decrease has been observed since the mid-1980s at the South Pole; in the hemisphere as a whole, data are insufficient to draw strong inferences.

In the stratosphere ozone is continually being formed and destroyed by chemical reactions. Large natural changes occur in stratospheric ozone concentration; for example between summer and winter, a change of about 25 percent can occur at mid-latitudes. Stratospheric ozone depletion occurs if the rate of ozone destruction becomes faster than its rate of formation, either because of natural causes or human activities. Over the past 15 to 20 years, loss of stratospheric ozone caused by CFCs and halons may have partially offset their direct warming effect. Stratospheric ozone depletion is also linked to increases in ultraviolet (UV) radiation.

Stratospheric Ozone Depletion

Long-term global satellite and ground-based monitoring data indicate that stratospheric ozone depletion has been occurring over most of the globe, except in the tropics, since late in the 1970s. The most dramatic evidence of this decline is the springtime ozone hole in the Antarctic. Downward trends of several percent per decade are now observed in all seasons at mid-latitudes (poleward of 20 degrees) in both hemispheres, with winter and springtime declines of as much as 6 to 8 percent per decade observed poleward of 45 degrees. Global ozone depletion worsened significantly in 1992 and 1993, including wintertime depletions of up to 25 percent over populated regions in the high latitudes of the Northern Hemisphere.

The observations of unprecedented and unexpected ozone depletion in 1992 and 1993, coinciding with the period following the eruption of Mt. Pinatubo, have revealed new gaps in scientific understanding and, hence, in prognostic capabilities. While ozone levels may have been perturbed by the Mt. Pinatubo eruption, either by changes in stratospheric temperature and/or circulation or by enhanced heterogeneous chemistry, the magnitude and timing of the recent, large ozone decreases are not fully explained by the current understanding of these effects. Consequently evaluation of the heterogeneous chemistry associated with surface reactions on aerosols through laboratory studies, atmospheric observations, and modeling remains a research priority.

Antarctic Ozone Hole. Each winter the atmosphere over Antarctica is isolated from the rest of the world by the polar vortex. It is dark and very cold, resulting in the formation of clouds in the ozone layer of the stratosphere. When the sun shines on Antarctica again in springtime, chlorine in these clouds causes local depletion of ozone, thus creating the ozone hole. The hole disappears when the Antarctic atmosphere warms up enough to break up the circulation which isolates it from the rest of the world. Ozone-rich air then flows in to replenish the ozone layer over Antarctica. The springtime Antarctic ozone hole has been growing successively larger and more intense since the 1960s. Now the springtime (October) average total ozone values over Antarctica are 50 to 70 percent lower than those observed in the 1960s. In 1993 the ozone hole over Antarctica produced the lowest values of ozone ever recorded anywhere in the world. The ozone hole is expected to reach its most severe levels early in the next century, and recovery is estimated to take 70 years.

Environmental Implications. Significant increases in ultraviolet (UV) radiation have been observed in conjunction with periods of intense ozone depletion. Analysis of fauna living in the Antarctic region, analysis of health data, and field and laboratory experiments indicate that increases in UV levels may have significant deleterious impacts on human health, fish populations, and, if sustained, most of the earth's ecosystems. In humans and other terrestrial and aquatic organisms, impacts can include immune system suppression, sunburn, cataracts, lesions, reduced vitamin D synthesis, and cancers which can result in reduced fitness and death. In plants UV can inhibit the photosynthetic process and result in the death of organisms.

Changes in UV exposure also relate to issues concerning changing species diversity and agricultural productivity and induce adverse effects on materials such as plastics. The 1993 springtime ozone hole over Antarctica allowed record levels of UV light to reach Antarctica. At one Antarctic monitoring site, UV-B, the part of the spectrum most harmful to life, was recorded at levels 44 percent higher than in 1992. Investigations are now underway on the impact that the increased UV might have on life on and around Antarctica, and on whether animals and plants may have mechanisms to avoid harm from increased UV. Current UV levels have already reduced productivity of ocean phytoplankton-microscopic plants that comprise the base of the Antarctic food chain-by 6 to 12 percent in areas affected by the ozone hole.

Stratospheric ozone depletion is also linked to changes in the surface climate. Loss of lower-stratospheric ozone is predicted to lead to a cooling tendency at the surface. As a result of this effect, ozone decreases offset some of Mt. Pinatubo eruption, either by changes in stratospheric temperature and/or circulation or by enhanced heterogeneous chemistry, the magnitude and timing of the recent, large ozone decreases are not fully explained by the current understanding of these effects. Consequently evaluation of the heterogeneous chemistry associated with surface reactions on aerosols through laboratory studies, atmospheric observations, and modeling remains a research priority.

The greenhouse warming of the halocarbons that caused the ozone change. Such indirect couplings complicate projection of changes in the global climate.

The United Nations Montreal Protocol (1987) and its amendments are being implemented to phase out production of ozone-depleting compounds. Even if the control measures are fully implemented, however, ozone depletion will continue for nearly another decade. Because of the long atmospheric lifetimes (up to 100 years) of many of the halocarbons, the earliest recovery of the Antarctic ozone hole

is several decades away, and a return to near-natural atmospheric levels of chlorine and bromine, and therefore of ozone, will take centuries.

Aerosols

Modeling studies suggest that, in contrast to greenhouse gases, anthropogenic particles in the atmosphere derived from sulfur dioxide emissions from coal and oil combustion and heavy industrial processes and from biomass burning can lower surface temperatures. Research on the radiative effects of these atmospheric aerosols is important to understand whether aerosols may be, in the near-term, offsetting the enhanced greenhouse effect of carbon dioxide. Recent studies suggest that the hemispheric asymmetry in this century's warming may be due, at least in part, to the preferential presence of sulfate aerosols in the Northern Hemisphere as a result of industrial emissions patterns.

Natural Factors

Natural factors can exert positive or negative radiative forcings. For example since about 1850, a change in the sun's output may have resulted in positive radiative forcing. In contrast some volcanic eruptions, such as that of Mt. Pinatubo in June 1991, result in short-lived (a few years) increase in aerosols in the stratosphere, causing a large, but short-lived negative radiative forcing. The effect of the Mt. Pinatubo eruption has been detected in the observed temperature record.

Climate Change Indicators

The accumulated evidence suggests that global climate change may be occurring. Among the indicators changes in surface air temperatures provide the most direct evidence. Global mean surface temperature, as indicated by the long-term measured climate record, has increased between 0.3 and 0.6 degrees Celsius over the past century. The observed warming over parts of the Northern Hemisphere mid-latitude continents largely characterized by increases in minimum (night-time) rather than maximum (day-time) temperatures. Scientists and governments around the world agree that if the current rate of increase in anthropogenic emissions of greenhouse gases continues, the global mean temperature will likely warm between 1.5 and 4.5 degrees Celsius over the next century.

Additional evidence for global climate change can be gleaned from observational and satellite records of precipitation over land areas in middle latitudes and in the tropics, areal extent of snow cover, date of snow cover disappearance in the Arctic, trends in sea-ice extent in the Arctic and Antarctic regions, melting of glaciers outside the polar zone, and sea-level rise.

Land Use and Global Climate Change

Alterations of natural systems-clearing land for agriculture, logging forests, or reclaiming swamps-have impacts on emissions and absorption of greenhouse gases but consequences whose magnitude is uncertain. Improved predictions of the response of terrestrial ecosystems to changes in temperature, rainfall, solar radiation, especially UV radiation, and changes in carbon dioxide concentrations will enable the development of management strategies for reducing damage to valuable ecosystems.

Why is Climate Change an Issue

The predicted increases in global mean temperature are likely to lead to shifts in precipitation patterns and rising sea level. Although the implications of these changes is not fully understood, it is climate change that poses the most serious threat to human health, global productivity, and worldwide economic stability.

Prospective changes in precipitation patterns from climate change are predicted to lead to important shifts in world agricultural, forestry, and grassland regions and in the availability of water resources, with the possibility of altering long-established patterns of land use. The growth rate of some plants might be increased in the presence of additional carbon dioxide-called the -fertilization effect-. Together these changes have the potential to cause important shifts in habitat for flora and fauna. Although average global food productively may not be affected adversely by climate change, local effects, especially in developing countries, could lead to hunger, malnutrition, and large-scale human migrations.

Climate change also poses a threat to forestry and fishery resources. Recent studies suggest that forest health may be impacted by negative synergisms among depositional pollutants (such as acid rain), global change parameters (such as elevated carbon dioxide), and biotic stresses (such as insect feeding). Slight changes in salinity or temperature may impact adversely larval stages of fish, the most vulnerable life stage to environmental change.

The warming of the oceans and the melting of icecaps and glaciers will result in sea level rise. The amount of sea level rise over the next century is projected to be tens of centimeters (several times the rate of rise in the recent past), which could lead to coastal flooding, the loss of valuable wetlands, and increased threats to coastal areas from storm surges and hurricanes.

Although there has been little research to date on the human health effects from climate change, such effects could range from increases in vector-borne diseases to higher mortality rates during increased conditions of excessive heat and air pollution, particularly in areas with a high incidence of poverty.

Estimates of human-induced changes in land-cover vary according to the system of land-cover classification used, but to provide some examples, human activities over the last three centuries have resulted in a net loss of approximately 2.32 million square miles or 6 million square kilometers of forest (an area slightly smaller than Australia); a net gain in cropland of approximately 4.6 million square miles or 12 million km2 (an area approximately the size of the United States and Mexico); and a net loss of approximately 0.62 million square miles or 1.6 million km2 of wetlands.

While the direct effects of land-cover changes on global environmental systems are not precisely understood, it is generally accepted that changes in land-cover from human activities have resulted in a net flux of carbon dioxide to the atmosphere approximately equal to the net release over the same period from fossil fuel burning, with land-use and land-cover change representing the largest human source of emissions of nitrogen dioxide. The potential impacts of land-cover changes on climate can only be crudely assessed at present. Much attention has been focused on the effects of deforestation of large areas of tropical rainforest and the resulting changes in radiative forcing through release of carbon into the atmosphere. But land-cover changes also affect regional climate by altering surface runoff,

temperature, and wind speed. In the United States, recent trends in land use such as the abandonment of farmland and the increase in forest area should enhance natural absorption of carbon dioxide and methane while reducing emissions of nitrous oxides associated with agricultural fertilizer use.

Program Accomplishments

The focus in 1993 was on global environmental change. President Clinton announced on Earth Day 1993 that the United States was committed to reducing greenhouse gas emissions to the 1990 level by the year 2000. Other accomplishments included a new Climate Change Action Plan and measures to help implement the Framework Convention on Global Climate Change, to protect the stratospheric ozone layer, and to phase out CFC-production.

U.S. Climate Change Programs

The United States is signatory to the 1992 Framework Convention on Climate Change that commits nations to the aim of reducing emissions of greenhouse gases and to the Montreal Protocol that strives to phase out production of CFCs and other ozone-depleting substances. In 1993 the United States undertook a number of programs that helped comply with these agreements.

Earth Day 1993

On the occasion of the 24th Earth Day, April 21, 1993, President Clinton announced that the United States was committed to reducing greenhouse gas emissions by the year 2000 to their 1990 levels and promised a plan to outline steps for achieving these levels. At the 1992 Earth Summit in Rio the United States had joined more than 150 other countries in signing the Framework Convention on Climate Change, whose objectives are to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system within a timeframe sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner. As of December 21, 1993, the Framework Convention had been ratified by 50 countries and was scheduled to enter into force in 1994.

The Climate Change Action Plan

In October 1993 President Clinton released a blueprint for reducing greenhouse gas emissions, The Climate Change Action Plan. The plan will provide a foundation for the National Report required under the Framework Convention on Climate Change that will describe the policies, programs, and measures the United States is taking to reduce greenhouse gas emissions. The plan targets all greenhouse gases and calls for 50 actions involving many sectors of the economy-industry, transportation, homes, office buildings, forestry, and agriculture. Examples follow.

Forests as Carbon Sinks. One action would reduce carbon dioxide emissions by protecting forests, which are natural greenhouse gas sinks.

Climate Challenge. The Department of Energy (DOE) has formed a new partnership with major electric utilities who have pledged to reduce greenhouse gas emissions. Participating utilities may choose from a range of control options and experiment with innovative ideas to achieve their emission reduction goals.

Climate Wise. As part of this joint program cosponsored by the DOE and the EPA, firms who agree to reduce greenhouse gas emissions set bottom-line emission targets that they can attain using the most cost-effective means available.

DOE Motor Challenge. This new initiative sponsored by the DOE, motor system manufacturers, industrial motor users, and utilities promotes installation of the most energy-efficient motor systems in industrial applications.

EPA Partnerships. Chemical companies are working with the EPA to reduce byproduct emissions of potent greenhouse gases by 50 percent from their manufacturing operations. Aluminum producers joined with the EPA to identify opportunities to reduce greenhouse gas emissions and set targets for real reductions.

U.S. Initiative on Joint Implementation. In addition to reducing greenhouse gas emissions with domestic actions, the Plan lays the foundation for an international response. The Framework Convention encourages countries to explore emission reduction projects together under a program of joint implementation. To gain experience in verifying net emission reductions from certain types of investments in other countries, the U.S. Initiative on Joint Implementation will develop projects to provide greenhouse gas reductions beyond the domestic programs and promote sustainable development. The initiative will advance thinking on issues that need resolution before an international joint implementation effort can be fully mounted.

White House Conference on Global Climate Change

The interagency team assigned by the President to develop a new Climate Change Action Plan relied heavily on public input. For that purpose the team helped organize the White House Conference on Global Climate Change, held on June 10-11, 1993, in Washington, D.C. The conference provided the opportunity for hundreds of recognized experts to offer their suggestions and views. The Climate Change Action Plan was released in October 1993.

Green Technology

The EPA continued to promote green programs that encourage the voluntary introduction of new energy-saving technologies in the marketplace. Accomplishments in 1993 included the following:

Natural Gas Star Program. In March 1993 the natural gas industry and the EPA launched this voluntary partnership to reduce methane emissions from their operations. The 16 participating companies represent 40 percent of U.S. gas transmission and distribution systems. Potential savings from the program could reach 1 million metric tons of methane-the CO2 equivalent of removing 3 million cars from the road.

Energy Star Computers. These computers have a feature that allows the machine to reduce its power consumption automatically or -go to sleep- when not in use. Energy Star computers entered the market in 1993;

Ozone-Friendly Refrigerators. Whirlpool won a $30 million contract in a contest sponsored by an electric utility consortium to provide consumers with energy-efficient, ozone-friendly refrigerators; and

Green Lights Program. This initiative, which encourages companies to replace their existing lighting with new, energy-efficient lighting fixtures, grew to over 1,000 participants in 1993.

Phaseout of Ozone-Depleting Substances

The United States continued to make progress in implementing its regulatory schedule for the phaseout of ozone-depleting substances (ODS). The regulatory implementation schedule, which meets domestic and international deadlines for the phaseout, takes a two-pronged approach:

. ODS Phaseout. Complete the phaseout of Class I ozone-depleting substances by the end of 1995, and

. Significant New Alternatives Policy (SNAP). Implement the SNAP, which evaluates substitutes or alternatives for ozone-depleting substances based on the ozone-depletion potential of a substance, global warming potential, flammability, toxicity, exposure potential, and economic and technical feasibility.

Freezing Methyl Bromide Production

In January 1993 in keeping with the Montreal Protocol and subsequent agreements, the United States signed a notice of proposed rulemaking (NPRM). In addition to accelerating the phaseout schedule, the proposed rule would list methyl bromide as a Class I substance and freeze its production at 1991 levels.

ODS Labeling Program

A labeling requirement for containers of ozone-depleting substances, for products manufactured with ODS, and for products containing ODS will go into effect in 1994. The following warning will appear on labels: -Warning: Contains (insert name of substance), a substance which harms public health and the environment by destroying ozone in the upper atmosphere.- The EPA will enforce use of the label.

CFC Replacements

Studies on CFC replacement compounds are underway to determine their potential impacts on humans and the environment. The metabolism and toxicity of hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), for example, are being investigated. Available data indicate that compounds that are rapidly metabolized are more toxic than those that are slowly metabolized. HCFC-132b is metabolized rapidly and yields metabolites that are potent inhibitors of the enzymes used by the body to detoxify many drugs and chemicals. As a result its development has been discontinued. Other research suggests that HCFC-123 may increase susceptibility to hepatitis in sensitive individuals. Computer modeling studies of reactions of CFC substitutes are being conducted to develop models that

will predict metabolism rates and identify compounds likely to be poorly metabolized and therefore of little toxic potential. Preliminary results of this research are promising, and the range of compounds to be tested has been expanded. The biospheric transport and fate of CFC substitutes are also being investigated to assess likely future concentrations of these new chemicals in air, water bodies, and soils.

UV Monitoring Network

Substantial progress has been made in establishing a U.S. Interagency Ultraviolet (UV) Monitoring Network. Several federal agencies are either currently operating or are developing UV monitoring networks. Because each of the individual agencies have different research and operational needs for UV data (such as concerns with effects on agriculture, on human health, and on fish and wildlife), each of these networks are using different types of instruments that best address their respective needs. A UV monitoring plan has been developed to ensure that data collected by the individual agency networks are intercalibrated.

International Climate Change Actions

The United States is a major participant in international efforts to understand and assess the state of knowledge about global change issues. Hundreds of scientists from more than 50 countries have participated in recent assessments which have included review of scientific results, environmental impacts, technologies, and economic considerations. These intergovernmental assessments are especially important as they are intended to serve as primary inputs to the many international conventions and protocols that the United States supports, including the Framework Convention on Climate Change, the Montreal Protocol on Ozone, and the Convention on Biological Diversity (see Chapter 6).

The Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organization and the United Nations Environment Program in 1988. The IPCC produces reports on climate change which characterize agreement and disagreement within the climate change research community on issues of importance to policymakers.

The IPCC has produced the 1990 Assessment covering changes in climate, potential impacts, and response strategies; a 1992 Supplement which updated the 1990 volume in time for consideration by governments at the Earth Summit; and a forthcoming 1994 Special Report focusing on radiative forcing of climate resulting from human emissions of greenhouse gases. That report also includes technical guidelines for evaluating sources and sinks of greenhouse gas emissions and technical guidelines for evaluating the potential impacts of climate change. The IPCC currently is preparing a second comprehensive assessment of climate change and the vulnerability of natural and socioeconomic systems to change, scheduled for completion in 1995.

The IPCC assessment process has been a critical part of establishing scientific consensus on climate change issues, largely because of the extensive involvement of a diversity of national and scientific

backgrounds, representation of minority views, extensive peer review, and a commitment to scientific excellence.

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Chapter 2: Water Quantity and Quality

From the first Americans to the present day, our people have lived in awe of the power, the majesty, and the beauty of the forest, the rivers, and the streams of America.

President Bill Clinton

Despite major droughts and chronic water shortages in some locales and record floods in others, the United States has an abundance of high-quality, fresh surface water and groundwater. In 1993 combined withdrawals from rivers, streams, lakes, reservoirs, and groundwater aquifers continued to meet U.S. needs for potable freshwater. Water issues centered on reauthorization of the Clean Water Act and the Safe Drinking Water Act. The Administration supports amendments that would provide better protection of our nation's water at a lower cost. Other issues ranged from joint U.S.-Canadian efforts to restore the Great Lakes ecosystem to U.S.- Mexican efforts to improve water quality in the Rio Grande River.

A number of federal agencies are involved in managing and protecting the nation's water resources. Within the Department of the Interior (DOI), the U.S. Geological Survey (USGS) provides the hydrologic information essential to these tasks. The Bureau of Reclamation (BOR) operates water projects to provide flood control, and water supplies to western states for irrigation, municipal and industrial use, hydropower, recreation, and fish and wildlife. Other DOI agencies, such as Fish and Wildlife Service and the Bureau of Land Management have programs to protect water quality and aquatic ecosystems. The U.S. Environmental Protection Agency (EPA) administers water pollution control and safe drinking water programs and, with the Army Corps of Engineers (COE), regulates the dredging and filling of wetlands and other coastal waters and ocean dumping. The COE also oversees a vast system of levees, dams, and reservoirs primarily for flood control, irrigation, hydropower, and navigation. Within the Department of Agriculture, the Soil Conservation Service administers swampbuster and wetlands reserve programs, and within the Department of Commerce, the National Oceanic and Atmospheric Administration (NOAA) conducts coastal and marine water quality assessments and supporting research. The NOAA also manages the nation's marine sanctuaries and estuarine research reserves. In addition many states assume principal administrative roles in managing water resources through programs delegated to them by the federal government.

Water resource issues tend to focus on either quantity and/or quality for surface water or groundwater. Hydrologic distinctions between surface water and groundwater are far from absolute, with groundwater supplying an estimated 40 percent of average annual baseflow to streams.

Water Quantity

Among the good news, the nation is not running out of water, and total water use is below estimates. Periods of above-normal precipitation, however, will likely follow periods of drought, in the future as in the past. Water-related events in 1993, which were a study in contrasts, support this contention. The prolonged 1987-1993 drought that affected much of California, Arizona, and other western states appeared to end only to be followed by winter floods on the Gila and Tijuana rivers; then summer came with record floods that devastated the Mississippi and Missouri river basins.

Conditions and Trends

In 1993 the renewable (long-term) supply of water in streams and aquifers was estimated to be 1,400 billion gallons per day for the conterminous United States. Offstream withdrawal of surface water continued to be the primary source of the nation's water supply, but groundwater, as it has since 1950, continued to gain in favor as an additional source. Groundwater, the source of drinking water for over half the U.S. population and for most rural residents, increased in use for all purposes except thermoelectric power generation where water is used in the generation of electricity by steam turbines.

The factors determining whether a community uses surface water or groundwater as its freshwater source differ across the country. The largest withdrawals of fresh surface water occurred in California, Idaho, Illinois, Michigan, Ohio, and Texas. Together eight states withdrew more than 10 billion gallons of freshwater per day for offstream uses, accounting for 41 percent of the total surface water withdrawals in the nation. States with the largest fresh groundwater use are in the West where irrigated agriculture is common.

Despite projections that U.S. water use would increase, total offstream and instream uses declined in 1985 compared to 1980. In 1990 although total offstream use rose 2 percent above 1985, it remained 8 percent less than earlier projections. For most water- use categories, a general slackening in the rate of increase changed to a decrease in water use between 1980 and 1985. Two exceptions are thermoelectric power plants, which in 1990 used the greatest share with 48 percent of total withdrawals, and public water supplies that accounted for only 9.4 percent of the total.

A 4-percent increase in total withdrawals for thermoelectric power from 1985 to 1990 was the result of a 15-percent increase in saline water withdrawals. This water is used for cooling purposes, with most of it returned to the source. Instream water used for hydroelectric power generation remained a major nonconsumptive use of managed water systems.

Even though the U.S. population increased 4 percent between 1985 and 1990, withdrawal and consumptive- use increased only 2 percent during this time, in part due to increasing efforts for water conservation, improved efficiency of water use, and use of water- reuse technology. These figures contrast the 1970-1975 figures, when the rate of increase in withdrawals more than doubled the rate of population growth.

Surface Water

The exploration and development of the United States has relied on surface water. Today surface water continues to be the major source of water for municipal and industrial use, irrigation, and generation of electricity. Rivers, lakes, and reservoirs also provide recreational opportunities for tens of millions of people each year and support fisheries and wildlife habitat.

The hydrologic cycle-the continual circulation of water from the sea to the atmosphere to the land and back again-determines the natural availability of surface water in any geographic area. This availability depends ultimately on the amount of rain and snow an area receives. Average annual precipitation in the United States is 30 inches per year; however, the range varies from a few tenths of an inch per year in desert areas of the Southwest to 400 inches per year at sites in Hawaii.

Streamflow

The standard measure of water quantity, whether offstream or in- stream and whether for recreation, irrigation, or public water supplies, is streamflow. The USGS 6-year streamflow trend data for October 1988-September 1993 illustrate the variation in natural distribution of water supplies across time and space. The hydrograph for the United States and Southern Canada shows that monthly streamflow for 1993 was well above the long-term median streamflow for the 30-year period 1961-1990. Streamflow amounts in many of the 12 hydrologic basins monitored by the USGS also were in the above-normal range, especially in the upper Mississippi River basin, which includes the Missouri River. In contrast streamflow has been below normal in the Northwest for most of the past several years.

Floods

Floods occur when weather deviates strongly from the long-term climate pattern and delivers more water to land surfaces than can be readily absorbed or stored.

The Midwest Flood of 1993. The single most damaging flood event of the year was -the Great Midwest Flood. This protracted event began setting itself in motion in January with development of abnormally high soil moisture levels in the Upper Midwest and a significant snowpack. Moderate flooding from heavy rains in April and May aggravated the situation. In late June an extraordinarily stable and extremely wet weather pattern established itself over the Midwest, producing intense rains over Iowa, Missouri, Minnesota, Wisconsin, Illinois, Kansas, Nebraska, and North and South Dakota. The rains continued through July and August, and produced record floods over much of this 9-state area. Flood waters overtopped, undercut, and breached over 1,000 levees, flooding thousands of acres of land and hundreds of homes, structures, and buildings.

The rainfall over the upper Midwest from May to August 1993, unmatched in the historical records of the central United States, was approximately 200-350 percent of normal for the northern plains southeastward into the central Corn Belt. The precipitation totals were remarkable not only in magnitude but also in their broad regional extent: record wetness existed over 260,000 square miles. With wet antecedent conditions which caused waterlogged soils, the water from the heavy rains had no place to go other than into the streams and river courses. The result was record flooding which equaled or exceeded flood recurrence intervals of 100-years along major portions of the mid-Mississippi and lower Missouri rivers. In terms of precipitation amounts, record river stages, flood duration, areal extent of flooding, persons displaced, crop and property damage, and economic impact, the Midwest Flood of 1993 surpassed all previous U.S. floods. Flood damages in the nine affected states are estimated at $15.6 billion, but fortunately the number of deaths was relatively low: 38 people died as a direct result of flooding.

Winter Floods In the Southwest. On January 19, 1993, the President declared the entire state of Arizona a flood disaster area. The excessively wet 1992-1993 winter, while beneficial to Arizona and California in breaking their longstanding drought, led to heavy runoff that caused the severe flooding, dam overtopping, agricultural and other property damage, and loss of life. Flood warnings were in effect almost continuously from January through April for the middle and lower Gila River. Among the forecast

locations monitored by the National Weather Service, 14 experienced record flows, but the most deadly flooding occurred on the Tijuana River, along the border between California and Mexico.

For the first time since it was constructed in 1960, the Painted Rock Dam on the Gila River, 50 miles southwest of Phoenix, filled to capacity (2.6 million acre-feet or 113 percent of flood control capacity) and had an uncontrolled spill. All upstream reservoirs on the Gila, Salt, and Verde rivers also filled and spilled through their emergency spillways. The uncontrolled flow out of the Painted Rock Reservoir resulted in flooding as far downstream as Mexico and led to the evacuation of 3,500 people. Total damages from the southwest winter floods were $392 million ($228.9 million in Arizona and $163.7 million in California), with 17 deaths attributed to the flood.

Flood Risk Reduction. As a result of 1993 floods and the damage and loss of life that occurred, the effectiveness of the traditional levee-drainage-diversion approach to alleviating flood risk in flood-prone basins is under review. In 1993 the Administration formed several interagency working groups to consider alternative ways to reduce flood risks in the future, such as programs that protect, restore, and enhance wetlands, thus reducing the rate of inflow from the watershed, and movement of dwellings out of hazard zones. For example hazard mitigation projects funded by the Federal Emergency Management Agency following these recent flooding disasters are removing development from floodplains and restoring some areas of the floodplains to open space and natural areas.

In the fall of 1993 the White House chartered the Scientific Assessment and Strategy Team to develop a database of flood and basin information at the EROS Data Center in Sioux Falls, South Dakota. The White House also appointed the Administration Floodplain Management Task Force to make recommendations on changes in current policies, programs, and activities of the federal government that most effectively would achieve risk reduction, economic efficiency, and environmental enhancement in the floodplain and related watersheds.

Droughts

At the other extreme from floods, droughts can severely reduce water availability and cause significant environmental impacts and economic hardships. The adverse effects of a drought on water supplies depend on the following factors:

. Amount of water stored or available from the preceding year;

. Water demands relative to average flow;

. Soil conditions;

. Natural flow during a drought period; and

. Drought-stressed vegetation that retard recovery of soil moisture until its deficit is satisfied.

The multi-year droughts of the late 1920s and l930s resulted in extensive regional impacts. For the past several years, river basins throughout the western region have experienced drought conditions.

Snow Water Equivalents. About 75 percent of the useable water in the western states originates as mountain snowfall. This snow accumulates during winter and spring and remains for as much as 9 months before it melts and appears as streamflow. Measured by snow water equivalents, snowpack is

the most relevant factor in determining water supply in the West. Fall precipitation influences soil moisture prior to the formation of the snowpack and explains, in part, the effectiveness of the snowpack in producing runoff. Soil moisture condition has been traditionally measured by the Palmer Drought Severity Index (PDSI), but is now also reported as a Surface Water Supply Index calculated from existing soil moisture conditions, snowpacks and precipitation, and expectations in several western states.

Water-Deficit Areas. Throughout the 19th and most of the 20th centuries, water management focused on acquiring additional water supplies to meet the needs of expanding populations and associated economic development in water-deficit areas. Much of this need was met by damming rivers and storing water in reservoirs during times of high flow. Engineering advances in the construction of high dams and the generation of hydroelectric power enabled the transportation of large amounts of water over great distances to irrigate arid lands and meet water demands of growing cities in the West and Southwest. Parts of the country, especially in the West and Southwest, have begun to face the physical limits of water resources. Large-scale development of water resources in the near future is unlikely because in many locations, the best reservoir sites are already developed. Construction costs and concerns about the environmental impacts of dams also call into question the feasibility of additional development. Continued growth in these regions will require some combination of importing water and using and managing water more efficiently.

Storage Impoundments. Water supplies in storage impoundments were affected by the drought which gripped much of the West and Midwest from 1987 through 1992. In most drought areas, water supplies reached critically low levels. The unprecedented flooding that occurred along the upper Mississippi and lower Missouri rivers essentially ended the drought in the Missouri basin. In 1993 the Columbia River in Washington, Idaho, and Oregon and the drainages of the Sierra Mountains in California and Nevada remained the only major areas of persistent drought in the nation.

Western Water Supplies

Water Year 1993 (October 1, 1992, through September 30, 1993) began with poor reservoir storage and poor soil moisture conditions. Some reservoirs had less than half of average storage after several years of drought in much of the West.

Central Valley Project of California. The Central Valley Project began the water year with 51 percent of average storage.

Nevada, Oregon, and Washington. Reservoirs in these states were in exceptionally poor condition, including those in the Humboldt River basin of Nevada and the Yakima River basin of Washington.

Southwest. The areas with good to excellent water supply were the Rio Grande basin of New Mexico, the Salt River basin of Arizona, and most of Texas.

Great Plains. A number of reservoirs in the Great Plains area had extremely high reservoir contents and had to evacuate water to provide space for flood storage. The upper portions of the Great Plains were affected by the weather patterns that produced the flooding in the Mississippi and Missouri rivers. Most reservoirs filled to capacity and remained full. In addition soil moisture conditions were extremely wet during the summer of 1993.

Snow Water Equivalents. Though it fluctuated as the year progressed, the February 1 snow water equivalent showed average to well above average snowpack in much of the West. The southern half of the region had exceptionally high snowpacks and forecasted inflow. Exceptions to this pattern were found in portions of the Northwest and Montana.

Streamflow Forecasts. These forecasts reflected the same fluctuating pattern with some accounting for dry soil moisture conditions. In general this pattern of snowpack and streamflow forecasts prevailed through the snow season into May when the last forecasts are made.

Palmer Drought Severity Index. End-of-year PDSI data showed most areas of the West with adequate to excellent soil moisture, and end-of-year water supply conditions showed most areas with good to excellent carryover reservoir storage.

Groundwater Availability

Groundwater is available nearly everywhere in the United States, although the quantity available and the conditions controlling its occurrence differ from region to region. Maximum average well yields occur in the Columbia Lava Plateau (Washington, Oregon, Idaho, California, and Nevada) and the southeastern Coastal Plain. The smallest yields generally are in the western mountain ranges. Groundwater pumping has increased steadily during the past several decades, with changes in water table levels in wells reflecting changes in the amount of groundwater in storage. In certain areas long-term withdrawals of large volumes of groundwater, primarily for agriculture, have resulted in widespread declines in water levels by 40 feet or more. Where the decline in water level took place many years ago, some areas have had their water table stabilize at a lower level. In other areas reduced water levels are relatively recent events. Development trends, such as in the following areas, suggest the need to conserve existing groundwater supplies if the nation is to meet future water needs.

Arizona and California. In water-deficit areas such as Arizona and California, large volumes of groundwater continue to be withdrawn to meet agricultural and municipal needs. Because of limited supplies, such withdrawals cannot be sustained indefinitely. Groundwater mining in the California San Joaquin Valley has resulted in sediment compaction and land subsidence.

Florida. Groundwater development in Florida has redistributed natural flow patterns in the aquifers, resulting in sinkholes, saltwater intrusion, and land surface subsidence.

Program Accomplishments

Although the federal government administers a significant portion of the nation's water storage and conveyance facilities, water allocation and administration rests principally with the states. The Army Corps of Engineers and the Bureau of Reclamation, through the operation of their projects, provide water supplies to the states.

Water and Power

The Army COE manages over 600 water management projects nationwide, and the BOR, which manages the majority of projects in the West, operates more than 350 reservoirs. These projects provide water

resources for municipal and industrial use, irrigation, hydroelectric power, flood control, navigation, recreation, and fish and wildlife.

Water Conservation Projects

Water conservation is a major element of the BOR water resources management program. The BOR and the Soil Conservation Service signed a Memorandum of Agreement in 1993 that lays the foundation for the two agencies to collaborate in carrying out water conservation projects. During the year the BOR provided technical assistance and training to states and water users in the West to improve water use efficiency and to develop water conservation plans. Examples include the following projects:

Klamath Project. The BOR provided water users and interested parties with a drought plan, identified water use priorities, suggested water conservation activities, provided water allocation projections, and hosted a drought survival seminar.

Northwest Salmon Recovery Projects. In the Pacific Northwest, the BOR cooperated with interest groups in selecting four demonstration projects for salmon recovery: the Snake River Flow Augmentation Project and three Tributary Enhancement Water Conservation Projects.

Water Quality

Water quality began to emerge as an issue following World War II. It took several decades of growing concern, but the 1972 amendments to the Federal Water Pollution Control Act, commonly known as the Clean Water Act, created the nation's landmark environmental legislation. The act and its amendments have improved water quality in surface waters that receive discharges from municipal wastewater treatment plants and industrial facilities. State governments and industry responded to regulations that control the discharge of pollutants into waterways by reducing discharges, becoming more efficient in water use, reducing the production of wastes, and improving the recycling of waste products. The Safe Drinking Water Act introduced measures to prevent contamination of drinking water supplies.

Efforts to further improve water quality will focus more on the reduction of pollution from diffuse, nonpoint sources, such as agricultural and urban runoff and contaminated groundwater discharges. In most cases nonpoint sources of pollution are hard to control and costly to treat. Preventing pollution is the preferred strategy for reducing nonpoint-source discharges.

Conditions and Trends

Water quality in the nation's rivers and streams either improved or remained about the same during the 1980s as shown by most available measures. Although modest improvements in water quality during this period of economic and population growth represent a significant achievement in pollution control, much remains to be done to reach existing water quality goals for the indicators currently monitored at the national level. Moreover data on biological and toxicological aspects of river and stream water quality are limited, leaving the questions of progress in these areas largely unanswered.

River and Stream Water Quality

From among the available surface water quality indicators, three types of national or regional data have been analyzed by the USGS: selected chemical, physical, and sanitary constituents or properties of water; toxic trace elements and pesticides in finfish tissues; and herbicides. The results of these analyses were published by the USGS in 1993.

Chemical, Physical, and Sanitary Constituents or Properties

These include fecal coliform bacteria, total phosphorus, dissolved oxygen, nitrate, suspended sediment, and dissolved solids.

Fecal Coliform Bacteria and Total Phosphorus. Notable improvements occurred in concentrations of fecal coliform bacteria, an important indicator of the suitability of streamwater for contact recreation. About 12 percent of monitoring stations showed decreased coliform concentrations. Total phosphorus, usually the nutrient controlling eutrophication in freshwater, also showed improvement, with about 20 percent of stations showing decreased phosphorus. Nationally the percentage of water quality monitoring stations having fecal coliform bacteria and total phosphorus concentrations greater than desirable limits also decreased during the 1980s. Despite widespread declines in these indicators, however, more than a third of the streams sampled in 1989 had annual average concentrations that exceeded desirable limits.

Dissolved-Oxygen Concentrations. Overall about 10 percent of stations showed increased concentrations of dissolved oxygen from 1980 to 1989. This improvement could reflect the effect of improving point-source controls.

Nitrate Concentrations. Nitrate concentrations and yields remained nearly constant nationally, but they declined in a number of streams draining agricultural areas where nitrate levels have been historically high. This general tendency toward constant or declining concentrations represents a significant departure from the pattern of trends for 1974 through 1981, when widespread increases in nitrate were reported. Nitrogen supports eutrophication, an aging process that slowly fills a body of water with sediment and organic matter and alters basic characteristics such as biological productivity, oxygen levels, and water clarity. The quantity of nitrate transported to coastal waters, where nitrogen supports eutrophication, decreased in the Gulf of Mexico area but increased somewhat in the North Atlantic and California coastal areas during the 1980s.

Suspended Sediment Concentrations. About 10 percent of stations showed decreased suspended sediment concentrations. The quantity of suspended sediment transported to coastal waters decreased or remained the same in all but the North Atlantic region.

Dissolved Constituents. Some change was noted in concentrations of dissolved constituents that have economic significance through their effects on the aesthetic characteristics of drinking water, the chemical characteristics of industrial process water, or the salinity of irrigation water. About 12 percent of stations showed decreased dissolved solids from 1980 to 1989, and annual average concentrations of dissolved constituents exceeded desirable limits at a third or fewer of the sampled streams. The most noteworthy changes were substantial decreases in the chemical corrosivity of stream water used for domestic and industrial water supplies.

Toxic Contaminants

National information documenting trends in the toxicological aspects of fresh water is limited to data on toxic contaminants in finfish tissue in major rivers and the Great Lakes. Contaminant concentrations in finfish tissue are an integrative measure of water quality and can reflect long-term average contaminant concentrations in stream water and sediment. The data show that, since the 1970s, concentrations declined significantly for arsenic, cadmium, lead, chlordane and related organic compounds, dieldrin, DDT and related compounds, toxaphene, and total PCBs (polychlorinated biphenyls). Concentrations of mercury, however, remained nearly constant during the same period.

Herbicides in Streams

Although national trends data for pesticides in stream water are not available, recent studies of herbicide concentrations in streams in agricultural areas of the midwestern United States (1989-1993) provide regional information on the magnitude and distribution of herbicides in streams. In a 1989 study atrazine exceeded applicable EPA drinking water criteria at 52 percent of the streams sampled during the first runoff following herbicide application. For alachlor, cyanazine, and simazine, the number of streams sampled that exceeded the criteria ranged from 2 to 49 percent. Substantially lower but detectable concentrations of these herbicides persisted throughout the year in many of the streams in the region. Subsequent sampling for these herbicides in the Mississippi River and its tributaries in 1991 and 1992 showed that atrazine and alachlor occasionally exceeded EPA drinking water criteria and that substantial quantities of these herbicides are transported by major rivers over long distances.

During the Great Flood of 1993, extraordinarily large amounts of agricultural chemicals were flushed into the Mississippi River, many of its tributaries, and ultimately, into the Gulf of Mexico. The flooding did not dilute the concentrations of herbicides as was anticipated. Instead larger-than-average amounts were flushed into streams, and the daily loads transported by some reaches were higher than those previously measured. For example the maximum daily load of atrazine transported by the Mississippi River in the vicinity of Thebes, Illinois, during the flood of 1993 was as much as 70 percent higher than that measured in 1991. The total load of atrazine discharged into the Gulf of Mexico from April to August 1993 was about 80 percent larger than the same period in 1991 and 235 percent larger than this same period in 1992.

National Inventory of Rivers and Streams

The EPA cooperates with states, territories, tribes, commissions, and the District of Columbia (collectively referred to as the states) to conduct a biennial water quality inventory as required by Section 305(b) of the Clean Water Act. For the 1992 EPA National Water Quality Inventory (finalized in 1993), 642,881 miles or about a fifth of total U.S. river miles, including nonperennial streams, canals, and ditches, were assessed.

Designated Uses. The inventory found that 56 percent of assessed river miles fully support designated uses, and an additional 6 percent support uses but are threatened and may become impaired if pollution control actions are not taken. Another 25 percent of assessed river miles partially support

designated uses, and 13 percent do not support them. Only 125 miles (less than a tenth of 1 percent) of the assessed waters could not attain designated uses. The states also assessed support of six individual designated uses in rivers and streams: aquatic life support, fish consumption, primary contact recreation such as swimming, secondary contact recreation such as boating, public drinking water supply, and agricultural water supply. Of the 221,352 river miles assessed for drinking water supply use, 27 percent could not attain drinking water use standards.

Source of Impairment. More than one source can contribute to impaired water quality. Agricultural runoff is the leading source of pollutants in rivers and streams. Other sources far less frequently reported include municipal point sources, urban runoff and storm sewers, and resource extraction such as mining. Loss of wetlands also can contribute to water quality problems. Without wetlands to trap sediments and pollutants, contaminants would otherwise be discharged into surface waters through runoff from adjacent lands.

Chief Pollutants. Pollutants resulting from runoff included siltation, pathogens, toxic chemicals, and excess nutrients. Such pollutants can produce low dissolved oxygen levels capable of suffocating fish and contaminating groundwater. Siltation and nutrients impair more miles of rivers and streams than any other pollutants, affecting 45 percent and 37 percent of impaired stream miles respectively. Other leading causes of impairment include pathogens, pesticides, organic enrichment, and resultant low levels of dissolved oxygen.

Lake Water Quality

Lakes are sensitive to pollution inputs because they flush out their contents relatively slowly. Even under natural conditions, lakes undergo eutrophication or aging, which alters basic lake characteristics. Human activities can accelerate eutrophication by increasing the rate at which nutrients and organic substances enter lakes from their surrounding watersheds. Runoff from agricultural, urban and construction sites, leaking septic tanks, sewage discharges, eroded streambanks, and similar sources can enhance the flow of nutrients and organic substances into lakes. These substances stimulate the growth of algae and aquatic plants, creating conditions that interfere with the health and diversity of indigenous plant, fish, and other animal populations and the recreational use of lakes. Enhanced eutrophication from nutrient enrichment due to human activities is one of the leading problems facing the nation's lakes.

National Inventory of Lakes

For the lake section of the 1992 EPA National Water Quality Inventory, 49 states assessed 46 percent (18.3 million acres) of U.S. lakes, ponds, and reservoirs. Overall 43 percent of the assessed lake acres fully supported uses such as swimming, fishing, and drinking water supply. An additional 13 percent were identified as threatened and in need of pollution control actions. Another 35 percent of assessed lake acres partially supported designated uses, and 9 percent did not support designated uses. The leading causes for lake water impairment in 1992 were nutrients, organic enrichment/dissolved oxygen depletion, metals, siltation, and priority organic chemicals (PCBs). The state data portray agriculture as the most specific source of pollution in the nation's lakes, followed by urban runoff and storm sewers, hydrologic and habitat modification, municipal point sources, and onsite wastewater disposal.

Acidic Lakes

Acidic lakes are generally found in areas where watershed soils have limited buffering capabilities. Acid rain or acid mine drainage can depress the pH levels of a lake to the point at which many forms of aquatic life are stressed or eliminated. Increases in lake acidity can also increase the solubility of toxic substances and magnify their adverse effects. Results of the National Acid Precipitation Assessment Program (NAPAP) studies indicate relatively few serious acidification problems in the nation's lakes.

Trophic Status of Lakes

Classification Characteristics

Oligotrophic: Clear water with little organic matter or sediment and minimum biological activity.

Mesotrophic: Waters with more nutrients and therefore more biological activity.

Eutrophic: Waters extremely rich in nutrients, with high biological productivity. Some species may be choked out.

Hypereutrophic: Murky, highly biologically productive waters, closest to the wetlands status. Many clearwater species cannot survive.

Dystrophic: Low in nutrients, highly colored with dissolved humic organic matter. Not necessarily a part of the natural trophic progression.

The EPA Environmental Monitoring and Assessment Program (EMAP) began piloting the EMAP-Surface Waters Program with a study of northeastern lakes in New England, New York, and New Jersey in 1991. Chlorophyll-a, which is a surrogate measure of algal biomass, and total phosphorus concentrations from the lake pilot study indicate the degree of nutrient enrichment in the lakes:

Classification Nutrient Enrichment

%

Oligotrophic lakes 38

Mesotrophic lakes 42

Eutrophic and Hypertrophic lakes 21

When statistically aggregated into three ecoregions-the Adirondacks, the New England Uplands, and the Coastal/Lowland/Plateau regions-the data show different spatial patterns in lake quality.

The Great Lakes Ecosystem

By area the Great Lakes ecosystem contains the world's largest body of surface freshwater. Once endowed with a natural abundance, the Great Lakes had seas of freshwater, splendid forests, plentiful animals, rich soils, immense wetlands, and multitudes of waterfowl; but three centuries of development have taken their toll. The passenger pigeon became extinct early in the 20th century, exterminated by

hunting and the loss of oak and beech forest habitat. Few of the once plentiful sturgeon survive, and lake trout populations are not self-sustaining. The bald eagle breeds with less success along the shores of the lakes than inland, while habitat available to other birds, fish, and wildlife is greatly reduced, as are their populations.

Recognizing these problems, the United States and Canada have achieved, over the past 30 years, encouraging successes. They have reduced phosphorus loadings to the lakes, abated excessive algae in Lake Erie, protected fish populations from sea lamprey, and restored oxygen-depleted waters. Although large industries have reduced their toxic discharges, they still release significant amounts of hazardous substances. While levels of some targeted toxic contaminants have declined in fish and wildlife, improving the health of many species, considerable levels of toxics remain in sediments in harbors leading into the lakes, and the Great Lakes ecosystem faces a range of new and enduring environmental challenges.

In 1993 the EPA, in cooperation with eight states-Illinois, Indiana, Michigan, Minnesota, New York, Pennsylvania, Ohio, and Wisconsin-proposed a water quality guidance program to protect the Great Lakes ecosystem. The program will establish minimum water quality criteria, antidegradation procedures, and implementation procedures for the Great Lakes basin with emphasis on bioaccumulative pollutants. The result would be consistent, basin-wide water quality standards for the protection of human health, aquatic life, and for the first time, wildlife. The initiative-a milestone in addressing environmental problems on an ecosystem basis-is a critical element of the U.S.-Canadian effort to protect and restore the water resources of the Great Lakes, which are experiencing the following problems.

Contaminated Fish and Wildlife. The Great Lakes food web remains contaminated by a variety of bioaccumulated toxic substances with unacceptable levels in some fish and wildlife. Levels are much lower than in the 1970s but still justify fish consumption advisories, usually directed at PCBs, mercury, and chlordane. Contaminants have been associated with health problems in 15 Great Lakes fish and wildlife species. Effects have usually been most pronounced at the top of the food web and across generations, as expressed in birth defects. Other documented fish and wildlife problems include loss of appetite and weight, hormonal changes, poor reproductive success, tumors, increased susceptibility to disease, and behavioral changes. With the significant decline in contaminant levels, many species seem to be recovering. Problems persist for fish and wildlife in certain locations, particularly in harbors and rivers with highly contaminated sediments, and for predators high in the food web, such as lake trout, mink, and bald eagles. Contaminant levels are generally higher in Lake Michigan and Lake Ontario, which have longer water retention times than the other lakes, though these lakes have also experienced the greatest declines in contaminant levels during the past two decades.

Contaminated Bottom Sediments. Bottom sediments in many harbors and rivers of the Great Lakes ecosystem contain a variety of bioaccumulated toxic substances, indicative of past loadings of contaminants to the lakes. Contaminated sediments are associated with tumors in bottom fish; they serve as a reservoir of contaminants that recycle into the food web through resuspension or uptake by bottom-dwelling organisms and injure such organisms. Contaminated sediments greatly increase the costs of navigational dredging owing to the added costs of handling and disposing of toxic materials. In some locations contamination has delayed navigational dredging for years and curtailed waterborne commerce.

Diminished Wetlands. More than half the Great Lakes wetlands have been lost since 1800. Chicago, Detroit, and Milwaukee stand on former wetlands. The present rate of destruction is much less than in prior eras, but development pressure continues to threaten remaining wetlands.

Exotic Species. More than 130 exotic (nonnative) species have been introduced to the Great Lakes since 1800, nearly a third carried in by ships. Some exotics have profoundly damaged native species. A troublesome recent invader, the zebra mussel, probably entered the lakes via ballast water discharge from an oceangoing vessel. The full impacts of the mussel are not yet known, but they are potentially great. A prolific breeder, the mollusk devours microscopic plants at the foundation of the food web and may create a food shortage for fish that graze on these plants, ultimately threatening predator fish such as walleye, salmon, and lake trout. Colonies also foul and clog water intake pipes to water treatment and power plants.

Depleted Native Fish Populations. Prior to settlement in the Great Lakes basin, over 170 species of fish existed in the lakes. Lake sturgeon lived up to 90 years and lake trout up to 75 years. Fish populations today are drastically different than those found in the 1800s, a result of food chain disruptions, overfishing, and habitat loss and disruption, such as drained wetlands, silted-over spawning beds, and dams that impede upriver passage. Add to these competition from nonnative species, for instance, alewife displacing lake herring and sea lamprey feeding on large fish. Great Lakes fish today are smaller, live shorter lives, and survive in sometimes substantially reduced numbers.

. **Threat to Native Species.** The damage to once richly abundant native fish populations is profound. Lake herring was once the predominant forage fish. Sturgeon grew six feet in length and weighed more than 100 pounds. Today sturgeon and lake herring survive in much depleted numbers. Hatchery-reared lake trout must be stocked to maintain ecological balance and to sustain sport and commercial fisheries. Stocked nonnative Pacific salmon-coho and chinook-are now the most abundant top predators, except in western Lake Erie where the top predator is walleye, but their fate may hinge on the availability of alewife, their principal and preferred forage. The chinook salmon began to decline in the mid 1980s, at least in part because of an increase in the incidence of bacterial kidney disease, a phenomena often seen in large fish culture programs. Walleye in western Lake Erie may be threatened by the zebra mussel which, because of its extraordinary filtration capacity, is changing the fundamental character of the aquatic plants, insects, and zooplankton. The new flora and fauna favor pike and bass species that favor walleye fry as a food source.

. **Sea Lamprey Control.** Some progress to improve fish resources has been made. Sea lamprey control has resulted in the reestablishment of deepwater fish populations, like whitefish in northern Lake Michigan. Such control programs remain essential to their survival. The stocking of lake trout and Pacific salmon that help to restore the predator/prey relationships in fish communities have permitted the growth of commercial and sport fishing industries.

Excessive Phosphorus. Since 1970 phosphorus detergent restrictions, municipal sewage treatment plant construction and upgrades, and agricultural practices that reduce runoff have cut the annual phosphorus load to the Great Lakes by half. The decline in phosphorus loadings is most evident in Lake Erie, which receives more effluent from sewage treatment plants and sediment from agricultural lands than any other Great Lakes. In the late 1960s, Lake Erie was infamously clogged by foul-smelling mats of algae that depleted dissolved oxygen from bottom waters by their seasonal die-off and decay. Lake Erie is also experiencing concurrent decline in phytoplankton biomass and decline in the rate of oxygen

depletion of the central basin, each an indicator of improving trophic condition. Phosphorus levels in the open waters of Lakes Superior and Michigan have been reduced to levels below those set as objectives in the Great Lakes Water Quality Agreement of 1978. Phosphorus levels in Lakes Huron, Erie, and Ontario continue to exceed the objective slightly. Nonetheless, nutrient enrichment continues to be a problem in many nearshore waters of all the Great Lakes except Lake Superior, especially shallow waters that receive agricultural runoff or areas with a high surrounding population such as Lake Erie, Lake Ontario, Saginaw Bay, and Green Bay.

Designated Uses. For the EPA 1992 National Water Quality Inventory, the states found toxic contamination to be the most prevalent and persistent water pollution problem facing the Great Lakes. Virtually all of the waters along the Great Lakes shoreline fail to fully support overall designated uses. Priority organic chemicals, such as PCBs and dioxins, are the most prevalent cause of impairment in Great Lakes waters.

Safe Drinking Water

For most of this century, land surface and subsurface disposal of wastes was considered safe and convenient. Only recently did researchers discover that natural processes have a limited capacity to convert contaminants into harmless substances before they reach groundwater. EPA research suggests that over half the nation's land area has geologic factors that would allow groundwater contamination and that 1 percent (68,500) of all U.S. drinking water wells exceed the EPA health-based limits on contaminants.

In the late 19th and early 20th centuries, industrial and agricultural wastes contaminated many of the rivers and streams that supplied drinking water for urban populations. Widespread contamination of drinking water sources eventually led to laws that required government intervention, such as the Safe Drinking Water Act (SDWA). Under this act the EPA sets standards for drinking water quality and requirements for treatment. Federal standards control both anthropogenic and naturally occurring contaminants, and the Public Water Supply Supervision Program, authorized by the SDWA, supervises compliance. In most cases states have the primary responsibility for oversight and enforcement. The EPA supports states through grants and technical assistance and, if necessary, enforces SDWA regulations.

Drinking water can still be a source of harm to human health, however, especially in the following areas:

. Where aquifers have been contaminated by septic systems, leaking storage tanks, and chemical releases,

. Where agricultural chemicals contaminate surface water and groundwater, and

. Where compounds leak from underground storage tanks or chemical dumps.

Direct exposure to these agents can occur when contaminated water supply is used for drinking, cooking, bathing, swimming, or washing utensils used for cooking or eating. Even with safe water supplies that have been adequately treated, contamination by infectious and toxic agents can occur when agents are reintroduced into plumbing or distribution systems by cross-connections in sewage lines, infiltration through waterline breaks, or through leaching of toxic substances, such as lead, from

the plumbing system. Water can affect human health indirectly when people consume crops irrigated with contaminated water, or when they eat fish, shellfish, or aquatic plants grown in contaminated water.

In 1993 drinking water supplies were generally safe from bacterial contamination and usually free of gross contamination or obvious chemical pollution. The most severe health effects from contaminated water, such as cholera and typhoid fever, have been essentially eliminated in the United States by chlorination and filtration of drinking water. Yet other hazards still remain. Contaminants of increasing concern over the last 20 years have been radionuclides, lead, chlorine-resistant microbial contaminants, pesticides, toxic chemicals, and by-products of the disinfection process. Of the 200,000 water systems in the United States, thousands fail to comply with the Safe Drinking Water Act.

Access to Water and Sanitation Services

The proportion of U.S. homes served by public and private water suppliers and public sewers has increased since 1970. In 1991 of the 104 million homes in the United States, 85 percent received water from public water systems or private water suppliers, and 76 percent were served by public sewers. The remaining homes obtained water from wells (13 percent) or other water supplies (2 percent) and used septic tanks, cesspools, chemical toilets, or other means (24 percent) for sewage disposal.

Indoor Plumbing Demographics

Using complete plumbing-hot and cold piped water, flush toilet, and a bath or shower-as another indicator of access to safe water and sanitation, the nation has upgraded the quality of housing significantly. In 1940 half of U.S. housing units lacked complete plumbing, but by 1990, this percentage had declined to only 1.1 percent. In 1990, nonetheless, a million U.S. houses remained without complete plumbing.

Housing units in metropolitan areas are more likely to have access to complete plumbing than units in rural areas, and persistent low- income counties traditionally have had the lowest access of any rural county type. The more remote rural counties in the South and the West, especially Arizona, New Mexico, and Alaska, had 3 percent of their housing units without complete plumbing in 1990. A major factor in western rates of incomplete plumbing is the long distances between houses and municipal water and sewer systems. In Alaska long distances combined with permafrost in many areas restrict the availability of water and sewer systems. Many southern counties with persistent low incomes also have limited access to complete plumbing.

Pesticides and Other Contaminants

The 1992 EPA National Pesticides Survey estimated that 10.4 percent of community water supply wells and 4.2 percent of rural domestic wells contain detectable levels of one or more pesticides. A more recent report from Illinois indicates that 12 percent of the private wells surveyed in the state had detections of at least one pesticide or pesticide degradate. Elevated levels of nitrates also have been frequently detected in groundwater. These and other groundwater contaminants, such as organic and inorganic chemicals, radionuclides, and microorganisms may cause adverse health, social,

environmental, and economic impacts. Among these impacts are the health risks of exposure to contaminants and expenditures such as groundwater purification systems. Because groundwater provides baseflow to streams, the potential for adverse impacts on surface- water quality also exists, especially under conditions where dilution is minimal.

Lead Levels in Drinking Water

Lead is a highly toxic metal that can have adverse health affects, including interference with red blood cell formation, reduced birth weight, mental retardation, and premature birth. The Safe Drinking Water Act requires public water systems to sample drinking water from taps in areas where higher lead levels are expected to be found and to report lead concentrations to the state or EPA.

Monitoring Requirements. In 1992 the EPA required large public water supply systems, those that serve more than 50,000 people, to conduct lead monitoring in two periods, from January to June and from July to December. Medium public water supply systems, those serving between 3,301 and 50,000 people, were required to conduct monitoring from July to December 1992. In results, released by the EPA in 1993, of the 6,483 large and medium systems conducting monitoring at the end of the year, 819 systems exceeded the lead action level of 15 parts per billion in 10 percent of their samples. These systems provide drinking water to 30 million people nationwide. Small systems, those that serve less than 3,300 people, comprise 90 percent of all drinking water systems nationwide and provide service to 10 percent of the U.S. population. These systems were required to initiate lead monitoring in 1993.

Protective Measures. Under the SDWA public water systems exceeding the lead action level are required to take the following measures to protect public health: Install corrosion control measures to reduce lead levels; perform additional monitoring; inform the public of elevated levels; and offer information on how to minimize drinking water lead exposure.

Waterborne Disease Outbreaks Associated with

Drinking Water

For more than two decades, the Centers for Disease Control and Prevention (CDC) and the EPA have carried out national surveillance of waterborne disease outbreaks associated with water intended for drinking, recreational water use, and outbreaks on cruise ships. Although the program involves voluntary reporting of disease outbreaks and may thus underestimate such outbreaks, it continues to be a useful means of characterizing the changing epidemiology of waterborne diseases. It helps identify the types of water systems, the water system deficiencies, and the etiologic agents associated with outbreaks. Although waterborne diseases in the United States are not associated with as much morbidity and mortality as they were earlier in this century, outbreaks continue to occur, sometimes even in relatively sophisticated community water systems.

The number of outbreaks of waterborne diseases in water intended for drinking has declined since the 1970s, although the relative proportions of outbreaks attributed to various types of water supplies and etiologic agents have remained fairly stable. The decrease in reported outbreaks may represent an actual decrease in the number of occurrences or a decrease in the recognition or reporting of outbreaks.

Despite the smaller number of outbreaks reported in recent years, some incidents have been extensive. For example, a cryptosporidiosis outbreak in Georgia in 1987 affected 13,000 people and, more recently, one in Milwaukee in 1993 affected 403,00 people. In both cases, people became ill with gastroenteritis after consuming water from a public water supply. Nonetheless, most disease outbreaks are associated with noncommunity or small community water systems, which may reflect the fact that large cities tend to have more sophisticated water systems. To prevent waterborne transmission of such diseases as Giardia, Cryptosporidium, and other infectious agents, the EPA has prepared guidelines for filtration and disinfection of all public water systems using surface water sources.

Giardia lamblia and Cryptosporidium. Giardia is the most commonly implicated protozoan parasite in outbreaks of waterborne disease. Many such outbreaks are associated with ingestion of chlorinated but unfiltered surface water and surface-influenced groundwater. Filtration is necessary to remove Giardia from water; chlorination alone is insufficient without high concentrations and long contact times. Cryptosporidium, also a protozoan parasite and even more chlorine-resistant than Giardia, was implicated in other recent outbreaks.

Shigella sonnei. In outbreaks caused by the most commonly implicated bacterial pathogen, Shigella, water supplies were found to be contaminated with human waste.

Program Accomplishments

The major water quality accomplishment of 1993 was the ongoing groundwork in Congress for reauthorization of the Clean Water Act and the Safe Drinking Water Act.

Reauthorizing the Clean Water Act

The goals of the Clean Water Act are fishable, swimmable rivers throughout the nation and zero discharge of pollutants into U.S. navigable waters. The act requires all municipal sewage and industrial dischargers to obtain a permit before discharging into waterways. Permits usually require dischargers to reduce or remove pollutants from their wastewater before discharge. It provides federal grants and capitalization of state revolving load funds to help communities build sewage treatment plants. The EPA and the states cooperate to establish limits on the amounts of specific pollutants that may be discharged by point sources such as municipal sewage treatment plants and industrial facilities. They base minimum discharge limits on available and economically achievable technologies, but also require higher levels of treatment for dischargers to water quality limited waterbodies.

During Congressional hearings on the major reauthorization issues, the Administration maintained that the statute is fundamentally strong but suggested the following changes:

. Stronger enforcement provisions,

. Increased emphasis on integrated wetlands and watershed management,

. More effective controls for reducing nonpoint-source and toxic pollution, and

. Increased funding for pollution control programs.

Reauthorizing the Safe Drinking Water Act

Debate over reauthorization of the Safe Drinking Water Act (SDWA) continued in 1993, and the Administration made the following recommendations to strengthen the act and the ability of the states to maintain sound drinking water programs:

. A drinking water state revolving loan fund to assist local water systems in meeting SDWA requirements;

. A user fee system to provide states with additional resources needed to maintain state drinking water programs;

. Source water protection mechanisms to prevent contamination;

. An improved process for determining which contaminants should be regulated by EPA and how soon they should be regulated;

. Flexibility in complying with statutory requirements;

. More efficient and stronger enforcement; and

. Special assistance for small systems.

Community Groundwater Protection

Many communities that rely on groundwater as a source of drinking water are confronted with contamination. Once contamination occurs, remediation is time-consuming and resource-intensive, and in some cases may be technologically infeasible. If groundwater is the sole source of drinking water, communities may be forced to rely on bottled water for years. To avoid this hardship, many communities are concentrating on preventing contamination. In 1993 the EPA supported pollution prevention activities by working through the states and directly with citizen groups to empower communities with the ability to protect their groundwater resources. Examples of EPA efforts follow.

State Groundwater Protection Programs. The EPA is working with the states to develop Comprehensive State Ground Water Protection Programs to coordinate federal and state programs. Coherence is necessary to establish successful community groundwater pollution prevention efforts. In 1993 the EPA issued guidance that will assist states in developing a strong prevention-oriented groundwater program. The guidance provides a framework for a strong federal-state alliance, with the goal of a fully-integrated, comprehensive groundwater protection effort.

Wellhead Protection Programs. Thirty-seven states and territories have an EPA-approved wellhead protection program. While state programs are necessary, the actual tools to prevent contamination are usually found at the city, township, county, and multi- county/regional level. Local governments may be the only appropriate level of government to conduct some prevention activities, such as regulation of local land uses. To support local efforts to protect drinking water supplies, the EPA has worked with states and communities to develop local as well as state wellhead protection programs. Focused on protecting a community's underground sources of drinking water by delineating the groundwater resources around the community's well, these programs identify the potential sources of contamination that could affect groundwater and the appropriate actions to ensure that resources are protected. By the end of 1993, EPA estimates that 18,000 communities have initiated some level of wellhead

protection, but only an estimated 4,500 of the communities are operating complete protection programs.

National Pollution Discharge Elimination System

Under the Clean Water Act, the EPA or approved states administer the National Pollutant Discharge Elimination System (NPDES). The agency and 40 approved states issue permits that establish effluent limits for all municipal and industrial dischargers. In addition to technology-based limits, the EPA may develop limits based on water quality criteria where technology-based controls are not stringent enough to make waters safe for such uses as fishing, swimming, and drinking. Stringent EPA standards for industrial dischargers control up to 126 toxic pollutants. Currently EPA has developed effluent limitation quidelines, based on the best available technology that is economically feasible, for 50 major industries. These guidelines establish minimum discharge limits for industrial dischargers to control nutrients, toxics, and other pollutants.

Wet Weather Runoff

In 1993 the EPA took the following actions to address the most significant remaining source of water quality impairment-wet weather runoff-the culprit of nonpoint-source pollution:

Nonpoint-Source Management. In January of 1993, EPA released in technical guidance for coastal states that provides a foundation for reducing nonpoint-source pollution, a problem associated with the degradation of many estuaries in the United States (See Chapter 3: Wetlands and Coastal Waters).

Combined Sewer Overflow Policy. Combined sewer overflows (CSOs) occur where sanitary and storm sewers are interconnected. During rainstorms combined sewer systems become overloaded and discharge a multitude of pollutants associated with sanitary sewage, industrial wastewater, and polluted runoff into local receiving waters. These discharges can cause exceedances of water quality standards that pose risk to human health, threaten aquatic life and its habitat, and impair the use and enjoyment of aquatic resources. To reduce these impacts, the EPA is expected to issue a national policy on assessing and controlling CSO discharges through the National Pollutant Discharge Elimination System (NPDES) in the spring of 1994. The policy, to be developed in collaboration with state and local governments, environmental groups, and other interested parties, will include guidance for developing appropriate, site'specific NPDES permit requirements and enforcement initiatives to ensure compliance as soon as practicable.

Stormwater Controls. The Clean Water Act requires a NPDES permit for all stormwater discharges from industrial facilities, and in 1993 EPA proposed a mechanism to assist industries in their efforts to control discharges and comply with Clean Water Act requirements. A multisector general permit, proposed for 29 industrial categories, would provide 45,000 facilities with an alternative to resource-intensive individual permits. The EPA developed the multisector permit in consultation with, and using data submitted by, the affected industries themselves.

Reducing Toxic Pollution

Toxic contamination of surface water and sediments is a major problem in some areas, posing risk to human health, aquatic life, and the environment. The EPA completed a final rule to establish numeric criteria for as many as 98 toxic pollutants in 12 states and two territories that failed to adopt water quality standards for such pollutants as required by the Clean Water Act. Water quality standards, normally adopted by the states and territories, are the keystone for all water pollution control programs. The National Toxics Rule, the largest EPA standards-setting action to date, demonstrates the agency's commitment to act when states fail to adopt standards that meet Clean Water Act requirements. The rule will remain in effect until the states and territories adopt and receive EPA approval of their own water quality standards.

Intergovernmental Task Force on Monitoring Water Quality

Although hundreds of billions of dollars have been spent by government and the private sector on water pollution abatement since the 1970s, the lack of a comprehensive, integrated national monitoring and reporting system makes it difficult to assess the effectiveness of these investments in achieving the goals and objectives of the Clean Water Act. To remedy these shortcomings, an Intergovernmental Task Force on Monitoring Water Quality (ITFM) undertook a comprehensive review and evaluation of ambient water quality monitoring in the United States. Twenty federal and state agencies with water quality monitoring responsibilities took part. The first-year report of the task force, issued in 1992, concluded that a comprehensive, well-integrated strategy is essential to understand the condition of the nation's water resources and to provide a basis for policies to assure the wise use and management of these resources. The task force concentrated on developing the -building blocks- needed to implement a national water quality monitoring strategy.

During 1993 the ITFM undertook a pilot study in Wisconsin to test various task force recommendations. State and federal agencies concentrated on jointly sampling selected sites and comparing agency methods to determine the magnitude of differences in measurement results and their causes. The study will be expanded in 1994.

River Cleanup in the Tennessee Valley

The Tennessee Valley Authority (TVA) is committed to establishing the Tennessee Valley as a model of sustainable development economically and environmentally. In addition to managing the TVA reservoir system to provide minimum flows for aquatic life and lake levels suitable for recreation, the TVA is committed to protecting and improving the health of the Tennessee River.

River Action Teams. The TVA approach to river cleanup builds partnerships for watershed protection and improvement. River Action Teams-small, self-directed teams of water resource specialists-are at work in four subwater sheds of the Valley. The teams identify and develop cooperative projects to solve pollution problems and protect aquatic resources. The TVA has plans to assign teams to all 12 subwatersheds in the Valley.

Cleanup Mechanisms. Between 1991 and 1993, the TVA took the following actions:

. Installed aeration systems to increase dissolved oxygen levels in releases from seven of its dams;

. Reclaimed 300 acres of land around the Copper Hill mine site in Tennessee;

. Helped implement best management practices on 60 farms in the eastern part of the Valley;

. Supported 10,000 hours of volunteer cleanup efforts on streams, rivers, and lakes; and

. Increased public awareness of water resource conditions by publishing the award-winning River Pulse, a colorful report card on the health of the Tennessee River.

The people of the Tennessee Valley have different needs and goals, influenced by watersheds that often cover more than one state and multiple counties, but the TVA outreach experience demonstrates that government agencies can accomplish far more by working with others than by working alone.

Mexican Border Initiative

The United States and Mexico continued their collaborative efforts to improve water quality along the Mexico border in 1993. Both countries took part in joint monitoring along the Rio Grande River and planned to begin groundwater sampling. Work continued on a design for an international wastewater treatment facility in Tijuana. The two nations signed an international agreement to provide wastewater treatment service to the Mexico/Calexico area and drafted an agreement for industrial wastewater pretreatment in the Nogales area.

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Chapter 3: Wetlands and Coastal Waters

For all that has been done to protect the air and water, we haven't halted the destruction of the wetlands.

President Bill Clinton

Wetlands and coastal waters, two areas rich in natural resources, have historically been under intense pressure from development, and the pressure is beginning to show. Of all species currently listed as threatened or endangered, 54 percent are found in wetlands and deepwater habitats.

Wetlands

Wetlands played a prominent role in the settlement of the United States. Farmers and settlers, perceiving them as a hindrance to productive land use, routinely drained, filled, or otherwise manipulated bogs, swamps, and marshes to produce dry land for agricultural use or homesites. Only recently has society begun to appreciate wetlands and their benefits, but not before half of them were converted to other uses.

Conditions and Trends

U.S. wetlands range from extensive coastal marshes and inland swamps in the Southeast to bogs and shrub swamps in the North, and from tropical wetland forests in Hawaii to permafrost wetlands in Alaska. This diversity reflects regional differences in climate, hydrology, soils, and vegetation. In coastal areas 73 percent of all wetlands are emergent herbaceous wetlands such as marsh, whereas inland, only 25 percent are marsh. The remaining inland wetlands are forested (53 percent), shrub (16 percent), and ponds (6 percent).

Wetland Benefits

Wetlands provide an array of beneficial functions and values. This ecotype plays an integral part in maintaining the quality of human life and wildlife as well as the vigor of the U.S. economy. Americans also use wetlands for recreational activities such as canoeing, fishing, and bird watching.

Natural Flood Control. Wetlands store large amounts of water in organic deposits and basins, providing erosion and flood control, flow stabilization, and the recharging of underground aquifers. Effective flood control is the result of a number of factors including the interrelationship of wetlands with streamflow within a particular watershed. Recent research finds that flood peaks may be reduced by 80 percent in watersheds with a 30-percent wetland area and by 65 percent if a watershed has only 15 percent of its area in wetlands.

Natural Filtration Systems. As water flows through a wetland system, plants, animals, and sediments absorb, assimilate, or change the chemical form of many contaminants, including heavy metals, introduced into the watershed by human activities. Significant amounts of suspended sediments also are removed from the water during the seepage process, and thus wetlands serve as natural filtration systems and improve the quality of the water.

Fish and Wildlife Habitat. Wetlands provide habitats for diverse and abundant fish, wildlife, and plant species, many of which are found in the diets of humans. The ecotype produces large amounts of detritus which forms the base of a complex food web that cycles energy and nutrients within the wetland environment and exports nutrients into adjacent areas. Half of the species that inhabit wetlands are restricted to this land-cover type or choose to frequent it.

Wetland Losses

Although the rate of wetland losses has declined in recent years, conservation efforts remain essential to protect this ecotype which the nation has come to appreciate. For a discussion of wetland conservation efforts on farmlands, see Chapter 4: Conservation Farming and Forestry; and for wetland conservation on federal lands, see Chapter 5: Public Lands and Federal Facilities.

Losses by State. Since the 1780s the conterminous United States has lost 53 percent of its original wetlands acreage, while Hawaii lost 12 percent, and Alaska less than 1 percent. Ten states (Arkansas, California, Connecticut, Illinois, Indiana, Iowa, Kentucky, Maryland, Missouri, and Ohio) have lost 70 percent or more of their original wetland acreage, and 22 states have lost over 50 percent of their original wetlands. By the mid-1980s, the lower 48 states contained 103.3 million acres of wetlands.

Losses by Type, Mid-1950s to Mid-1970s. A net loss of 9 million acres of wetlands occurred in the conterminous United States during this period, of which 96 percent involved inland forested and emergent wetlands. Partially offsetting these losses, though not replicating the lost functions or values, was a gain in inland open water areas, primarily farm ponds. Agriculture was responsible for most inland wetlands losses. Coastal wetland losses resulted primarily from a shift to open water as the result of channelization and flooding associated with sea level rise, coastal subsidence, and construction of canals, and from conversion to other uses such as urbanization.

Losses by Type, Mid-1970s to Mid-1980s. From the mid-1970s to the mid-1980s, wetland losses slowed to an annual average net loss of 290,000 acres. As in earlier decades, most of these losses took place as inland wetlands were converted to nonwetlands cropland and urban areas. Similarly the area of inland open waters increased, primarily because of flooding in arid areas and pond construction, and the majority of coastal wetland losses occurred as emergent wetlands (marsh) became open salt water as a result of flooding. In contrast to earlier losses, agriculture decreased as a cause of wetland loss, from 87 percent of such losses to 54 percent. The main reason for this decline was the implementation of federal wetlands protection programs (such as the Swampbuster and Wetland Reserve programs). Urban, industrial, and residential development increased as a cause, accounting for 41 percent of losses from the mid-1970s to the mid-1980s.

Losses Since the Mid-1980s. Wetland losses continue to slow. From 1987 to 1990, programs to restore wetlands under the 1985 Food Security Act added 90,000 acres to the nation's wetlands inventory. In 1992 approximately 36,000 acres of farmed wetlands, prior converted wetlands, and wetlands farmed under natural conditions were enrolled in the pilot Wetlands Reserve Program for restoration under the Food, Agriculture, Conservation, and Trade Act of 1990. Other programs to protect wetlands, like the Swampbuster provisions of the Food Security Act, have significantly aided in conserving wetlands (See Chapter 4: Conservation Farming and Forestry).

Human-Induced Conversions. Of the human-induced wetland conversions, urban development and built-up land were the main causes of wetland losses, followed by agricultural development. A decrease in rural land and increases in both population and urban and built-up land were associated with wetland loss. Proportionately however wetland loss caused by development was greater in coastal states than in inland states, while agriculture- related wetland losses were similar in both groups. Proportionate declines of forested versus nonforested wetlands were not significantly different among states.

Losses and Degradation in the 1990s. In the EPA 1992 National Water Quality Inventory, 27 states listed sources of current wetland losses, with agriculture and commercial development as the major sources followed by residential development, highway construction, impoundments, and resource extraction (mining). Another 14 states reported on causes and sources that are degrading wetland integrity, although they could not quantify the wetland area impacted by individual pollutants or sources. Sediment was the most pervasive pollutant impacting wetlands followed by nutrients, water diversions, and pesticides. The leading source of these wetland-degrading pollutants was agriculture followed closely by development, channelization, road construction, and urban runoff. At the same time, the loss of wetlands continued to decline in the 1990s because of more effective implementation of the Clean Water Act Section 404 program and swampbuster and wetlands restoration programs.

Losses in Flyways. Huge decreases in wetlands have occurred in the major flyways that form the routes of migratory waterfowl. These losses have been cited as being a major contributor to declines in waterfowl and other migratory birds in North America that depend on a variety of wetland types throughout the continent during the annual cycle of breeding, migrating, and wintering. Overall, with decreasing wetland area and associated uplands available for waterfowl during their annual cycle, populations have decreased (see Chapter 6: The Ecosystem Approach to Management).

Program Accomplishments

Recognizing the need to improve federal wetlands policy, the Administration issued a comprehensive package of initiatives that included legislative recommendations and administrative actions addressing both the Clean Water Act Section 404 program and nonregulatory protection approaches. In addition an array of federal programs were underway to acquire, mitigate, protect, and restore wetlands.

Federal Policy on Wetlands

On August 24, 1993, the Administration announced a package of wetland reforms entitled Protecting America's Wetlands: A Fair, Flexible, and Effective Approach. The reform package was prepared by the Interagency Working Group on Federal Wetlands Policy convened in June 1993 to formulate a workable policy. Chaired by the White House Office on Environmental Policy, the group included the EPA, Army Corps of Engineers, Office of Management and Budget, and the departments of Agriculture, Commerce, Energy, Interior, Justice, and Transportation. The Interagency Working Group is monitoring implementation of these reforms, which are based on the following principles:

No Net Loss Followed by Gains. The interim goal is no overall net loss of remaining U.S. wetlands, along with a long-term goal of increasing the quality and quantity of wetland resources.

Clear Regulations. Regulatory programs must be efficient, fair, flexible, and predictable and must be administered in a manner that avoids unnecessary impacts upon private property and minimizes effects that cannot be avoided, while providing effective protection of wetlands. Duplication among regulatory agencies must be avoided and the public must have a clear understanding of regulatory requirements and various agency roles.

Public-Private Efforts. Nonregulatory programs, such as advance planning; wetlands restoration, inventory, and research; and public/private participation must be encouraged to reduce the reliance of federal government on regulatory programs as the primary means to protect wetland resources and to accomplish long-term wetlands gains.

Ecosystem-Watershed Approach. The federal government will expand partnerships with state, tribal, and local governments, the private sector, and individual citizens. Federal land agencies will approach wetlands protection and restoration in an ecosystem/watershed context.

Best Available Science. Federal wetlands policy should be based upon the best scientific information available.

Coastal America: A Renewed Commitment

Coastal America, a nationally coordinated multi-agency partnership, represents a new approach to addressing complex environmental problems in a time of limited resources. The partnership provides the following benefits:

. A mechanism for leveraging resources, expertise, and authorities;

. A collaborative problem-solving focus that expedites initiatives;

. A consensus-building process that avoids conflicts;

. A philosophy that encourages cost-efficient, creative solutions; and

. An action-oriented approach that achieves results.

In its first year, 1992, the partnership initiated 24 projects in 15 states, projects valued at over $12 million, with over half the funds contributed by nonfederal partners. In 1993 the partnership initiated an additional 43 projects in 17 states, valued at $18 million. The partners have made significant nonmonetary in-kind contributions as well and have forged strong relationships that ensure project success.

Sagamore Marsh Project. A major marsh restoration project is being undertaken at the Sagamore Marsh in Massachusetts. Gradual filling of tidal channels that carried saltwater into and throughout this 400-acre marsh has degraded the system. The benefits of restoration include a gain in lost habitat, a reduction in fire hazards, mosquito control, and the possibility of public use enhancements, since the marsh is next to other state and federal lands.

Right Whale Project. The Right Whale Project is designed to mitigate human activities (principally ship strikes) on these whales while in their calving and wintering grounds, the coastal waters of northeastern Florida and southeastern Georgia. Approximately a third of known mortalities of this endangered

western Atlantic whale species (estimated population:320-350 off the eastern United States) are caused by human impacts. In targeting a reduction of ship strikes, this project addresses the priority one item in the implementation schedule of the National Right Whale Recovery Plan. Only one whale strike was reported in 1993.

Gulf of Mexico Fishing Reef Project. Based on the initial success of the 1992 Coastal America Galveston Bay Oyster Reef Project, where coal ash was used to build oyster reefs, coal ash products are also being used in the development of a fishing reef on the floor of the Gulf of Mexico south of Freeport, Texas. Testing results on the oyster reef habitat demonstrated that coal ash materials are strong enough to withstand the rigors of the marine environment; provide an excellent substrate for organisms such as oysters, barnacles, tube worms, and algae; and are not an environmental or public health hazard.

Following a 1993 review of Coastal America, the Administration endorsed the partnership and directed federal agencies to implement its goals and objectives.

Mapping the Nation's Wetlands

The U.S. Fish and Wildlife Service (FWS), as mandated by the Emergency Wetlands Resources Act of 1986, is mapping all wetlands in the conterminous United States. This effort must be completed by 1998. Amendments to the act require wetlands mapping of Alaska by the year 2000 and digitized wetlands maps for all of the United States by 2004. The FWS administers the National Wetlands Inventory (NWI) to gather the data needed for these maps. The inventory provides information to resource managers and the public on the type, size, location, and status and trends of wetlands, essential information for managing habitats effectively and for acquiring wetlands. By the end of 1993, the NWI had produced over 38,000 detailed wetland maps covering 75 percent of the conterminous United States, 26 percent of Alaska, and all of Hawaii and the U.S. Territories. The Inventory had digitized 11,000 of its wetland maps, representing 19 percent of the conterminous United States. The annual rate of map production is 2,800 wetland maps at the scale of 1:24,000 for the conterminous United States and 60 wetland maps at the scale of 1:63,360 for Alaska.

Each year the FWS distributes 130,000 copies of NWI maps for such uses as comprehensive resource management planning, environmental impact assessments, permit reviews, facility and corridor siting, oil spill contingency plans, natural resources inventories, and wildlife surveys. The number of map users increases each year, with requests coming from individuals, private organizations, industry, consultants, developers, agencies from all levels of government, and academia. The inventory maintains three databases:

. **Maps Database.** This metadata database for all map and digital data describes 19 fields of information.

. **Wetland Values Database.** This annotated bibliography describes functions and values of wetlands that can be accessed by geographic area.

. **Wetland Plant Database.** This database maintains a complete accounting of all hydrophytic vegetation that occurs in wetlands within the United States.

The NWI produces comprehensive, statistically valid, detailed reports on the status and trends (such as losses and gains) of the nation's wetlands. Estimates of the current status and trends of wetlands

provide information for reviewing the effectiveness of existing programs and policies, for identifying national or regional land-use problems and allocation, and for general public awareness. The FWS issued two status and trends updates in 1991:

. *Wetlands Losses in the United States: 1780s to 1980s*, which gives a state-by-state account of original wetland acreage and subsequent losses.

. *Wetlands Status and Trends in the Conterminous United States:* Mid-1970s to Mid-1980s, which describes wetland losses and gains due to land use practices and identifies losses and gains by type of wetland. The Emergency Wetlands Resources Act requires an update of this report every ten years.

Information generated from status and trends analyses helps develop federal policies on wetlands conservation.

Federal Geographic Data Committee Wetlands Subcommittee

In accordance with Circular A-16, -Coordination of Surveying, Mapping, and Related Spatial Data Activities,- issued by the Office of Management and Budget in 1990, the Federal Geographic Data Committee established a Wetlands Subcommittee. Chaired by the U.S. Department of the Interior, the subcommittee is composed of representatives from all federal agencies involved in wetlands mapping. The group is testing the feasibility of increased coordination and integration of wetlands mapping interests.

Federal Standard for Wetlands Classification. Issues of primary concern to the subcommittee are improved data collection methods to produce verifiable statistics on the status and trends of wetlands, the adoption of a federal standard for wetlands classification, and consistency in wetland trends information.

Wicomico County Study. The subcommittee is sponsoring a number of wetlands data studies. One study underway has all federal and state agencies with wetlands data for Wicomico County, Maryland, comparing the results of their independent efforts. This brings together data collected by both conventional color-infrared aerial photography (vector data) and satellite (Thematic Mapper, raster data) at various scales or resolution, gathered using several data collection methodologies, classified using different systems, and spanning a time period of almost ten years. The USGS compiled and analyzed the data using state-of-the-art Geographic Information System (GIS) technology. Results of this data integration effort will be available in 1994. The Wetlands Subcommittee is considering a similar project to investigate wetlands quality within an entire watershed.

Wetlands Restoration and Acquisition

The U.S. Fish and Wildlife Service has adopted wetland restoration as its hallmark. Since 1986 partnerships formed through the North American Waterfowl Management Plan (NAWMP) have restored 300,000 acres of wetlands, and NAWMP enhancement actions have been taken on an additional 800,000 acres. In FY 1993 the FWS added 140,381 acres of wetlands to the National Wildlife Refuge System, which brings the wetlands acquisition average to 127,000 acres/year over the last five years.

Partners for Wildlife:

Applying Habitat Restoration in an Ecosystem Approach

The U.S. Fish and Wildlife Service (FWS) is a lead federal agency for the conservation of federal trust fish and wildlife species, consisting of migratory birds, endangered and threatened species, and anadromous fish. The majority of remaining high quality habitat for these species, as well as the greatest habitat restoration potential, occurs on private lands.

In recognition of the importance of nonfederal lands in fish and wildlife conservation matters, the FWS has been restoring wetlands and other federal trust species habitats on private lands since 1987 under voluntary cooperative agreements with landowners. Conducted in cooperation with the U.S. Department of Agriculture (USDA), this habitat restoration work is one component of the FWS Partners for Wildlife initiative. FWS Private Lands Coordinators are located in every state.

In 1993 the FWS, landowners, and their partners restored over 44,703 acres of wetland, riparian, stream, and grassland habitats for federal trust species and other wildlife. To date the program has restored 17,000 sites comprising over 210,000 acres of wetlands and associated habitats and involving 10,900 landowner agreements.

Forested Riparian Wetlands

The USDA Forest Service has given priority standing to the management of riparian wetlands, which include the following components:

. Watershed analysis and assessment,

. Modified riparian management practices, and

. An aggressive restoration program.

As an example the Forest Service has restored western red cedar to the riparian ecosystem of the North Fork of the St. Joe River in the Idaho Panhandle National Forest, where it had been eliminated by repeated wildfires.

Circle of Flight Wetlands Restoration

Since 1991 Indian tribes in Michigan, Minnesota, and Wisconsin have worked to restore 400,000 acres of tribal wetlands. Through a series of projects designed to increase and manage waterfowl populations and improve wetland habitat on their reservations, ten tribes have cooperated on what is known collectively as the Circle of Flight. The Bureau of Indian Affairs, in cooperation with the North American Wildlife Management Plan, meets with the tribes each year to plan specific restoration projects.

Wetlands Mitigation

In 1993 the Army Corps of Engineers expended $46 million on wetlands mitigation, restoration, and protection associated with 90 federal projects. As part of levee rehabilitation necessitated by the 1993 Midwest Flood, the Corps is seeking potentially beneficial environmental opportunities for natural flood control by modifying operations and structures on existing Corps projects.

EPA Wetlands Grants

The EPA administers a number of grant programs that support the protection and restoration of wetlands.

State Wetland Protection Development Grants. The EPA initiated the State Wetland Protection Development Grant program in 1990 to support new or existing state/tribal wetland protection programs. Response has been enthusiastic with requests for funding far exceeding the amount of funds available. In 1993 funding for the program increased to $10 million, and 100 grants had been issued to 45 states, 18 tribes, and 3 territories. By the end of the 1993 grant cycle, every state had received at least one grant.

State Wetland Conservation Plans Grants. States and tribes continued to demonstrate their interest in developing State Wetland Conservation Plans (SWCP). The intent of a SWCP is to improve the effectiveness and efficiency of government programs and private sector efforts to protect, restore, enhance, and create wetlands by identifying opportunities for coordinating existing wetland programs and determining where additional authorities or programs are needed. In 1993 nine states and six tribes received grants to develop SWCPs.

Watershed Protection Approach Grants. The Watershed Protection Approach is designed to involve the EPA and state and local governments in planning water resource protection programs in a holistic, integrated manner by promoting geographically targeted decisionmaking. The EPA funded seven Watershed Protection Approach projects in 1993.

Coastal Waters

With continued development of the nation's coastal areas, increasing amounts of pollutants are being discharged into surface waters. If unchecked this can result in beach closures, shellfish bed closures, fish kills, high concentrations of toxic substances in marine organisms, and algal blooms (evidence of eutrophication) in near-coastal waters and estuaries. Oil spills and waste discharges from boats, industrial facilities, and municipal wastewater treatment plants are identifiable sources of pollution. Other activities that occur throughout a watershed, even at some distance from the sea, are not as identifiable and they include runoff from agricultural and urban areas that carry nutrients, chemical pesticides, and a myriad of other chemicals. Runoff also carries sediment from agricultural and development activities.

Pollution in coastal areas greatly impacts recreational use, human health, fish and shellfish populations, and wildlife habitat. Beach closures, fish and shellfish consumption advisories, and diminished aesthetic quality have become commonplace in many coastal areas because of unsafe levels of fecal coliform bacteria or marine debris.

The viability of three-quarters of the nation's commercial fisheries depends on clean and functioning estuaries. Pollution and physical alteration actually may render coastal habitats incapable of providing the elements necessary for many species of fish and shellfish to survive, resulting in both ecological and economic losses.

The federal agencies that monitor the nation's coastal waters and administer federal laws to protect marine resources include the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce, the U.S. Coast Guard in the Department of Transportation, and the EPA, with assistance from other agencies.

Conditions and Trends

Today over half (54 percent) of the total U.S. population lives within 50 miles of the coast or the Great Lakes an area representing 25.1 percent of the total U.S. land area. Populations along the Gulf of Mexico and Pacific Coast have more than doubled since 1960 and that of eastern Florida has more than tripled. Between the years 1993 and 2020, the total U.S. population is projected to grow from 258 million to 326 million people. Most of that growth will be in coastal areas, especially in California, Texas, and Florida.

Half of American jobs are located in coastal areas, and a third of the nation's Gross National Product (GNP) is produced there, with the coastal GNP rising at a rate faster than total U.S. GNP. Coastal recreation and tourism are growing at impressive rates in many areas, but this growth is tempered by poor environmental quality conditions. During 1990-1993 beaches were closed or advisories issued against swimming on 2,000 occasions in those states that monitor beach quality.

Marine Ecosystems and Biodiversity

Coastal areas represent some of the nation's most sensitive ecosystems, which provide habitat for 75 percent of the total U.S. commercial landings of fish and shellfish and an even larger proportion of recreational fish and shellfish. Human activities affect marine biodiversity in direct ways through pollution and in indirect ways, such as by habitat loss and introduction of nonindigenous species. As the human population increases, the human impact on the diversity of life will increase, especially in coastal areas. Loss of organisms and entire species threaten the diversity of the nation's rich marine ecosystems. Even in those areas that show evidence of progress toward improved conditions, increasing human population and development could offset short-term improvements. The NOAA has estimated that by the year 2010 the coastal population will have grown to more than 127 million persons, an increase of almost 60 percent from the 1960 population.

Shellfish Harvests

In 1990 a survey of 23 shellfish-growing states, conducted by the NOAA National Ocean Service, found 17 million estuarine acres nationwide classified for shellfish harvest, with the following categories:

. Approved Waters. Of the 17 million acres, 63 percent were approved, allowing harvest at all times. This figure was down 6 percent (1.2 million acres) from 1985;

. Conditionally Approved Waters. Another 9 percent of the waters were conditionally approved for harvest when microbiological pollution criteria are met;

. Restricted Waters. Three percent of shellfish waters could be harvested if shellfish were subjected to a suitable purification process; and

. Prohibited Waters. Another 25 percent of the waters were prohibited, with harvest for human consumption not allowed. This figure was up from 19 percent in 1985.

The reduction in waters approved for shellfish harvest and the increase in prohibited waters between 1985 and 1990 were primarily the result of expanding coastal development, urban runoff, faulty septic systems, marina development, and buffer zones around sewage treatment plants.

The rate of decline in approved acreage is highest in the most productive estuaries such as the Chesapeake Bay, the Mississippi Delta Region estuaries, and Puget Sound. The coastal drainage areas affecting these estuaries already receive some of the heaviest pollution loads in the nation, a condition that is not likely to change as development continues. A third of all U.S. shellfish-growing waters are harvest-limited (the sum of shellfish waters that are classified conditionally approved, restricted, and prohibited). This category includes half of the shellfish-growing waters in the Gulf of Mexico. Harvest-limited status represents an ecological problem and an economic one, for if current trends continue, wild, natural shell fishing is at stake.

Harvest-Limited Waters and Recreational Boating

A notable example of the impact of coastal development on shellfish-growing waters is the increase in harvest-limited waters, up by half, affected by pollution from recreational boating. Increases in recreational boating in many coastal areas have resulted in a proliferation of marinas, many of which do not have facilities to collect or process sewage. Many marinas are located in or near productive shellfish-growing areas, as are the housing and other facilities related to such development. In 1990 pollution from boating and marinas affected 25 percent of the harvest-limited shellfish-growing waters in half of the shellfish- producing states.

National Shellfish Register

Although reporting on classifications of shellfish-growing waters began with the 1966 National Shellfish Register, data have only been collected and analyzed on pollution sources, landings, and state shellfish programs since 1985. Inferences on relationships of classification, pollution source, and harvest are based most heavily on the 1985-1990 period. Indications are that declines in approved and conditionally approved shellfish-growing waters and wild-stock harvests are continuing.

State Shellfish Management Programs

During the 1985-1990 period, half of the nation's shellfish- producing states reduced funds for shellfish management programs. Continued declines in the funding needed for states to monitor, classify, and manage waters may further reduce the nation's ability to sustain wild and natural stocks of mollusks and other shellfish.

Aquaculture and Molluscan Shellfish

Declines in approved shellfish-growing waters have been paralleled by declines in the harvests of wild or natural stocks of molluscan shellfish. To maintain natural harvests of shellfish, the nation will need to reverse the decline in the water quality of productive estuaries and resolve problems of over harvesting and disease. Aquaculture, involving the propagation, planting, cultivation, and harvest of shellfish in a controlled setting, may offer an option. Successful aquaculture operations in estuaries such as Willapa Bay, in southwest Washington state, have shown that sustained production can be achieved. Aquaculture, however, requires access to high- quality water and a nearby land base. It also requires exclusive use of parcels of land and water, often competing with other uses such as swimming, boating, fishing, and navigation. Although well- established in a few estuaries, aquaculture is not encouraged by existing laws and regulations that govern private access to public lands and approved shellfish-growing waters. Without increased aquaculture, mollusk (oyster and clam) harvests in estuaries are likely to continue to decline.

Environmental Impact of Fish Farms

Aquaculture can provide substantial environmental benefits to wild stocks of fish, shellfish, and crustaceans by providing an alternate source of supply, thereby diminishing harvest pressures. In addition impacts on species caught incidentally to the harvest of target species and damage to the environment caused by some methods of commercial fishing can be reduced when aquaculture serves as a major source of supply. Aquaculture, however, can have negative environmental impacts, if effluents from production facilities are not handled properly, escapement of diseased or nonindigenous species is not controlled, interactions with fish- eating birds and mammals is not managed carefully, and development sites are not chosen in accordance with responsible ecosystem management plans.

Coastal Fisheries

In addition to shellfish, populations of virtually all estuarine and inshore species of finfish have been reduced to historically low levels of abundance by over fishing, habitat loss, and pollution. These are both ecological and economic problems.

In 1992 U.S. commercial fishermen earned $3.7 billion in ex-vessel revenue on 4.8 million metric tons of fish and shellfish. About 80 percent of these landings were used directly for human food. The commercial harvesting and seafood-processing sectors of the U.S. economy support 300,000 full-time jobs. With 6 percent of the world's commercial landings, the United States is the sixth largest producer of seafood in the world.

The nation's marine resources support many other uses. For example off the Atlantic and Gulf of Mexico coasts 17 million U.S. recreational fishermen took 53 million saltwater fishing trips and caught 285 million finfish in 1992. Marine resources also support subsistence fishing by Native Americans and recreational activities such as whale watching. The protection and recovery of depleted stocks of marine mammals, sea turtles, and other threatened and endangered species will yield both ecological and economic benefits.

Northeast Fisheries. Averaged over the 3-year period ending in 1992, the fisheries of the Northeast region contributed 20 percent of the prorated U.S. recent ex-vessel revenue and 16 percent of the

volume of the nation's commercial fisheries. Total 1992 landings of all species in the Northeast measured 769,667 tons, with an estimated ex-vessel revenue of $818 million. The mixed-species groundfish fishery is the most valuable fishery of the region ($188 million), followed by American lobster ($161 million) and Atlantic sea scallop ($152 million).

Recreational Fisheries. Species such as cod, winter flounder, mackerel, striped bass, bluefish, and bluefin tuna contribute greatly to the region's economy. A total of 19 million recreational marine fishing trips in 1992 produced landings of 100 million fish.

Long-Term Potential. Recent annual landings of Northeast marine resources have totaled only half of their long-term potential. The discrepancy between recent landings and potential production results from significant over utilization of 18 stocks in the region, including principal groundfish, flounders, and others, and underutilization of 8 stocks. Stocks of Atlantic mackerel and herring are both underutilized at present and collectively could produce an additional 200,000 tons of long-term potential yield. The region is fully utilizing 13 species or stocks.

Southeast Fisheries. The combined U.S. long-term potential yield for southeast Atlantic, Gulf of Mexico, and Caribbean living marine resources is estimated at 1.2 million tons (16 percent of the total U.S. long-term potential yield). Recent catches have run 99 percent of current potential yield and 76 percent of long-term potential yield. The status of several of these fisheries follows.

Atlantic Highly Migratory Pelagic Fisheries. Ocean pelagics are highly migratory species that include swordfish, several species of tuna and marlin, sailfish, long bill spearfish, and other minor species. Since 1960 the top species by volume in the U.S. harvest has shifted from bluefin tuna to swordfish to yellow fin tuna as each species became increasingly fished down. A few Atlantic large pelagic species appear to be underutilized, and several are far over utilized.

Atlantic/Gulf of Mexico/Caribbean Reef Fish Fisheries. Many southeast Atlantic snappers and groupers, and Caribbean reef fish have been over utilized, and some stocks are at historically low levels. The status of many other reef fish stocks is unknown. Individually these stocks are minor portions of the catch, but, in aggregate, they support valuable recreational and commercial fisheries.

Atlantic/Gulf of Mexico Coastal Migratory Pelagic Fisheries. The recreational and commercial coastal pelagic species (mackerels, dolphin fish, and cobia) yield only 56 percent of their estimated aggregate long-term potential yield as a result of over utilization. Certain individual stocks are severely depressed (such as Gulf of Mexico king mackerel). The impact of Mexican fisheries on these stocks is not well known but may affect stock-rebuilding efforts.

Atlantic Shark Fisheries.

Atlantic Shark Fisheries. Seventy-two species of sharks frequent the waters of the U.S. Atlantic, Gulf of Mexico, Puerto Rico, and U.S. Virgin Islands. For many years sharks were fished moderately and only limited to coastal waters. In recent years, however, large coastal sharks (such as white, tiger, lemon, bull, hammerhead) have been fished intensively over broad geographic areas and are considered over utilized. Small coastal sharks (such as Atlantic and Caribbean sharpnose, finetooth, blacknose) are considered fully utilized. Information is insufficient to assess the status of pelagic sharks (such as mako, blue, thresher).

Commercial Shrimp. Currently all commercial shrimp species are approaching their long-term potential yield level, but these fisheries are overcapitalized and could produce similar yields with considerably less effort, if fishing mortality were reduced. For this reason they are classified as over utilized. A consequence of excessive fishing mortality on shrimp is excessive by catch, which adversely impacts finfish stocks. The dominant catches are Gulf of Mexico brown, white, and pink shrimp, which represent 89 percent of the total U.S. shrimp catch. In 1991 those three species produced a total catch of 104,361 tons, valued in excess of $400 million.

West Coast and Western Pacific Fisheries. West Coast and Pacific island fisheries account for 1.1 million tons and 15 percent of the U.S. long-term potential yield. These include fisheries for tuna, bill fish, and swordfish (Pacific-wide); reef and seamount finfish and lobster (Pacific islands); and U.S. West Coast groundfish, salmon, coastal pelagic fishes, and the near shore species. On the Pacific Coast, including near shore resources, most of the stocks are fully utilized or over utilized, with only 2 of 38 stocks underutilized. In the oceanic Pacific, 8 of 22 stocks are underutilized; the status of 7 others is unknown. The status of several of these fisheries follows.

Pacific Salmon Fisheries. Long a part of the cultural heritage of the Pacific Northwest, salmon support commercial and recreational fisheries and tribal ceremonial and subsistence fisheries in Washington, Oregon, and California. All five species (chinook, coho, sockeye, pink, and chum) are considered over utilized in the region. Loss of spawning habitats, impacts from hydroelectric power development, and harvest appear to be the main causes of salmon decline. Habitat restoration, changes in hydroelectric operations, and fishing limitations are needed to protect the stocks. Management is complex, involving many stocks that originate from various rivers and under several management jurisdictions. Chinook and coho salmon are managed primarily by the bilateral Pacific Salmon Commission and state and tribal fishery agencies.

Coastal Pelagic Fisheries. Providing food, bait, and industrial fishery products along the Pacific Coast, all of these species are fully utilized except jack mackerel, one of the few underutilized West Coast species. The Pacific sardine population has been increasing after decades of low abundance.

Invertebrates. Of the western Pacific invertebrate fisheries regulated by the Western Pacific Fishery Management Council (WPFMD), the spiny and slipper lobster fishery is the most valuable, but landings and effort have dropped substantially since 1989 because of over exploitation. The fishery was closed in 1993 to allow rebuilding of these stocks.

Alaska Fisheries. The Alaska region is one of the most productive areas of the world's oceans, supporting large populations of salmon, groundfish, crabs, marine mammals, and seabirds. Fishing is a tradition and heritage in Alaska. It contributes significantly to the recreation, food supply, and economy of Alaska; it helps reduce the U.S. trade deficit; and it is the largest nongovernment employer in the state. Alaska's combined long-term potential yield of economical species is 3.8 million tons. Marine resources are generally in a healthy condition with current potential yield only 5 percent below the long-term potential yield. The recent average yield has been steady at 2.4 million tons. The extra yield potential cannot be fully utilized, because the harvest is managed conservatively to offset scientific uncertainty and lack of data. Management objectives include economic, by catch, and protected species considerations.

U.S. Near shore Fisheries. Atlantic oysters, hard and softshell clams, bay scallops, and abalones are over utilized, at least in part of their ranges. Fully utilized resources include Pacific shrimp and clams, Dungeness crab, blue crab, and calico scallop. Because these species frequent near shore waters, they are not included in federal fishery management plans. Some are managed under regional, state, and/or local authority employing measures such as size limits, gear restrictions, area closures, bag limits, and catch quotas.

Contaminants and Pollutants in Coastal Waters

Of the various pollutants released to the environment, little is known about how they affect marine organisms. In 1993 a number of state and federal programs gathered data on coastal water contaminants and pollutants.

Fish Kills in Coastal Waters

Impact assessments based solely on fish kills provide only partial and conservative inferences of pollutant effects; however, they do help define the spatial and temporal dimensions of potential problems such as areas with recurring problems. Temporal records of fish kills also can be used to evaluate evidence of water quality problems such as pesticide spills or discharges of high levels of chlorine disinfectant from a wastewater treatment plant. Some fish kills are linked to natural phenomena such as oxygen depletion resulting from sustained periods of hot weather coupled with low-flow conditions. Many events, however, are linked to a complex combination of human-related and natural factors such as an oxygen depletion resulting from algal blooms stimulated by nutrients carried in nonpoint-source runoff.

The Public Health Service began reporting pollution-caused fish kills in 1960. In 1972 reporting was transferred to the EPA where it remained until discontinued in 1991. Using data from the EPA program and other sources, the NOAA issued a 1991 report on fish kills in coastal waters, with the following findings:

Number of Fish Kills. From 1980 to 1989, over 3,650 fish-kill events, involving 407 million fish, were reported to have occurred in 533 coastal and near-coastal counties in 22 states. Although fish kill data are difficult to evaluate over time, an upward trend exists in the number of events, with a downward trend in the number of fish killed nationwide.

Timing of Fish Kills. The largest number of events (64 percent) and the highest number of fish killed (86 percent) occurred during the warmest months of the year, May through September. The month with the single greatest number of events was August, while the event with the greatest number of fish killed took place in June.

Causes of Fish Kills. Urban land use, natural events, and low dissolved oxygen were the most frequently cited causes of fish kills. The largest reported fish kill occurred in the Jolly Rogers Canal in Jamaica Beach, Texas, where an estimated 50 million gulf menhaden (Brevoortia patronus) died due to low dissolved oxygen from unspecified sources. Toxic releases or spills, a less frequent cause of fish kills, tend to be more localized and to kill fewer fish.

Types of Fish Killed. The families of fish most commonly involved in a kill event are Clupeidae (menhaden, shad, herring), Centrarchidae (sunfish, bluegill, bass), and Cyprinidae (carps, minnows, dace, chubs, shiners). Of these Clupeidae are involved in 36 percent of all fish-kill events and account for 61 percent of the total number of fish killed.

National Coastal Pollutant Discharge Inventory

In 1993 the federal government continued documenting marine pollution off U.S. coasts. The NOAA first began gathering data for the National Coastal Pollutant Discharge Inventory (NCPDI) in 1982. This database contains pollutant-loading estimates for major categories of point, nonpoint, and riverine sources of pollution that discharge to the estuaries, coasts, and oceanic waters of the contiguous United States, excluding the Great Lakes. The inventory estimates discharge rates for 9 major source categories and 17 pollutants. These estimates, made for the base year 1982, approximate pollutant discharge conditions for 1980-1985, and estimates are updated continuously.

Gulf of Mexico States. Reports for Alabama, Mississippi, Florida, Texas, and Louisiana, the Gulf of Mexico states, summarize the number, type, location, and pollutant discharge characteristics of major dischargers in the NCPDI study area. This information provides coastal resource managers with valuable insight into which facilities are major dischargers to coastal waters.

Virginian and Acadian Provinces. Reports on the Virginian Province, Cape Cod to Cape Hatteras, and on the Acadian Province, the Gulf of Maine, were scheduled for release in 1994.

Contaminants in Sediments and Marine Organisms

Since 1986 the NOAA National Status and Trends (NS&T) Program for marine environmental quality has made annual collections and chemical analyses of mussels and oysters from a set of 200 sites around the coastal and estuarine United States. With the possible exception of an increase in copper, the only observable national trends in contaminant concentrations through 1992 have been decreases. Statistically the decreases have been seen in concentrations of chlorinated hydrocarbons (DDT, PCB, chlordane) and two trace elements (cadmium and lead). The use of these chemicals has been banned or severely curtailed, and other chemicals are subject to regulations. Although regulations have not caused decreasing trends, they perhaps account for the lack of increases.

Because the NS&T Program is by definition national, its sampling sites are selected to represent large areas and its assessments of distribution and temporal trends in contamination apply on a large scale. Although nationwide the trends do not show chemical contamination as a serious threat to environmental health, extreme levels of contamination can occur over smaller spatial scales and cause severe biological effects. To quantify the cumulative extent of such contamination, the NS&T Program conducts bioeffects surveys with closely spaced samples collected along contaminant-concentration gradients. Surveys have been conducted in Boston Harbor, Long Island Sound, Hudson Raritan Estuary, Charleston Harbor, Tampa Bay, bays along the Florida panhandle, Southern California Bight, and San Francisco Bay.

In all of these locations sediment toxicity was measured with a series of test organisms, and native fish were examined for evidence of histological and genetic damage and reproductive losses attributable to

chemical contamination. Since responses to contamination among native fish vary with species, comparisons can only be made among locations with common species. In each location at least a few sites had sediments toxic to at least one of the test organisms. Whether the bioeffects measurement is based on bioassays or on responses among native fish, the effects are found over relatively limited areas close to centers of population and industrial activity.

Nutrient Enrichment in Estuaries

Among the most prominent barometers of human impacts on the nation's coastal and estuarine ecosystems is the continuing decline in water quality in estuaries, particularly problems associated with the excessive discharge of nutrients to estuaries. Even though reports dating back to 1969 consistently identify nutrient enrichment as a critical concern, no effort has been made to quantify and evaluate the nationwide extent, scope, and severity of the problem.

Scientists can explain how and why eutrophication occurs but to formulate an effective response, they need more complete and comprehensive information. In 1993 the NOAA initiated the National Assessment of Nutrient Enrichment Conditions in Estuaries as a first step toward solving recurring and persistent nutrient enrichment problems. The program is establishing a database and identifying areas of priority concern. It also is evaluating monitoring and research needs and establishing a network of local and regional expertise. More precise data on the national significance of this environmental issue will be available in 1994-1995.

Agricultural Pesticide Runoff

Over 29.4 million pounds of 35 commonly used agricultural pesticides were applied to the 32 million acres of cropland in the nation's coastal watersheds in 1987 (the latest year for which these estimates are available from the NOAA). The Gulf of Mexico region had the highest agricultural application of chemical pesticides, with over 10 million pounds, followed closely by the South Atlantic region with nearly 10 million pounds and the Middle Atlantic region with 8 million pounds.

Florida Bay, an Estuary of Concern

One estuary of critical concern to coastal resource managers is Florida Bay, located between the southern tip of the peninsula and the keys. This bay strongly influences the salinity, temperature, and quality of the waters surrounding the Middle Florida Keys, and any strategy to improve the water quality of these islands must consider the bay. Considerable scientific controversy exists regarding the effects of changes in the water quality and quantity of Florida Bay.

Seagrasses have been dying in the bay since 1987, with the decline of the pink shrimp fishery linked to the seagrass die- off. Over the past several years, algal blooms that have caused the death of sponges have been linked to adverse impacts on commercial and recreational fisheries. Controversy exists about whether the algal blooms are the result of the seagrass die-off, in which case increasing freshwater flows to Florida Bay could help, or whether algal blooms result from sources of excess nutrients that are external to Florida Bay, in which case increasing freshwater flows could increase the problem by adding

nutrients to the bay. The unanswered questions in Florida Bay are perhaps the most salient example of the need for eutrophication research.

The Chesapeake Bay estuarine drainage area had the highest rate of pesticide application with nearly 5 million pounds applied to land within the basin. The highest hazard-normalized application (an application is normalized according to its potential hazard to the aquatic environment) occurred in the Albemarle/Pamlico Sounds estuarine drainage area in the South Atlantic region.

Although the presence of pesticides in coastal waters causes fish kills, residues in aquatic biota, and changes in estuarine community biomass, observable impacts do not appear to be widespread. Impacts are most often observable near the site of pesticide application and during the growing season. The lower environmental persistence and bioconcentration potentials of the 35 pesticides in the NOAA inventory, compared to pesticides used in the past, appear to account for reduced impacts on aquatic organisms.

Spills of Oil and Hazardous Materials

Congress passed the Oil Pollution Act of 1990 (OPA) to improve the nation's ability to respond to oil and hazardous materials spills. The Coast Guard (USCG), which implements the OPA in the coastal zone, is responsible for responding to spills with assistance from National Response Team (NRT) agencies, including the NOAA Hazardous Materials Response and Assessment (HAZMAT) Division. In 1993 agencies responded to 9,809 oil spills, 350 chemical spills, and 660 spills of unknown material. The NOAA provided scientific support on 67 oil spills and 14 chemical spills.

Program Accomplishments

In 1993 federal agencies developed management strategies for coastal ecosystems to reduce nonpoint-source pollution entering the nation's coastal waters and to improve response to oil and hazardous material spills.

NOAA Coastal Ecosystem Management Programs

The NOAA has created cross-disciplinary science and management teams to work on marine resource issues, at the national level as well as in selected coastal ecosystems. In 1993 operations included support for state coastal watershed management objectives; ecosystem management on protected areas, such as the 13 National Marine Sanctuaries, and revised habitat protection and restoration efforts.

Coastal GIS. The NOAA is developing a comprehensive, national information system to support decisionmaking at the ecosystem and coastal watershed levels. The system will describe the health, biodiversity, and integrity of coastal ecosystems as well as changes in land cover and land use. It will use satellite imagery, aerial photography, in-situ monitoring, research data, and other collateral data within a geographic information system (GIS) context. The effort is cooperative and cost-shared with other federal and state agencies.

Coastal Ecosystem Outreach. NOAA scientists and outreach specialists are translating highly technical information for use by all coastal resource managers. On the international level, in 1993 the NOAA helped prepare a joint Canada-USA proposal for a pilot project to develop and share information on managing marine resources along the East Coast of North America.

National Estuarine Research Reserves. The NOAA National Oceans Service (NOS) administers the National Estuarine Research Reserve System, in conjunction with participating coastal states. The estuarine reserves program was established to preserve estuaries and seek new knowledge of these vital areas. In 1993 the National Estuarine Research Reserve System consisted of 21 reserves encompassing 400,559 acres.

National Marine Sanctuaries

Congress established the National Marine Sanctuary Program in 1972 in response to public concerns about the effects of pollution on marine resources. Today 14 sanctuaries protect 18,500 square miles, from the 5,327-square-mile Monterey Bay site off California to Fagatele Bay's 0.3-square-mile tropical coral reef system off Tutuila Island in American Samoa. Reefs, underwater canyons, historic shipwrecks, and a diversity of marine life provide opportunities for marine education to elevate respect for marine resources and awareness of their vulnerability and the need for conservation. The newest sanctuaries, those surrounding the Florida Keys and off the coast of central California, provide opportunities to sustain marine biodiversity in areas that are culturally, historically, and commercially significant. Coastal management and ongoing research provide information on climate change, marine biodiversity, and critical marine habitats.

Florida Keys Sanctuary DEIS. In 1993 the NOAA helped establish a process for reaching consensus on complex coastal management issues. A National Marine Sanctuary Advisory Council working with a core group of local experts, released a Draft Environmental Impact Statement (DEIS) for the Florida Keys National Marine Sanctuary. The document includes an overview of the affected environment (2,600 square nautical miles), a sum-mary of management strategies and alternatives, assessments of the environmental and socioeconomic consequences of each management strategy, and a description of how these strategies can be implemented.

Oil Spill Response and Contingency Plans. As part of its Hazardous Materials Response and Assessment Program, the NOAA is developing oil spill response and contingency plans for its marine sanctuaries and estuarine reserves, beginning with the Monterey Bay (California) and Key Largo (Florida) National Marine Sanctuaries.

Natural Resource Damages. In 1993 the NOAA continued to investigate potential biological effects resulting from the industrial and nuclear waste dump site within the Gulf of the Farallones Marine Sanctuary off San Francisco. Working from a research vessel, the NOAA and EPA obtained samples of sediment and sable fish within a dumpsite. The use of a submarine and a remotely operated vehicle (ROV) to determine the status of waste containers was planned for 1994.

EPA National Estuary Program

The EPA Office of Wetlands, Oceans, and Watersheds administers the National Estuary Program (NEP). The NEP is designed to protect and restore the health of estuaries while supporting economic and recreational activities. To meet these goals, the EPA helps develop partnerships between government agencies that oversee estuarine resources, and the people who depend on the estuaries for their livelihood and quality of life. Each of the 21 estuary programs in the NEP develops a comprehensive plan that identifies environmental problems, recommends solutions, and makes financial commitments for implementing the solutions. The plan is approved by the EPA and the governor of the state. In 1993 comprehensive plans for Narragansett Bay and San Francisco Bay were approved.

Nonpoint-Source Pollution Management

In 1993 the EPA released technical guidance for coastal states to provide a foundation for reducing nonpoint-source pollution. Although state programs to prevent and reduce nonpoint-source pollution have been underway for many years, water quality impairment remains a serious issue for many coastal areas.

Coastal Zone Act Reauthorization Amendments. These 1990 amendments, known as the CZARA, require that all states with approved coastal zone management programs develop programs to control coastal pollution. States without approved Coastal Zone Management (CZM) programs are subject to loss of funding. The amendments directed the EPA, in consultation with other agencies, to issue guidance specifying management measures to control nonpoint-source pollution. The CZARA also requires the EPA to implement nonpoint-source pollution controls with enforceable mechanisms and policies.

Best Available Technology. The EPA guidance provides economically achievable measures that reflect the best available technology for reducing pollutants from sources, including agriculture, forestry, urban areas, marinas and recreational boating, and hydro- modification. The EPA and NOAA developed companion guidance for incorporating management measures into state coastal zone programs. The guidance provides states with new information on ways to address the most serious threats to water quality in coastal waters.

Oil and Hazardous Pollution Prevention

In 1993 the Coast Guard, NOAA, and other federal agencies and state governments cooperated on a number of programs to improve hazardous materials response and assessment. Programs included monitoring the recovery of shoreline environments from spilled oil, for example Prince William Sound in Alaska. Both the Coast Guard and the State of Alaska declared the Exxon Valdez cleanup complete in June 1992. Significant 1993 actions related to the spill included the report of the Coast Guard On-Scene Coordinator (OSC), published in September, and the successful testing of a microbial bioremediation agent in July.

Coast Guard On-Scene Coordinators. The OSC coordinates planning efforts at the area level, supported by other federal, state, and local agencies. The 48 Area Committees in the coastal United States are involved in interagency planning, intensive mapping, and trajectory modeling support for threat assessment, shoreline- specific protection strategies, and habitat-specific treatment plans. In 1993

prototype, all-digital Environmental Sensitivity Index maps had been prepared for most coastal shorelines.

Oil Spill Response Plans. The OPA requires oil spill response plans for tank vessels and marine transportation facilities. Approved plans are valid for up to five years. In 1993 the Coast Guard received 1,500 vessel response plans for 6,000 vessels and 2,600 facility response plans.

Area Contingency Plans. Coastal and Inland Area Contingency Plans (ACPs), mandated by the OPA, expand and improve local oil spill response planning by involving local government, industry, and private citizens in the planning process. By July 1, 1993, all coastal ACPs had been submitted for Coast Guard review. Inland ACPs are subject to EPA jurisdiction.

Spills of National Significance. The Coast Guard developed a catastrophic spill plan to provide an effective response to Spills of National Significance (SONS), such as the Exxon Valdez oil spill. The SONS Task Force report was under review in 1993. Once approved the SONS protocol will be incorporated into appropriate planning documents.

State and Federal Regulations. Since states have leeway under the OPA to regulate the maritime industry, inconsistent state and federal requirements can result. A new Coast Guard program improves coordination with the states and forges a more consistent environmental protection strategy. A comprehensive Memorandum of Agreement sets forth the relationship between the Coast Guard and the states with respect to marine environmental protection activities. Agreements have been signed with California, Hawaii, and the Territory of the Northern Mariana Islands. In 1993 negotiations were underway with four additional states.

Liability. In 1991 in response to the OPA, the Coast Guard created the National Pollution Funds Center to address claims related to oil discharges. The OPA allows each state up to $250,000 in federal funds per incident for immediate removal costs. States also may perform removal actions under the direct supervision of the Federal On Scene Coordinator, or they may submit claims under OPA section 1012(a)(4) for uncompensated removal costs determined by the President to be consistent with the National Contingency Plan. These options are not subject to the $250,000 limit per incident.

Scientific Support Coordinators. A network of NOAA support coordinators, located in USCG districts, provides the Coast Guard with round-the-clock scientific and technical support in responding to oil and hazardous materials spills nationwide. Coordinators are located in New York City; Boston; Portsmouth, Virginia; Miami; New Orleans; Cleveland; Long Beach, California; Seattle; and Anchorage. Since 1976 the NOAA has responded to spills on virtually all U.S. coastlines and to many spills in international waters. NOAA spill support to the Coast Guard includes trajectory analysis; assessing the nature, behavior, and fate of oil and hazardous substance spilled; identification of natural resources requiring protection; and evaluating various cleanup strategies for effectiveness.

HAZMAT Technical Experts. The NOAA Hazardous Materials Response and Assessment (HAZMAT) Division provides technical experts to work with the USCG, state agencies, and industry. They help collect the detailed local physical, biological, and geomorphologic information needed to develop site-specific countermeasure plans for spills of oil and hazardous materials. One result of their ongoing work was the 1993 Coast Guard report, Preventing Oil Spills in Delaware Bay.

Global Positioning System. In 1993 the Department of Transportation worked with the Department of Defense and other interested parties to expand civil applications of the Global Positioning System (GPS), which includes the implementation of Differential GPS (DGPS). The Coast Guard plans to implement a full DGPS network by 1996 that will cover the coastline of the continental United States, the Great Lakes, Alaska, Hawaii, Puerto Rico, and the Mississippi River basin. The system, which will provide 3-meter accuracy, has the potential to reduce ship accidents in adverse conditions, thereby reducing the number of polluting incidents at sea.

Computer-Aided Management of Emergency Operations. CAMEO (Computer-Aided Management of Emergency Operations), a software program designed to address the needs of emergency planners and first responders to chemical spills, was used in 1993 in response to spills of oil and hazardous materials. It contains information on 3,000 commonly transported chemicals and a dozen easily adaptable database files with the means for meeting the data management requirements of the Emergency Planning and Community Right To Know Act (Title III of SARA, the Superfund Amendments and Reauthorization Act of 1986).

Air Dispersion Modeling Software. In 1993 the Metropolitan Water District of Southern California selected the NOAA HAZMAT air dispersion modeling software, ALOHA 5.0, as the standard model for emergency response at chlorinating facilities throughout Southern California. This software is used by chemical emergency response organizations, including municipal fire departments, state and local agencies, and industry.

Nonindigenous Species

The Nonindigenous Aquatic Nuisance Species Prevention and Control Act of 1990 requires the Coast Guard to take the following actions:

. Develop a ballast water management program for the Great Lakes;

. Issue mandatory ballast management regulations for the Great Lakes;

. Provide mariner education services; and

. Conduct a study of the extent to which shipping is a vector for the introduction of aquatic nuisance species such as the zebra mussel.

Regulations requiring ballast exchange by vessels headed for Great Lakes ports in the United States went into effect on May 10, 1993. In 1993 legislation was proposed that would require the Coast Guard to develop a similar program for the Hudson River.

Coastal Transport of Trash and Medical Debris

The Shore Protection Act of 1988 is intended to help prevent the deposit of trash and medical debris in U.S. coastal waters. The DOT and EPA are responsible for issuing permits and enforcing regulations implementing the act. Since 1989, when permit responsibilities were delegated to the Coast Guard, 350 permits have been issued, primarily to garbage barges, sewage sludge barges, and vessels hauling drilling mud in the Gulf of Mexico.

Natural Resource Damages

The NOAA is expanding its capabilities in natural resource damage assessment on an ecosystem basis to negotiate and litigate settlements with responsible parties, to identify areas within coastal systems suitable for protection or restoration, and to undertake restoration activities.

The NOAA damage assessment and restoration program meets the trustee responsibilities of the agency under the Superfund Act; Oil Pollution Act; Clean Water Act; and the Marine Protection, Research, and Sanctuaries Act. The program addresses releases of oil and hazardous materials, as well as all types of injuries to marine sanctuary resources. Among program accomplishments in 1993 were the following:

Blackbird Mine and Chinook Salmon. In 1993 the NOAA Damage Assessment Center (DAC) began its first mine waste damage assessment at the Blackbird Mine on the Salmon National Forest in Idaho. Acid runoff and high concentrations of copper and other heavy metals contributed to the elimination of Chinook salmon, a threatened species, in the Panther Creek watershed. The State of Idaho, NOAA, and the USDA Forest Service have begun a unified damage assessment. The Blackbird Mine is one of 24 natural resource damage cases that the NOAA Damage Assessment Center worked on in 1993.

Commencement Bay Superfund Site. The NOAA and four co-trustees, the U.S. Department of the Interior, Washington State Department of Ecology, Puyallup Tribe, and Muckleshoot Tribe are implementing the first phase of a bay-wide natural resource damage assessment for the Commencement Bay Near shore Tide Flats Superfund site in Washington. Ten industrial and local government potentially responsible parties (PRPs) have agreed to contribute to funding the damage assessment in return for the opportunity to participate in planning and implementation. The trustees previously negotiated a natural resource damage settlement worth $1 million with two parties, Champion International Corp. and Simpson Tacoma Kraft Co., for a portion of the site and have agreed on a bay-wide settlement worth in excess of $12 million with the Port of Tacoma.

New Bedford Harbor Superfund Site. The first federal claim under Superfund for damages to marine resources was filed on behalf of the NOAA by the U. S. Department of Justice in December 1983. The claim was for injuries to coastal and marine species resulting from discharges of PCBs into New Bedford Harbor in Massachusetts. The third and final settlement in this case, for $10 million, was approved in early 1993. The total of all three settlements for natural resource damages and trustee costs was $21.3 million, with an additional $10 million held in an escrow account to be used either by the EPA or the trustees to clean up PCB hot spots in the outer harbor where fishery closures are still in effect.

East Coast Oil Spills. Settlements have been reached in negotiations on two major east coast oil spills-the June 24, 1989, Presidente Rivera spill in the Delaware River and the June 7, 1990, B/T Nautilus spill in the Arthur Kill in New York Harbor. The Presidente Rivera case was settled in late 1993 for approximately $3.9 million in natural resource damages and costs. The B/T Nautilus case was settled in late 1993 for $4 million in natural resource damages and costs. The NOAA, DOI, and states affected by each spill (Delaware, New Jersey, and New York) have collaborated as co-trustees in damage assessments and negotiations.

Spiller Restoration. The NOAA Damage Assessment Center, the Restoration Center in the NOAA National Marine Fisheries Service, and the NOAA Office of General Counsel are working on two

innovative, restoration-based settlements in which the spillers (Mobil Mining and Minerals in Texas and Greenhill Petroleum in Louisiana) will carry out a restoration under trustee supervision rather than paying the trustees monetary damages. Under these pending settlements, the trustees will be paid for assessment costs, restoration oversight, and long-term monitoring costs. Such settlements are a more effective and efficient way to resolve natural resource damage claims where no significant claim can be made for interim lost resource services, such as recreational fishing or boating, reduced or lost between the time of the spill and restoration.

Rapid-Response Capability. In 1993 the NOAA Damage Assessment Center completed a rapid response system for assessing oil and chemical spills. The DAC now can send support personnel to a spill site within six hours of notification. This rapid response capability enabled the NOAA to take the lead in organizing co-trustees and in planning initial damage assessment during the March 28, 1993, Colonial Pipeline spill in Reston, Virginia.

International Coastal Pollution Control

The following are examples of efforts to control international coastal pollution supported by the United States in 1993.

MARPOL Convention. The MARPOL 73/78 Convention is the primary international instrument for the control of marine pollution from ships. The Convention's five annexes contain specific regulations for preventing operational discharges of harmful substances, with more restrictive regulations for certain substances in designated Special Areas. Among the Special Areas designated under Annex V (garbage) is the Wider Caribbean, and in April 1993 the Coast Guard coordinated a MARPOL Annex V Enforcement Workshop sponsored by a number of agencies.

International Convention on Oil Pollution. Following the Exxon Valdez oil spill in March 1989, the Coast Guard negotiated the creation of the International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC) through the International Maritime Organization. The Coast Guard is using OPRC as an umbrella agreement under which future international response planning will be coordinated. The Convention enters into force on May 13, 1995.

Arctic Environmental Protection Strategy. This nonbinding agreement among Canada, Denmark, Finland, Sweden, Iceland, Norway, the United States, and Russia was signed in June 1991. Through an Arctic Monitoring and Assessment Program, the AEPS addresses the issue of Russian dumping of radioactive wastes. In 1993 the Coast Guard led the development of a regional environmental risk assessment to determine whether existing international agreements are adequate to deal with environmental emergencies in the Arctic.

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Chapter 4: Conservation Farming and Forestry

We must put our actions where our values are. Our government is a leading purchaser of goods and services. And it's time to stop not only the waste of taxpayers' money but the waste of our natural resources.

President Bill Clinton

Agriculture and forestry are becoming more environmentally friendly. Participants in federal programs to promote conservation farming and forestry have been highly effective, with cropland erosion levels down by over one-fifth from 3 billion tons in 1987. It is a remarkable accomplishment in a short period of time, and the incentive-based conservation practices that prevented the erosion are a return on the investment of the American taxpayer.

CONSERVATION FARMING

U.S. agriculture finds itself in the midst of a major shift from traditional post-World War II farming approaches and markets to advanced production techniques and expanding world trade, all under an umbrella of environmental interests and concerns. As the ecosystem approach to management helps achieve environmental goals, all sectors of agriculture are recognizing this new factor in the agricultural equation. No longer is it simply a chain of production, harvest, transport, and consumption, but rather a mesh of interwoven events, connections, and interactions that determine how consumers perceive the food on their table. Today consumers are concerned about quality, healthfulness, and whether food was produced in an environmentally sound manner. Producers are responding to these consumer concerns.

Conditions and Trends

For the American farmer and the Soil Conservation Service (now the Natural Resource Conservation Service), 1993 was a banner year with soil erosion down by 694 million tons from the previous year. Although the conservation practices responsible for the reduction are widely applicable, their benefits vary with conditions. Such practices include erodible cropland reserves, conservation or crop-residue tillage, contour plowing and stripcropping, vegetative buffer strips, and vegetative covers applied to highly erodible cropland.

Farmland

The terms cropland and farmland are distinct. Farmland encompasses the whole farm-cropland, woodlots, pasture, waterways, wetlands, and developed areas. Cropland is only that acreage used to produce crops, whether it is irrigated or not, cultivated or temporarily fallow, idle, or planted to pasture.

The trend toward fewer but larger farms that accelerated during the 1950s and 1960s and began to reshape U.S. agriculture continues, but at a slower rate. In the 1970s farm numbers stabilized in response to improved economic conditions in farming and an increase in rural residences. The 1980s witnessed a resumption in the decline in farm numbers as many farmers left agriculture and fewer entered it, but the rate of decline, while more rapid than during the 1970s, was slower than during the

1950s and early 1960s. In 1993 only 1.9 million farms remained in the United States, compared to a peak number of nearly 7 million in the mid-1930s.

Much of the prime farmland in the United States is located in urban and suburban areas, and over half of the nation's top-value agricultural commodities (largely perishable fruit and vegetables) come from farms in metropolitan counties or adjacent ones. Because America's settlers chose prime farmland to support their 18th-century agrarian society, it follows that today's cities are located on some of the best soils in some of the most conducive climates for growing crops and livestock. If current population growth patterns continue, however, cities are destined to cast ever-enlarging suburban rings into the surrounding countryside, destroying prime farmland and significantly affecting agricultural production. Estimates place the amount of prime farmland disappearing from 1982 to 1992 at a little over 600 thousand acres each year. Two-thirds (66 percent) of this loss is due to conversion to rural and urban development.

Agricultural Land Use Changes

Between 1982 and 1992, 39 million acres of nonfederal cropland and 14 million acres of nonfederal rangeland were removed from production, continuing a trend that has prevailed since 1950. Of the 39 million acres of cropland, however, most (82 percent) was highly erodible and went into the Conservation Reserve Program while about 4 million acres were converted to developed land. The decrease in rangeland occurred because of land conversions to a variety of other uses-cropland, developed land, other rural lands-and a change in ownership from nonfederal to federal land.

Developed land increased by 14 million acres (18 percent more than the 1982 figure). This increase came from conversion of about 2.5 million acres of pastureland, 2 million acres of rangeland, 5.4 million acres of forestland, and about 4 million acres of cropland. In 1992 developed land totaled 92.4 million acres, nearly 5 percent of the U.S. land base.

Cropland

In 1993 an estimated 333 million acres of cropland was used for crops, down 7 million from 1992. Much of the decline can be attributed to reduced corn, soybean, and sorghum plantings caused by wet weather and flooding in the Corn Belt, Lake States, and

Northern Plains.

Harvest estimates of principal crops totaled 298 million acres which, combined with minor crops, increased total harvested acres to more than 311 million acres. About 10 million acres of the harvest were doublecropped. After allowing for doublecropping, cropland harvests totaled 301 million acres, also down 7 million acres from 1992.

Crop failure is estimated at 10 million acres for 1993, the same as in 1988. Another 22 million acres were summer fallowed in 1993, down a million acres from 1992. Estimates for cropland harvested were down, and crop failure was up sharply in the Lake States and Corn Belt. Similar changes on a smaller scale occurred in the Delta States, Northern Plains, and Appalachian regions.

Cropland idled by federal programs increased by one million acres, mostly from additional land enrolled into the Conservation Reserve Program. Decreased idling of wheat, barley, and cotton offset increased idling of corn and rice acreage.

Pastureland

Pastureland includes improved pasture, native pasture, and cropland pasture, and almost all of it (126 million acres in 1992) is privately owned. Improved pasture is land that has been planted to domesticated grasses and forbs and is managed for intensified livestock production. Native pasture includes former cropland on which the plant cover is changing to native vegetation, improved pasture that has reverted to a stand of native vegetation, and grazed woodlands that are not managed for wood production but where trees have been removed or thinned to increase the grazing resource. Cropland pasture is cropland that has been seeded to grasses and routinely rotated between cropland and grazing land.

Most of the nation's pastureland occurs east of the Continental Divide, and its condition is improving. Between 1982 and 1992, the acreage of pastureland needing conservation treatment was reduced by 16 percent, from 69.4 million acres to 58.4 million acres. The 1992 pastureland areas needing conservation treatment represented 15 percent of the pastureland base in the country.

For a discussion of the nation's 700 million acres of rangeland, over half of it privately owned in the Rocky Mountains and Great Plains states, see Chapter 5: Public Lands and Federal Facilities.

Cost of Conservation Farming

Spending on conservation practices by the U.S. Department of Agriculture and state and local governments has increased steadily over the past decade. In recent years rental payments for land retired for conservation purposes have become the largest category of USDA conservation expense. In 1993 conservation expenses exceeded $3.9 billion up from $3.6 billion in 1992. While these costs have been rising in recent years, budget reductions in 1994 could bring the first drop in several years.

The majority of these expenditures are rental and easement payments, such as the rental payments to participants in the Conservation Reserve Program for land retired from production. Easement payments are also involved in the new Wetlands Reserve Program. Technical assistance of $814 million in 1993 is the highest ever and accounts for almost one-fourth of the total USDA conservation budget.

Conservation Reserve Trends

The Conservation Reserve Program (CRP), authorized by the 1985 Food Security Act (the 1985 Farm Bill), offers 10-15 year rental payments and cost-share assistance to establish stable vegetative cover on cropland that is highly erodible or contributing to a serious water quality problem. No crops are produced on CRP lands; they are protective reserves. In the 10 years since its inception, the CRP, by offering 12 signup periods, has retired from production, at least temporarily, 36.4 million highly erodible acres and other sensitive lands. This figure represents 96 percent of the program goal.

The future of the CRP and of the environmental benefits gained by the program are in question because of uncertain funding to maintain or expand enrolled acreages beyond current contracts. As initial CRP contracts begin to expire in late 1995, farmers can bring that land back into production. The results of a 1993 survey by the Soil and Water Conservation Society indicate that over half (63 percent) of CRP acres will be returned to some type of crop production after contracts expire.

Anticipated post-contract uses of land in the Conservation Reserve Program.

Planned land use CRP acres*

%

 Plant to a crop 43

 Idle to meet annual commodity program

set-aside requirements 4

Enroll in 0/92 or 50/92 programs** 3

Rent or lease to other farmers 13

 Leave in tree cover for commercial wood

 products 4

 Leave in grass cover for hay production

 or livestock grazing 23

 Leave in grass or tree cover for wildlife/

 recreation 2

 Leave in grass or tree cover with no

specific use planned 3

Sell 3

Other uses or unknown 2

- Based on 34 million acres enrolled in the Conservation Reserve Program in 1990.

** 0/92 is an option federal acreage diversion program which allows wheat and feed producers to devote all or a portion of their permitted acreage to conservation uses or to a minor oilseed crop and, under some conditions, receive deficiency payments. 50/92 is an option federal acreage diversion program which allows upland cotton and rice producers to underplant their permitted acreage and, under some conditions, receive deficiency payments on part of the underplanted acreage.

Source: Osburn, C.T., M. Schnepf & R. Klein, The Future Use of CRP Acres: A National Survey of Farm Owners and Operators, (Ankeny, IA: Soil and Water Conservation Society (SWCS), 1994).

Conservation Compliance Trends

The conservation compliance provisions of the 1985 Farm Bill and the 1990 Farm Bill (the Food, Agriculture, Conservation, and Trade Act of 1990) require farmers to implement conservation practices on highly erodible land (HEL) by 1995 to be eligible for most USDA program benefits. With its stimulus for farmers to properly treat highly erodible lands, conservation compliance could further reduce erosion. Status reviews of compliance plans in 1993 estimated that when all plans are completed there would be an annual reduction of over 1 billion tons of soil erosion, which will result in a 66 percent reduction in the erosion rate. This reduction is in addition to the CRP acres or other croplands eroding at the soil loss tolerance level or below (soil loss tolerance is the maximum average soil loss, estimated by SCS for a specific soil, that will permit a high level of production economically and indefinitely). Field practices encouraged by this program include the following examples.

Crop Residue Management. These techniques leave a protective cover of residue from the previous crop. Crop residue is not only a primary defense against sediment loss, water runoff, and chemical loss but also improves soil tilth (the state of aggregation), organic content, and moisture retention. This type of crop management increases the opportunity for chemicals to break down into harmless components through the action of microorganisms contained in organic matter in the residue or in the top layer of soil in the presence of air and sunlight. Conservation tillage is used mainly on corn, soybeans, and small grains, which are the largest fertilizer and pesticide users. Tillage operations and the amount of previous crop residue on the soil surface serve as indicators of erosion potential.

. Conservation Tillage. Techniques such as no-till, ridge-till, and mulch-till leave 30 percent or more of the soil surface covered with previous crop residue after planting to protect against the erosive effects of wind and water. The results of recent national surveys show increased use of conservation tillage and other crop residue management practices and a shift away from clean tillage. No-till ridge-till, and mulch- till practices accounted for 36 percent of total tillage (more than 100 million acres) in 1993.

. Conventional or Clean Tillage. In contrast conventional tillage leaves the soil surface clean, with less than 15 percent residue from weeds or a previous crop; the practice loosens soil particles that then can be dislodged by wind and water erosion.

Conservation tillage systems are usually more cost effective than other erosion control measures used in protecting cultivated cropland. While new or retrofitted machinery may be required, immediate cost savings are attained because of the need for fewer trips over the field, smaller machinery, and reduced labor. On the other hand, conservation tillage requires more attention to proper timing and placement of fertilizers and pesticides.

Other Conservation Practices. Field practices such as contour farming, stripcropping, cover crops, field terraces, filter strips, and watered grassways reduce soil erosion and retard water runoff and associated chemical loss.

. Contour Plowing and Stripcropping. These practices are especially beneficial on sloping lands;

. Vegetative Buffer Strips. Maintaining vegetative buffer strips between fields and along waterways slows down and filters runoff;

. Windrows. Maintaining thickets of shrubs and trees between fields and on the edges of fields reduces wind erosion and damage (and provides wildlife habitat);

. Vegetative Covers. Keeping a vegetative cover on idle or fallow land reduces erosion;

. Crop Rotations. By rotating crops farmers can lower pesticide runoff risks by increasing crop residue levels and water infiltration while improving soil structure. Crop rotations often reduce the area needing treatment with pesticides and decreases reliance on annual application of the same pesticide, which tends to reduce the efficiency of the treatment as pests build up a resistance to the pesticide.

Wetlands Reserve Trends

Cropland conversions have been the leading cause for the loss of U.S. wetlands over the past 200 years. One-fourth of the cropland in the United States, 100 million acres, was obtained by clearing and draining wetlands. According to the Fish and Wildlife Service, wetlands were converted to agricultural uses at a rate of 300,000 acres per year from the mid-1950s to the mid-1970s. The conversion rate fell to around 150,000 acres per year from the mid-1970s to the mid-1980s. A Soil Conservation Service study indicates that the agricultural conversion rate has fallen to about 50,000 acres per year for the 1987-1991 period. Based on this latest study of conversion rates, a 1-million-acre wetlands reserve could restore enough wetlands to offset many years of agricultural wetland conversions and recover lost wetland functions and values (see Program Accomplishments later in this chapter).

Fertilizers

Consisting of primary plant nutrients such as nitrogen, phosphorus, and potash, fertilizers stimulate plant production and substantially increase yields per acre, even when the soil condition is reduced because of erosion, compaction, or removal of crop residue. A side effect, however, is that nutrients not taken up by plants remain in the environment and can degrade the quality of surface water and groundwater. Agricultural chemicals are among the principal sources of eutrophication in surface waters and nitrate contamination of groundwater.

Fertilizer use on farms in the United States increased steadily for decades after World War II until crop reduction programs and farm economic stresses caused a reversal of this trend in the early 1980s. Since then fertilizer consumption has fluctuated in response to acreage reduction programs and weather-for instance, reductions due to drought in 1987 and floods in 1993.

Corn is the most fertilizer- using crop, followed by wheat and soybeans. Most of the 1993 decrease in fertilizer use was due to less corn planting. The 1993 flood caused fewer acres to be planted and prevented many midwestern farmers from making more than one fertilizer application during the crop year.

Pesticides

Pesticide use on the major field crops in 1993 was down from previous years, primarily because planted area for corn, a heavy pesticide user, was reduced because of the 1993 flood. Herbicides account for 84 percent of total pesticide use, while insecticides make up 14 percent and fungicides 2 percent.

Atrazine and Water Quality

Atrazine, used alone or in combination with other active ingredients such as alachor or metolalchor, is the most commonly used herbicide in corn production. The active ingredients of these chemicals control a large number of broadleaf and grass weeds and, when applied in combination, the control spectrum can be widened.

Over the past decade, numerous monitoring studies for atrazine have been conducted on river systems and on individual water supply facilities and reservoirs. Recent findings indicate that elevated amounts of atrazine are running off fields and entering surface water, primarily in the Midwest where the herbicide is applied to corn and sorghum fields. Kansas, Missouri, Ohio, Illinois, and Iowa report at least one water supply with mean annual atrazine concentration greater than the maximum contaminant level (MCL) of 3 parts per billion which could put them in noncompliance with the Safe Drinking Water Act. Atrazine is sometimes found in groundwater but rarely above the MCL.

The EPA classifies atrazine as a possible human carcinogen. It is moderately toxic to coldwater fish and moderately to slightly toxic to warmwater fish. It can be highly toxic to freshwater insects but is practically nontoxic to birds. Whether the concentrations of atrazine currently found in surface water are affecting ecosystems is currently unknown.

Drinking water drawn from small rivers or reservoirs having agricultural watersheds appears to be most at risk from atrazine contamination. On rivers seasonal spikes in atrazine levels can be very high, and concentrations greater than the MCL can persist for up to six weeks after the application period. Reservoirs tend to act as pollutant sinks; if contaminated during spring rains, atrazine concentrations tend to remain high for a long time. Under such conditions the likelihood increases of municipal water supplies being out of compliance with the Safe Drinking Water Act. If this happens, an alternative source of water must be found or treatment technology installed.

Atrazine can enter water resources through point source or nonpoint source discharges. Point source discharges are due to carelessness in storage, mixing, and disposal. Nonpoint discharges occur when the chemical leaches through the soil profile or is carried with surface water before it is degraded. Atrazine loadings can be reduced by reducing application rates and preventing atrazine-carrying runoff. Better timing, using scouts to identify when treatment is needed, and applying the herbicide in bands rather than spraying the entire field can reduce atrazine application rates. Crop management systems such as incorporating atrazine directly into the soil, rather than on the surface, conservation tillage, contouring, stripcropping, and filter strips reduce the opportunity for surface runoff. Switching to other herbicides, though more costly and less effective, and increased use of corn-soybean rotation are management options for reducing atrazine in the environment.

No simple solution presents itself in the atrazine problem. A general reduction in application rates and banning all pre-plant and pre-emergent applications would generate producer costs of $320 million and reduce yields, but consumers would not be affected significantly. A total ban on atrazine would cost producers and consumers about $800 million, which would exceed the cost of removing atrazine from drinking water. At the same time, it would reduce annual government program costs by as much as $300 million because of higher corn and sorghum prices, assuming no changes in farm programs. Farmer response to a ban might include increased use of atrazine substitutes and corn-soybean rotation. While

increased rotations would have environmental benefits, the increased use of other herbicides could lead to different water quality problems. Another possible solution would involve targeted atrazine controls with local bans in certain areas, which would require identifying those watersheds requiring atrazine runoff control, and the most appropriate alternative management strategies.

Integrated Pest Management

Integrated pest management (IPM) is a sustainable approach to managing pests which combines biological, cultural, physical, and chemical tools in a way that mimimizes economic, health, and environmental risks. To use IPM effectively, farmers need to understand pest and crop biology, consider root causes of pest population explosions, and understand how other management factors influence pest populations and the beneficial organisms that could potentially hold some pests in check. The IPM concept promotes monitoring of pest populations and crop growth to determine the need for management action. Pesticides are used as a last resort and only when pests reach an economic threshold, in other words, the point at which pest damage exceeds the costs of pest control. In short IPM requires more information, more skillful management and better decision-making than previous practices.

IPM is more than simply scouting for pests and applying a pest-control treatment after the crop is growing in the field. It can involve practices implemented long before a field is planted, at planting, during the season, and after harvest. Breeding and selecting pest-resistant crop varieties, rotating crops, field sanitation, delayed planting, early harvest, and many other non- chemical practices are all part of IPM.

The concept of IPM is not new, yet because of the availability and wide use of chemical pesticides, many of the components of IPM systems have been neglected. Since the 1960s efforts have been made to develop IPM, especially as the potential environmental and health-related problems associated with chemical pesticide use became better known. Integration of multiple pest suppression techniques has the highest probability of sustaining long-term crop and livestock production. Recent successes include eradication of the boll weevil, suppression of Mediterranean fruit fly, pink bollworm, and screwworm populations, and efforts to suppress fly populations around poultry houses and livestock yards.

Irrigation

Irrigated land on farms, as reported by the Census of Agriculture, peaked in 1978 at 50.4 million acres and then declined to 49 million acres in 1982 and subsequently to 46.4 million acres in 1987. Since then, the amount of irrigated farmland has increased to nearly 52 million acres in 1993. Considerable year-to-year variation occurs in irrigated areas, with a major factor being annual acreage idle under USDA programs.

Historically most of the irrigated farmland has been found in seventeen arid Western states. However, irrigation development has moved north and east. The crop mix has also changed. Irrigation of corn, wheat, and especially soybeans has grown much faster than irrigation of cotton, hay, and other crops. Declines in irrigation from 1992 to 1993 came primarily in the Lake States, Corn Belt, and Northern Plains in response to wet weather and in California where water use has not recovered from the recent

drought. Nationally the irrigated area of corn, wheat, and rice declined in 1993, while irrigated cotton area increased.

The estimated depth of water applied per season now averages less than 22 inches, or 13 percent less than in 1969. This decline resulted from the adoption of more efficient irrigation technologies and practices in the 1970s and shifts in geographic location of irrigation and the crop mix being irrigated in each state. Water applied per acre has declined in most of the western states, but has increased in the eastern states. On corn, wheat, soybeans, and hay, average use has declined. Water use per acre of rice, which increased about 20 percent during the 1969-1979 period, has declined in recent years.

Farmers used an estimated 95 million acre-feet of irrigation water in 1993. Irrigated agriculture continues to dominate water usage in the United States, accounting for 81 percent of total freshwater consumption. In the West, irrigation water use accounts for 90 percent of total water use while in the East, it accounts for half, with the greatest use in the Southeast and Delta regions.

Livestock and Poultry Trends

The structure of the livestock and poultry sectors reflect adjustments to market forces and consumer attitudes similar to the general farm economy. Trends toward fewer, but larger and more efficient livestock and poultry units are continuing as environmental concerns and regulations focus more attention on pollution abatement. These trends are particularly evident in the more arid, less populated areas of the country. Livestock and poultry operations are moving quickly to adopt environmental friendly practices to reduce surface water pollution and runoff problems.

Hogs. In the past hundreds of thousands of small independent hog farms were the heart of the U.S. pork industry. Today the pork industry has a new makeup. The number of hog farms has plummeted, as the industry consolidates on fewer, larger, more specialized hog farms. A change in marketing arrangements between hog farmers and pork processors has accompanied the industry's shift to fewer, larger farms. Approximately 70 percent of total U.S. hog production originates in the North Central region, with Iowa the largest production state. In 1993 rapid expansion of very large concentrated units placed North Carolina second in production. Development of very large concentrated units is also occurring in the arid areas of Oklahoma, Texas, Colorado, and Utah. The remaining hog operations in the United States, comprising 62 percent of the hog farms, have less than 6 percent of the hog inventory.

Beef Cattle. The beef cattle industry is undergoing a similar transformation, from a very large number of seasonal operations located largely in the Midwest to large operations feeding cattle throughout the year. Eighty percent of fed beef cattle are kept in operations holding more than 1,000 animal units. Most of these feedlots are located in the arid areas of the Great Plains. The beef cow-calf sector is largely a residual claimant to land not used for crop production. It is a land-extensive operation using forage from pasture to range, crop residues, and cover crops on cropland. Size of these operations depends not only on the usual economies of scale, but also on the carrying capacity of land. For example, the grazing acreage requirement for a 1-to-2 bull and 15- to-50 cow unit can range from about 1 acre of highly improved pasture per cow grazed year round to as much as several hundred acres of arid rangeland per cow grazed only part of the year because of a short growing season. Of the nearly 1 million beef cow operations in 1993, 81 percent raised fewer than 50 cows each, but nearly 33 percent of the U.S. beef cow inventory. Operations with 500 or more beef cows comprised less than 4 percent of

the operations, but nearly 34 percent of the inventory. Herds are most concentrated in the Great Plains, the Southeast, and the arid West.

Dairy Cattle. The structure of dairy farms has also significantly changed over the last two decades. The number of milk operations has declined as more farms become more specialized and large farms have multiplied. Total milk cow numbers have declined, but milk production per cow and total milk production has increased. In 1993, farms with 100 or more milk cows, while representing only 13.6 percent of total dairy operations, contained 50.5 percent of the inventory of milk cows. Although small dairy farms still dominate each U.S. milk producing region, operations with fewer than 50 cows are declining in number and share of production. A large number of these dairies are concentrated in the North Central and New England areas. In contrast, dairies in California, Florida, Idaho, New Mexico, Texas, and Washington are expanding inventories to very large production units.

Poultry. The poultry industry is already a highly concentrated industry of a small number of major operators located largely in the southeastern quadrant of the United States. Over half of the broiler inventory and half of the layer inventory in the United States are contained on farms with more than 1,000 animals.

Water Pollution from Feedlot Waste

Recent data collected by the EPA pursuant to the Clean Water Act identify significant water pollution problems caused by feedlots and animal holding areas. These data indicate that animal feedlots cause 7 percent of all impairment in U.S. lakes and 13 percent of all impairment in U.S. rivers. Nationally estimated feedlot pollution is comparable in magnitude to pollution from combined sewers or storm sewers and runoff. No conclusive evidence, however, currently indicates the relative water quality impacts caused by small versus large operations or regulated (NPDES-permitted) versus nonregulated (nonpermitted) feedlots and holding areas.

Program Accomplishments

The farmers participating in federal programs that reserve highly erodible land from production or stimulate the use of conservation field practices continued to record successes in 1993. The programs continue to be successful despite proposed budget reductions, agency downsizing, and reorganization. Wetlands protection on agricultural lands received new attention following the 1993 Midwest flood.

Conservation Reserve Program

Since 1987 cropland erosion on CRP acres has been reduced an average of 19 tons per acre per year. More than half of the erosion reduction occurred on CRP lands; the remaining on other highly erodible lands implementing conservation compliance practices. The CRP also has a pollution prevention aspect, as enrolled lands receive lower applications of fertilizer and pesticides than if they had remained as harvestable cropland. In 1993 Congress did not provide funds for the CRP, and therefore no signups were conducted.

Conservation Compliance Program

By the end of 1993, farmers had developed 1.7 million conservation plans covering 143 million acres and had applied conservation plans approved by the Soil Conservation Service (SCS) on 98.4 million acres of highly erodible land (HEL) or 58 percent of the total HEL determined by the SCS to date. Another 45 million highly erodible cropland acres have approved plans that were in the process of being implemented and certified. Farmers have not requested or accepted conservation plans on 6 million HEL acres, which will make these farmers ineligible for future USDA program benefits.

Crop residue management is designated for 75 percent of the planned highly erodible acres. Conservation tillage was practiced on 89 million acres in 1992 and over 100 million acres in 1993. The most rapidly growing conservation tillage practice-no-till-nearly tripled in applied use between 1989 and 1993, from 14.1 million acres to 37 million.

Wetlands Reserve Program

The Wetlands Reserve Program (WRP) is among the newest USDA conservation efforts. The 1990 Farm Bill authorized the WRP for voluntary restoration and protection of wetlands by agricultural landowners through permanent easements on up to 1 million acres of prior converted and farmed wetlands. It began in 1992 as a pilot program in nine states with an initial funding of $46 million to enroll a maximum of 50,000 acres. By restoring converted cropland and farmed wetlands, the nation can regain wetland functions and values. Many complex environmental relationships depend on wetlands, and their loss through wetland conversions have had adverse impacts on aquatic and terrestrial ecosystems.

The WRP has gained broad-based public support and interest as a permanent way to restore wetlands and provide environmental values. Because it offers an optional land use for difficult-to-farm wet areas, the program is popular with farmers. Bids for the pilot program were five times the number of acres that could be accepted.

To be eligible for the pilot WRP, land had to be prior converted cropland, farmed wetlands, wetlands farmed under natural conditions, or contiguous uplands, riparian areas, or natural wetlands. Eligible cropland also had to be planted to an agricultural commodity in at least one of the crop years from 1986 to 1990.

Prior Converted Cropland. Such land has been modified for crop production to the extent that it no longer has wetland characteristics and, therefore, cannot be identified as a wetlands.

Farmed Wetlands. This cropland has been partially drained for crop production but still retains wetlands characteristics.

Wetlands Farmed under Natural Conditions. Such croplands need no modification for crop production and still retain wetlands characteristics.

Upland Buffer Areas and Natural Wetlands. Adjacent buffer areas and natural wetlands are eligible if they enhance and protect restored wetlands.

Riparian Areas. These buffer strips along rivers, streams, channels, or water bodies are eligible if they link restored wetlands.

On January 14, 1993, after reviewing bids, eligibility, costs, and benefits, the Agricultural Stabilization and Conservation Service accepted 298 bids for 49,888 acres to be enrolled as wetlands reserves from 265 farms.

Environmental Benefits of Wetlands Reserves

An estimated 15 percent of the wetland area restored under the Wetlands Reserve Program will benefit directly the recovery of threatened or endangered species. Another 60 percent of accepted acres may be used by threatened and endangered species or lie within ongoing state and federal wetland restoration and wildlife project areas. A sample of expected benefits follows.

Mississippi/Louisiana. The restoration of a combined total of more than 26,281 acres of bottomland hardwood wetlands in Mississippi and Louisiana will have significant benefits to aquatic and terrestrial wildlife, commercial and recreational hunting and fishing, and drinking water quality. Studies indicate that more than 50 percent of all fish species, such as largemouth bass, sunfish, catfish, and crappie, use the flooded portions of bottomland hardwoods for feeding, spawning, and rearing young. In addition the retention of seasonal floodwaters in these forests removes sediments, pesticides, and nutrients from water running off adjacent agricultural fields. An additional 2,591 acres of emergent, scrub-shrub, and other wetlands habitat will be restored, providing critical resting and feeding sites for migratory waterfowl, wading birds, and neotropical migrants that move along the Mississippi Flyway. Species that will benefit from the restoration of a projected 3,037 acres in Louisiana include the black bear, bald eagle, and Bachman's warbler. In Mississippi 14,864 restored acres may be used by threatened or endangered species or lie in special wildlife management areas.

California. Ninety-four percent of the 6,026 acres to be restored and protected in California will be restored to emergent wetlands such as marshes or wet meadows. Of these restored areas, estimates are that 3,299 acres will be adjacent to or in close proximity to existing wetlands, which will provide a reliable seed source for native wetland plant species and benefit a diversity of wildlife. Establishment of persistent, emergent vegetation is expected to be rapid and significant gains in habitat benefits are likely to occur within two to three years after the initial restoration efforts. An estimated 237 acres of the restored wetlands should directly benefit the recovery of federally listed threatened or endangered species, including the Aleutian Canada goose, California freshwater shrimp, giant garden snake, and southern bald eagle. In California 85 percent of threatened or endangered species are dependent on, or associated with, wetlands.

Iowa/Minnesota/Wisconsin. The restoration of 7,449 acres of emergent (prairie pothole), forested, and scrub-shrub wetlands, and adjacent herbaceous and scrub-shrub upland habitat in these states should provide significant benefits to wildlife, especially migratory birds that depend on prairie potholes for critical nesting, foraging, and resting habitat. Of the WRP wetlands in these states, 718 acres will be next to publicly accessible or managed areas and 214 enrolled acres should directly aid the recovery of threatened or endangered species.

North Carolina. A total of 4,630 acres of prior converted cropland in North Carolina was accepted into WRP, with one tract containing more than 2,000 acres. The restoration of large, contiguous blocks of wetland habitat can be a critical factor in establishing viable, reproducing populations of interior forest animal and plant species, particularly large mammals, such as the black bear, red wolf, red-cockaded woodpecker, smooth loosestrife, various species of pitcher plants, and the Venus fly trap. The restoration of 3,703 acres should directly contribute to the recovery of threatened or endangered species that rely upon forested and scrub-shrub systems. In addition the restoration of wetlands near estuarine receiving waters will also improve water quality and yield a constant, diffuse flow of freshwater that provides essential nutrients to shellfish and juvenile finfish.

New York. Approximately 46 acres of prior converted and farmed wetlands, along with 24 acres of highly disturbed upland buffers, have been accepted into the pilot WRP for restoration and protection in New York. Although the acreage is small, restoration efforts will likely benefit recovery efforts for federally listed threatened or endangered species, as well as migratory birds and non-game wildlife.

Missouri. Of the 2,669 acres tentatively accepted in Missouri, 1,859 acres will be reestablished as forested wetlands, and 662 acres will be restored to emergent or marsh wetlands. All of the Missouri wetland acreage accepted is next to existing wetlands, which will increase contiguous habitat for permanent and migratory residents. Approximately 319 acres should directly benefit the recovery of threatened or endangered species.

Water Quality Initiative

Established in 1990 the USDA Water Quality Initiative (WQI) provides farmers with the knowledge and technical means to voluntarily address on-farm environmental concerns and related state water quality requirements. By 1993 the WQI had extended assistance to farmers in 200 selected projects in nearly all 50 states, Puerto Rico, and the Pacific Basin. By implementing improved nutrient management, WQI participants used 50 million pounds less nitrogen and 65 million pounds less phosphorus annually. The initiative has the following projects:

Demonstration Projects. Each of 16 WQI demonstration projects will be operational for five years or more and emphasizes education and technical assistance to farmers on agriculture-related water quality concerns. Projects demonstrate and evaluate new and innovative technologies and water quality practices.

Hydrologic Unit Areas. A total of 74 projects, of at least five years in length, stress practical applications of water quality practices in areas defined through the EPA Section 319 process as having critical nonpoint source pollution problems.

Water Quality Special Projects. In 1993 appropriations were not provided for water special projects. Assistance to WQSP was limited to servicing long-term agreements from prior years; and

Regional/Estuarine Projects. A total of 6 regional and 21 estuarine projects were joint efforts with other agencies, such as the EPA, USGS, and NOAA, to seek solutions to water quality problems.

During 1993 improved practices such as nutrient and pesticide management, animal waste storage and utilization, wellhead protection, irrigation water management, and toxic/salt reductions were

implemented in the Demonstration Projects and Hydrologic Unit Areas. Monitoring of water quality changes in surface and ground water, well water testing, and computer simulation modeling have shown cases of reduced concentrations of nitrogen, phosphorus, pesticides, salts, and pathogens entering U.S. waters.

Agricultural Water Quality Incentive Project. The Agricultural Water Quality Incentive Projects (WQIP), although not specifically part of the Water Quality Initiative, provided financial and technical assistance to farmers who voluntarily modified their agricultural practices to reduce water quality problems. To participate in the program, farmers must submit a water quality resource management plan, showing how water quality will be improved on their farm. In 1993 farmers submitted over 2,000 requests for improving water quality on more than 370,000 acres.

Chemical Use Databases

Agricultural chemical use surveys covering major crops and growing areas, initiated in 1990, continue with annual surveys. Data gathered includes types, application, timing and amounts of fertilizer, pesticides, and other chemicals used in agricultural operations.

On May 10, 1993, farmers who were not already keeping records, began to record the use of chemicals in their agricultural operations. The recordkeeping is restricted to pesticides, including products used, amounts, date applied, and treatment location. The data will be assembled into an annual survey and become part of a national pesticide database.

Forestry

Forest ecosystems are sources of social and economic benefits and of homes for vast numbers of plants and animals; and as such they are vital components of the global environment. In 1993 federal land agencies continued to manage public lands and help private forestland owners use and manage their forests in a manner sensitive to their ecological value. For a discussion of forestry programs on federal lands, see Chapter 5: Public Lands and Federal Facilities, and for a discussion of uses of ecosystem management on forestlands, see Chapter 6: Ecosystem Approach to Management and Biodiversity.

Conditions and Trends

Almost a third of the United States is covered with forests, which vary from sparse scrub forests of the arid interior West to the highly productive forests of the Pacific Coast and the South. Most of the nation's forests, 488 million acres, are in state and private ownership, with the remaining 249 million acres in federal forests.

Acreage. In 1993 forests covered 70 percent of the forestland area that existed in the year 1600. Since colonial times, however, much of this forestland area has been cutover and since regenerated, sometimes more than once, and about 307 million forested acres have been converted to other uses, mainly agricultural. More than 75 percent of the net conversion to other uses occurred in the 19th century. As agricultural productivity increased in the 1920s, cropland area stabilized as did forest area.

This trend reversed itself during the agricultural boom of the 1950s and 1960s. Forestland area declined after 1952, eventually stabilizing between 1987 and 1993.

Timberland. A valuable component of U.S. forestland is its timberland-those 490 million acres capable of producing crops of industrial wood. Private landowners control three-quarters of this land. In the long run, this amount is expected to decrease, with a net loss in forest area of 5 percent by the year 2040. Not all timberland is being harvested; for example 250,000 acres of federal timberland are managed as wildlife areas or for other nontimber purposes.

Productivity. The United States has a supply of 858 billion cubic feet of wood, with 92 percent in growing stock. Most high productivity forestlands-lands capable of producing more than 120 cubic feet per acre per year-are in the South and in the Pacific Northwest. The largest areas in this class are in the eastern oak- hickory and loblolly/shortleaf pine types and in the western coastal Douglas-fir types. Total timber growth declined about 2 percent, all in softwoods, between recent surveys in 1986 and 1992.

Growth and Removal. The most recent inventory of growing stock in 1991 revealed that nationwide total timber growth exceeds removals. For the first time in its history, however, the United States does not have a large reserve of softwood sawtimber to draw upon to meet the need for housing and other purposes. In national forests, which contain 47 percent of the nation's standing softwood sawtimber inventory, the trend is toward protected areas and away from timber sales. In addition the 1991 inventory showed that southern softwood removals exceeded growth in all ownerships (federal, state, and private) by 12 percent.

Timber Harvest. In the United States, timber harvest rose rapidly during the last half of the 19th century (from 2.7 billion cubic feet in 1850 to 12.1 billion cubic feet in 1900). Production peaked in 1910 at 13 billion cubic feet. Because of replacement of wood fuels by coals and oil, more efficient use of wood, and wider use of wood substitutes, production of timber began a slow decline that lasted until after World War II. After the war increased demand for housing caused timber production to rise, and by the mid-1970s, timber production again reached record levels. Production has increased consistently since then. Timber supplies are now being affected by reduced harvests on public lands, increased mortality, and state and local regulations. Although nonindustrial private lands are not being intensively managed for timber or other forest resources, pressures will increase for these lands to satisfy a greater share of the nation's timber demand.

Reforestation. Americans reforested 2.4 million acres of public and private forestland in 1993 and a comparable acreage regenerated naturally. Reforestation can improve damaged ecosystems and help protect watersheds, soil, and crops. Of all acres planted in trees, 84 percent were on private lands and, of these, 41 percent were nonindustrial lands.

Forest Fires. In 1993 over 6,900 fires burned 238,625 acres of National Forest System lands (data for private forestlands are not currently available). These figures represent light fire activity due to a wetter than normal summer, except in areas of the Southwest, and a high level of preparedness and initial attack capability of fire fighting personnel. Hazardous fuels were reduced on 385,000 acres through a combination of prescribed burning and a variety of mechanical methods. In cooperation with state and local firefighting agencies, more than 350 million acres are protected with coordinated fire suppression response.

Forest Pests. Throughout the nation forest pests are causing serious damage. The European gypsy moth defoliated 1.4 million acres in 1993, affecting the health of oaks and other species, but on fewer acres than in previous years. The southern pine beetle damaged 10.4 million acres; the mountain pine beetle, 0.8 million acres; the eastern spruce budworm, 0.1 million acres; and the western spruce budworm, 0.4 million acres (the latter being below 1 million acres for the first time in over 25 years).

Asian Gypsy Moth. Federal inspectors detected an introduction of the Asian gypsy moth from foreign cargo in July 1993 at Wilmington, North Carolina. The only other known introductions of this pest were successfully eradicated in 1991 in a joint effort by the U.S. Department of Agriculture and the states of Oregon and Washington at a cost of $19 million. A decision on the need for eradication in North Carolina was scheduled for 1994 based on recommendations of a scientific panel.

Pine-Shoot Beetle. Since mid-1992 the pine shoot beetle, a native European bark beetle, has been found in Illinois, Indiana, Michigan, Ohio, New York, and Pennsylvania. The USDA Animal and Plant Health Inspection Service has quarantined infested counties in those states to regulate the movement of Christmas trees and other forest products. In 1993 Forest Service scientists and state and private cooperators conducted tests on potential controls for forest pests.

Program Accomplishments

USDA agencies sponsor a number of programs to assist nonindustrial private forestland owners in managing their forests for maximum benefits from timber to wilderness. Training programs also are provided for commercial loggers.

Reforestation of Nonindustrial Private Lands

In 1993 the USDA Agricultural Stabilization and Conservation Service and USDA Forest Service conducted programs that planted 306,000 acres of trees on nonindustrial private lands. The agencies provided technical and cost-share assistance to landowners through state foresters.

Forest Stewardship. The Agricultural Stabilization and Conservation Service (now part of the Farm Service Agency), the Forest Service, the Soil Conservation Service, and the nation's state foresters have established a cost-sharing Stewardship Incentives Program. It offers incentives to landowners who agree to plant trees, stabilize eroded lands, protect riparian areas and wetlands, improve wildlife and fisheries habitat, enhance forest recreation, and establish and renovate windbreaks and hedgerows. In 1993 the program helped landowners develop 19,000 forest stewardship plans to better manage natural resources on 2.6 million acres of private forestland.

Rural Community Assistance

Through Economic Recovery and Rural Development programs and Economic Diversification Studies, the Forest Service assisted over 100 rural communities in developing natural resource enterprises. The programs emphasize the interdependence of the environment and sustainable local economies.

Logger Education to Advance Professionalism. This pilot project of the USDA Extension Service is designed to update the logging community on forest ecology, silviculture, and interrelationships within

the forest ecosystem. The Extension Service, working with public and private partners, instructs loggers on the impacts of timber harvesting on the nation's soil, water, plant, and animal resources. Eight states have received grants to develop and test the incorporation of silviculture and ecology instruction into planned or ongoing logger training.

Linking Neighbor to Neighbor. The Master Woodland Manager program recruits and trains lay volunteers to assist in promoting forestry and conservation to the nation's nonindustrial forest landowners. Private forest landowners tend to implement land management practices more readily, if they are encouraged by a trusted friend or neighbor who has forestry experience.

Forest Health

Federal agencies are adopting ecological approaches in their response to wildfire and pest problems that threaten forest health. A prime example is the use of ecological techniques in controlling introductions of exotic forest pests.

Forest Health Monitoring Program. In 1993 state forest resource agencies, the Forest Service, the Bureau of Land Management (BLM), EPA, and the Tennessee Valley Authority monitored long-term trends in the health of U.S. forest ecosystems. The monitoring network now includes 14 states. When fully implemented, the Forest Health Monitoring Program will provide regional and national data on the health of all U.S. forestland.

Pest Risk of Imports. In response to proposed log imports by the timber industry, the Forest Service assessed pest risks from Chilean logs. The USDA Animal and Plant Health Inspection Service used the assessment to formulate regulatory measures excluding exotic pests from U.S. forests.

Forest Technology

A variety of technological developments continue to occur which provide greater opportunities for more environmentally-sensitive harvesting methods.

Cut-To-Length Harvesting and Log Forwarding. This includes a mechanical harvester that fells, delimbs, and bucks trees into logs (normally up to 20 feet in length) and a log forwarded which loads and hauls the logs fully suspended and can offload directly onto trailers or decks. These harvesting techniques are less damaging to the environment than conventional ground-based harvesting equipment. They reduce impacts on soils, require relatively less road construction and smaller landings, and create less damage to residual stands. They also make it possible to economically harvest small timber.

Central Tire Inflation. This consists of electronic, pneumatic and mechanical equipment which enables a truck operator to adjust pressures in tires to match speed, load, and road conditions. Ultimately, it provides opportunities to reduce sedimentation from logging roads as well as reduce costs for road maintenance, road construction and truck maintenance, increase traction and breaking performance on steep roads, and improve comfort for drivers.

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Chapter 5: Public Lands and Federal Facilities

If there is one commitment that defines our people, it is our devotion to the rich and expansive land we have inherited.

President Bill Clinton

In 1993 the federal government introduced an ecosystem approach to planning on the public lands for which it is steward. The management of public lands and federal facilities was examined in the President's National Performance Review (NPR), which in September 1993 directed federal agencies to plan cross-agency budgets to fund ecosystem management demonstration projects. The review also directed federal facilities-collectively the nation's largest energy consumer-to link water consumption with energy use and to showcase renewable energy technology.

Public Lands

The federal agencies responsible for managing America's natural resources must meet both the public desire to protect them and the public expectation of economic growth based on them. Within the federal government, a number of agencies contribute to the management of natural resources associated with public lands.

Department of the Interior

The Department of the Interior (DOI) manages 450 million acres of public lands, half of them in Alaska, together with the natural resources on those lands. The DOI manages 10,000 miles of National Wild and Scenic Rivers and 60 million acres of Wilderness Preservation Areas. The following agencies are the principal DOI land managers:

Bureau of Land Management. The BLM is responsible for the multiple-use management of natural resources on 270 million acres of public land and for supervising mineral leasing and operations on an additional 300 million acres of federal mineral estate that underlies other surface ownership. Through programs like Fish and Wildlife 2000, the BLM manages 18 national strategy plans designed to improve habitats and resources while ensuring recreational use of its lands. In 1993 the BLM designated 85 special locations as Back Country Byways, Watchable Wildlife Sites, or Special Recreation Management Areas. The bureau built 16 campgrounds, 6 non-motorized trails, and 13 boat launch facilities; implemented management plans for 17 designated wilderness areas; and completed 354 challenge cost-share projects with partner contributions of $5.4 million in labor and materials. The BLM purchased 46,000 acres of land and acquired 118,000 acres through land exchanges.

Fish and Wildlife Service. The FWS conserves, protects, and enhances fish and wildlife and their habitats. Management duties extend over 91 million acres of public land and include 494 national wildlife refuges, 32 wetland management districts, 84 fish hatcheries, 23 research centers, and 88 associated field stations. In addition the FWS is responsible for administering the Endangered Species Act and providing comments and consultations on water development and water quality under the Fish and Wildlife Coordination Act and section 404 of the Clean Water Act. The FWS acquired 75,581 acres of land in 1993 and estimates the acquisition of 45,000 more acres in 1994.

National Park Service. The NPS protects natural and cultural resources while promoting outdoor recreation, historic preservation, and environmental awareness. In 1993 the NPS recorded 273 million recreational visits to the 367 units of the National Park System, which account for 80 million acres of public land. The NPS has added six new units since 1991 and has recorded an increase in recreational visits of 7 million. Since 1970 a total of 85 new NPS units have been added, increasing land area in all units by 48 million acres; recreational visits increased by 102 million visits during the same time period. In 1993 the agency acquired 13,587 acres of land in 25 NPS units, with 8,643 of these acres added to four units. The largest recipients were the Appalachian National Scenic Trail with 1,662 acres traversing ten states (Connecticut, Maine, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Vermont, and Virginia); Big Cypress National Preserve in Florida, with 2,523 acres; El Malpais National Monument in New Mexico with 3,926 acres; and Everglades National Park in Florida with 1,476 acres.

Bureau of Indian Affairs. The BIA manages and protects natural resources on 56 million acres of Indian trust lands and assists tribes in serving roughly 1 million American Indians and Alaskan natives. The BIA provides a wide variety of community and social services, maintains law enforcement systems, and assists in agricultural, ranching, forestry, and mining activities on reservations,and funds 187 BIA and tribal-operated schools in 24 states.

Bureau of Reclamation. In 1992 the BOR was the largest supplier of water in 17 western states and delivered 10 trillion gallons of water for agriculture, municipal, industrial, and domestic purposes. Multipurpose BOR projects provide flood control, power, recreation, and fish and wildlife benefits. Today the bureau is emphasizing innovative water management technologies to balance greater water demand with the greater demand for natural resource protection.

Department of Agriculture, U.S. Forest Service

The Forest Service manages the 191-million acre National Forest System under principles of ecosystem management. The national forests contain 140 million acres of forestland, with the remaining acres in grasslands. In 1993 the Forest Service reforested 474,000 acres. Sites included timber harvest sale areas and areas affected by natural catastrophes such as fires, insects, diseases, and windstorms. The agency has shifted from its reliance on the use of clearcutting as a regeneration technique to other regeneration methods. Acres clearcut decreased 18 percent from 1992 to 1993. In 1993 the Forest Service sold 4.5 billion board feet of wood, with timber sale revenues exceeding program costs. Gross revenues were $1.017 billion and net revenues, $301 million.

Department of Defense. The DOD manages 25 million acres of public lands at 600 major installations in the United States, and 2 million acres abroad. The Department is an active steward of these installations, which vary greatly in size and use and contain a rich diversity of flora and fauna. The Army Corps of Engineers (COE), which manages 11.7 million acres of land and inland water areas, provides recreation opportunities at 463 lakes throughout the United States. In 1993 COE land and water areas supported nearly 200 million visitor days of recreation use, the second highest among all federal agencies, and netted over $20 million in visitor fees.

Tennessee Valley Authority

The Tennessee Valley Authority (TVA) manages 300,000 acres of public lands and forests adjacent to a series of 45 reservoirs in the Tennessee River watershed. In 1993 the TVA released a draft environmental impact statement on natural resource management activities at its 170,000-acre Land Between the Lakes site.

Federal Forestry

Federal forestry initiatives, domestic and international, are conducted primarily by the Department of Agriculture (USDA), the Department of the Interior (DOI), and the Department of Defense. The Agency for International Development supports an international forestry program. On federal forests 37 million acres currently are reserved from harvesting and managed as parks or wilderness, and an additional 212 million acres are used for other purposes. As an example the BLM manages 50 million acres of forestland in 12 western states and Alaska. The BLM Total Forest Management Policy provides an ecosystem approach to timber harvesting, water quality, soil conservation, fish and wildlife habitat, old growth, aesthetics, and recreation. During 1993 the bureau reforested 12,522 acres of public lands.

Federal Grazing Lands

Grazing lands include rangeland, permanent pasture, grazed forestland, and cropland pasture. These lands provide a food source for domestic livestock and habitat for wildlife including deer, elk, moose, wild horses and burros, turkey, quail, and grouse, to mention a few. Managed grassland ecosystems can protect water quality and riparian areas and provide recreational opportunities.

Rangeland

One third (700 million acres) of the nation's total land area is classified as rangeland. A little more than half (57 percent) of this land is privately owned in the Rocky Mountains and Great Plains states. The remainder, under federal stewardship, is located in the arid and semiarid lands of the Southwest and the tundra, shrub, and muskeg-bog lands of interior Alaska. Public rangelands provide only 10 percent of total forage consumption by domestic livestock.

Pacific Northwest Forest Conference and Forest Plan

On April 2, 1993, the President convened a Forest Conference in Portland, Oregon, as the first step in resolving the Old Growth-Spotted Owl Controversy. Following the conference, an interdisciplinary Forest Ecosystem Management Assessment Team developed ten management options for the area. As the foundation of his ecosystem plan for the Pacific Northwest, the President selected the watershed-based Option Nine (see Chapter 4 for details). He also incorporated recommendations of a Labor and Community Assistance Work Group and an Agency Coordination Work Group. Three months later, on July 1, 1993, the President released a proposed forest plan with the following provisions:

Federal Forestlands. The plan proposed the establishment of late-successional (old-growth) reserves, riparian reserves, ten adaptive management areas for ecological experimentation, and a matrix of land for forest management across the 24 million acres of federal forestland in the region. The final plan

provides for a sustainable timber harvest within the old- growth ecosystem with sustainable annual sales of 1.1 billion board feet from federal forests-national forests, BLM forestlands, and Indian forestlands. Federal assistance would bring to market backlogged timber sales on Indian reservations in the area.

Geographic Information System Database. A new GIS database would allow natural resource agencies to coordinate their efforts in the collection and development of research and data.

Physiographic Province-Level Teams. Provincial teams of relevant federal, state, and tribal officials would develop analyses for physiographic provinces and particular watersheds. Analysis of a watershed would involve all affected parties in discussions of ecological needs as well as those of the timber industry and the local community. An interagency executive committee would coordinate and direct teamwork.

Endangered Species Act Consultation Process. The plan would revise the ESA consultation process to include the Fish and Wildlife Service (Department of the Interior) and the National Marine Fisheries Service (Department of Commerce) early in the planning process for an action such as a timber sale.

Supplemental Environmental Impact Statement. The President ordered a supplemental EIS for current and proposed forest and timber management plans for the Forest Service and the BLM.

Overuse in the past 150 years has diminished natural rangeland ecosystems. The tallgrass prairie of the eastern Great Plains, which once covered a million square kilometers, is virtually gone, with less than 1 percent of its natural vegetation remaining. The shortgrass prairie of the western Great Plains (Colorado, Montana, and Wyoming) though fragmented still can be found on the 15,000-square kilometer National Grasslands. Other grassland losses include 65 percent of the bluestem-grama ecosystem, 45 percent of the grama-buffalograss, and 6 percent of the Nebraska sandhills prairie.

Much of the nation's rangeland was severely damaged during the 19th century because of rapid settlement and the fragility of range ecosystems. Range scientists report that rangeland has been improving since the 1930s. In spite of that trend, however, 51 percent of federal rangeland are not in good condition.

Grazing Reform

The Administration has proposed grazing reform measures that would provide healthy and productive public rangelands by increasing biodiversity, improving fish and wildlife habitat, and improving water quality on public rangelands.

BLM Rangelands

The BLM manages 170 million acres of rangelands that are used for a variety of purposes including recreation, livestock grazing, and ecosystem research and monitoring. In 1993 rangelands in poor condition were down to 15 percent from nearly 50 percent in the 1940s, while rangelands in good to excellent condition remained at 39 percent, with an overall 88 percent in static or improving condition. In 1993 the BLM managed grazing on 21,500 allotments in 15 states and collected a grazing fee of $1.86 per animal unit month from 19,108 operators. Concern over the condition of public rangelands and their

uses resulted in several reports on the BLM rangeland management program. The trend is toward protection and restoration.

Grazing Reform Report. In Rangeland Reform '94, the BLM outlines a rangeland management program to improve the ecological conditions of rangelands while providing for sustainable development and recreational use. The report describes the framework for the transition from current management practices to ecosystem management, including issues of grazing leases, desert grazing, monitoring, range improvements, grazing fees, and the grazing fee formula.

Standards, Guidelines, and Grazing Fees. To restore ecological conditions on public rangelands, the BLM developed national standards and guidelines for livestock grazing. These will supplement other BLM programs such as Riparian Wetland Initiative for the 1990s, Fish and Wildlife 2000, and Recreation 2000. The new initiative will focus on efforts to balance grazing management practices with the recovery of endangered and threatened species, maintenance and restoration of water quality on riparian wetlands, rest periods for critical plant growth and regrowth, reduced pesticide use, and vegetative restoration. Annual grazing use and permit/lease renewal would be contingent upon the permittee's adherence to these standards.

Forest Service Rangelands

Of the 191 million acres managed by the USDA Forest Service, over 97 million acres are available for use by domestic livestock. The agency has adopted ecology-based range management to accomplish resource stewardship and provide healthy rangeland ecosystems.

In 1993 the Forest Service administered 9,343 grazing allotments in 33 states. Grazing fees varied from $1.86 to $3.40 per animal unit month. Fees collected from public grazing on national forests, excluding national grasslands, totaled $9.5 million in 1992 and $9.2 million in 1993. Fees collected from national grasslands totaled $1.3 million in 1992 and again in 1993.

Yavapai Ranch and Best Management Practices for Grazing

The 110,000-acre area in Arizona known as Yavapai Ranch has a checkerboard pattern of private and federal grasslands where the Forest Service balances landowner concerns and agency mandates by applying ecological principles to manage the landscape. Using an integrated planning process to assess environmental effects and encourage public involvement, the Yavapai Ranch Partnership and the Prescott National Forest developed a Coordinated Resource Management Program. With EPA funding they developed and demonstrated Best Management Practices for Grazing that meet state and federal water quality and nonpoint-source pollution goals on Arizona grazing lands.

A strategic team of cooperating agencies is working with the ranching partnership to monitor the results of management practices. Participants include the Forest Service, Soil Conservation Service, Arizona Department of Environmental Quality, Arizona Game and Fish, University of Arizona, Arizona State University, Chino Winds Natural Resource Conservation District, Arizona Land Department, and Yavapai County Cooperative Extension Agents.

Prior to the project, the entire ranch was managed under a continuous year-long grazing strategy that resulted in poor range conditions and degraded habitat for the pronghorn antelope. In 1993 the overall condition of the range and its watershed showed improvement. With continued restoration of antelope habitat, populations of this species, which had declined, are expected to increase.

Federal Wetlands

Well-managed federal wetlands can serve as models for the rest of the nation. In 1993 federal agencies implemented programs to conserve and restore wetlands on public lands. For federal partnership wetlands programs, see Chapter 3: Wetlands and Coastal Waters; and for Wetlands Reserve Program, see Chapter 4: Conservation Farming and Forestry.

National Forest System Wetlands

The USDA Forest Service takes an ecological approach to the management of 14 million acres of wetlands and riparian areas in the National Forest System. Half of these acres are wetlands distributed mainly in the eastern United States and Alaska. The other half are riparian areas generally in the West. Recognizing wetlands benefits to humans as well as to fish and wildlife, the Forest Service designs management activities to restore and protect wetland functions and values. Among sensitive species in the national forests, 80 percent are dependent upon riparian areas. Acting on this finding, the agency has made riparian wetlands management a priority and is increasing its use of watershed analysis and assessment, modifying management practices, and undertaking an aggressive restoration program.

Ecosystem Research on the Copper River Delta

On the Chugach National Forest south of Anchorage, Alaska, the 65-mile long, 700,000-acre Copper River Delta is formed by the 100 million tons of sediment produced each year by glacier-fed tributaries. Composed of estuaries, mudflats, marshes, and barrier islands, it is the largest and one of the richest wetlands on the Pacific Coast of North America. During the spring migration, as the Delta thaws, it provides habitat for 10 million migratory shorebirds including almost the entire Pacific Coast populations of western sandpipers and dunlin and the entire world population of dusky Canada geese. Other fauna include five species of salmon, eagles, wolves, various furbearers, mountain goats, black bear, brown bear, and moose.

This pristine ecosystem, with its interdependence of diverse plant and animal communities and physical environment, offers opportunities for scientific research and human enjoyment. The Copper River Delta Institute, a cooperative research venture, is managed by the Chugach National Forest, other federal and state agencies, universities, environmental and natural resource interest groups, native Alaskan corporations, and local governments. The cosponsors conduct research and educational and interpretive programs to better understand and manage the Delta ecosystem.

National Wildlife Refuge Wetlands

In 1993 the Fish and Wildlife Service restored 140,381 acres of wetlands within the National Wildlife Refuge System. Wildlife refuges have averaged 127,000 restored wetland acres per year over the last five years.

Federal Fish and Wildlife Programs

The Department of Interior land agencies, the Forest Service in Agriculture, and the National Marine Fisheries Service in Commerce share responsibility for managing the nation's fish and wildlife resources. The management trend is toward native species in restored and protected habitats.

FWS Fisheries

The mission of the Fish and Wildlife Service Fishery Program is -to protect, restore, and enhance fisheries resources for a net gain of fish, aquatic ecosystems, biodiversity, and public use.- In 1993 the FWS maintained a network of 77 fish hatcheries, 53 fishery resource offices, 9 fish health centers, and 5 fish technology centers. FWS has placed increasing emphasis in recent years on evaluating the impacts of its fishery program on fishery resources, with special attention to genetics management, conservation biology, and coordination with fishery management plans. In 1993 the FWS expended $64 million for restoration, mitigation, and recovery of anadromous and non-anadromous fish populations.

Anadromous Fish Operations. The FWS supports multi-agency programs to restore anadromous fish populations to historic spawning areas along the Pacific, Gulf, and Atlantic coasts. Included in these efforts in 1993 were improvements to fish passage facilities, implementation of fishery management plans, and hatchery production of 68 million Pacific salmon and steelhead trout, 6.2 million Atlantic salmon, 7.5 million Atlantic and Gulf striped bass, and 27,500 threatened and endangered anadromous species.

Non-Anadromous Fish Operations. The FWS supports multi-agency efforts to maintain and restore non-anadromous fish to historic interjurisdictional waters, to mitigate impacts of federal water development projects, and to meet recreational fishery management needs on federal lands. Included in these efforts in 1993 was technical assistance related to the conservation of threatened and endangered species, trust responsibilities of tribal interests, support to other federal agencies, prevention and control of aquatic nuisance species, and the production of 99 million warmwater and coldwater fish species, 14 million inland salmonoids, 8.7 million lake trout for the Great Lakes, and 1.5 million threatened and endangered non-anadromous fish species in FWS hatcheries.

BLM Riparian Initiative

The BLM has been restoring health to 23.7 million acres of riparian wetlands on its lands since 1991. Healthy functioning riparian areas are key to long-term improvements in fish habitat and to increasing fishing opportunities on public lands. In 1993 the BLM revised 180 site-specific management plans, surveyed nearly 2,000 miles of streams, constructed 567 riparian habitat improvement projects, acquired nearly 37,000 acres of riparian habitat to improve watershed management, and implemented management plans on 145 riparian acres through partnerships with state and private cooperators.

Wildlife Management

Federal land agencies increasingly work together to manage wildlife on the public lands. Partnerships with the states and private environmental groups also are increasing.

Cypress Creek National Wildlife Refuge. This refuge in southern Illinois has the largest and highest quality cypress-tupelo stands in the state, with trees over 1,000 years old. It comprises some of the state's most diversified wildlife habitat and supports significant populations of waterfowl and several state and federal endangered species, threatened species, and species of special concern. These include red-shouldered hawk, copper's hawk, barn owl, Mississippi kite, bald eagle, interior least tern, gray and Indiana bat, and dusky salamander. In 1993 the FWS acquired 10,000 acres for the refuge, with plans to acquire an additional 4,000 acres in 1994. When acquisition is complete, the refuge will total 35,000 acres. These acquisitions complement efforts by the State of Illinois and The Nature Conservancy to acquire two large ecological preserves adjacent to the refuge: the Cache River State Area and Limekiln Slough Preserve.

Trinity River National Wildlife Refuge. This 20,000-acre refuge in Liberty County, Texas, which protects critically threatened palustrine forest and wetlands, is in an area threatened by residential and commercial development. The FWS added 3,000 acres in 1993 and plans to acquire additional acres in 1994. The refuge protects priority wetland habitat and species, including neotropical bird species, snapping turtles, American alligators, canebrake rattlesnakes, American swallow kites, river otter, and bald eagles.

Deer Haven Ranch. This 4,900-acre ranch, located near Colorado Springs, Colorado, was acquired by the BLM to protect the wildlife, recreation, and riparian values of the site. The ranch is crossed by the Gold Belt Town National Backcountry Byway, contains 4 miles of riparian vegetation, and provides habitat for species such as bald eagle, deer, and elk.

Watchable Wildlife. Federal land agencies have formed Watchable Wildlife partnerships with groups such as Defenders of Wildlife, the National Wildlife Federation, and the National Audubon Society. Initiated in 1988 the Watchable Wildlife Partnership Program is a nationwide effort to increase wildlife viewing opportunities, provide information on the needs of wildlife, and promote wildlife conservation. The BLM manages 225 Watchable Wildlife sites in 11 states (Alabama, Arizona, California, Colorado, Indiana, Montana, Nevada, New Mexico, Oregon, Vermont, and Wyoming), and the National Park Service manages sites in 50 different national parks. The program produces Watchable Wildlife viewing guides used for wildlife identification in 14 national parks.

Wildlife Law Enforcement. The FWS, in cooperation with other federal agencies, enforces provisions of 11 different federal wildlife and resource protection laws to control the importation and exportation of illegal fish, wildlife, and plants. In 1993 a staff of 75 wildlife inspectors and 200 special agents detected and stopped 71,661 illegal shipments of fish and wildlife, worth about $173 million, from U.S. and territorial ports. Through the Convention on International Trade in Endangered Species (CITES), the FWS has extended its cooperative wildlife law enforcement program throughout the world.

Federal Wilderness

The National Wilderness Preservation System, with 564 units and 96 million acres of land, was managed in 1993 by the following federal agencies:

Agency Wilderness Units Acreage

National Park Service 42 39.1+ million

Forest Service 398 34.6 million

Fish and Wildlife Service 75 20.6+ million

Bureau of Land Management 68 1.6 million

New Wilderness Areas

On August 13, 1993, the President signed the Colorado Wilderness Act adding 553,203 acres to the National Forest Wilderness Preservation System. This legislation established nine new wilderness areas, two within BLM holdings and seven within Forest Service units. The National Forest Wilderness Preservation System now constitutes 18 percent of the National Forest System with units in 36 states. Land on national forests makes up 74 percent of the National Wilderness Preservation system in the lower 48 states, and 36 percent of the entire system including Alaska wilderness.

25th Anniversary of Wild and Scenic Rivers Act

To commemorate the occasion, the Department of the Interior and the USDA Forest Service held a 4-day symposium on river protection and conservation. With the addition of a 129-mile section of the Great Egg Harbor River in New Jersey, the National Wild and Scenic Rivers System now has 152 units and 10,503 river miles.

Recreation and Cultural Resources

The national forests and grasslands were the most visited federal lands in 1993 with 786 million visitors or 296 million recreation visitor days (a visitor day equals 12 visitor hours by one or more persons). A total of 72.5 million visits were made to BLM recreational lands; 274 million visits were made to 396 national park units; and 25 million visits were made to Fish and Wildlife Service recreation areas. The BLM issued 113,000 camping permits; 8,568 long-term visitor area permits; 1,817 commercial special recreation permits; 379 competitive special recreation permits; and 10,147 other special recreation permits.

Forest Service Recreation Areas. The National Forest System contains 43 congressionally designated recreation areas, encompassing 7 million acres and including 18 national recreation areas, 6 national scenic areas, 4 national monuments, and 15 other areas. In 1993 Congress added the 316,000-acre Spring Mountains National Recreation Area on the Toiyabe National Forest in southern Nevada.

Statewide River Assessments. The National Park Service and state agencies have completed 11 state inventories of streams and rivers and will complete another 4 in 1994 in Arizona, Connecticut, Tennessee, and California. Park Service personnel assist the states in data collection on riparian, fish and

wildlife, cultural, historic, and recreational uses of river resources. Planning documents identify the highest and best uses of river resources in each participating state.

Environmental Security and the Department of Defense

The mission of the U.S. Department of Defense (DOD) is to defend the national security of the United States, which today encompasses environmental security. The post-cold war era requires the DOD to adopt a common sense approach to solving environmental problems, and thus the Department has undertaken environmental security programs to protect human health and the environment and to steward natural and cultural resources. Making a fundamental change in its attitude toward solving environmental problems, the DOD is committed to being a leader in environmental stewardship.

Legacy Resource Management Program

Congress established the Legacy Resource Management Program in 1991 to make stewardship of natural and cultural resources a DOD priority. A collaborative, inter-service program, Legacy seeks to balance the intensive use of military installations for training and testing with conservation. Funding for the program increased from $10 million in FY 1991 to $50 million in FY 1993. By institutionalizing Legacy concepts within DOD, the conservation of natural and cultural resources is becoming an integral part of the military mission.

In 1993 over 200 military installations in 50 states, the District of Columbia, and five U.S. territories sponsored Legacy projects. Among them were 500 projects that enhanced resource management and awareness of biological species, earth resources, ecosystems, and cultural and historic places and materials. Legacy partners include 30 organizations and agencies, among them the federal land agencies and private environmental and archaeological groups.

Conservation Program

A comprehensive, long-range conservation program integrates biological, cultural and geological resources on DOD lands with requirements of the military mission. The program gives priority to identifying, conserving, and restoring natural and cultural resources. Through the Legacy program, and other initiatives, the Department has improved its stewardship of natural resources, thus ensuring resource conservation, preventing or minimizing pollution, and halting degradation of the environment. The program is conducted in partnership with federal, state, and local agencies and private groups.

Oregon Trail Visitor Center at Flagstaff Hill. This new visitor center commemorates the thousands of pioneers who braved the crosscountry journey to settle the West. The 23,000-square-foot interpretive center features state-of-the-art exhibits and living history demonstrations. Visitors can hike four miles of footpaths and see actual ruts of the Oregon Trail. The center attracted 100,000 visitors in its first three months of operation.

BLM Cultural Resources. BLM lands harbor an estimated 4 million archaeological, historic, and paleontological properties. In 1992 the BLM completed 94 new on-site interpretive projects. An example is an interpretive site in Montana at the confluence of the Marias and Missouri rivers that explains three

sites of historic interest-the City of Ophir, Fort Peigan, and a Lewis and Clark campsite. The project includes an accessible trail, three interpretive signs on a knoll overlooking the site, and a parking area.

Minerals on Federal Lands

In 1993 the percentage of oil, gas, and sodium produced from the nation's Outer Continental Shelf (OCS) and from federal onshore and Indian mineral leases increased 1.0 percent for oil and 1.1 percent for gas and decreased 10.8 percent for sodium from 1992. Coal, lead, and potash produced from federal onshore and Indian mineral leases increased by 1.07 percent and 1.19 percent for coal and lead, respectively, from 1992 and decreased by 19.41 percent for potash.

Bureau of Land Management Minerals. The BLM supervises mineral leasing and operations on 300 million acres of onshore federal mineral estate that underlie other surface ownership. The bureau fosters development of onshore minerals to achieve sustained yield, multiple use, and conservation of natural resources on another 300 million acres of public land. In FY 1993 oil, coal, and gas extracted from these federal onshore leases had a value of $7.5 billion, for which a royalty of $847 million was received by the U.S. Treasury.

Minerals Management Service. The MMS collects, disburses, accounts for, and audits revenues generated from mineral leasing on federal and Indian lands onshore, as well as managing and overseeing the Outer Continental Shelf (OCS) program. In 1993 the MMS managed 1.5 billion OCS acres, administered 5,227 leases covering 27 million OCS acres, and had financial and audit responsibility for 67,134 leases that covered 46.5 million acres on federal onshore lands. The agency collected, accounted for, and distributed $3.9 billion in mineral revenues from onshore and offshore leases. In 1993 oil and gas extracted from OCS lands had a total value of $2.9 billion, from which $900 million was supplied to the Land and Water Conservation Fund and $150 million to the Historic Preservation Fund.

Federal Facilities

Although they represent only a fraction of the regulated community, federal facilities-military and energy installations especially-can be larger and more complex than private facilities, often with more sources of hazardous waste requiring cleanup. Industrial activities at federal facilities can present management problems involving compliance with environmental statutes.

In 1993 the nation invested heavily in environmental cleanup and compliance at federal facilities, continuing an upward trend in environmental budgets. The budget for cleanup and compliance at federal facilities increased from $3 billion in FY 1989 to $10 billion in FY 1993.

Executive Orders on Federal Facilities

In 1993 the President signed several executive orders (EOs) that impact environmental management at federal facilities.

EO on Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances

On Earth Day (April 21, 1993), the President signed Executive Order 12843 which directs federal agencies to change their procurement policies to reduce the use of ozone-depleting substances earlier than the 1995 phaseout deadline called for in the Montreal Protocol. Federal agencies are directed to modify specifications and contracts that require the use of ozone-depleting substances and to substitute with non-ozone-depleting substances to the extent economically practicable. Through affirmative acquisition practices, the federal government will provide leadership in the phaseout of these substances on a worldwide basis, while contributing positively to the economic competitiveness on the world market of U.S. manufacturers of innovative safe technologies.

EO on Federal Use of Alternative Fueled Vehicles

Also on Earth Day 1993, the President signed Executive Order 12844 which places the federal government in the leadership of the use of alternative fueled vehicles (AFVs). This EO calls on each federal agency to adopt aggressive plans to exceed the purchase requirements of AFVs established by the Energy Policy Act of 1992 (see Chapter 7: Energy and Transportation).

EO on the Purchase of Energy-Efficient Computer Equipment

Under Executive Order 12845, also signed by the President on Earth Day 1993, the U.S. government became a participant in the Energy Star Computer program by agreeing to buy energy-efficient computers, monitors, and printers to the maximum extent possible. As long as equipment meets other performance standards and is available in a competitive bid, agencies must purchase only those computer products that qualify for the Energy Star logo.

EO on Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements

On August 3, 1993, the President signed Executive Order 12856 on Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, which includes the following directives:

Reductions in Toxics. Federal agencies are to reduce emissions and releases of toxic chemicals or pollutants by half by 1999. The required review and revision of all federal and military specifications and standards will help eliminate or reduce procurement of extremely hazardous substances and chemicals by federal facilities in such activities as manufacturing and processing.

Community Right to Know and Toxics Release Inventory. Federal facilities are to comply with all provisions of the Emergency Planning and Community Right-To-Know Act and the Pollution Prevention Act, including emergency planning and the Toxics Release Inventory (TRI) reporting requirements. Citizens and local governments will have access to information on potential chemical hazards at federal facilities in their communities. Local communities will be able to participate with federal facilities in developing emergency response plans. Within 12 months each federal agency will develop a pollution prevention policy and a strategy for achieving the President's 50-percent toxic emissions reduction goal. The first TRI report containing federal facilities data covering the year 1994 is due on or before July 1, 1995.

EO On Acquisition, Recycling, and Waste Prevention

On October 20, 1993, the President signed Executive Order 12873 which directs federal agencies to implement acquisition programs aimed at encouraging new technologies and building markets for environmentally preferable and recycled products. It also provides a boost to federal agency efforts to reduce waste at the source and to institute aggressive recycling programs. The EPA prepared guidelines for release in 1994 for recycled content in federal purchases of such items as carpet, floor tile, office recycling containers, office waste receptacles, remanufactured toner cartridges, binders, and plastic trash bags. All federal purchases of writing and printing paper are to contain 20 percent post-consumer material by the end of 1994 and 30 percent by the end of 1998. In 1993 paper accounted for 40 percent of all solid waste and 77 percent of government office waste. Existing EPA guidelines address re-refined motor oil and retread tires.

Program Accomplishments

In 1993 federal facilities took steps to improve environmental management in all phases of their operations. A sampling of programs by agency follows.

Environmental Protection Agency

The EPA functions as a partner to other federal agencies, providing environmental education, technical assistance, and leadership. The agency also serves as an enforcer to ensure that federal facilities comply with environmental statutes, regulations, and standards in the same manner that the nation expects of private industry.

Federal Facilities Enforcement Office. The EPA Federal Facilities Enforcement Office (FFEO) enforces environmental laws and provides technical assistance for pollution prevention, cleanup, and reuse of federal facilities. In 1993 the FFEO negotiated interagency agreements required under Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) for the cleanup of each federal facility site listed on the Superfund National Priorities List of most contaminated sites (NPL). The magnitude of the cleanup effort is reflected in the following profile:

Federal Facilities Hazardous Waste Compliance Docket. Over 1,900 federal facilities engage in hazardous waste activities;

Superfund National Priorities List (NPL). In 1993 the NPL contained 126 federal facility sites with 123 final listings and 3 proposed;

Superfund Interagency Agreements (SIAs). A total of 111 SIAs were signed in 1993;

Remedial Projects. A total of 500 remediation projects were ongoing at federal facilities on the NPL;

Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities. Federal facilities had 338 hazardous waste TSD facilities, with 90 of these facilities on the NPL; and

Federal Facilities Compliance Agreements (FFCAs). Of the 90 federal hazardous waste TSD facilities, 70 have signed FFCAs.

Multi-Media Enforcement and Compliance Initiative. In 1993 the EPA Office of Enforcement began a 2-year initiative that targets key federal facilities for comprehensive multi-media inspections. The initiative

promotes pollution prevention strategies to reduce toxic waste generation. Following nspections the EPA prepared pollution prevention profiles for 100 federal facilities.

Citizen Participation. To support the federal effort to increase the visibility and accountability of cleanup and compliance decisionmaking at federal facilities, the EPA emphasizes public involvement in cleanup and compliance agreements. In 1993 the agency continued to work with the DOD, the Department of Energy (DOE), and other agencies to improve communications and coordination with the public.

Pollution Prevention. In 1993 the EPA prepared draft guidance on implementation of Executive Order 12856 on federal compliance with right-to-know laws and pollution prevention requirements. Training will be available through the ten EPA regions to assist federal facilities in complying with the order.

Fast Track Cleanup Program for Base Closures. On July 2, 1993, the President issued a Five Point Plan to speed the economic recovery of communities where military bases are slated for closure. A Fast Track Cleanup program will speed the clean-up process at these bases. The Five Point Plan complements the Base Realignment and Closure (BRAC) program established by the DOD and involves the EPA in the cleanup process at closing military bases. The program integrates economic development, transition assistance, and environmental restoration to allow early reuse of the bases' assets.

Community Environmental Response Facilitation Act. The new Community Environmental Response Facilitation Act (CERFA) requires the EPA to assume the following responsibilities:

- Identify uncontaminated parcels of land and demonstrate that approved remedial actions on contaminated parcels operate properly;
- Accelerate ongoing and planned installation-wide Remedial Investigation/Feasibility Studies (RI/FS);
- Expedite response actions such as removals and interim response actions;
- Place public and private sites on the NPL;
- Coordinate with the DOD, states, communities, and private interests on transfer and environmental issues;

 Address issues associated with overlapping federal and state laws such as CERCLA and RCRA; and

 Develop and coordinate national policies and approaches on base closure with all stakeholders, including Congress.

Innovative Technology Development. To stimulate the use of innovative technologies at contaminated sites on federal facilities, the EPA is fostering the use of federal facilities as testing and demonstration centers.

Public-Private Partnerships. Working through a grant to Clean Sites, Inc., the EPA is developing partnership demonstration projects at five federal facilities. As an example, at McClellan Air Force Base in California, a public/private partnership includes the Air Force, EPA, state of California, and seven private firms. In 1993 the partners prepared demonstrations at three sites on the airbase and held discussions with the Army, Navy, and DOE to identify additional federal facility demonstration sites.

Western Governor's Association. The EPA, along with the DOD, DOE, and DOI signed a Memorandum of Understanding (MOU) with the Western Governor's Association to use federal sites in the West for developing innovative technology to deal with mixed radioactive, military, mining, and munitions waste. The MOU is reducing regulatory and institutional barriers to technology development.

Compliance Training. To provide ongoing technical assistance to federal agencies on complying with environmental statutes, regulations, and standards, the FFEO engages in joint training through such projects as the Accelerated Training Subgroup co-chaired by the DOE and EPA. This group helps federal facilities identify their training needs and develops exchange mechanisms to facilitate participation in training offered by the EPA, DOE, and DOD. A success story is the joint EPA/U.S. Air Force training course, -Team Approach to Federal Facilities Environmental Clean-up.- In one year EPA and Air Force instructors jointly provided this training to 500 participants. The course is designed to promote an understanding of cultural differences and other communication barriers to effective working relationships within and between agencies.

Federal Partnerships. The EPA has a number of efforts underway to promote partnerships with other federal agencies.

Environmental Roundtable. The Federal Agency Environmental Roundtable representing 50 federal agencies meets each month to exchange information on policy, strategy, standards, and regulations. Topics of discussion include the hazardous waste docket, proposed EPA strategies for national programs, technical information systems, the NPL, and base closures.

Civilian Federal Agency Task Force. Civilian federal agencies contribute half the sites listed on the hazardous waste docket and will spend an estimated $2 billion on site cleanup and restoration by FY 1995. Many of the smaller federal agencies, however, do not have the expertise or funding to respond adequately to new regulatory requirements. Recognizing their need for assistance, the FFEO formed the Civilian Federal Agency Task Force (CFA) to initiate a dialogue and to evaluate needs and funding sources within and outside the federal community. CFA members are developing a Civilian Agency Strategy.

Department of Defense

With environmental security now a part of the DOD mission, employees take responsibility for achieving environmental goals. In material purchases and process applications, they consider environmental impacts and choose a course of action to reduce or prevent pollution.

Cleanup. In 1993 the DOD was engaged in cleanups at about 800 military installations in the United States; 94 U.S. military installations were listed by the EPA on the NPL.

Fast-Track Schedule. The DOD placed 90 military installations scheduled for closure or realignment on a fast-track schedule for cleanup so that the land can be put to productive, nonmilitary use.

Environmental Hotspots. The DOD focused on interim measures to reduce risk at environmental hotspots; using existing and emerging technology to solve routine problems; forming environmental partnerships with major DOD stakeholders-the Congress, federal and state regulators, industry, and the public; incorporating future land use into cleanup plans; and setting objectives and completion dates.

Restoration Account. The Defense Environmental Restoration Account (DERA) in FY 1993 was $1.6 billion including $438 million of obligational authority in FY 1992 supplemental appropriations.

Remedial Actions. Interim Remedial Actions (IRAs) in 1993 more than doubled the number of actions in 1992, reflecting the growing realization among regulators and cleanup managers that interim remedial actions reduce risks to public health and the environment while longer-term solutions are being developed.

Compliance. Compliance programs include fire prevention and protection; vehicle, ship, and aircraft safety; explosives safety; and pest management. Environmental compliance is challenged by the number, size, and complexity of DOD facilities and operations; by increasingly stringent laws, regulations, and standards; and by the number of regulations, permits, and agreements at the national, state, and local levels, and overseas. Other factors include the following:

Strategies. DOD components must attain and sustain full compliance by meeting current deficiencies, eliminating noncompliant activities, and identifying future needs. Operations, training, and acquisition programs need to comply with legal requirements to ensure continued access to land, air, and water for basing, training, and mobilization-both in the United States and abroad.

Annual Report to Congress. On July 6, 1993, the Military Departments and Defense Agencies reported on their compliance programs for FY 1994-99 in the DOD Annual Report to Congress on Environmental Compliance. The DOD Environmental Security Review identified opportunities for improving program performance and control costs: periodic compliance self-assessments; improvement in the Planning, Programming, and Budgeting System (PPBS) process; and improved compliance training and education.

Pollution Prevention. The DOD has adopted pollution prevention strategies, beginning with source reduction, recycling, treatment, and finally disposal, and seeks practical solutions through the following actions:

Processes and Operations. The Department considers how DOD activities affect the environment and how to incorporate pollution prevention while still accomplishing the mission;

Material Standards and Specifications. The DOD is developing or revising all specifications and standards with environmental impact in mind;

Major Systems Acquisition. All new systems under development are being evaluated for environmental effects. A new Acquisition Directive integrates environmental impact and pollution prevention at the start of the acquisition process. A review of military specifications continues to eliminate or minimize the use of hazardous materials. The goal is to ensure that environmental and safety factors are considered in the design, acquisition, and operation of every weapon system.

Hazardous Waste Disposal. In 1993 the DOD continued to reduce hazardous waste disposal after meeting its 50-percent reduction goal a year early.

Environmental Defense Technology

To coordinate and integrate environmental research and development (R&D), the DOD Environmental Technology Program focuses on technology requirements, strategy, public-private partnering,

demonstration and implementation, and training and education. In FY 1993 the DOD invested $180 million in environmental technology through the Strategic Environmental Research and Development Program (SERDP) and $132 million through the Technology Base Program. Accomplishments under the Defense Environmental Technology Program include the identification of technology requirements. Examples of early successes under the program include:

Western States Restoration and Waste Management. The Joint Federal/Western States Cooperative Environmental Restoration and Waste Management Program coordinates efforts of the DOD, DOI, DOE, EPA, and state governments to meet federal and state regulatory requirements and facilitate demonstration of innovative technologies for environmental restoration at military bases; and

Technology Reinvestment Project. Working through the Advanced Research Projects Agency (ARPA), the DOD, DOC, DOE, DOT, National Science Foundation, and NOAA identify environmental technologies for defense conversion and application.

Department of Energy

The Department of Energy (DOE) Environmental Restoration and Waste Management Program is the largest in the world, with a FY 1994 budget of $6.5 billion. In 1993 as part of its responsibilities for cleaning up tens of thousands of acres containing hazardous waste, contaminated soil, groundwater, and structures at 120 sites in 36 states and territories, the DOE established initiatives to develop new environmental technologies for the 21st century.

Management Actions. The structure for much of DOE environmental work is incorporated into environmental compliance agreements established with the EPA and the states. By 1993 over 90 agreements had been developed establishing timetables for environmental compliance and cleanup. To promote effective management of activities, the DOE undertook the following actions:

Estimating Costs of Restoration and Waste Management. The DOE worked on plans to develop a baseline of future costs of environmental restoration and waste management programs. Preliminary baselines are set for completion in 1995.

Computerized Progress Tracking System. The DOE continued to develop a computerized Progress Tracking System to track program performance-costs, schedules, and technical data-for environmental restoration and waste management. The system will be used to review the status of activities, monitor changes in baselines, conduct trend analyses, support management decisions, and report on the progress of compliance and cleanup.

Restoration and Waste Management Contracts. New DOE environmental restoration and waste management contracts are being structured to improve contractor accountability and performance and to reduce costs. Pilot sites for this initiative include the Fernald Environmental Restoration and Waste Management Project in Ohio and the Hanford Environmental Restoration Management Project in Washington state.

Evaluating Health Risks. In 1991 the Office of Technology Assessment (OTA) published a study, Complex Cleanup, regarding the environmental problems in the DOE nuclear weapons complex. The study found that the DOE lacks a sufficient basis for evaluating health and environmental risks. In 1993 the DOE

initiated a comprehensive effort to develop better tools and an independent method for evaluating the long-term health and environmental risks related to environmental restoration and waste management activities at its major sites and facilities. A comprehensive survey of immediate exposure risks was set for completion in FY 1994, and the development of analytical tools for evaluating long-term risks and for identifying specific data needs in FY 1995. Input from the academic and public health communities, states, regulators, citizens, and other stakeholders was sought. The results should provide environmental decisions based on a broad understanding of risks along with other considerations such as statutory mandates, anticipated land use and associated costs, technical feasibility and cultural values, worker health and safety, and environmental equity.

Multi-Phase Cleanup. The EPA and DOE are increasing their use of interim remedies, a multi-phase cleanup approach recommended by the OTA and by experienced private contractors. This approach has the following advantages:

- It achieves near-term cleanup results;
- Develops more cost-effective, long-term remedial technologies;
- Characterizes health, safety, and environmental threats; and
- Develops achievable and protective cleanup standards.

Converting Defense Labs to Environmental Technology. In 1993 the DOE continued developing long-term cleanup technologies by promoting the conversion of national laboratories from defense missions to environmental technology-development programs.

Mixed Waste Management and Treatment. In response to the Federal Facilities Compliance Act of 1992, the DOE in cooperation with the EPA and state regulatory agencies is developing plans for treating mixed waste, which has both hazardous and radioactive components.

Cleanup Standards and Land Use Planning. Under the terms of an interagency memorandum of understanding, the DOE is providing the EPA with pertinent technical information for use in developing national cleanup standards for consistent and technically-defensible remediation requirements. Within such a national regulatory scheme, specific technical requirements would be established with state regulators and the EPA to address conditions at specific contaminated sites, with consideration of future land uses.

General Services Administration

The array of GSA environmental programs includes waste reduction, alternative fuel vehicles, gas and diesel restrictions, recycling, the use of recycled and other environmentally oriented products, CFC reductions, energy and water efficiency, ride-sharing, and the Greening of the White House. GSA programs ensure good indoor air quality, reduce radon exposure, control exposure to asbestos and lead-based paint, manage hazardous waste, and prevent underground storage tanks from leaking.

Recycled and Recycled-Content Products. To stimulate the U.S. market for recyclables, the GSA provides the federal community with a range of recycled paper and paper products, all of which meet and, in most cases, exceed EPA minimum content standards. In 1993 the GSA contracted for over 1,000

different recycled paper products including, office stationary, file folders, labels, calendars, envelopes, notebooks, index cards, cardboard boxes, art and drafting paper, and copier paper. Over 120 specifications were changed to incorporate requirements for recycled content, and sales for these items amounted to over $200 million.

GSA Environmental Catalogs. Several GSA catalogs highlight environmentally oriented items in the GSA supply system, including those with recycled content; those that are energy or water saving; and those that have been reformulated to be less environmentally detrimental. The GSA Federal Supply Schedules, the New Item Introductory Schedule, and the Customer Supply Center Catalog all highlight environmentally oriented items. The very successful Recycled Products Guide is being expanded and updated to include all environmentally oriented items from all GSA supply programs.

Green Cleaning Products. Presently the GSA cleans approximately 1,339 buildings by contract or in-house employees. In response to a lack of criteria to aid in the selection of environmentally preferable cleaning products, the GSA initiated in 1993 development of product criteria with the EPA Office of Pollution Prevention and Toxics (OPPT). Criteria will consider efficacy, human health, and environmental safety.

Energy Conservation. In 1993 the GSA continued to develop and implement projects to reduce energy use in buildings owned, operated, or leased by the Federal Government.

Energy Workshops. The Energy Policy Act of 1992 requires the GSA to conduct workshops in each federal region for state, county, local, and tribal governments. In 1993 the GSA held workshops in Boston and Atlanta, which focused on strategies to maximize conservation resources and energy conservation through improved building design, retrofit, maintenance, and construction. Other topics were procurement of energy efficient products and dissemination of energy conservation information. The GSA is planning a special workshop for tribal communities.

Energy Efficient Computers. In 1993 the GSA issued regulations and guidelines on federal agency implementation of Executive Order 12845, which requires agencies to procure only microcomputers, monitors, and printers that meet EPA Energy Star requirements for energy efficiency.

Water Conservation. In response to the requirements of the Energy Policy Act of 1992, the GSA created a water program unit to coordinate water conservation strategy, evaluate existing water conservation technologies, and track water consumption on a limitedbasis. Over the past two years, the GSA conserved approximately 4.1 million gallons of water through implementation of conservation initiatives.

Ride Sharing. The GSA Federal Ride Sharing Program promotes energy conservation by encouraging the use of vanpools, carpools, public transportation, and other means to commute to and from work. Using a network of Employee Transportation Coordinators, federal workers are educated on the environmental benefits of using alternate modes of transportation and are provided the mechanisms (such as bulletin boards, computer matching) to make it happen.

Greening of the White House. As federal landlord, the GSA is participating in the President's effort to Green the White House by helping to identify energy and water conservation opportunities in the White House complex that can serve as models for other federal agencies, state and local governments, businesses, and families in their own homes.

GSA Environmental Health Programs

As federal landlord, the General Services Administration conducts a number of programs to ensure the health of occupants of GSA-managed buildings.

Indoor Air Quality Program. According to the World Health Organization, 30 percent of new and remodeled buildings may have poor indoor air quality. The GSA Indoor Air Quality Program strives to provide good indoor air and prevent the sick building syndrome. The GSA requires facility managers to respond promptly to complaints from tenants and to correct problems when detected. Indoor air quality assessments are performed as part of safety and environmental management surveys conducted at all GSA-owned, leased, and delegated facilities. In 1993 the GSA and EPA entered into an agreement to establish a baseline for indoor air quality in office buildings. This information will be used to develop guidelines for indoor air quality in all large buildings.

Asbestos Management Program. This program minimizes asbestos exposures for all building occupants. Asbestos in good condition is managed in place, but when asbestos is damaged or subject to disturbance by routine operations or planned renovations, it is promptly abated.

Hazardous Waste and Underground Storage Tanks. When hazardous waste is generated at a GSA facility, this program ensures that the waste is stored properly, transported safely, and disposed of according to federal and state regulations. All GSA-owned or operated underground storage tanks are managed in accordance with federal and state regulations.

Radon Program. In response to this hazard, the GSA started its Radon Program in 1988. All GSA-owned, leased, and delegated buildings are tested for radon, and the gas is mitigated when radon levels exceed the EPA action level.

Lead Program. To ensure the health and safety of children at GSA-owned and delegated child care centers, the GSA is testing these centers for lead in the drinking water and for lead-based paint. The agency takes corrective action when lead levels exceed federal regulations or guidelines. To protect workers from lead exposure, the GSA requires that paint be tested for lead whenever a project requires the sanding, welding or scraping of painted surfaces. GSA employees and contractors are required to follow the Occupational Safety and Health Administration requirements, if lead is detected.

Department of Veterans Affairs

The importance of waste minimization, recycling, energy reduction, and environmental compliance of construction projects is apparent within the Department of Veterans Affairs. The following are highlights of these efforts.

Waste Reduction. In 1993 the National Center for Cost Containment of the Department of Veterans Affairs (VA), in collaboration with the VA Environmental Management Service, conducted a second annual survey of recycling and waste minimization at 171 field facilities. The survey is part of an ongoing effort to promote cost-effective waste reduction and recycling of usable materials in all Veterans Health Administration operations and facilities. The results indicate a sizable reduction in radioactive waste and an increase in the number of facilities recycling reusable materials.

Affirmative Procurement. The VA official policy and implementing document for affirmative procurements was published in 1993. This policy assures that items composed of recovered materials will be purchased to the maximum extent practicable. It consists of four components:

Preference Program. This applies to the purchase of recycled paper and paper products, cement and concrete containing fly-ash, building insulation products containing recovered materials, re-refined engine and gear oils and hydraulic fluids, retread tires, recycled toner cartridges, and soy-based inks for printing;

Promotion Program. Preferences in recycled goods are incorporated in all solicitations and contracts;

Certification and Verification. VA employees are required to use or procure recycled goods; and

Annual Review and Monitoring. The VA Recycling Coordinator reviews and monitors the department's achievements to determine whether the procurement program is effective.

U.S. Postal Service

In 1993 the U.S. Postal Service issued four new policies to protect the environment:

. Providing employees and customers with a safe and healthy environment;

. Prohibiting smoking in postal occupied buildings;

. Requiring two-sided copying; and

. Showing preference for the purchase of recycled paper and recycled laser toner cartridges.

The following environmental initiatives were undertaken by the U.S. Postal Service:

Alternate Fueled Vehicles. Based on extensive testing, the Postal Service concluded that compressed natural gas (CNG) is the best alternative fuel for its use. By the end of 1993, 978 postal vehicles were operating on CNG and a contract to convert an additional 1,769 vehicles had been awarded. Also in 1993 the Postal Service received one of the Natural Gas Vehicle Coalition's First Annual Achievement Award in recognition of its contributions to advancing natural gas as a vehicular fuel. Under an agreement with the Ford Motor Company and the Department of Energy, the Postal Service will test six electric vans in southern California. The first vehicle will be delivered in 1994. The feasibility of converting other postal delivery vehicles to electric is being considered.

Pollution Prevention. In 1993 the Postal Service, in cooperation with EPA Region II, completed an assessment of pollution prevention opportunities at post office and vehicle maintenance facilities in Buffalo, New York, a model for achieving pollution prevention at other postal facilities.

Environmental Quality Assurance Reviews. The Postal Service has begun a series of audits addressing air pollution control, water pollution control, hazardous spill control and emergency response planning, solid and hazardous waste management, underground and above ground storage tanks, soil and groundwater contamination, drinking water management, PCBs (polychlorinated biphenyls) management, asbestos management, pollution prevention, and reporting under Superfund Amendments and Re-Authorization Act (SARA) and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

Recycling and Waste Reduction. In 1993 the Postal Service recycled office paper, undeliverable bulk business mail, pallets, plastic, aluminum, steel, oil, solvents, antifreeze, batteries, and tires. In recent years the Postal Service has played an important role in the development of water-based inks that do not contain lead or other metals and of water-activated adhesives that dissolve during recycling. These water-based inks are used in stamps and stationary. Ninety-five percent of stamps produced in 1993 were made with water-activated adhesives. The Postal Service is working with the paper and mailing industries to make mail more environmental friendly and to reduce the amount of undeliverable mail (as a result undeliverable bulk business mail has been reduced by 1.4 million pieces in recent years). The agency developed an affirmative procurement plan addressing the 1993 Executive Orders.

Universal Postal Union Study. The Postal Service participated in a Universal Postal Union study of technical issues and pollution prevention policies to determine the present status of technical guidelines and the need for new ones, improved environmental policies, and pollution prevention in postal administrations worldwide. The goal is to provide for more sustainable economic and environmental development coincident with industrial growth in mailing and communications industries globally. In 1993 the Postal Service chaired the first international symposium on -The Post and the Environment-, which led to the development and adoption of environmental policy by the Universal Postal Union Congress.

Storm Water Management. The Postal Service is developing storm water pollution prevention plans at its facilities and is initiating steps for long-term monitoring of storm water management. These activities are being integrated with the vehicle maintenance facilities to reduce or eliminate the use of toxic chemicals used in repair and maintenance.

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Chapter 6: ECOSYSTEM APPROACH TO MANAGEMENT AND BIODIVERSITY

In Portland, Oregon, we brought together business people, timber workers, and environmentalists from throughout the Northwest to discuss how best to preserve jobs and to protect the old-growth forests and the species which inhabit them. People sat down in a conference room not a courtroom.

President Bill Clinton

Ecosystems are complex entities. Each ecosystem comprises interdependent, interacting biotic and abiotic components which are linked by the transfer of energy, materials, and information. Sustainability of any ecosystem depends on maintained conditions or on the resilience of organisms within changing conditions. What differs among ecosystems is the amount of solar energy, in the form of food and heat, and water available for microbiota, plants, and animals in the system. Conditions vary around the globe, and microbiota, plants, and animals evolve and adapt to diverse, specific environments. Adaptation allows for the diverse biota found in given sets of conditions. As conditions change or become disrupted, habitats change. Biota often cannot evolve rapidly enough or adapt sufficiently to keep up with change. The result can be impaired biodiversity.

The link between an ecosystem approach to management and biodiversity was evident in 1993 at the President's Forest Conference. The controversy involved timber harvests in old-growth forests of the Pacific Northwest, habitat degradation, and resulting impacts on native plants and animals, among them the northern spotted owl and the region's famed salmon species. The President convened the conference to seek an economic-ecological solution. Resolution will depend ultimately on a forest plan that assures the survival of the old-growth ecosystem, a plan that will -keep all of the pieces,- as the forester-wildlife biologist Aldo Leopold once cautioned.

In September 1993 the National Performance Review recommended that the President issue a directive establishing a national policy to encourage sustainable development through ecosystem management. This could best be accomplished, the NPR report concluded, by a cross-agency ecosystem approach to planning in coordination with state, local, and tribal governments. The report called for an Interagency Ecosystem Management Task Force to select demonstration projects on ecosystem assessment and ecosystem management funded by cross-agency budgets. The Task Force was to determine lead agencies and appoint interagency multidisciplinary ecosystem management teams to develop an assessment framework and protocols and management plans for ecosystem sustainability.

Ecosystem Approach to Management

Late in 1993 the Interagency Ecosystem Management Task Force was constituted and adopted the following working goal:

To restore and maintain the health, sustainability, and biological diversity of ecosystems while supporting communities and their economic base.

Chaired by the director of the White House Office on Environmental Policy, the Task Force is made up of assistant secretaries from 12 departments and agencies, as well as representatives of the Office of Management and Budget, Council on Environmental Quality, and Office of Science and Technology Policy.

Defining Ecosystems

The Interagency Ecosystem Management Task Force has agreed on the following definitions:

. An ecosystem is an interconnected community of living things, including humans, and the physical environment with which they interact.

. Ecosystem management is an approach to restoring and sustaining healthy ecosystems and their functions and values. It is based on a collaboratively developed vision of desired future ecosystem conditions that integrates ecological, economic, and social factors affecting a management unit defined by ecological, not political boundaries.

. Biodiversity refers to the diversity of life: species, their genetic structural, behavioral, and functional variability and the communities and ecosystems of which they are comprised. Human interaction, biodiversity, and ecosystem dynamics are highly integrated, with components of biodiversity making up the dynamic elements expressed through ecosystem processes.

Conditions and Trends

The United States varies in physical, biological, and climatological features from mountains to coastal plains, from forests to grasslands, from wetlands to deserts. Across this heterogeneous landscape, living organisms and their physical environment-earth, water, and atmosphere-are related, interacting upon each other so that the flow of energy leads to trophic structure, such as food chains or webs; biodiversity; and elemental cycles-the exchange of materials between living and nonliving parts. This landscape provides suitable habitat for plants and animals, produces food and fiber, yields mineral, energy, and water resources, provides for recreational and wilderness experiences, and contributes to the global climate.

Public concern about the environment, together with new thinking by scientists and resource managers, has led to a new management philosophy. This philosophy says that we can manage resources to sustain their full array of values and uses through a broader understanding of their associated ecosystems. This new thinking calls for a shift of focus from the more traditional single-resource, single-species management approach to one based on a holistic view of natural and managed ecosystems. This approach requires knowledge of the composition, structure, and function of ecosystems, their relationships and influences on each other, and their capacity to support multiple uses and to produce goods and services without sacrificing health, sustainability, or biodiversity.

The Human Dimension

Humanity is a relatively new but dynamic component in earth ecosystems. Restoration and protection of both natural and managed ecosystems require an ecological perspective that also considers the human components of ecosystems. The need for this type of perspective is simple. Continued growth in human populations and increases in their production, use, and disposal of resources are not matched by corresponding growth in the resource base available to meet those demands under traditional

management approaches. These issues can be translated into several basic reasons for exploring ecosystem management:

. People need and want a wider array of uses, values, products, and services from a finite resource base than in the past, especially, but not limited to, the amenity values and environmental services of healthy, diverse lands and waters;

. New information and a better understanding of ecological processes highlight the role of biodiversity as a factor in sustaining the health and productivity of ecosystems and the need for integrated ecological information at various spatial and temporal scales to improve management;

. Public awareness and concern for natural resources and for national and global environmental issues is increasing;

. People want more direct involvement in the process of making decisions about public resources; and

. The complexity and uncertainty of natural resources management call for stronger teamwork between scientists and resource managers than heretofore has been practiced.

Ecosystem management, as the term is used by the Interagency Ecosystem Management Task Force, recognizes human needs and the importance of developing a vision that integrates ecological, economic, and social factors. It involves a recognition of the interrelationship of a healthy economy and a healthy environment, and it focuses on policies that foster both a sustainable economy and a sustainable ecosystem. In short it employs an economically based, environmentally responsible approach to resource management.

Principles and Guidelines for Ecosystem Management

As an initial step in communicating the requirements of an ecosystem approach, the Task Force identified guiding principles for ecosystem management:

. Is aimed at restoring and/or maintaining the health, sustainability, and native biological diversity of ecosystems;

. Involves management decisions based on considerations of ecologic units and time frames-generally broader geographic views, and longer-term time frames-that allow for considerations of cumulative effects;

. Supports sustainable economies by meeting the needs of the present without compromising the ability of future generations to meet their needs;

. Requires a vision of what constitutes sustainable health and biodiversity for an ecosystem, in collaboration with all interested parties;

. Requires a mechanism for setting priorities among objectives, and for identifying and reconciling conflicts;

. Develops coordinated, partnership approaches, in which federal agencies develop implementation strategies collaboratively with all interested parties on a voluntary basis, assist interested communities, design plans and budgets to meet the goals, prevent duplication of effort, and create efficiencies;

. Relies on the best available scientific understanding of ecosystem composition, structure, and function, and related human socioeconomic dynamics;

. Uses specific, measurable benchmarks to monitor and evaluate outcomes;

. Employs adaptive management, learning from successes and failures and allowing management flexibility to respond to new information; and

. Provides that goals for the desired range of future conditions in an ecosystem be developed through an understanding of past ecosystem conditions; that it be achieved through adjustment and implementation of legally mandated agency activities, along with state, local, and private sector efforts.

In late 1993 the Task Force formed an interagency working group to assist in its work, to conduct case studies, and to develop a report on implementing an ecosystem approach.

Coordinated and Adaptive Approaches to Ecosystem Management

Elaborating on the principle for a coordinated approach to ecosystem management, the Interagency Ecosystem Management Task Force recommends the following actions for federal agencies:

. Jointly develop ecosystem management strategies for federally managed lands and programs;

. Seek to catalyze collaborative efforts with state, tribal, and local governments, nongovernment entities, private landowners, and the public, to achieve desired future conditions for the ecosystem;

. Actively assist interested communities to anticipate changing environmental and economic conditions and facilitate resolution of potential resource conflicts where requested;

. Incorporate ecosystem management goals into strategic, financial, and program planning and design budgets to meet the goals and objectives of the ecosystem management implementation strategy; and

. Actively seek to prevent undesirable duplication of effort, minimize inconsistencies, and create efficiencies in programs affecting ecosystems.

Regarding adaptive management, the Interagency Ecosystem Management Task Force recommends that, based on periodic reviews of implementation, federal agencies should make adjustments to the standards and guidelines applicable to management activities affecting ecosystems. For example federal agencies should try to institutionalize flexibility in management practices so that they can accommodate the evolution of scientific understanding of ecosystems. They should review ongoing interagency activities and institutional structures in the ecosystem, to modify them if they are a deterrent to interagency ecosystem management and to discontinue them if they are no longer needed.

Program Accomplishments

The United States is moving forward with an ecosystem approach to management that will be scientifically sound, ecologically based, and totally integrated. This approach has many elements in common with sustainable development, sustainable management, sustainable agriculture or forestry, and a number of other terms being used to identify an ecological approach to land and aquatic resource management.

In 1993 ecosystems received a good deal of media attention, particularly in the Florida Everglades and the old-growth forests of the Pacific Northwest. The President has committed his Administration to resolving the conflict between timber and environmental interests in the Pacific Northwest. In Florida an ecosystem approach was the only way to restore water to the endangered Everglades and declining Florida Bay. The Congressional Research Service has compiled a compendium of ecosystem management activities at 19 federal departments and agencies. Examples include Forest Service efforts to conserve the karst ecosystem in Alaska, the multiagency Man and the Biosphere Cooperative applying ecosystem management in the Southern Appalachians, and activities such as TVA river action teams that develop public-private partnerships to address water quality on a watershed basis.

Pacific Northwest Forest Ecosystem Plan

On July 1, 1993, the President selected his preferred option for the Pacific Northwest Forest Ecosystem Plan to resolve what the nation has come to be known as the Spotted Owl controversy. The plan appeared three months after the April 1993 Forest Conference in Portland, Oregon. The conference set the stage for a plan to ensure sustainable ecosystems and a sustainable economy.

Following the conference the President assembled a Forest Ecosystem Management Assessment Team to review the biological information and develop management options. Comprising 150 scientists and resource professionals from federal agencies and academia, the team received its charge from the President to develop -a scientifically sound, ecologically credible, legally responsible basis for managing the federal forests of the Pacific Northwest and northern California.- From ten alternatives presented to him by the team, the President selected the watershed-based option as the foundation for his proposed plan, which includes the following points:

Ecosystem Management. Planning and monitoring levels would be established for managing the old-growth ecosystem at regions, smaller ecological provinces, and individual watersheds.

Old Growth Reserves. A complex of late-successional (old-growth) reserves, riparian reserves, Adaptive Management Areas, and a forest management matrix would be created across the 24 million acres of federal forestland in the northern spotted owl region.

. Late-Successional Reserves. Following watershed boundaries, 7.05 million acres of the most valuable old-growth forests would be set aside in reserves. Some thinning and limited salvage that support or are neutral to old growth or to the values of reserves would be allowed. Conservation areas would be designated to protect specific wildlife species.

. Riparian Reserves. On 2.23 million acres, buffers would be provided along streams.

. Adaptive Management Areas. Ten areas ranging from 78,000- 380,000 acres would be designated for intensive ecological experimentation and social innovation to develop and demonstrate new ways to integrate ecological and economic objectives and to allow for local involvement in defining the future use of the land.

. Matrix. On 6.35 million acres, forest management would be allowed according to prescriptions based on geographic area.

Timber Sales. The plan provides for a sustainable timber harvest in the old-growth ecosystem (for a discussion of timber sales on public lands in the Pacific Northwest, see Chapter 5: Public Lands and Federal Facilities).

Labor and Community Assistance Work Group. In formulating various options, the President received recommendations from a Labor and Community Assistance Work Group that identified ways to help affected communities and individuals and from an Agency Coordination Work Group that identified ways to improve communication and coordination among the agencies involved in ecosystem management.

Supplemental EIS. The President called on his Administration and Cabinet members to fully comply with the National Environmental Policy Act and proceed with a supplemental environmental impact statement for current and proposed forest and timber management plans of the Forest Service and the Bureau of Land Management.

Threatened and Endangered Species. The economic and ecological challenges of the Pacific Northwest extend beyond the logging/spotted owl debate to such problems as reduced salmon runs in coastal streams and in the Colombia River System and the listing of salmon species as threatened or endangered. Solving these problems requires the cooperation of divergent, even competitive, interests: public, tribal, and private lands; public dams and private dams; commercial harvest, sports fishing, tribal fishing and other treaty rights; public and private power; ranchers and farmers using public lands and public water distribution systems; developers and environmentalists. The human component-how people live, work, and play in an ecosystem - cannot be ignored.

Everglades Ecosystem Restoration Plan

One of the nation's best known and treasured ecological systems, the Everglades, continues to suffer severe habitat and water quality degradation largely because of human activities. In June 1993 the Secretary of the Interior initiated an effort by federal, state, and local government agencies, private groups, and individuals to restore the Florida Everglades ecosystem. Significant alteration of the natural water flow through the construction of levees and diversions of naturally flowing water coupled with nutrient loadings associated with agriculture have taken a heavy toll. The increase in the number of species listed and proposed for listing as endangered, human health advisories for consumption of all freshwater fish, and an invasion of exotic species provide telling evidence of the degrading condition of the ecosystem.

The Everglades ecosystem is a vast wetlands whose watershed begins in the headwaters of the Kissimmee River and extends South through Lake Okeechobee to the Everglades proper, ending in Florida Bay. This wetlands once stretched 100 miles from the southern end of Lake Okeechobee to the tidal estuaries of the Gulf of Mexico and Florida Bay. Today the ecosystem has a much-altered water regime, subject to flood control and irrigation efforts, etched with canals, and replete with pumps that shunt water to the east and west coasts of Florida or redirect it for irrigation. Over the years water managers have taken these actions:

. Channelized the Kissimmee River;

. Ringed Lake Okeechobee with a levee that prevents it from overflowing and nourishing the Everglades wetlands system; and

. Converted 700,000 acres south of the lake to the Everglades Agricultural Area, which divides the original hydrologic regime into two poorly connected watersheds.

Over the years, the Everglades received too little water, at the wrong times, in the wrong places, and the water it got was laden with nutrients, pesticides, and mercury. Since the turn of the century, drainage has lowered water levels in the Everglades by as much as six feet. The aquatic food chain has collapsed; the population of wading birds has fallen 90 percent; species have become endangered and threatened; and Florida Bay, the Florida Keys Marine Sanctuary with its coral reefs, and coastal estuaries are declining at an accelerated rate.

The DOI took the lead in developing closer working relationships with the federal and state agencies that affect, or are affected by, various restoration programs. The DOI's efforts to bring together the varied interests in this large ecosystem have resulted in a federal task force, passage of Florida's Everglades Forever Act which provides for an extensive restoration plan, and establishment of the Governor's Commission for a Sustainable South Florida, all working together to restore the Everglades ecosystem. Federal, state, and county governments, along with individual farmers have all been involved in the restoration effort. The activities and projects of these entities are gaining the coordination and focus they lacked in the past.

One of the major actions underway is a $670-million Corps of Engineers ($256 million Federal and $414 million non-Federal) restoration project to reconnect the Kissimmee River with its natural floodplain. Once completed this restoration will result in significant ecological benefits. Wetland acres will be restored by 27,000 acres, and habitat values within the floodplain will be restored and enhanced for over 300 fish and wildlife species.

Solid science supported by monitoring and assessment and the cooperation of federal, state, and local agencies along with private concerns are essential to solve an ecosystem crisis on the scale of the Everglades. In November 1993 preliminary federal objectives for the restoration were developed by an interagency scientific task force.

Karst Ecosystem Management Plan

The Tongass National Forest consists of over 1,800 square miles of limestone and marble in Southeastern Alaska. A karst ecosystem of mature spruce and hemlock forests and productive terrestrial and aquatic communities has developed over much of the area. The karst landscape is also characterized by well-developed subsurface drainage and vast and complex cave systems. The deepest natural limestone shaft in the United States occurs in the Ketchikan Area of the Tongass. Paleontological finds in the cave networks date to 44,500 years before present. Human use of the caves spans the last 4,500 years.

Approximately 70 percent of the commercial forestland on karst has been harvested to meet requirements of 50-year timber sale contracts. Timber harvesting operations have clogged some karst features and caves with sediment and logging debris, and the hydrology and geochemistry of

subterranean karst streams have been altered, flooding once dry cave systems, creating surface streams where none existed, and dissolving fragile speleothems.

The Forest Service is integrating current findings about the complex relationships between the karst landscape and its native plants and animals into landscape-level land management planning. Intensifying on-the-ground inventories of karst areas where timber harvests are proposed.

The Forest Service has entered into partnerships with the National Speleological Society and local cavers to help locate, map, and inventory karst development and caves. To date over 80,000 feet of passage have been mapped within some 300 caves. The Forest Service also has formed partnerships with local schools, universities, research institutions, and the Boy Scouts. The Smithsonian Institution and the National Geographic Society support research projects, and the Ketchikan Pulp Company is seeking ways to help manage and protect the resources.

Karst management involves critical decisions concerning timber harvest, anadromous fisheries, sensitive species, hydrology, soils, karst development and caves, and paleontological and cultural resource protection. The karst landscape is a three-dimensional system that includes forest and peatlands atop and adjacent to the karst, the surface and subsurface interactions, the unique cave resources within these cave systems, and the groundwaters which flow through these systems. Karst landscapes impose land management liabilities not encountered in non-karst areas. Subsurface drainage networks generally operate independently of, and with more complexity than, the surface drainage systems above them.

To characterize the karst landscape, the Forest Service is developing a risk assessment analysis strategy referred to as -vulnerability mapping.- The thesis of this approach is that not all karst development and resources have evolved equally, and some parts of a karst landscape are subject to appreciably greater resource damage potential and groundwater contamination risk than other karst lands. Differences are a function of the degree of karst development, the continuity of solution openings within the karst system, and the interdependency of associated resources that benefit from the karst groundwater system. The analysis considers the degree of karst and cave development, the nature of the soils, the slope, the karst hydrologic system, and associated fisheries. High value karst systems are identified and removed from timber harvest plans. On karst areas found to be of low and/or moderate vulnerability, low-impact timber harvest and road-building techniques that provide for minimal soil disturbance and hydrologic impacts are prescribed to maintain site productivity and protect the karst ecosystem.

Man and the Biosphere in the Southern Appalachians

Another example of the ecosystem approach to natural resource management is the Southern Appalachian Man and the Biosphere Program (SAMAB) established in 1988 as the SAMAB Cooperative. Its Zone of Cooperation covers parts of Alabama, Georgia, North Carolina, South Carolina, Tennessee, and Virginia. Federal agencies in the Cooperative include the Forest Service, Fish and Wildlife Service, Department of Energy, Economic Development Administration, Tennessee Valley Authority, National Park Service, EPA, and U.S. Geological Survey. State agencies are now joining. The following are among the current initiatives of the SAMAB Cooperative:

. A model community planning program to demonstrate that tourism-based development and conservation of natural resources are compatible objectives;

. Support for restoration of endangered and threatened animal and plant species, including reintroduction of the red wolf in the Great Smoky Mountains National Park;

. Establishment of a forest health monitoring program for Southern Appalachia; and

. Public education for controlling dogwood anthracnose disease and other threats to the environment.

Forest Ecosystem Management. In 1993 the USDA Forest Service began to implement ecosystem management on the national forests and grasslands with an Ecosystem Management National Framework. Forest Service personnel met with The Nature Conservancy, Wilderness Society, American Forest and Paper Association, National Association of State Foresters, Congressional Research Service, Ecological Society of America, National Woodland Owners Association, and Sport Fisheries Institute to develop a framework for action. The result was the following initiatives:

. Departmental Ecosystem Management Group. The Forest Service and the Soil Conservation Service formed this working group to coordinate ecosystem management actions. The group developed draft policy and guidelines on ecosystems and biodiversity for the USDA.

. National Ecoregion-Based Ecological Assessment. The Forest Service worked with other agencies and societies to conduct a national assessment of ecoregions;

. Management by Watersheds. The agency has developed a new strategy called Management by Watersheds to maintain ecological processes that sustain biophysical watersheds and aquatic systems. Forest managers treat watersheds as ecological units and manage the unit to assure the hydrologic function and conditions typical of healthy watersheds and streams.

Grassland Guidelines. In revising its grazing rules and fees, the Bureau of Land Management stresses restoration and ecosystem management. BLM range managers are adopting ecosystem management as a process that considers the total environment and requires the skillful use of ecological, economic, social, and managerial principles to sustain the integrity of grassland ecosystems. With extensive public participation, the BLM prepared new grazing guidelines that assess the functional condition along with the social, cultural, ecological, and economic characteristics and values of ecosystems. The Bureau provides guidance for its managers on selecting priority watersheds, on the use of interdisciplinary teams, on science-based goalsetting, and on monitoring results.

Restoring the Rangeland Ecosystem of the Malpai-Borderlands. The Malpai-Borderlands, in Southeastern Arizona and neighboring New Mexico, revolves around a ranch purchased by The Nature Conservancy and a nonprofit organization of 36 local ranchers, called the Malpai Borderlands Group. This project covers approximately 1 million contiguous acres of a near-pristine range ecosystem. The Group is working with soil conservation districts and federal agencies, including the Soil Conservation Service, Forest Service, and Bureau of Land Management. The ranchers, who sought a common voice to work with federal agencies, contribute innovative ideas such as a revolving fund and the use of grass banks that allow deferment from grazing to support reintroduction of fire to the ecosystem without interrupting the cash flow most ranchers require to stay in production. The resource concerns of the ranchers include the diversity of the range plant community, water quality, threatened and endangered plants and animals, and the ability to manage their ranch lands for sustainable agricultural production. The Soil Conservation Service led the development of conservation plans for the project and will assist

the Group with installation of practices such as fencing, water development, and seeding depleted areas with native species of grasses.

Managing Dams to Protect Watershed Resources. The Bureau of Reclamation is working with other federal and state agencies and outside groups to address environmental problems at the watershed level. Efforts include the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin and the National Irrigation Water Quality Program sponsored by the Department of the Interior. The BOR is adjusting the timing and volume of water released by its dams to protect natural resources in such watersheds as California's Central Valley, the Columbia River System, and Glen Canyon Dam on the Colorado River.

Watershed Perspective for Wildlife Refuges. The U.S. Fish and Wildlife Service, through its National Wildlife Refuge System, is planning new refuge acquisitions using a watershed perspective. Areas include the Canaan Valley National Wildlife Refuge in West Virginia at the headwaters of the Blackwater River, the Upper Mississippi National Wildlife and Fish Refuge, and the Rio Grande National Wildlife Refuge. Refuge personnel work with private landowners who share the watershed to achieve common goals.

Watershed Management at Mammoth Cave. The National Park Service, through its Watershed Protection Program, encourages individual park units to enter into cooperative watershed management endeavors with federal, state, and local agencies. An example is the Mammoth Cave National Park in Kentucky, where underground rivers that support a variety of aquatic life are recharged by a vast area of sinkholes and sinking streams on 60,000 acres of private land, which happens to be some of the state's most productive farmland. A coalition of local, state, and federal agencies protect park groundwater by working with area farmers to help them better conserve and manage their lands.

Old Mines and Watersheds. The Bureau of Mines, working with the Bureau of Land Management, the Forest Service, and the Fish and Wildlife Service, used watersheds to select areas of analysis for an environmental study. Among the sites selected were the Lolo Creek watershed in west central Idaho and the Soldier Meadows Allotment in northwest Nevada which includes smaller watersheds of intermittent and perennial streams. The Bureau of Mines works with federal and state agencies to identify and locate abandoned mines and associated hazardous wastes that are damaging public lands and the ecosystems they occupy. The Bureau is characterizing amounts and toxicities of metals at abandoned mine sites in major watersheds. Such data on metals and other contaminants at old mine sites are essential for cost-effective reclamation on federal lands.

Biodiversity

Biodiversity and the fate of many threatened and endangered species are central issues in the debate over approaches to ecosystem management. It is axiomatic that conservation of biodiversity cannot succeed through -crisis management- of an ever expanding number of endangered species. The best way to minimize species loss is to maintain the integrity of ecosystem function, and the best time to restore or sustain a species or ecosystem is when it is still common. For certain species and biological communities, the pressing concern is perpetuation or enhancement of the genetic variation that provides for long-term productivity, resistance to stress, and adaptability to change.

This requires cooperative efforts and multiple-use management across entire landscapes-at the scale of habitats or ecosystems rather than species. Additionally steps need to be taken to incorporate the benefits of biodiversity and the use of biological resources into local, regional, national, and international economies. The real and potential wealth represented by conserved biodiversity cannot be replaced.

Conditions and Trends

Information on the conditions and trends of biodiversity in the United States is limited in comparison to the full array of genetic and biological diversity. Data on genetic diversity is limited primarily to species of commercial value or species considered vulnerable to extinction. Data on species diversity, while more extensive, are restricted mostly to threatened and endangered species and game species.

Extinct Species

Although scientists still differ on terms, they agree that current extinction rates exceed speciation rates for a net loss of biodiversity. They can account for the extinction worldwide of 75 mammals and birds between 1600 and 1900, for a loss rate of one species every four years. Between 1900 and 1980, however, another 75 mammals and birds became extinct, and the loss rate accelerated to one species a year. In 1993 the estimates for mammal and bird extinctions were one to three species a year. Speculations suggest rates for all taxonomic species vary from one to three species a day to the most pessimistic estimates of one to three species an hour.

Among those species that have become extinct since 1600, half were native North American higher vertebrates. In the past century, 40 taxa (27 species and 3 genera) of North American fish became extinct-not including marine or distinct anadromous fish. Of the 40 taxa, 19 have become extinct since 1964. Eight species of mussels and all five species of a limpet subfamily have become extinct in the Southeast. Since 1850 among Hawaii's native flora and fauna, 85 percent of the island's plant and animal species have become extinct or severely reduced in numbers. Island species are especially susceptible to extinction, and half of Hawaii's endemic birds and hundreds of plants and invertebrates have been lost. Over the past decade, seven species and subspecies were removed from the Threatened and Endangered Species List because they are believed to be extinct. Among them are the dusky seaside sparrow, Sampson's pearly mussel, and the Tecopa pupfish. The Fish and Wildlife Service is no longer considering another 200 candidate species because they are believed to be extinct. The major contributing causes are habitat destruction, over-exploitation, and competition from exotic species.

Threatened and Endangered Species

Over the past 16 years, an average of 34 species per year have been listed as threatened or endangered under the Endangered Species Act (ESA). This number of listings, which does not reflect all the species that are threatened or endangered, is limited by FWS staff resources. Vertebrate species dominated the list during the first three years of the program, but plant species (48 percent) and invertebrates (13 percent) now comprise a greater proportion of the listed biota.

Candidate Species. While the listing rate has increased with time, the number of candidate species has remained constant. Of 3,500 candidate species, 59 percent are plants, 27 percent are invertebrates, and 14 percent are vertebrates.

Distribution Patterns. Listing data indicate broad distribution patterns of threatened and endangered species. Associations of threatened and endangered species with land types occur in broad natural land-cover categories, including forest, range, barren, wetland, and water. To date more threatened and endangered species are associated with forest ecosystems than with other categories. Animals comprise most of the species associated with forest environments-a pattern observed consistently among all land types, except barren land, where plant species dominate. Invertebrate species are associated with aquatic environments, particularly water systems embedded in forested landscapes. The following information pertains to 667 species that were officially listed in August 1992:

Forest Habitats. Within forest habitats, evergreen types contain more listed threatened and endangered species than mixed or deciduous types. Among forest-associated taxa, more mammalian, avian, reptilian, insect, and plant species were found in evergreen types; these taxa comprised more than 65 percent of all listed species associated with forest habitats. Mollusks and crustaceans were the only taxa where the majority of forest species were associated with deciduous types, although these taxa only comprise a small proportion (14 percent) of forest-associated species.

Shrub and Brush Rangeland. Of all listed threatened and endangered species with rangeland habitats, 63 percent were associated with shrub and brush rangeland. Predominant taxa were plants and fish, which comprised 119 of the 170 species associated with this cover type. Eleven out of the 12 reptile species associated with rangeland habitats were from shrub and brush lands.

Barrens. More than one-fourth of the 667 threatened and endangered species were associated with barren land habitats. Half were plants; and most of these were associated with natural exposed rock habitats. The predominant animal taxa were mammals, birds, and reptiles, particularly in affiliation with beach or dune environments.

Aquatic Habitats. Water associations are dominated by fish and mollusks. A third of listed mammals and birds were found in open water environments. Many more threatened and endangered species were associated with lotic (actively moving water as in rivers or streams) compared to lentic (still water as in lakes, ponds or swamps) systems; this pattern is consistent among all taxa. No more than 25 percent of the listed species affiliated with aquatic environments use lakes, reservoirs, bays, or estuaries.

Wetlands. Although wetland habitats supported fewer threatened and endangered species than other terrestrial or aquatic environments, this relatively rare habitat type supported a disproportionately high number of listed species. Wetlands comprise only 5 percent of the land base in the conterminous United States, yet 30 percent of listed animal species and 15 percent of listed plant species are associated with wetlands.

Factors Contributing to Endangerment. General factors believed to adversely affect threatened and endangered species include habitat loss or change; human overuse; interspecific interactions including disease, predation, and competition; and other natural causes. In 1993 habitat loss associated with land use intensifications was the predominant factor in species endangerment. More than 95 percent of the listed U.S. species had habitat loss or alteration indicated as a factor explaining the current status of the

species. Interspecific interactions, particularly those associated with introduced species, have adversely affected more than half the listed species.

Game and Nongame Species Groups

Historically state and federal wildlife managing agencies have placed more emphasis on documenting game species populations for management purposes. Consequently, very limited information exists on the status of nongame wildlife populations.

Invertebrates. The only group of invertebrates with fairly complete information is mussels. Of the remaining mussel species in North America, 73 percent are rare or imperiled, and 50 percent of all U.S. mussels are listed or proposed for listing under the Endangered Species Act.

Amphibians. Documented declines in local amphibian populations during the 1980s, both in the United States and worldwide, have led scientists to believe that some species are declining at rapid rates, some to the point of extinction. In the United States, the most extensive declines are in the Northwest.

Fish. Of the estimated 1,033 known full species of freshwater fish in North America, 74 to 103 are considered endangered, 85 to 114 are vulnerable or threatened, 101 to 147 are rare or of special concern, and 27 are believed extinct. Significant losses of native fish fauna have been documented in the Great Lakes (see Chapter 2), the upper Colorado River basin, the Illinois and Maumee rivers, the Chesapeake Bay (see Chapter 3), and aquatic systems in California, Oregon, Washington, and Idaho.

Birds. Birds came to the forefront as indicators of environmental health during the 1960s by focusing world attention on the detrimental effects of agricultural pesticides such as DDT. Since then much broader phenomena have been affecting birds: incremental, cumulative loss of habitat; increases in competitively superior populations of alien and exotic bird species; and increased predation by predators associated with human alteration of natural habitat.

Birds of Agricultural Lands and Grasslands. Over the past several decades, birds associated with agricultural lands and grasslands have shown downward population trends. In fact, native, endemic grassland birds have declined in the past 25 years more consistently and across a broader geographic range than any other group of birds. These trends are associated with removal of windbreaks and hedgerows; haying practices that disrupt nests in grasslands; reversion of abandoned farms and pastures to woodlands; use of agricultural chemicals; and increased predation.

Birds of Forestlands. Declines in many forest-dwelling bird populations are associated with forest fragmentation which reduces preferred habitat below a sustainable threshold. Population declines have been most dramatic and pervasive in forests fragmented by development and those invaded by the brownheaded cowbird, a nest parasite, and predators.

Wading Birds and Shorebirds. Colonial wading birds were seriously depleted by commercial exploitation in the early 1900s. Since then all but the endangered wood stork have recovered as the result of human intervention and are stable or even expanding their range. Most species of shorebirds also have made substantial recoveries, with the exception of a few federally listed species, yet they remain vulnerable because of their reliance on beaches and wetlands which continue to be developed (see Chapter 3).

Birds of Prey. Raptors such as the bald eagle, osprey, peregrin falcon, and Cooper's hawk have responded favorably to federal protection and restrictions on the use of DDT and other pesticides. Other raptors are declining because of lost critical habitat elements. The sharp-shinned hawk, after notable recovery, has declined for unknown reasons in the past decade.

Ducks. Duck populations have declined significantly since the early 1970s and remain below the long-term (1955-1993) mean. In 1993 the estimated breeding population of all ducks (excluding scoters, eiders, oldsquaws, and mergansers) was 26.3 million, an 11-percent decline from the 1992 estimate and 18 percent below the long-term average. The primary reasons for the decline are loss of wetland habitat and degradation of adjacent upland habitat.

Geese and Swans. Most goose and swan populations in North America are numerically sound and, with few exceptions, have increased substantially since the late 1960s. Exceptions include greater white-fronted goose, brant, and the Atlantic and Southern James Bay populations of Canada geese which have been marked by low population indices in recent years.

Terrestrial Mammals

Trend data on terrestrial mammals are available primarily for game species and furbearers-those with commercial value. Dramatic shifts have occurred in the distribution and abundance of many large mammals since colonial settlement, particularly in the eastern United States. Moose, elk, bison, wolves, mountain lions, and black bear once were widely distributed in the East. Today the white-tailed deer is the dominant species; elk and bison were extirpated, although elk have been reintroduced in some areas; black bear and moose are restricted in distribution; and the gray wolf and eastern mountain lion are endangered species that occur in small, geographically restricted populations.

White-tailed deer have increased dramatically in the eastern United States since 1900, and in some parts of the country are considered excessive. Wild turkeys have shown large population increases in the East in the past 30 years, a result of restocking programs and favorable landscape changes.

The western part of the country has a more diverse group of large mammals, including white-tailed deer, mule deer, elk, pronghorn, bighorn sheep, mountain goat, and moose. After declining in the 1970s, white-tailed and mule deer populations are now increasing or stable. Pronghorn populations, which once numbered between 30 and 40 million until reduced to 13,000 animals in the 1920s, have increased dramatically over the past 20 years, as a result of regulation of hunting, improved range condition, and increased habitat.

Trend data for small mammals are available for rabbits and squirrels, but for a limited time frame. The eastern cottontail showed downward trends between the 1960s and 1980s. Squirrel populations declined slightly in the Midwest, and increased in the northeast and southern United States during the same period.

Population trends vary for furbearers. Muskrat populations continue to be abundant throughout their North American range, with fluctuations generally following wetland conditions. Raccoons, beaver, and opossum all have shown recent population increases, while fox and mink population are declining in some parts of the country. Bobcat populations increased in the 1950s and 1960s, but have since

declined, and the coyote is increasing and expanding in many regions despite intensive control programs.

Of the non-game North American mammals, bat species have experienced serious population declines due primarily to human destruction of bat colonies and their roosting and hibernating habitat. Six of the 42 species of bats that are found in the United States and Canada are endangered, including the Hawaiian hoary bat, Ozark and Virginia big-eared bat, Mexican long-nosed bat, grey bat, and Indiana bat. In Guam, only 500 Marianna fruit bats are present in the island's sole remaining colony. The decline of the fruit bat in Guam and throughout Micronesia is due primarily to unrestricted hunting and poaching.

Marine Mammals

At least 35 species of marine mammals range in the western North Atlantic Ocean and the Gulf of Mexico, including 32 species of whales, dolphins, and porpoises, four seal species (harbor, harp, ringed, and gray seals), and the West Indian manatee. Of these, seven species are listed as endangered; sei, sperm, blue, fin, humpback, and North Atlantic right whales and the West Indian manatee. The migratory stock of coastal bottlenose dolphins is considered depleted as a result of a 1987-1988 massive die-off. The status of the remaining stocks is under investigation.

At least 50 marine mammal species occur in U.S. waters of the eastern North Pacific Ocean and eastern tropical Pacific, including walrus, polar bear, sea otter, 36 species of whales, dolphins and porpoises, and 11 species of seals and sea lions. Nine species are listed as threatened or endangered. Right whales in the eastern North Pacific are at critically low levels; only five to seven sightings have been made in the past 25 years. The eastern North Pacific California gray whale, on the other hand, has recovered to 21,000 animals, near to or surpassing its historical abundance level. Some northern west coast pinniped populations, such as Steller sea lion, northern fur seal, and harbor seal, have declined in the last 20 years, while during the same period, other pinniped populations farther south, such as harbor seal, California sea lion, northern fur seal, and northern elephant seal, have increased. Human activities may be affecting the recovery of species such as humpback whales; females with calves are abandoning traditional nearshore calving and calf-rearing habitat near Maui, Hawaii, possibly in response to repeated human interference or contact associated with whale-watching excursions.

The Hawaiian monk seal, abundant when Europeans discovered the Hawaiian Islands, is an endangered species today because of overexploitation. In 1993 progress in managing the recovery of this species varied among the main breeding populations.

Unusual Marine Mammal Mortalities

Over the past few years, several unusual mortality events have impacted marine mammal populations, particularly in harbor seals, humpback whales, and bottlenose dolphins along the Atlantic and Gulf of Mexico coasts. Over 500 dead harbor seals were recovered along the New England coast during an influenza outbreak in 1979-1980, and a smaller outbreak of the same disease occurred in 1982. Although high levels of mortality didnot occur, phocine distemper was detected in harbor seals in 1992. The same disease was responsible for the death of over 17,000 seals in Europe in 1988.

In late 1987 a group of 14 humpback whales apparently died as a result of the presence in prey species of a biotoxin associated with algal blooms. Three different mortality events affected bottlenose dolphins in the last few years. A major mortality event affected the coastal migratory stock on the east coast in 1987-88, reducing the population by over 50 percent and, as a result, leading to the stock's listing as depleted. In the winter and spring of 1990, mortality levels of bottlenose dolphins along a portion of the Gulf coast were much higher than usual, and in 1992, over 100 dead bottlenose dolphins were recovered from a 2-county area of Texas within a 2-month period.

Sea Turtles

Sea turtles are highly migratory and are found in all but the coldest of the world's oceans, but nesting is restricted to tropical and sub-tropical beaches. Seven of the eight species of sea turtles, including the loggerhead, green, leatherback, hawksbill, Kemp's ridley, olive ridley, and black turtle occur in U.S. waters. Under the Endangered Species Act, all marine turtles, with the exception of the flatback turtle found in Australia, are listed as endangered or threatened. The loggerhead, black turtle, and olive ridley are listed as threatened throughout their U.S. ranges, as is the green turtle, except the Florida breeding population which is listed as endangered. The leatherback, hawksbill, and Kemp's ridley are listed as endangered. The National Marine Fisheries Service (NMFS) has authority to protect and conserve sea turtles in their marine environment, and the Fish and Wildlife Service maintains jurisdiction over sea turtles in their nesting habitat. See Table 86 in Part II for information on sea turtle populations.

Fishery Interactions, Habitat Degradation, and Sea Turtles

On January 1, 1993, a United Nations moratorium on high-seas driftnet fisheries went into effect and halted incidental, driftnet bycatch of sea turtles in the North Pacific. Bycatch rates were monitored on driftnet vessels by U.S., Canadian, Japanese, Korean, and Taiwanese scientific observers. Although the effect of driftnet fisheries on U.S. sea turtle populations is unknown, the moratorium is viewed as a positive step toward the recovery of threatened and endangered species. Sea turtles are also killed incidentally in other commercial fisheries:

. In Hawaii, turtles are caught and killed in pelagic longline fisheries targeting tunas and billfishes. During late 1993 research techniques were formulated to determine mortality rates of turtles incidentally caught by longline.

. Prior to implementation of turtle excluder device (TED) regulations in the Gulf of Mexico and U.S. Atlantic, as many as 11,000 sea turtles were killed annually in offshore shrimp trawls, and an unknown number are killed in inshore shrimp trawls. To reduce incidental mortality, the use of TEDs is now mandated for most of the Atlantic and Gulf of Mexico shrimp and summer flounder trawl fisheries. Studies indicate that TEDs, which enable 97 percent of turtles to escape shrimp trawls and avoid drowning, only minimally reduce shrimp catches. Research continues on the development of new TED designs to exclude small turtles and to work in small trawls.

Additional concerns involving sea turtles include the following:

. Coastal development, including seawalls and bulkheads, which reduces and degrades nesting and foraging habitats;

. Commercial gill net and non-shrimp trawl fisheries that incidentally capture and kill turtles;

. Encounters with motorized vessels which cause mortality through propeller and hull collisions;

. Floating tar balls and plastics, which if eaten can cause mortality; and

. A fibropapilloma tumor disease in green turtles that may affect the recovery of green turtle populations world-wide.

Program Accomplishments

In 1993 President Clinton signed the Convention on Biodiversity and the North American Agreement on Environmental Cooperation, emphasizing the importance of conservation and sustainable use of biodiversity on global and continent-wide scales. The Council on Environmental Quality issued a report with recommendations for incorporating biodiversity into National Environmental Policy Act analyses and environmental management. Federal agencies, meanwhile, continued the groundwork for reauthorization of the Endangered Species Act, in addition to sponsoring a number of biodiversity programs. A sampling follows.

Convention on Biological Diversity

The President signed the Convention on Biological Diversity on June 4, 1993. This comprehensive agreement marks an unprecedented worldwide commitment to stem the loss of the earth's species, their habitats, and ecosystems. By joining with other countries in implementing the convention, the United States can continue to take a lead role in ensuring that future generations can enjoy the economic, health, nutritional, aesthetic, and other benefits derived from the world's rich biological inheritance.

The convention calls for the nations of the world to address conserving biodiversity now, before it is too late. The convention seeks to achieve this objective through provisions that encourage nations to:

. Take Domestic Actions to Conserve Biodiversity. Adopt sound conservation regimes, similar to those that the United States has long had in place. Nations are called on to establish national parks and protected areas, promote the recovery and rehabilitation of threatened species, and expand research and training, public education, and use of environmental impact assessments.

. Promote Sustainable Use of Biodiversity. The convention recognizes that biodiversity conservation is not an end to itself and that biodiversity can be used sustainably to benefit mankind. By emphasizing measures to realize the economic and other benefits of biodiversity in a sustainable manner, the convention encourages countries to commercialize and conserve biodiversity.

. Promote Benefit Sharing Through International Cooperation. Recognizing that much of the planet's biodiversity lies in less developed countries, the convention promotes a concept whereby benefits stemming from the productive use of genetic resources flow back to those countries that act to conserve biological diversity and provide access to their genetic resources. These benefits-determined on the basis of voluntary agreements among all concerned-could take the form of monetary

compensation for the use of genetic resources, or as technology transfer programs in training, participation in research, cooperative work programs, and improved access to information.

. Participate in a Global Forum on Biodiversity. The biodiversity convention creates a global forum for countries to share their experience and knowledge on the conservation and sustainable use of biodiversity. This forum should prove to be an effective mechanism for implementing convention provisions and maintaining the long-term focus on biodiversity issues.

North American Agreement on Environmental Cooperation

On September 14, 1993, the President and the heads of Canada and Mexico signed the North American Agreement on Environmental Cooperation. The agreement supplements the environmental provisions and objectives of the North American Free Trade Agreement (NAFTA), further ensuring that trade liberalization will not come at the expense of environmental protection. The agreement's chief objective is to foster cooperation on continent-wide environmental issues and to improve and ensure enforcement of national environmental laws. The agreement creates a new forum for environmental ministries of the United States, Canada, and Mexico to develop approaches regarding the conservation and protection of wild flora and fauna and their habitat.

This historic agreement creates a new Commission for Environmental Cooperation, with an independent secretariat that will receive complaints from citizens about any non-enforcement of environmental protection laws and will ensure openness to the public. The degree of state, local, and public participation in this new Commission will be unprecedented.

Endangered Species Act and Species Recovery

The federal land agencies continued to promote species recovery under the ESA.

Bald Eagle Recovery. The bald eagle was listed by the Fish and Wildlife Service as an endangered species in 1967. At that time eagle population declines were attributed to habitat loss, uncontrolled shooting, and exposure to the pesticide DDT in prey species. Bald eagle recovery has been a significant success. In the Northern States Recovery Region, the bald eagle nesting population grew at an average annual rate of 10 percent between 1988 and 1993. Throughout the lower 48 states, nesting pairs increased from 417 in 1963 to more than 4,000 pairs in 1993. Preliminary data indicate that this trend is continuing. Cooperative agreements with private landowners have aided in this success, and similar activities will continue.

Using NEPA to Conserve Biodiversity

In a 1993 NEPA report, the Council on Environmental Quality set forth general principles for incorporating biodiversity into NEPA analyses and environmental management (see Chapter 10). These principles form a bridge between concerns for biodiversity and the management approaches needed to achieve it.

. Take a big-picture or ecosystem view. Sites exist not in ecological isolation, but in the context of local and regional ecosystems.

. Protect communities and ecosystems. Look beyond individual species to the community interrelationships and natural processes that sustain the species.

. Minimize fragmentation. Connection links or threads of viable habitats allow wider distribution of species than a series of isolated habitats.

. Promote native species. Non-native species often are successful in competing and may actually displace native biological diversity.

. Protect rare and ecologically important species. Protection of keystone species can have positive overall effects on ecosystem structure and function.

. Protect unique or sensitive environments. Areas unique or substantially different from their surroundings may be ecologically critical.

. Maintain or mimic natural ecosystem processes. Ecosystems cannot function without the internal processes that shape and maintain them.

. Maintain or mimic naturally occurring structural diversity. Activities that change the naturally occurring number and type of specialized ecological niches should be avoided.

. Protect genetic diversity. To preserve genetic adaptations, species should be maintained in natural habitats or reintroduced in ecologically similar areas.

. Restore ecosystems, communities, and species. Take advantage of opportunities to restore ecosystems and to replace native species that have been lost from parts of their range.

. Monitor for biodiversity impacts; acknowledge uncertainty; be flexible. Be willing to learn and manage adaptively and sequentially as a substitute for lack of information.

Concluding that scale is the central issue in the ecosystem approach, the report encourages land managers to select boundaries that consider all resources subject to non- trivial impacts.

Red-Cockaded Woodpecker Recovery and Management Planning. The red-cockaded woodpecker, a small woodpecker native to southern pine forest habitats, was listed as an endangered species by the Fish and Wildlife Service in October 1970. The primary reason for population declines was habitat loss, specifically the loss of the open pine forest and longleaf pine savannah habitats needed by the bird for foraging and nesting. At the time of listing, fewer than 4,000 colonies remained throughout the species 13-state range. In 1993 the Fish and Wildlife Service issued its -Strategy and Guidelines for the Recovery and Protection of the Red-Cockaded Woodpecker on National Wildlife Refuges- to address the conservation needs of colonies on FWS lands. Most colonies, however, are found on other agency and private lands. To further address recovery needs, the FWS has entered agreements with other agencies and private industry to allow for large-scale conservation and management of this species. The first such agreement was with Georgia-Pacific, which developed a plan to combine woodpecker protection with industrial forest management. The Georgia-Pacific approach provides for scientific research on 4.2 million acres along with numerous habitat protection and management actions that will allow for red-cockaded woodpecker colonies on company land in perpetuity. The plan provides mechanisms to achieve both environmental and business goals.

Planning Natural Communities Conservation Program (NCCP). Throughout California increasing numbers of plant and animal species and unique habitat types have experienced significant declines, prompting concern for the future of the state's natural heritage. To address these concerns, California established the NCCP program by enacting the Natural Community Conservation Planning Act of 1991 which provides for region-wide planning to protect natural resources while allowing compatible and appropriate growth and development. The initial NCCP effort was a Coastal Sage Scrub (CSS) NCCP, a partnership by the California Department of Fish and Game (CDFG), the U.S. Fish and Wildlife Service, and the county governments within the CSS habitat area. The CSS community was chosen in part because of the anticipated listing of the coastal California gnatcatcher, which occurs almost exclusively in CSS, generally at the lower elevation coastal areas of Southern California where much of the pressure for growth is occurring. When the gnatcatcher was listed as threatened on March 25, 1993, an estimated 2,600 pairs remained in California. The FWS issued a special rule to allow economic development to continue while providing gnatcatcher habitat protection, enhancement, and restoration through conservation planning. The use of an ecosystem approach to conserve and manage the CSS community will benefit many other animal and plant species of concern within the community. By addressing the conservation needs of species that are possible candidates for listing through an ecosystem approach such as the NCCP, land agencies may avoid the ultimate listing of these species.

Species Delistings and Reclassifications

The primary goal of the Endangered Species Act (Act) is to ensure the survival of species and the habitats upon which they depend and to recover the species to the point at which protection under the act is no longer warranted. In 1993 the FWS delisted-removed from the Lists of Endangered and Threatened Wildlife and Plants-the following species:

. Tumamoc globeberry (Tumamoca macdougalii) in Arizona and Mexico;

. McKittrick pennyroyal (Hedeoma apiculatum) in New Mexico and Texas, and

. Spineless hedgehog cactus (Echinocereus triglochidiatus var. inermis) in Colorado and Utah.

As a result of cooperative conservation actions-federal, state, tribal, and private-as well as intensive surveys to locate additional populations, these species are now considered secure.

Proposed for delisting were the following species:

. Cuneate bidens (Bidens cuneata), a Hawaiian plant, and

. Arctic peregrine falcon (Falco peregrinus tundrius), which nests across northern North America, including Alaska, and winters in Central and South America.

In 1993 two species met the criteria for reclassification identified in their respective recovery plans and were reclassified from Endangered to Threatened:

. Louisiana pearlshell (Margaritifera hembeli), a freshwater mussel in Louisiana; and

. Siler pincushion cactus (Pediocactus sileri) in Arizona and Utah.

The FWS proposed reclassification of the following five species from Endangered to Threatened status in 1993:

Hawaiian hawk (Buteo solitarius), endemic to Hawaii;

MacFarlane's four-o'clock (Mirabilis macfarlanei), a plant in Idaho and Oregon;

Pahrump poolfish (Empetrichthys latos), an Arizona killifish;

Small whorled pogonia (Isotria medeoloides), an orchid scattered among several eastern States and Ontario, Canada; and

Virginia round-leaf birch (Betula uber), which has been established at 20 new locations since its rediscovery in 1975.

In addition to actions taken for these U.S. species, the FWS reclassified the Nile crocodile (Crocodilus niloticus) from Endangered to Threatened throughout its African range and proposed the delisting of three species of kangaroos on mainland Australia-the eastern gray (Macropus giganteus), western gray (M. fuliginosus), and the red (M. rufus) kangaroos. Although the FWS does not prepare and implement recovery plans for foreign species, status reviews provide data to enable the agency to assess whether delisting or reclassification is appropriate.

Endangered Species and Clean Water

A third of all federally listed threatened and endangered species rely on aquatic ecosystems for their survival, and their recovery depends in part on Clean Water Act provisions that restore and maintain the chemical, physical, and biological integrity of the nation's waters. As the lead agency with water restoration and maintenance responsibilities, the EPA administers programs that contribute to the protection of listed species.

Marine Mammal Protection and Recovery

Before passage of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA), the only protective measures for marine mammals were through the International Whaling Commission (IWC), and those were only for certain depleted large whales. All marine mammals are now protected by the MMPA and some by the ESA. Other management responsibilities are addressed in the Magnuson Fisheries Conservation and Management Act, which extends the jurisdiction of the MMPA throughout the U.S. exclusive economic zone.

The International Dolphin Conservation Act of 1992 amended the MMPA and provided for the State Department to enter into an agreement to establish a global moratorium prohibiting the harvest of tuna through the use of purse seine nets that entrap dolphins or other marine mammals.

The MMPA governs the management of marine mammals in the United States. Prior to the 1988 amendments, fisheries could only be granted permits to take marine mammals incidentally if scientific evidence proved that all stocks of marine mammals involved in the fisheries were at or above their optimum sustainable population (OSP) level. Because sufficient evidence regarding the status relative to OSP only exists for a few stocks, this system of management caused problems and economic losses. In

1988 the MMPA was amended to allow a 5-year interim exemption period, during which time the incidental taking of marine mammals was permitted in commercial fishing operations. During this time it was expected that additional information would be gathered on the species involved and on the nature and extent of their interactions with different fisheries.

In 1993 the NOAA National Marine Fisheries Service (NMFS) initiated several actions to restore or protect marine mammal populations:

Northern right whale. On May 19, 1993, the NMFS proposed critical habitat pursuant to the 1991 final recovery plan for the northern right whale: a foraging area in Great South Channel; a foraging/nursery area in Cape Cod Bay; and the only known calving area in U.S. waters located in coastal southeastern United States. Also in 1993 the NMFS convened several meetings to focus on the northern right whale in southeastern waters and formed the Southeastern U.S. Right Whale Recovery Plan Implementation Team.

Gulf of Maine (GME) Population of Harbor Porpoise. On January 7, 1993, the NMFS proposed the GME harbor porpoise population for listing as threatened under the Endangered Species Act primarily because of the level of harbor porpoise bycatch incidental to commercial gillnet fisheries that extend in coastal and offshore waters from at least the Bay of Fundy, Canada, south throughout the eastern United States to North Carolina. Average annual bycatch of harbor porpoise in the entire GME gillnet fishery was as high as 2,400 to 1,700 individuals for 1990 and 1991, respectively, but down to about 900 individuals in 1992 and 1993.

Steller Sea Lion. On February 22, 1993, the NMFS completed a Population Viability Analysis for steller sea lions in Alaskan waters. Based on observed declines in the number of adult females at rookeries between 1985 and 1992, the results suggest that the next 20 years may be critical to the population as individual rookeries may be reduced to very low levels. After 20 years rookeries may disappear, and extinction probabilities could increase rapidly. Other studies indicate serious declines in the number of pups at major rookeries in Alaska. On April 1, 1993, as part of its recovery efforts for the steller sea lion, the NMFS proposed the following critical habitats: major rookeries, haulouts and associated terrestrial, air, and aquatic zones in Alaska; three aquatic foraging areas in Alaska; and major rookeries and associated air and aquatic zones in California and Oregon.

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Chapter 7: ENERGY AND TRANSPORTATION

Today every other advanced nation is more energy efficient than we are. We can do better and we will. Our long-term strategy invests more in pollution prevention, energy efficiency, solar energy, renewable energy, environmental restoration and water treatment.

President Bill Clinton

In the last decade of the 20th century, environmental quality is linked to the by-products of energy production and transportation. The burning of fossil fuels in power plants, industry, and motor vehicles accounts for most of the air pollution in the United States. Coal-burning power plants are major generators of sulfur dioxide, nitrogen oxide, and carbon dioxide-pollutants that contribute to acid rain and perhaps to global warming. Coal mining and the transport and handling of petroleum products release more greenhouse gases into the atmosphere. Current laws have significantly helped abate these sources of pollution, but more is being done to improve air quality. In 1993 the Clinton administration supported ongoing efforts and proposed new initiatives.

Energy

Energy policies that are sensitive to environmental concerns can reduce the impacts of energy production and consumption on air, land, and water resources. The Energy Policy Act of 1992 provides federal support for programs that improve energy efficiency and increase the use of renewable energy in the building, industrial, transportation, and utility sectors. Programs emanating from the National Energy Policy Act have the potential to reduce greenhouse gases significantly, improve air quality, and minimize wastes. In 1993 the Clinton administration ensured increased federal funding for energy programs that sustain and improve the environment, while stimulating jobs and the economy. The administration is highlighting natural gas, alternative fuel vehicles, energy efficiency, and renewable energy.

Conditions and Trends

Over the last two decades, the United States has reduced energy-related air pollutant emissions, primarily with controls mandated by the Clean Air Act and its 1990 Amendments. These reductions are having a direct and beneficial effect on problems of acid rain, poor urban air quality, and global warming (see Chapter 1. Air Quality and Climate). Other environmental legislation, such as the Clean Water Act, the Resource Conservation and Recovery Act, and the Oil Pollution Act of 1990, also impact the way energy is produced and used. Under these laws the nation is making significant progress in resolving the land and water conflicts created by energy production and use.

Carbon Dioxide Emissions

In 1990 U.S. carbon dioxide emissions totaled 1.3 billion metric tons (carbon equivalent), a 13-percent increase over 1970 and a reflection of the increase in population and energy use in that period. Despite a 22-percent increase in population during the same period, per capita emissions of carbon dioxide decreased by 7 percent (see Chapter 1. Air Quality and Climate).

Civilian Nuclear Waste

The Department of Energy is developing a waste-management system for spent nuclear fuel and high-level radioactive waste from both civilian and government facilities. The system will consist of a geologic repository, a monitored retrievable storage (MRS) facility, and a transportation system to support storage and disposal. The Nuclear Regulatory Commission will license civilian facilities. A conceptual design has been completed for the MRS, which will handle and store fuel until it is permanently disposed of in a repository. Scientific feasibility investigations continue at Yucca Mountain in Nevada, which Congress has selected as a candidate site for the geologic repository. The construction of an underground Exploratory Studies Facility is underway at Yucca Mountain to enable scientists to examine the geologic, hydrologic, and geochemical characteristics of the potential host rock.

Energy Resources and Reserves

U.S. domestic energy resources are extensive and diverse. Coal, oil, natural gas, and uranium occur in significant quantities within the nation's borders. Unconventional sources, such as coal-bed methane and oil shale, are potential energy sources for the future. Renewable energy sources, such as geothermal, solar, and wind, are available and the cost-effectiveness of the technologies used to harness them is rapidly improving.

Oil and Natural Gas

The combined oil-equivalent proved reserves of crude oil, natural gas, and natural gas plant liquids in the United States increased each year from 1949 to 1968, when, for the first time, production exceeded net additions to proved reserves. Except for Alaska's North Slope reserves in 1970, the trend for proved reserves has been downward, falling to 58 billion barrels oil equivalent in 1992. Through 1992 (the most recent year for which data are available), crude oil cumulative production of 167 billion barrels from 39,335 fields equaled 87 percent of estimated ultimate recovery. For the past seven years, total new discoveries have been relatively low, reflecting a similar trend in exploratory drilling that followed the crude oil price collapse of 1986. Three areas, Texas, Alaska, and the Federal Offshore, accounted for 74 percent or 350 million barrels of total new discoveries for 1992.

Natural gas cumulative production of 838 trillion cubic feet from 34,909 fields equaled 83 percent of ultimate recovery. Areas with the largest proportion of the 7,048 billion cubic feet of total new discoveries for 1992 were Texas, the Gulf of Mexico Federal Offshore, Oklahoma, Colorado, and Wyoming. At the beginning of 1993 estimated proved reserves of crude oil were 23.8 billion barrels, which is sufficient to meet U.S. demand at current levels for ten years. Estimated proved reserves of natural gas were 165 trillion cubic feet, also sufficient to meet U.S. demand at current levels for ten years.

Coal

The estimate of the demonstrated reserve base of coal in the United States was 474 billion short tons. Although recoverability rates differ from site to site, an estimated 56 percent of the demonstrated

reserve base is recoverable. Coal reserve estimates by sulfur content indicate that, on a nationwide basis, both demonstrated and recoverable coal reserves are equally distributed among low-sulfur, medium-sulfur, and high-sulfur categories. About 83 percent of the nation's low-sulfur reserves are located in the West, while the interior region of the United States (Arkansas, Illinois, Indiana, Iowa, Louisiana, Kansas, Kentucky, Missouri, Oklahoma, and Texas) contains 66 percent of the high-sulfur reserves, Appalachia 26 percent, and the West 8 percent.

Uranium

Uranium reserves with forward costs (those yet to be incurred in production) of up to $30 per pound totaled 295 million pounds of uranium oxide, of which 40 percent is in Wyoming and 20 percent in Texas. Smaller reserves are located in Arizona, California, Colorado, Idaho, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, and Washington. Potential resources and speculative resources in the $30-per-pound category totaled 2.2 billion and 1.3 billion pounds, respectively.

Recoverable Oil and Gas

Under general conditions of historical prices and existing technology, estimated remaining recoverable oil and gas resources are 140 billion barrels of crude oil and 1,188 trillion cubic feet of natural gas. Alaska, including its federal offshore region, accounts for one-third of all U.S. crude oil resources. The Gulf Coast and the federal offshore region of the Gulf of Mexico accounts for half of U.S. natural gas resources, with Alaska's onshore and offshore regions accounting for one-fifth.

Energy Production

Historically fossil fuels have accounted for the bulk of domestic energy production, which in 1993 totaled 66 quadrillion Btu. Coal accounted for the largest share of domestic energy production before 1951 and, after a long hiatus, again in 1982 and in 1984 through 1993. In the interim crude oil and then natural gas dominated domestic energy production.

Petroleum

Production of crude oil and refined products accounts for a fourth of U.S. annual energy production.

Domestic. During much of the 1950s and 1960s, domestic petroleum production capacity exceeded demand to such an extent that the federal government implemented production pro-rationing and import ceilings to protect domestic production. By the 1970s with petroleum demand increasing, the average productivity of wells began to decline, and oil production leveled off. Increases in Alaskan production at the end of the 1970s and through 1988 partially counteracted declines in the lower-48 production. In 1989 and 1990, however, Alaskan production declined, and 1993 production was the lowest in 35 years.

Imported. Over 40 percent of the crude oil used in the United States is imported-much of it from politically volatile regions of the world such as the Persian Gulf, which holds two-thirds of known global

oil reserves. The U.S. Department of Energy (DOE) expects demand for petroleum to increase, even if petroleum prices rise. Because of the steady decline in domestic production, much of this increase will be met by greater use of imports in the future.

Natural Gas

Natural gas accounts for one-fourth of U.S. annual energy production. In 1993 gross withdrawals of natural gas, at 22.93 trillion cubic feet, increased for the seventh consecutive year and exceeded the previous production record of 22.85 trillion cubic feet in 1974. Consumption of natural gas is expected to increase considerably over the next 20 years, with the bulk of gas demand met by domestic supplies. Texas, Louisiana, and Oklahoma, the largest producers of natural gas, accounted for 62 percent of total U.S. production in 1993. Most of the withdrawals came from onshore wells and offshore wells in state waters.

Coal

U.S. coal reserves are the largest in the world and supply 32 percent of annual U.S. energy production. Nine-tenths of domestic coal use is for electricity generation at large power stations. Consumption of coal for electricity generation is expected to grow as demand for electricity rises over the next two decades. Except for wartime increases in the 1940s, coal's share of domestic energy resource production declined from the 1920s to the early 1960s, when the trend reversed itself in response to higher prices for other, cleaner fossil fuels. Reflecting a growth in domestic coal consumption and U.S. coal exports, coal production rose by 68 percent from 1970 to its peak in 1990. In 1993 production was down from the 1992 level, partly as result of a 1993 strike by the United Mine Workers of America against member companies of the Bituminous Coal Operators' Association.

Coal Types. Of all coal production, bituminous and subbituminous coal account for 90 percent of the share in 1993. Despite its superior burning qualities, anthracite, mined in northeastern Pennsylvania, accounts for a diminishing share of total coal production, down from 8.9 percent of total coal production in 1949 to 0.4 percent in 1993. Lignite accounts for the remainder of coal produced. In 1993 a number of programs supported the development of more environmentally benign new technologies. Advancements in natural gas and superclean coal technologies can prevent pollution and increase energy efficiency.

Superclean Coal. The Clean Coal Technology (CCT) Program, initiated in 1986, demonstrates advanced, cleaner burning coal technologies through government-industry collaboration. Following five competitive rounds, the program currently has 45 active projects. In 1993 government funding totaled $2.7 billion with industry more than matching that amount with $4.1 billion. Early projects demonstrated major reductions in sulfur dioxide and nitrogen oxides. By mid-year 23 projects were generating data on advanced technologies that can reduce emissions from new and existing coal-burning, electricity-generating power plants. Such technologies will help utilities meet control requirements for sulfur and nitrogen oxides under the Clean Air Act Amendments of 1990. Current projects focus on advanced power generation technologies that are not only superclean in terms of pollution reduction but also significantly more efficient than today's systems. Higher efficiencies mean lower emissions of carbon dioxide from power plants.

Mine Locations. More coal is mined east of the Mississippi River than in the West, but the West's share of total production has increased almost every year after 1965. By 1993 western mines had increased by a factor of 15 to 420 million short tons or 44 percent of the total coal production. The growth in western coal resulted partly from concerns about sulfur dioxide emissions and increased demands for low-sulfur coal, which is concentrated in the West. Surface mining, with its higher average productivity, also is more prevalent in the West.

Nuclear Material Uses

From 1949 through 1967, the Atomic Energy Commission was the major purchaser of uranium, which it used largely for military purposes. Domestic production grew from 0.4 million pounds of uranium oxide in 1949 to 35 million pounds in 1960. As military stockpiles grew, purchases and domestic production declined. From 1966 through 1976, production fluctuated between 21 million and 27 million pounds, until subsequent orders for new nuclear power plants led to renewed growth.

Uranium Production Peak. Production of uranium peaked in 1980 at 44 million pounds only to fall again in response to cancellations and postponements of nuclear power plants. The reasons for the decline in uranium production were a decline in demand, buildups in inventories at electric utilities, and foreign competition. By 1993 production had fallen to 3.1 million pounds. Nonetheless the contribution of nuclear electric power to electricity net generation increased almost every year from the late 1950s through 1992, only to decline in 1993.

Nuclear Power plants. The number of nuclear power units in all stages of planning, construction, and operation in 1993 was 116, one fewer than in 1992. The 1993 total is well below the total of 226 in 1974. Many planned units have been cancelled, and since 1977 no orders for new units have been announced, primarily because of environmental, safety, and economic concerns. The future of nuclear power is linked to resolution of these issues.

Surface Mining Control and Reclamation

Compared to underground coal mining, surface mining generally costs less, is safer for miners, and results in more complete recovery of coal. It also results in more extensive disturbances of the land surface, which can cause serious environmental problems unless the mined land is carefully reclaimed.

During the early years of coal mining, reclamation of mine sites and facilities was not required by law. In the 1930s, as surface mining became more widespread, the idea of mandatory environmental protection and reclamation gained ground. By 1945 several states had enacted laws to regulate the coal mining industry, but the war demand for coal took priority over environmental concerns with little consideration given to mined land reclamation. Mining pits were not refilled; dangerous highwalls were left exposed; trees and other vegetation were dumped down slopes below mines; and topsoil was buried or allowed to wash away, clogging streams with sediment. Slopes stripped of their vegetation eroded rapidly, and landslides were common. Contaminated water collected in mine pits and acid drainage frequently polluted rivers and streams.

After 1945 more coal-producing states instituted regulatory programs, but these varied in scope giving operators in states with less stringent rules an economic advantage, generally at the expense of

environmental quality. In the 1970s the increased demand for coal for electricity generation, the continued lack of uniformity among state surface mining programs, and the increase in unreclaimed land and associated pollution of water and other resources led to a demand for nationwide regulation of surface coal mining. The result was the Surface Mining Control and Reclamation Act (SMCRA) of 1977.

Current mining activities are conducted under stringent rules for protecting and restoring the environment. The abandoned mine land provisions of SMCRA have mitigated many of the past problems associated with surface and underground mines. For example, from 1977 through 1992, more than 200 miles of dangerous surface mine highwalls were eliminated and 800 potentially dangerous landslides were reclaimed. Mine drainage and pollution problems, caused by both surface and underground mines, have been mitigated at one-third of 1,500 abandoned U.S. mine sites with known water quality problems. Over 14,000 openings to abandoned underground mines have been filled or closed, and 2,000 land subsidence problems have been corrected. Fire, which plagues many abandoned underground mines and above-ground coal outcrops and coal refuse piles, has been eliminated on half the sites discovered. Progress to date of environmental cleanup of coal mining sites has been considerable, but continued work is required as previously unidentified problems are discovered.

Renewables

After World War II, the United States relied heavily on petroleum, natural gas, and coal. In addition to having high energy contents, these fuels were inexpensive, readily available, and easy to transport. During the 1970s, however, price increases for petroleum and natural gas, concerns about the stability of supplies, and environmental factors stimulated interest in alternative sources of energy.

Sources. In 1993 renewable energy sources, including hydropower, solar, bio-mass, municipal solid wastes, wind, and geothermal, provided nearly 10 percent of U.S. annual energy production, with hydro-power as the leading source.

Uses. Although half of U.S. renewable energy goes to generate electricity, the nation also uses biofuels for transportation and solar energy to heat buildings and water. The cost of renewable energy has continued to decline. With continued support of renewable energy programs over the next 20 years, increased use of biofuels will meet more of U.S. energy demand.

Electricity

The net generation of electricity increased during the 1950-1993 period, registering year-to-year declines only twice-during the 1982 recession and again in 1992. The growth rate of electricity net generation slowed, however, over the 44-year period. From 1950 through 1979, the annual rate of growth averaged 7 percent, whereas from 1980 through 1993, it averaged only 2 percent. After the mid-1970s, coal and nuclear fuels provided increasing shares of input for electricity generation, displacing petroleum and natural gas. In 1993 electricity net generation totaled 2.9 trillion kilowatt hours, up 3 percent from the 1992 level.

Sources. Coal continued in 1993 to fuel most of the generation, accounting for 55 percent of the total. The natural gas share accounted for 8.9 percent of electricity net generation, a slight decrease from 1992, whereas petroleum-fired production, while accounting for only 3.5 percent of production,

increased due to lower petroleum prices. Nuclear-based generation, accounting for 21 percent of generation, declined for the first time in 13 years, down 1.5 percent from 1992. Conventional hydroelectric power, accounting for 9.3 percent of the total was up 10 percent from generation in 1992, as the persistent drought in the West subsided. Hydroelectric pump storage, however, was down 4 percent because the energy used for pumping exceeded the generation. Geothermal and other renewable energy sources accounted for 10 billion kilowatt hours (9.6 percent of the 1993 electricity net generation), up 9 percent from 1992.

Changing Structure of the Electric Power Industry

Electricity is produced by electric utilities and nonutilities-industrial manufacturers that produce electricity for their own use and non-utility generators that recently have begun providing electricity and other services for sale to others. The electric utilities share of electric power generation increased steadily from 1970 to 1979, when it reached 97 percent. Their control of the industry depended largely on their position as owners and operators of the wholesale and retail electric power transmission and distribution system.

New technologies are contributing to competition in the industry, more recently by lowering capital costs of new generation, increasing thermal efficiency, and reducing the time needed to construct the facilities. These are also increasing efficiencies for transmission systems.

By 1992 the electric utilities share of generation declined to 91 percent. Reasons for the change include: reasons:

Public Utility Regulatory Policies Act of 1978 (PURPA). This act encourages nonutilities to enlarge their small portion of electricity generation by guaranteeing a market for the electricity they produce from qualified facilities and by exempting them from previous legislative restrictions.

State Regulations. More stringent regulatory review of utility costs by state regulators in the 1980s, in some cases, made utilities reluctant to build new electricity generating capacity. When projected capacity needs did not materialize due to conservation and low growth, state regulatory agencies did not allow some utilities to recover capital costs. This made utilities reluctant to initiate new capital-intensive generation projects. Non-utilities and their investors were willing to accept the risks.

Increased Costs. Rapidly increasing costs to utilities of generating electricity resulted from increased fuel prices and increased construction and operating costs of generating plants due in part to more stringent environmental requirements and safety regulations.

Energy Sources. Electric utilities produce the majority of their electricity by burning coal, and their second major source of energy is nuclear power. In contrast nonutilities produce half of their electricity from natural gas-fired boilers and a third from renewable fuels, including wood and waste. In part this difference is due to the cogeneration opportunities for non-utilities and the requirement of PURPA that utilities buy power from non-utilities and co-generators.

The process of change in the structure of the electric power industry has not yet run its course; the outcome will depend on the resolution of several issues. For nonutilities the issues are continued viability-meeting commitments to provide electricity and satisfying financial obligations-and reliability-

extending their participation into the wholesale power transmission grid without degrading its reliability. Utilities must adapt to the new, more competitive circumstances of the electric power industry, to recover the costs of their current generation resources. The issue facing regulators and lawmakers is to ensure that electricity is produced to meet the demands of all sectors in an economically efficient, environmentally sound manner.

Uses. Electricity use in the U.S. economy continues to increase. By 2010 an estimated 41 percent of the primary energy consumed in the United States will be used to generate electricity, up from 36 percent in 1992.

Energy Consumption

The U.S. economy more than doubled during the 1950-1973 period. Likewise, energy consumption doubled during the same period, increasing from 33 quadrillion Btu in 1950 to 74 quadrillion Btu in 1973. The domestic energy market was dominated by rapid growth in petroleum and natural gas consumption, which more than tripled during the period. After the 1973 oil price shock, energy consumption fluctuated, influenced by changes in oil prices, changes in the rate and growth of the domestic economy, and concerns about the effects of energy use on the environment. The post-1973 low point of energy consumption, 71 quadrillion Btu, occurred in 1983 during a period of high oil prices. The highest level of energy consumption, 84 quadrillion Btu, occurred in 1993, when oil prices were low.

Indicators: Energy Intensity of the Economy

The energy intensity of the U.S. economy can be measured with the use of the following indicators:

Consumption per GDP. The relationship between total energy consumption and real gross domestic product (GDP) is a traditional indicator of the energy intensity of the economy. In 1970 a total of 23 thousand Btu of energy was consumed for each 1987 dollar of GDP. Higher energy prices in the early 1970s led to increases in energy efficiency and a significant restructuring of the energy-intensive activities of the manufacturing sector. The energy intensity of the economy as a whole fell in 1986 to 17 thousand Btu per 1987 dollar, where it remained through 1991. In 1992 and 1993, the energy intensity of the economy was 16 thousand Btu per 1987 dollar.

Consumption per Capita. A second indicator of energy intensity is per capita consumption. Throughout the 1960s and early 1970s, the growth of end-use energy consumption exceeded the growth of the population. Per capita consumption rose from 212 million Btu in 1960 to a peak of 285 million Btu in 1973. Thereafter per capita consumption trends were downward to as low as 225 million Btu in 1983. In the 1990s low petroleum prices encouraged energy use, and end-use energy consumption rose to 245 million per capita in 1993.

Americans depend on energy to produce goods and services in the following end-use sectors:

Residential and Commercial. This sector accounts for 26 percent of U.S. end-use energy consumption. Of total residential and commercial use, 38 per-cent is currently in the form of electricity. Much of the growth in energy consumption during the 1950-1993 period occurred in the residential and commercial

sector. It leveled off in the late 1970s and early 1980s in response to higher energy prices but rebounded to record high levels between 1986 and 1993 when energy prices were lower.

Industry. The industrial sector accounts for 38 percent of end-use energy consumption, relying on a mix of fuels. Of the energy it consumes, industry uses 70 percent to provide heat and power for manufacturing. This sector uses 25 percent of the nation's petroleum, half of that as feedstocks. Energy consumption by the industrial sector increased throughout the 1960s and in 1973 reached 32 quadrillion Btu. Of the three end-use sectors, industry has been the most responsive to the turmoil in energy markets after the 1973-1974 embargo. In 1979 industry consumption peaked at 33 quadrillion Btu. In the early 1980s, it declined, reaching a 16-year low of 26 quadrillion in 1983, as a slow economy restrained industrial consumption. Economic growth in the late 1980s spurred industrial demand for energy. Despite slow economic growth in the 1990s, industrial energy consumption has continued to increase. Industrial energy demand is expected to continue to grow over the next two decades. At the same time, energy use per dollar of economic output is expected to decline as a result of energy efficiency improvements.

Transportation. The United States devotes 36 percent of its end-use energy consumption to the transport of people and goods. Virtually all of this energy consists of petroleum products used to power automobiles, trucks, ships, airplanes, and trains. The transportation sector accounts for two-thirds of U.S. petroleum use. Over the past 44 years, the transportation sector's consumption of petroleum more than tripled, but growth was slower in the 1980s and early 1990s than in previous decades. While the use of alternative-fueled vehicles will rise in the future, petroleum fuels likely will continue to dominate transportation energy use for the next 20 years (see Transportation section in this chapter).

Energy Efficiency

Over the past two decades, the nation has learned to use energy more efficiently in every sector. Between 1985 and 1991, DOE surveys showed that many manufacturing groups became more energy efficient. The following factors increase or facilitate improvements in energy efficiency:

. Improved Energy Management. Better equipment maintenance, improved insulation, lowering thermostats, routine energy audits, and conservation goals improve energy management;

. Computers. Computer controls and instrumentation allow companies to track energy use and keep processes running at optimal efficiency;

. Heat Recovery and Exchange. Lower stack temperatures, installation of waste-heat recovery boilers, and condensate recovery contribute to heat recovery and heat exchange;

. Cogeneration. Improvements in electricity cogeneration include switching to gas turbines; and

. Technological Advances. Increases, renovations, and turnover in production capacity commonly incorporate technological advances and improved operational techniques.

Commercial Conservation

In 1992 (the most recent year for which data are available), energy conservation features in commercial heating, ventilation, and air conditioning systems were in use in 2.6 million of the 4.8 million commercial buildings in the United States. Conservation features associated with lighting occurred in 1.2 million buildings. Estimates of energy intensity in the commercial sector (available for the years 1979, 1983, 1986, and 1989) show a 20-percent reduction in energy consumption per square foot of floorspace (or gross energy intensity) and a 23-percent reduction in gross energy intensity per hour of operation. The trend toward reduced commercial energy use was most apparent in buildings built after 1945, and of these, the lowest energy consumption per square foot per hour of operation was found among those built in the 1980s.

Residential Conservation

Energy consumption in residential structures is also more efficient today. In 1990 (the most recent year for which data are available), household energy consumption totaled 9.2 quadrillion Btu, 13 percent less than in 1978. This decline in consumption shows the effect of past energy conservation efforts in space heating, water heating, air conditioning, appliances, and building construction and insulation. In housing units constructed in 1980 or after, the average heating intensities (Btu per square foot and per heating degree-day) of all main-source heating fuels were significantly lower than in homes constructed in the 1950s and 1960s.

Fuel Efficiency

The average fuel rate of passenger cars, which make up a sizeable portion of the U.S. motor vehicle fleet, began to improve in 1974. It increased throughout the 1970s and 1980s, reaching an average of 22 miles per gallon in 1991 and 1992 (the most recent year for which data are available). Many believe the Federal Corporate Average Fuel Economy (CAFE) standards, which require automobile manufacturers to meet fleet fuel rate minimum averages, played a major role in the increase in fuel efficiency rates.

Program Accomplishments

In 1993 the President requested increased funding for energy programs with environmental components. For the first time, the DOE budget for energy efficiency and renewable energy programs would pass the billion dollar mark, with a proposed 34-percent increase over FY 1993. This included a 75-percent increase for programs in alternative-fuel vehicles. The administration continued support for programs authorized by the Energy Policy Act of 1992 to increase efficiency and reduce waste in industry, buildings, and transportation. In 1993 federal programs helped reduce greenhouse gases, improve air quality, and minimize waste.

Renewable Energy

Funding for research and development (R&D) in the renewable energy supply is increasing. R&D can accelerate application of emerging renewable energy technologies, reduce costs, improve energy and environmental performance, and make these technologies competitive in the marketplace.

The President requested $30.4 million for the wind energy program, including funding to complete the National Wind Technology Center near Rocky Flats, Colorado, which will provide world-class technology and testing facilities for private and government wind energy research. The National Renewable Energy Laboratory (NREL) is relocating its wind technology staff to the new center to support wind industry development in rapidly expanding domestic and international markets. Static and dynamic blade fatigue testing facilities will support the next generation of wind turbines that will be developed in the mid-1990s and into the next decade. Full turbine test capabilities will support 500 kW of large utility-scale wind turbines.

Geothermal Energy

The DOE is supporting research on cost reductions for generating electricity from geothermal energy resources. Instruments that reduce drilling costs have been developed for the harsh conditions of geothermal wells to increase the information available from deep in the earth. Such instrumentation enables drillers to make cost-saving decisions. Analysts have refined and validated geothermal resource computer models to better predict energy recovery and prolong the lifetime of the resource. With commercialization of these technology advances, geothermal energy could become an economically sound renewable energy alternative at more locations around the United States.

Biomass

The DOE Regional Biomass Energy Program supports efforts to increase the production and use of biomass energy resources. These include waste-to-energy conversions, using wood, municipal and agricultural wastes, and biogas-to-energy conversions of materials in landfills, animal waste lagoons, and wastewater. Initiatives cosponsored by the DOE, EPA, and USDA Soil Conservation Service assist animal producers in minimizing the environmental impacts of their operations on air and water by utilizing biogas from lagoon systems to supplement energy requirements.

Biofuels. The DOE is collaborating with the U.S. Department of Agriculture to produce alternative fuels from renewable biomass resources. The goal is to produce biofuels that are competitive with petroleum-based fuels by the year 2000.

Energy Efficiency

Alternative Fuels and Vehicles

The President has directed the administration to accelerate the acquisition and use of new vehicles that operate on fuels other than gasoline and the conversion of current vehicles to alternative fuels. Many of the vehicles will join the federal fleet.

Hybrid Vehicles. The DOE initiated the Hybrid Propulsion System Development Program as a 5-year cost-shared cooperative program to develop and demonstrate hybrid-electric propulsion systems for light-duty vehicles. Such vehicles have the potential to satisfy EPA Tier II emission standards, improve fuel economy by 100 percent, and offer performance competitive with conventional vehicles.

Clean Cities Program. The Clean Cities program was initiated by DOE to achieve goals established by the Energy Policy Act of 1992 and to provide a supporting network for DOE alternative fuels programs, including the Public Information Program, the State and Local Incentives Program, the Replacement Fuels Program, and the Certification of Training Program. Additionally Clean Cities seeks to advance the Clean Air Act Amendments of 1990 and other federal legislative and regulatory initiatives to promote nationally the public and private sector uses of alternative fuel vehicles. Specifically the program is designed to accelerate and expand the use of alternative fuel vehicles (AFVs) in communities throughout the country and to provide refueling and maintenance facilities for their operation. Through the establishment of locally-based government and industry partnerships combined with federal guidance and leadership in vehicle acquisitions, Clean Cities seeks to build a sustainable, nationwide alternative fuels market. Encouraging the commercialization of AFVs and the development of alternative fuel infrastructure both play an important role in building the foundations for a transportation future that is more diverse, energy efficient, and environmentally friendly. Since September 1993 the DOE Clean Cities program has implemented over 680 partnerships in 26 cities throughout the country. These cities feature over 26,000 AFVs with the potential to displace 600,000 barrels per year of oil and reduce emissions by up to 5,000 metric tons per year.

Partnership for a New Generation of Vehicles

On September 29, 1993, President Clinton and Vice President Gore joined with the Chief Executives of the Big Three U.S. Automakers to announce the formation of a new partnership aimed at strengthening U.S. competitiveness by developing technologies for a new generation of vehicles. The government and the U.S. Council for Automotive Research (USCAR), representing Chrysler, Ford, and General Motors, have launched development efforts to address the following three specific, interrelated goals:

Goal 1. Significantly improve national competitiveness in manufacturing;

Goal 2. Implement commercially viable innovation from ongoing research on conventional vehicles; and

Goal 3. Develop a vehicle to achieve up to three times fuel efficiency of today's comparable vehicles (i.e., the 1994 Chrysler Concorde, Ford Taurus, and Chevrolet Lumina).

To address Goal 3, research and development is needed in the technology areas leading to vehicle and propulsion system improvements. These technologies may include among others: advanced lightweight materials and structures; energy efficient conversion systems (e.g., advanced internal combustion engines, and fuel cells); energy storage devices (such as advanced batteries, flywheels, and ultracapacitors); more efficient electrical systems; and waste heat recovery. A concept vehicle is expected to be available in approximately six years and a production prototype in approximately ten years.

Advanced Battery Consortium. The DOE established the U.S. Advanced Battery Consortium (USABC) in 1991 to develop future generations of electric vehicles with increased range and performance. The consortium has signed contracts with teams of battery developers for nickel/metal hydride, lithium polymer, and lithium/iron disulfide battery systems. The contracts include six Cooperative Research and Development Agreements (CRADAs) and five subcontracts. Prototypes are expected to be pilot tested in 1995.

DOE funding for energy efficiency programs increased in 1993 in recognition of the importance of improved energy efficiency in industry, buildings, and transportation.

Industrial Energy Audits. Through an expansion of the DOE Industrial Energy Audit Program, 25 Energy Analysis and Diagnostic Centers (EADCs) are now in operation at U.S. universities. Managed through western and eastern regional field offices, the EADCs perform energy audits of small-and medium-sized manufacturers, identifying cost-effective ways to improve plant energy efficiency. To date 4,900 EADC audits, conducted at a cost of $25 million, have resulted in $485 million in energy savings to industry. Collaborating with utilities to improve audit techniques, the DOE extends the usefulness of audit data to a broader industrial audience. A new DOE-EPA energy and waste audit program will expand the audit process to look at energy efficiency and at ways to reduce or reuse waste at industrial facilities.

NICE3. The National Industrial Competitiveness through Energy, Environment, and Economics (NICE3) program demonstrates new applications for technologies to increase energy efficiency and reduce wastes through pollution prevention. With cost-sharing by the DOE, EPA, states, and industries, NICE3 has completed notable projects such as recovery and reuse of methanol in hydrogen peroxide production, recovery and reuse of paint manufacturing wastewater, and ultrasonic cleaning of dishes and tanks. Each project reduced wastes by at least 90 percent and improved energy efficiency. In 1993 Motorola Corporation and Sandia and Los Alamos Laboratories worked on a joint, cost-shared project to modify a specific soldering machine for the production of printed circuit boards that totally eliminated the use of CFCs and the requirement for post-soldering cleaning.

Advanced Turbine Systems. The DOE, Electric Power Research Institute (EPRI), and Gas Research Institute (GRI) are conducting a research program with major turbine manufacturers. The goal is to develop the next generation of utility and industrial gas turbine systems with a 15-percent improvement in thermal efficiency, low nitrogen oxide emissions, and low-cost electricity. The focus is on developing natural gas turbine-based systems which are more environmentally sound than oil-or coal-based turbines. In 1993 the Low Emission Turbine Consortium began funding the GM Allison Gas Turbine Division to modify combustors operating in NOx nonattainment areas. Headed by the Santa Barbara County Air Pollution Control District, the consortium includes DOE, Gas Research Institute, Southern California Gas, and Chevron Corporation.

Energy-Efficient Buildings. The DOE supports R&D on a range of energy-efficient building technologies and the development of computer models that target energy conservation. Advanced technologies include the following:

. Electrochromic smart windows that benefit the heating, cooling, and lighting of buildings;

. Innovative materials such as power-evacuated panels;

. Variable-conductance building- appliance insulations;

. Non-CFC refrigerators that use 60 percent less energy than those of 20 years ago;

. Very-high-frequency lamps that will replace fluorescent lamps; and

. Optimum-spectrum lamps that produce increased proportions of visible light.

The following are new developments:

. A CFC/HCFC ratiometer to identify the many different types of refrigerant mixtures that will be used during the transition away from CFCs;

. A flame-quality indicator that detects when oil-heat system efficiencies begin to degrade; and

. A deposition process that revolutionizes the application of Electrochromic films to glass and plastic windows and substantially reduces film costs.

To encourage the acceptance of energy-efficient technologies and practices and the use of renewable energy in buildings, the DOE sponsors market-conditioning activities that provide information on the demonstrated performance of these options. Other efforts include developing cost-effective building energy efficiency codes, product-testing procedures, labeling, and appliance and equipment efficiency standards. The DOE promotes energy efficiency by the federal government-the nation's largest energy consumer-through a Federal Energy Management Program. The goal is a 20-percent reduction in energy use per square foot in federal buildings by the year 2000, with government savings of $400 million annually.

Integrated Resource Planning. The DOE increased funding for Integrated Resource Planning (IRP) to improve analytical capabilities and support state and local resource planning programs. Utilities use IRP to determine the mix of demand and supply-side resources to meet customer electricity demand. Through improvements in energy efficiency and other noncapital alternatives, IRP techniques can reduce the need for new power plants.

Transportation

Transportation is the circulatory system of the U.S. economy. Moving goods and people not only supports the quality of life at home but maintains U.S. competitiveness in world markets. At the same time, transportation is a major user of energy and can generate significant adverse impacts on human health and the environment. Unwanted side effects are products of the following factors:

. Combustion of fossil energy in transportation vehicles;

. Land development associated with transportation networks and facilities;

. Noise, vibration, and structural damage caused by transportation vehicles;

. Transportation accidents and human injuries and fatalities; and

. Spills of wastes and hazardous materials.

Underlying these problems is an American society that has become increasingly more mobile in passenger and freight transport, traveling greater distances, and spending a greater proportion of disposable income on transportation.

Conditions and Trends

The transportation system of the United States, among the largest in the world, includes 196.9 million automobiles, vans, and trucks operating on 3.9 million miles of streets and highways; 78,000 transit vehicles operating on those streets, as well as more than 7,000 miles of subways, streetcar lines, and commuter railroads; 207,000 airplanes operating in and out of 18,300 airports and landing fields; 18,000

locomotives and 750,000 railcars operating over 113,000 miles of roadway; 20 million recreational boats, 31,000 barges, and over 8,000 U.S. ships, tugs, and other commercial vessels operating on 26,000 miles of waterways, the Great Lakes, and the ocean; and 1.5 million miles of intercity and distribution pipelines.

Infrastructure of the U.S. Transportation System

Highway Transportation. The size of the U.S. highway system has not changed appreciably for many years, although the proportion of the system with higher service levels continues to increase. Most roads are now paved, and a larger proportion of multiple-lane facilities serve larger volumes of traffic. Nationwide mileage of poor pavement conditions declined throughout the 1980s and continues to do so in the 1990s; however 234,500 miles of roads remain rated poor or mediocre.

. Indicators of Highway Conditions. These include vehicle speed, trips made, miles traveled, and congestion. Speeds, which dipped sharply in 1973 with implementation of a nationwide 55 miles-per-hour limit, have since increased to levels just below those of earlier years. The percent of urban interstate mileage and peak-hour travel experiencing congested conditions continued to rise in 1993, with more than half of this congestion in urban areas with populations exceeding 1 million persons. Over the past 20 years, total traffic on the nation's highways increased 78 percent, while combination truck traffic increased 143 percent.

. Bridges. The number of bridges on public-use roads totaled 573,846 in 1993, a figure which has changed little over the years. Bridge conditions have stabilized with reduced numbers of structurally deficient bridges, down from 134,100 in 1990 to 111,512 in 1993.

Air Transportation. The United States has more airports than the rest of the world combined, with 5,545 public-use airports and 12,301 private airports in 1992. However, approximately 60 percent of all commercial passengers enplane through only 25 airports. Few performance indicators have been developed for the air transportation system. Average delay per takeoff or landing was 7.1 minutes in 1992 and is projected to be 8.4 minutes in 2002. and rising in following years if improvements are not made.

Intercity Rail Transportation. The extent of the rail track network in the United States has been declining for decades, as railroads attempt to meet changing market conditions and improve financial viability. As a result, the density of traffic on the remaining freight rail network has increased significantly. While almost every large community in the nation is connected to the rail freight system, direct rail service to minor markets and some agricultural production areas has been significantly reduced. However, due to deregulation of the rail industry in 1980, the number of shortline railroads continues to grow. Between 1980 and 1989, 226 new railroads were established, comprising 21,028 miles of track. The railroads market share has increased in recent years, from 37.4% of revenue ton-miles in 1990, to 38.1% in 1993. Except in the Northeast Corridor between Washington, D.C., and Boston, Amtrak operates over the track of the freight railroads. The extent of trackage used for rail passenger service is less now than in the years prior to the formation of Amtrak in 1970. Amtrak still operates more than 25,000 route miles out of 523 stations crossing 45 states, but carries less than 2% of intercity passengers per year at a substantial per passenger subsidy ($40). In 1993, the railroad industry invested a record $4.2 billion in roadway, equipment, and structures.

Urban Transit. Among the various modes of urban transit service, motor buses lead are the most common transit vehicle, followed by vans, trolley buses, subways or heavy-rail transit, commuter rail, light-rail transit, automated guideway transit, cable cars, and tramways. The number of transit operators has been growing in recent years, but the average age of transit buses exceeds federally recommended average usable age by 20 to 35 percent.

Pipeline Transportation. Two primary categories of pipelines exist in the United States:

. Oil pipelines transport crude petroleum and various petroleum products, and

. Gas pipelines move natural gases and liquified petroleum gases.

The pipeline system is aging, and, although data are incomplete, concerns are rising regarding the effects of corrosion and erosion on pipe over time, which reduce its ability to support stress and higher pressures. Preventive actions such as frequent monitoring, corrosion control programs, and selective rehabilitation or replacement can be taken to offset the effects of aging. Some 19 percent of natural gas pipelines were built before 1950, while most liquid product lines were built after 1950.

National Travel

National travel has two main components-local and intercity. The comings and goings of household members in their daily activities of work, shopping, school, personal business, visits to friends, and recreational opportunities constitutes local travel, whether in a metropolitan setting (a city and its suburbs) or a nonmetropolitan, rural setting. Metropolitan travel makes up an increasingly large proportion of local travel each year, but over time the temporal pattern and purpose of metropolitan travel have changed. The tendency for work travel to peak abruptly in the morning and evening declined about 10 percent between the late 1960s and the early 1990s because of several factors:

. Decline in the Factory System. The trend away from manufacturing to service employment brought with it a decline in the factory system. It is less common for large numbers of employees at a central site to start and end work at the same time. The increase in smaller employment units is oriented to consumers, resulting in more weekend and evening employment, which tends to remove some workers from the otherwise traditional morning and evening rush hours;

. Extended Rush Hour. Commuters tend to travel before or after the peaks to miss the congested periods; and

. Flextime. Employees are opting for flextime schedules, in which they elect to work 10-hour, 4-day schedules or some alternative.

Work Travel. Several dominant factors have shaped U.S. work travel over the last several decades:

. New Jobs. A massive creation of jobs occurred in the 1970s and 1980s as babyboomers entered the work force;

. Women in the Labor Force. The entry of women into the labor force occurred in large numbers; and

. Suburban-to-Suburban Commute. The shift from a suburb-to-central-city pattern of work commuting to a predominantly suburban-to- suburban one followed the rise of suburban populations (see Chapter 8). With it came a parallel growth in commercial, retail, and overall employment in the suburbs.

Modal Shares. Statistics on modal shares of work commuting for 1980 and 1990 indicate that although the proportion of people traveling by automobile changed little, the number of vehicles increased, with a significant shift from ridesharing to driving alone. In 1990 an additional 22 million workers drove alone to work compared to 1980. Only 15 million workers drove with more than one worker in 1990, compared to 19 million in 1980. Mass transit passenger-miles increased 8 percent during the 1980s, partially reversing a trend that began before World War II, but mass transit's share of the commuting pie declined slightly. An estimated 4 percent of workers walked to work, while 0.4 percent bicycled, with both shares decreasing since 1980. One significant trend reversal was an increase in the number of people working at home since 1980; they now comprise 3 percent of all workers. This increase is predominantly in urban areas, indicating that the long-predicted growth of telecommuting may be finally happening. In contrast, the number of people who work at home remained stable in rural areas, where populations have declined for many years as people left farming. Causes for these shifts in modal shares include:

. Continuing increases in automobile availability;

. Continuing shifts to noncentral-city-oriented commuting;

. Declining real gas costs;

. Free parking provided by employers as a fringe benefit;

. Continuing shifts away from areas of the country traditionally disposed to transit toward areas where the automobile is dominant; and

. A society under great pressure that feels the need for more flexibility and speed.

Nonwork Travel. While work travel grew substantially from 1969 to 1990, personal and social travel grew even more. Declining household sizes and the more rapid growth in households relative to population, along with growing affluence, have spurred nonwork trip travel. Except for walking and the use of school buses and public transit for school-related trips, the automobile is almost exclusively form of nonwork transportation.

Local Travel in Rural Areas

As rural counties become bedroom communities of metropolitan areas, they also assume a more business and manufacturing orientation, both of which result in more dependence on personal travel. In 1991 one-third of the nation's rural counties focused on nonfarming land uses. Even though rural populations comprise only 22 percent of the U.S. population, and suburban populations constitute 46 percent, the rural orientation toward the automobile is about the same as the suburban.

Rural residents walk more and make fewer trips on public transit, which is generally not available. Trip-purpose distributions are similar for rural and suburban populations, with respect to trip-making and total miles of travel. Although rural work trips tend to be shorter than metropolitan trips, rural nonwork

trips are longer. The rate of ownership of driver's licenses in rural areas exceeds the national average, as does miles driven per driver. Automobile ownership rates per household are similar to suburban rates, but share of income spent on transportation differs. Rural residents spend about 20 percent of their income on transportation, while their generally more affluent urban neighbors spend only 17 percent. Demographic differences include the occurrence of more trucks than cars in rural areas and more used vehicles than new ones.

Intercity Travel. The automobile is the predominant mode of intercity transportation, followed by air, bus, and train. Business travel accounts for 16 percent of all intercity travel, and personal travel of varying types accounts for 76 percent. In recent years the trend is toward more frequent, shorter trips. Paralleling this trend is a tendency toward more weekend trips.

Freight Transportation. Over the past 40 years, tons and ton-miles (one ton of freight moved one mile equals one ton-mile) of freight moved have increased, as have tons and ton-miles per capita. However, in recent years tons moved per unit of GNP have declined, reflecting a shift in the national economy toward services, increasing use of lighter materials, and greater penetration of imported goods that have helped reduce domestic movement.

Modal Tonnage. In a comparison of modal ton-miles and revenue shares, trucking has 25 percent of ton-miles and receives 79 percent of revenues, while airfreight with only 0.3 percent of ton-miles receives 4 percent of revenues. The long-term trends in modal tonnage indicate the following:

. Rail Freight. For more than a decade, rail freight retained a 38-percent share, following a small decline from a 40-percent share at the start of the 1970s. Double-stack service (in which containers are stacked two high on the railcar) continues to grow vigorously;

. Trucking. In recent years trucking showed slow but continuous gains in shares, from 16 percent in 1950 to 28 percent in 1993;

. Rivers and Canals. Waterborne transport shares on rivers and canals grew rapidly from 5 percent in 1950 to a 10-percent share in 1970 and then to 12 percent in 1993; however during the time period the Great Lakes share dropped from 10 percent to 3 percent;

. Pipelines. Pipeline shares rose rapidly from 12 percent in 1950 to just under 25 percent in 1975 and then declined to a share of 18.5 percent in 1993; and

. Air. While small in comparison to other modes, air shares increased tenfold from 0.03 percent to 0.3 percent in 1993.

Energy Use

Following the first oil price shock in 1973, the transportation sector improved energy efficiency in almost every mode-passenger and freight. As a result total transportation energy use, which had been growing at a rate of 3.5 percent per year since 1950, increased by only 0.5 percent per year until the oil price collapse of 1986. The energy efficiency improvements that held the growth of energy use in check for a decade and a half have slowed to a crawl, stopped, and in some cases have been reversed. Despite price shocks and other stimuli, transportation remained nearly totally dependent on petroleum, about half of which is imported. The ability to switch to alternative fuels remains very limited. Even if all other sectors

cease using petroleum, substantial imports of petroleum would be necessary to satisfy transportation needs.

Since 1988 major legislation has been enacted to create an impetus for alternative fuel use in transportation. The Alternative Motor Fuels Act of 1988 and the 1992 Energy Policy Act provide incentives and fleet mandates for alternative fuel vehicle purchase and use. The 1990 Clean Air Act Amendments set forth clean fuels requirements for air quality nonattainment areas and allow states to opt into the California Clean Fuels Vehicle Program, which provides that 10 percent of car sales be Zero Emission Vehicles by 2003. Currently, battery-powered electric vehicles are the only vehicles that qualify. Although aimed at emissions reductions, these laws could have far-reaching effects on transportation energy sources and technology.

Energy Efficiency

In the transportation sector, energy efficiency is measured in several ways: fuel economy (miles traveled per gallon of fuel consumed) and energy intensity (Btu per vehicle-or passenger-mile for passenger modes and Btu per vehicle-or ton-mile for freight modes).

Cars vs. Trucks. Over the past 20 years, gains in energy efficiency for automobiles outweighed the increase in travel and slowed the growth of motor gasoline consumption. For 2-axle light duty trucks, however, the average fuel economy of the on-the-road fleet has improved more slowly, and fuel use rose because of increased numbers of trucks and increased truck travel.

Passenger Vehicles vs. Transit. Most passenger modes of transportation-automobiles, intercity buses, air carriers, and Amtrak-improved their energy intensity; transit buses and rail transit, which were already very efficient, did not.

Land vs. Water. Both heavy single-unit trucks and two-axle, four-tire trucks have shown improvements in energy intensity since 1965, as did combination trucks. Between 1981 and 1991, railroad energy intensity improved while energy intensity deteriorated for water transportation. As a result, in 1991 a ton-mile of rail freight required only 388 Btu-s, compared to 402 Btu for a ton'mile of freight transported by water.

Transportation and Noise

Over the years legislation and government efforts have helped mitigate transportation noise problems. According to a report published by the Organization for Economic Cooperation and Development (OECD), 0.4 percent of the U.S. population is exposed to noise levels more than 75 decibels (dBA) from highway vehicles, and 0.1 percent is exposed to similar noise levels from aircraft. Normally a noise level of 55 to 60 dBA is acceptable in residential areas.

Transport and Spill of Hazardous Materials

Each year the U.S. economy generates millions of tons of waste and hazardous materials. Many hazardous materials, such as gasoline, are critically important to the U.S. economy; however the transportation of these materials can present an environmental hazard, if careful attention is not given to packaging, routing, and other safety factors. In 1992 vessels caused 60 percent of all oil spill incidents into U.S. navigable waters.

Municipal Solid Waste: A New Transportation Business

The increase in the volume of municipal solid waste and the closure of local sanitary landfills have turned an environmental problem into a new line of business for railroads and long-haul trucks. Between 1987 and 1990, interstate transport of municipal solid waste quadrupled from New York exports alone. Between 1989 and 1990, New York and New Jersey exported 8 million tons, more than half of all municipal waste moved in interstate commerce. This volume equaled 400,000 truckloads of waste.

Historically trucks have dominated the market for transporting municipal solid waste, but with the increase in longer distance transportation, the market for rail is growing.

Program Accomplishments

In 1993 the Department of Transportation (DOT) continued implementing recent legislation to increase compatibility of the transportation system with the environment. The DOT also supported efforts by the Administration to develop policies on climate change, wetlands, and Clean Water Act reauthorization.

Intermodal Surface Transportation

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) established new and expanded programs for funding transportation-related environmental initiatives. It increased funding flexibility in the major capital funding categories and required more rigorous integration of environmental considerations into the planning process. In 1993 DOT efforts focused on communicating the environmental and planning philosophy of ISTEA to state and local governments, as well as to interested nongovernmental organizations. The DOT Federal Highway Administration (FHWA), the National Park Service, and EPA cooperated with the Surface Transportation Policy Project to cosponsor conferences on ISTEA and livable cities in 11 U.S. cities.

ISTEA provides for air quality improvement and transportation enhancement projects, such as scenic byways and recreational trails. More than half of the FY 1992 Congestion Mitigation and Air Quality Improvement Program funds were used for transit. FY 1993 obligations were set at $832 million for the air quality program and $332 million for transportation enhancement activities, such as historic preservation, nonmotorized transportation, scenic activities, and activities related to water quality.

Funding flexibility in the major capital programs of the 6-year ISTEA legislation ($155 billion in total authorizations through FY 1997) can lead to significant environmental benefits. In FY 1993 states and localities used $400.2 million in ISTEA funds for projects such as alternatively fueled bus and van purchases, intermodal facilities design and construction, and bicycle path construction. Funding for these projects was $302.4 million in FY 1992.

National Scenic Byways Advisory Committee. A 17-member National Scenic Byways Advisory Committee was created by ISTEA to make recommendations to the Secretary of Transportation on a National Scenic Byways program to encompass state and federal byways that warrant designation as National Scenic Byways and All-American Roads. The Advisory Committee presented a report to the

Secretary of Transportation and to the Congress in November 1993, recommending criteria for designation of National Scenic Byways and All-American Roads. A corridor management plan (which describes corridor operation, preservation, and enhancement) must accompany each nomination for a National Scenic Byway or All-American Road.

Transportation Planning. In 1993 the DOT issued regulations governing transportation planning at the metropolitan and statewide levels in 1993. A stronger tie between transportation planning, land use planning, and environmental planning promises solutions that, among other benefits, will account for cumulative and secondary impacts of transportation decisions.

Transit Benefit Programs. To help reduce congestion and promote air quality and energy conservation, the Federal Transit Administration (FTA) spearheaded a DOT effort to make permanent the authority federal agencies have to establish Transit Benefit Programs. The DOT proposal was enacted in 1993 as the Federal Employees Clean Air Incentives Act, which allows federal agencies to provide employees who commute by public transportation with transit benefits of up to $60 per month, tax-free.

Alternative Fuels Bus Program. Since the inception of its Alternative Fuels Program in 1987, the FTA has supported 61 alternative fuel bus projects with $165.8 million in federal funds. Local matching funds were $79.7 million, for a total investment of $245.5 million.

Travel Model Improvement Program. Many of the transportation planning tools used today were developed in the 1960s, before air quality and other environmental issues were consideration in transportation policy. DOT, DOE, and EPA, are sponsoring a program which aims to improve the quality of analytical tools used for transportation decision making at all levels. Use of computer models developed in this program predict travel demand, land-use development, and air quality impacts, thus ensuring consideration of environmental factors early in the planning and decisionmaking process.

Mobility Partners. EPA inaugurated the Mobility Partners Program in 1993 to encourage transportation infrastructure decisions that are also environmentally sound. Mobility Partners will provide:

. Training and technical assistance to state and local environmental officials, as well as citizens groups, seeking to understand transportation policy and analysis and their linkages to environmental requirements;

. Transfer of successful technologies and techniques for environmentally friendly transportation across individuals, companies, and governments; and

. Direct assistance to areas seeking cross-media approaches to transportation and the environment. Examples include the Milwaukee Project, involving the State of Wisconsin and the Center for Clean Air Policy, which integrates local transportation and Clean Air Act policy with concerns for reducing the risk of climate change, and a study of cross-media impacts to the Chesapeake Bay of pollutants from automobile exhaust and runoff from roadways.

Air Quality

In 1993 a number of air quality accomplishments were recorded in transportation-related programs.

Climate Change Action Plan. As described in Chapter 1, the Administration released in October of 1993 its Climate Change Action Plan, a series of over fifty actions intended to return emissions of greenhouse gases in the United States to their 1990 levels by the year 2000. The Plan includes a number of transportation sector strategies, such as measures to advance transportation demand management, and incentives for states (e.g., credits under the Clean Air Act for policies that also reduce emissions of greenhouse gases). The Plan calls for the promotion of telecommuting and fuel economy labels for tires. Of tremendous potential is a legislative proposal called Parking Cash Out that would reform the federal tax treatment of parking so as to provide employees with more flexible commute benefit choices. In total these actions are expected to reduce carbon equivalent greenhouse emissions in the year 2000 by eight million metric tons, about 7 percent of the reductions contained in the Plan as a whole.

Air Quality Report. In 1993 the DOT and EPA cooperated on activities related to transportation and air quality, completing the first report to Congress on transportation-air quality programs as required by the Clean Air Act. Clean Air Through Transportation: Challenges in Meeting National Air Quality Standards provides a status report on meeting the transportation provisions of the Clean Air Act Amendments of 1990 and the air quality provisions of ISTEA.

Air Quality Conformity Regulations. The DOT cooperated with the EPA to develop transportation air quality conformity regulations published in 1993. The FHWA and FTA, in cooperation with EPA and the National Association of Regional Councils (NARC), conducted seminars on implementing the regulations for transportation and air quality planners. NARC also developed technical information, including a manual on best modeling practices, under a grant from FHWA, FTA, and EPA. FTA developed guidance for performing quantitative air quality analyses that assist transit operators and their consultants in analyzing particulate matter (PM-10) impacts of new bus and rail facilities.

Transportation and Clean Air Conference. The FTA, FHWA, and National Governors Association cosponsored a conference in November 1993 which brought together state government and environmental officials to discuss progress by the states in meeting the transportation requirements of the Clean Air Act Amendments of 1990.

Smoke-Free Travel. Concerned with the quality of air quality of travelers, the DOT has set a goal of a smoke-free environment in all modes of public transportation. In 1992 the Assembly of the International Civil Aviation Organization passed a resolution calling for the phaseout of smoking on international flights by July 1, 1996. As a follow-up to the resolution, the United States proposed an agreement with Canada and Australia to ban smoking on all nonstop flights between these countries, and plans to work toward further agreements with other countries.

Bicycle and Pedestrian Programs. In 1993 DOT completed a number of case studies to be included in The National Bicycling and Walking Study, a report mandated by Congress. The goal set by the study is to double the modal share of bicycling and walking and to decrease pedestrian/bicycle accidents by 10 percent. The report outlines action plans for implementation at the local, state, and federal levels. As of June 30, 1993, states and localities used $425,504 in federal ISTEA funds in bicycle/pedestrian projects and $10.3 million in incidental projects, such as bicycle/pedestrian improvements that are part of highway projects. One half of the ISTEA transportation enhancement funds have been used for bicycle projects. In 1993 DOT also published materials for promoting bicyclist and pedestrian safety.

Railroad Programs. To address the environmental and social impacts of alternative transportation systems such as railroads, the Federal Railroad Administration (FRA) published two annotated bibliographies: Transportation and the Environment and Environmental Externalities and Social Costs of Transportation Systems.

. High Speed Rail. The Administration has proposed funding for high speed rail technology research to develop the next generation of passenger rail by improving existing system components and promoting innovative concepts. The goal is to transform the economics of high-speed rail systems by reducing start-up costs and annual operating expenses making high speed rail a more attractive alternative to state and private sponsors.

. Environmental Impact Analysis. In 1993 the DOT issued a Draft Environmental Impact Statement for a project to electrify the New Haven-Boston segment of the Northeast Corridor (NEC). The project would complete electrification of the Amtrak NEC from Boston to Washington, D.C., reducing Boston-to-New York travel time to less than three hours.

Aviation Noise. The Airport Noise and Capacity Act of 1990 set national aviation noise policy and provided for transition to a quieter all Stage 3 commercial airplane fleet by December 31, 1999. The DOT's Federal Aviation Administration (FAA) implementing regulations provide for interim compliance dates and annual reporting by foreign and domestic operators. These reports indicate that as of December 31, 1993, Stage 3 aircraft constituted 62.4 percent of the combined domestic and foreign carrier fleets of large turbojet airplanes operating to and from U.S. airports. This compares favorably with a Stage 3 fleet mix of 52 percent based on the 1992 reports from operators.

Hazardous Materials Transportation. In 1992 and 1993 the DOT issued a number of rules to implement federal hazardous waste legislation such as the Hazardous Materials Transportation Uniform Safety Act (HMTUSA) and the Oil Prevention Act of 1990 (OPA).

. Marine Pollutants. On November 5, 1992, the DOT issued a final rule amending hazardous materials regulations by listing and regulating, in all modes of transportation, those materials identified as marine pollutants by the International Maritime Organization. The requirements took effect on October 1, 1993.

. Hazmat Training. DOT Final Rule HM-126F, published on May 15, 1992, established training requirements for all persons involved in the transportation of hazardous materials. The rule required hazmat employers to complete employee training and testing by October 1, 1993.

. Registration of Shippers and Carriers. DOT Final Rule HM-208 was published on July 9, 1992, requiring all persons involved in the transportation of certain hazardous materials to file and pay an annual fee. This fee funds the emergency response grant program.

. Emergency Grants. DOT Final Rule HM-209, published on September 17, 1992, implemented Public Sector Training and Planning Grants. In 1993 the DOT's Research and Special Programs Administration (RSPA) awarded emergency planning and training grants to 47 states and territories and prepared transportation awards for disbursement to Indian tribes.

. Oil Spill Prevention and Response. The RSPA published an interim final rule in February 1993 to implement the OPA. The rule strengthens release prevention by subjecting the bulk transportation of unregulated oil to the RSPA regulations issued under HMTUSA. The rule protects the environment from

oil spills by requiring carriers to improve oil spill prevention efforts and emergency response plans and capabilities. The rule was controversial because the Federal Water Pollution Control Act (FWPCA) definition of oil includes nonpetroleum oils such as vegetable oils. On June 16, 1993, RSPA published an interim final rule that creates new requirements for implementing provisions of FWPCA and keeps HMTUSA and FWPCA requirements separate. This rule also applies to response plans for nonpetroleum oils.

. Marine Transportation and Oil Pollution. The Oil Pollution Act of 1990 expanded the role of the federal government in the prevention of oil spills, providing for cleanup of spills and compensation for public and private damages. As a DOT agency, the U.S. Coast Guard administers the law in cooperation with the NOAA and EPA. For a description of these programs, see Chapter 3: Wetlands and Coastal Waters.

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Chapter 8: Risk Reduction and Environmental Justice

Poor neighborhoods in our cities suffer must often from toxic pollution. Cleaning up the toxic wastes will create new jobs in these neighborhoods for those people and make them safer places to live, to work, and to do business.

President Bill Clinton

Although pollution affects all people, no matter where they live, direct exposure to pollutants and other environmental hazards are disproportionately distributed. Some studies have indicated that low-income, racial and ethnic minorities are more likely to live in areas where they face environmental risks.

Risk Reduction

Actions to reduce environmental risks will depend on analysis of toxic substances and of how they are created by the flow of materials in the U.S. economy (see Chapter 9: Environmental Economics). The variety of materials used to manufacture the goods that have become an essential part of modern society-machines, housing, roads, cars, packaging, and other consumer products-has increased over the years. The impacts of these uses on the environment are increasing and may disproportionately impact minorities and low-income communities in proximity to the manufacturing processes.

Solid and Hazardous Wastes

As material flows increase, the waste products from extraction, processing, use, and ultimate disposal of materials also increase. Only a combination of change in industry practice, new technology development, shift in material use, and change in consumer behavior will change the growing residuals-producing trend. Otherwise current environmental problems may worsen since the ability of the environment to absorb waste products is limited.

Since the earliest days of U.S. industrial development, substantial volumes of waste have been produced and disposed of in ways that created problems for current and future generations. Wastes generated in the home or workplace were swept away, buried, or poured down drains or directly into streams, rivers, lakes, and oceans. Some were sold as fill for uneven ground or marsh. Much was burned in local stoves or community incinerators, and even more was dumped in backyards, backlots, and rural backroads.

The major development in solid and hazardous waste management in 1993 was continued groundwork on congressional reauthorization of the Resource Conservation and Recovery Act (RCRA), as revised by the Hazardous and Solid Waste Amendments of 1984, and of the Superfund legislation.

<u>Managing Municipal Solid Waste</u>

Many areas of the United States face serious problems in safely and effectively managing the waste that they generate. As the nation generates more trash than ever before, the limits to traditional waste management practices become obvious. Many landfills and combustors have closed, and new waste disposal facilities are difficult to site. Some communities are paying premium prices to transport waste

long distances to available facilities. Other communities have found creative solutions through source reduction and recycling programs, but much still needs to be done.

The generation of municipal solid waste grew steadily between 1960 and 1990 (the latest date for which data are available), from 88 million to 195 million tons per year. Per capita generation increased from 2.7 pounds per day in 1960 to 4.3 pounds per day in 1990.

By the year 2000, total municipal solid waste generation is projected to be 222 million tons per year with a per capita waste generation of 4.5 pounds per day. These projections, which represent a slowdown of waste production rate, hinge on hard-to-predict variables, such as the following:

. Demographic changes,

. Economic factors,

. Consumer preferences such as lighter packing materials,

. Social trends such as decline in newspaper readership,

. Source reduction such as backyard composting,

. Packaging reduction, and

. Production of more durable goods.

Resource recovery-materials removed from the wastestream for recycling or composting-has gradually increased from 7 percent of the municipal solid waste generated in 1960 to 17 percent in 1990. Projected recovery rates are 20-30 percent in 1995 and 25-35 percent in the year 2000. To achieve these recovery rates, some products will have to be recovered at rates of 50 percent or more, and the nation will have to achieve substantial composting of yard trimmings.

Incinerators or combustors handled 30 percent of the municipal solid waste generated in 1960, most of them with no energy recovery and no air pollution controls. In the 1960s and 1970s, combustion dropped steadily as old incinerators were closed, reaching a low of 10 percent of municipal solid waste generated by 1980. More recently combustion has increased to 16 percent in 1990. All major new facilities have energy recovery and are designed to meet air pollution standards. Projected estimates of combusted municipal solid waste (35 million tons in 1995 and 46 million tons in 2000) are based on an assumption that the facilities will operate at 80 percent of capacity.

The amount of waste sent to landfills fluctuates with changes in the use of alternative municipal solid waste management methods. In 1960 approximately 62 percent of municipal solid waste was sent to landfills. This increased to 81 percent in 1980, then decreased to 67 percent in 1990 as the result of changing trends in combustion and recovery rates.

The EPA waste reduction program implements a national strategy for businesses, which provides guidance on waste prevention and recycling and on improving and expanding markets for recycled products. Municipal landfills, however, remain an integral part of solid waste management. As federal regulations on landfills are phased in, landfills will become safer for adjacent communities and for the environment. In 1993 the EPA maintained partner-ships with states, tribes, industry, and individual citizens to keep landfills from becoming sources of pollution.

RCRA Program

The Resource Conservation and Recovery Act and its amendments provide the legislative mandate for a nationwide program to protect human health and the environment from the risks of hazardous and solid wastes. The RCRA program, the world's largest, most stringent regulatory program for managing wastes, has revolutionized the waste management industry. It has spawned new partnerships in waste management and new technology in waste prevention and reduction.

In 1993 the RCRA program, administered by the EPA, emphasized risk- based management standards. To develop hazardous and solid waste management strategies that ensure equitable and efficient program implementation, the agency is taking the following actions:

. Focus resources on areas presenting the greatest risk to human health and the environment;

. Work in partnerships with states to carry out national waste management objectives;

. Emphasize pollution prevention, source reduction, waste minimization, and recycling in EPA regulations; and

. Develop new regulations and revise existing ones to incorporate the latest science and technology for the safe disposal and processing of hazardous and solid waste.

In 1993 the EPA focused RCRA initiatives on environmental justice through siting, permitting, public involvement, corrective action, disproportionate impacts, and Native American tribal issues. For example the EPA is expanding public involvement and improving its own ability to include environmental justice in public health considerations and to assure that priority-setting methods adequately address environmental justice concerns.

Hazardous Waste Management. The RCRA encourages hazardous waste generators to minimize waste products through process or equipment changes and recycling. The result has been a 17-percent decline in the amount of RCRA hazardous waste generated in the United States.

Strategy on Combustion and Waste Minimization. In 1993 the EPA developed a strategy that defines the appropriate roles for hazardous waste incineration and applies economically sound source reduction practices to achieve an integrated waste management program. The strategy strengthens technical controls on waste incineration and increases opportunities for public participation in the permitting process. The new controls will be based on the latest, most viable technical advances in risk assessment and management. Using extensive risk assessments at facilities burning hazardous waste, the EPA will issue guidance concerning assessments of direct and indirect exposure at specific sites. Increased EPA presence at commercial hazardous waste combustion facilities will support state inspections and enforcement.

Strategy for Corrective Action through Stabilization. The EPA can require corrective actions to address all releases of hazardous waste or hazardous constituents from any facility required to have a RCRA hazardous waste permit. The agency has begun implementing a strategy to increase the number and pace of cleanups at RCRA treatment, storage, and disposal facilities that require corrective action. This strategy of corrective action stabilization emphasizes controlling the immediate spread of contamination as soon as feasible. Comprehensive facility cleanup is the long-term goal for the program, but corrective

action stabilization emphasizes the immediate need to control releases at hazardous waste facilities. It allows the EPA and the states to address the most serious releases at a larger number of facilities in a shorter period of time. In 1993 approximately 1,000 hazardous waste facilities were candidates for stabilization action.

Underground Storage Tanks. Petroleum or hazardous substances that escape from underground tanks can contaminate drinking water supplies. Fumes from these tanks can cause fires and explosions and pose other health hazards. The RCRA amendments require tank owners and operators to register their tanks and comply with leak prevention, corrective action, and financial responsibility regulations. As of August 1993, states and private parties had confirmed 227,000 releases, initiated 174,000 cleanups, and completed 79,000 cleanups of leaking underground storage tanks. The EPA is working with states to streamline corrective action processes and encourage the use of improved technologies to help keep pace with the growing cleanup workload. When a responsible party for a tank cannot be found to oversee corrective action, the EPA authorizes states and territories to use the Leaking Under ground Storage Tank Trust Fund for cleanups. Approximately 86 percent of these funds were disbursed to states in 1993 for cleanup activities.

Superfund Program

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and its amendments established the Superfund program as a response to the release or threatened release of hazardous substances, pollutants, and contaminants stemming from accidents or uncontrolled hazardous waste sites. The act requires parties responsible for contamination to conduct the cleanup. Where EPA enforcement is not successful, the federal government can clean up a site using the CERCLA Trust Fund (Superfund), which is supported by excise taxes on feedstock chemicals and petroleum and by a more broadly based corporate environmental tax. If the Superfund program conducts the cleanup, the government can take court action against responsible parties to recover up to three times the cleanup costs.

Now more than 12 years old, the Superfund program has reduced risks posed to human health and to the health of ecosystems from releases of hazardous substances. As part of the program, the EPA will establish, by the end of FY 1995, community advisory groups to address environmental justice issues in the vicinity of Superfund sites. A summary of Superfund initiatives follows.

Site Evaluations. As of June 30, 1993, the EPA had identified 37,921 potentially hazardous waste sites across the nation. Of these sites, 94 percent have undergone a preliminary assessment to determine the need for further action.

National Priorities List. The EPA maintains the Superfund National Priorities List (NPL), which identifies the nation's most seriously contaminated hazardous waste sites eligible for permanent Superfund cleanup. As of June 30, 1993, a total of 1,320 sites had been listed or proposed for listing; work was underway at 93 percent of the these sites, and cleanup construction was in process or complete at 43 percent. In FY 1992 permanent cleanup construction had been completed at 149 sites since inception of the program. In FY 1993 this figure rose to 217 out of the 650 sites targeted for completion through the year 2000.

Removal Program. The Superfund removal program responds to releases or threats of releases of hazardous substances that present an imminent threat to public health, welfare, or the environment. Removal actions are generally shortterm, relatively low-cost actions intended to respond to near-term threats to human health and the environment. Where additional response actions are appropriate, removal actions serve to protect the public and the environment until a long-term solution can be implemented. In other cases, the removal action sufficiently addresses the problem. Removal activities to stabilize or eliminate the threat posed by a release can include excavating or pumping hazardous substances for treatment or off-site disposal; providing alternative water supplies to nearby residents; treating hazardous wastes on-site; relocating residents temporarily; and installing fences to prevent exposure. Removals can be undertaken at both NPL and non-NPL sites but generally are limited under CERCLA to one year and $2 million. Since inception of the Superfund through 1993, the removal program has conducted 3,400 removal actions, including 2,500 at non-NPL sites.

EPA Technology Innovation Office. Established in March 1990 to promote the development and application of new treatment technologies for remediation of contaminated soils and groundwater, the EPA Technology Innovation Office (TIO) supports projects such as the following:

. Development of a database with information on specific vendors of innovative technology;

. Completion of a joint EPA-Air Force effort summarizing the status of 48 cleanup technologies;

. Assessment of the commercial marketplace for innovative technologies;

. Initiation by the U.S. EPA, California EPA, and Air Force of a Public-Private Partnership Program with Fortune 500 companies to address contamination problems at McClellan Air Force Base in Sacramento, California; and

. Initiation of similar technology evaluation projects at sites operated by the Department of Energy, the Army, and the Navy.

Superfund Innovative Technology Evaluation Program. The SITE program measures the effectiveness of new technologies through field demonstrations. The program provides grant funding for emerging technologies such as physical/chemical/biological processes that can destroy, immobilize, or reduce contaminated hazardous materials. Since its creation the SITE program has completed 49 full-scale field demonstrations of new technologies for commercialization and 23 laboratory and pilot-scale studies.

Superfund and the Role of Disadvantaged Communities

In 1993 the Clinton Administration evaluated Superfund and how it has worked over the last dozen years, taking into account criticisms that the program has generated in the following areas:

. The pace and cost of cleanup;

. The degree to which sites are cleaned;

. The fairness of liability under CERCLA;

. The role of states in the process; and

. The role of local communities, particularly disadvantaged communities, in the Superfund program.

Superfund Administrative Improvements Task Force Report

To explore options for making administrative improvements to Superfund, the EPA established a task force with members from EPA headquarters and regional offices and from the DOJ. On June 23, 1993, the task force issued an Administrative Improvements to Superfund Report containing four goals and nine initiatives that can be achieved without changing the statute. Priority was given to actions that could be implemented before September 30, 1994, the date set for Superfund reauthorization.

Superfund Improvement Goals and Initiatives

In 1993 the EPA began to implement the task force initiatives, incorporating several ongoing initiatives as part of administrative improvements to Superfund.

Goal: Enhance Enforcement Fairness and Reduce Transaction Costs.

Initiative 1: Make Greater Use of Allocation Tools. The Superfund program has been criticized for the high transaction costs incurred by Potentially Responsible Parties (PRPs) in reaching settlements and in litigating, where settlement efforts are unsuccessful. The EPA is offering alternative dispute resolution (ADR) to facilitate PRP efforts to allocate cleanup responsibility. ADR uses a neutral third party to organize negotiations, facilitate settlement deliberations, and provide an opinion to negotiating parties. The EPA may adopt Non-binding Allocations of Responsibility (NBARs) as a preliminary step to allocating response costs among PRPs. The agency also is testing a binding allocation process. The agency assists allocation efforts by gathering follow-up information to share with PRPs.

Initiative 2: Foster More Small Volume Waste Contributor Settlements. Small volume waste contributors often complain that they are not able to settle with the EPA until late in the remedial process or when complete information about all PRPs is available.These settlements can be time consuming and resource intensive for the EPA. PRPs assert that they incur substantial costs in forming a steering committee group and distributing information. Parties responsible for small amounts of waste, referred to as de micromis parties, find themselves subject to contribution actions by major waste contributors. To address these issues, the EPA is taking the following actions:

. Issue a directive to reduce the amount of information necessary to make de minimus findings under Section 122(g) of CERCLA and allow greater flexibility and use of judgement in entering into these settlements; increase the number of sites where the EPA can enter into such settlements and facilitate them early in the process.

. Issue guidance on identifying sites where de micromis parties are subject to contribution actions and on settling with those parties.

. Institute negotiations at sites where PRPs have brought contribution actions against de micromis parties and develop a communications strategy to assist PRPs involved in the de minimus and de micromis process.

Initiative 3: Assure Greater Fairness for Owners at Superfund Sites. Concerns have been raised in the past that the EPA may not have given property owners sufficient notice and opportunity for comment before perfecting liens on their property. Uncertainty regarding the meaning of -all appropriate inquiry-

for purposes of the CERCLA innocent-landowner defense may have discouraged the purchase and use of previously developed land and the provision of loans for such purchases. The EPA policy on settlements with prospective purchasers may have been overly narrow in defining the circumstances under which the agency would be willing to grant a covenant not to sue to a prospective purchaser. To address these issues, the EPA is taking the following actions:

. Issue supplemental federal lien procedures providing site owners an opportunity to submit information or meet with the EPA before the agency perfects a lien on their property.

. Clarify the requirements of -all appropriate inquiry- under CERCLA.

. Issue supplemental prospective purchaser guidance as well as a model prospective purchaser agreement.

Initiative 4: Evaluate Mixed Funding Policy. Mixed funding refers to cleanups that are jointly funded by the Superfund and PRPs. Some PRPs have objected to the EPA interpretation of its mixed funding authority as too conservative. PRPs also believe that the documentation requirements associated with mixed funding are overly burdensome. The EPA is taking the following actions:

. Evaluate different mixed funding options, including an analysis of cost implications to the Superfund Trust Fund, exploring options for streamlining the mixed funding decisionmaking and documentation requirements.

. Enter several mixed funding settlements as pilots, evaluating them to assess changes in the EPA mixed funding policy.

Goal: Enhance Cleanup Effectiveness and Consistency.

Initiative 5: Streamline and Expedite the Cleanup Process. Critics claim that the Superfund program takes too long to decide upon remedies at sites and to achieve cleanup. They claim that the site-specific decisionmaking process is a major source of delay and inconsistency. To accelerate the pace of cleanups, the EPA is taking the following actions:

. Promote the use of presumptive or standardized remedies to clarify the land use policy.

. Set out approaches for dealing with lead contamination at sites.

. Provide a strategy to address the problem of Dense Non Aqueous Phase Liquids (DNAPLs) in groundwater, including solvents that are particularly difficult to clean up.

Initiative 6: Develop Soil Screening Levels. Cleanup levels of soil have historically been set through a risk assessment process for each site. The EPA is developing soil screening levels for 90 chemicals to identify contaminant levels below which there is no concern and above which further site-specific evaluation is warranted. Soil screening levels will accelerate investigation of soil contamination at sites, streamline the baseline risk assessment, and increase consistency between the RCRA corrective action program and Superfund soil cleanups.

Goal: Enhance Public Involvement.

Initiative 7: Implement an Environmental Justice Strategy for Superfund Sites. The EPA is taking steps to assess potential areas of inequity at Superfund sites and to identify solutions. The agency is

completing a preliminary analysis of populations living near 300 listed Superfund sites. The analysis links minority and site variables and identifies ethnic populations living near multiple sites. The agency is undertaking the following efforts:

. Environmental Justice Demonstration Sites. In each EPA Region, the agency is designating a demonstration site where strategies to address equity and other environmental justice issues will be developed.

. Superfund Environmental Justice Strategy. Lessons learned from demonstration sites along with other data and analysis will form the basis of a new Superfund Environmental Justice Strategy. The EPA will assign site project managers and community relations staff with appropriate language skills and cultural sensitivities. The agency will simplify applications for Technical Assistance Grants (TAGs) and publish them in English and Spanish.

Initiative 8: Pursue Early and More Effective Community Involvement. A critical problem in the Superfund program is the lack of support for the cleanup among communities located around Superfund sites. Citizen groups and communities often are dissatisfied with both the pace and the results of cleanups. Community involvement problems include difficulties in obtaining technical assistance grants and in interpreting health studies, inaccessibility of information and of site decisionmakers, and lack of opportunity for interaction early in the process. To address these problems, the EPA is undertaking the following efforts:

. Superfund Public Participation Plan. In 1993 the EPA prepared a Superfund public participation plan based on comments from citizens at EPA Superfund Public Forums and other meetings. The plan, which includes community involvement, is scheduled for use at Superfund sites.

. Site-Specific Advisory Boards. The EPA is monitoring progress made by other federal agencies establishing Site-Specific Advisory Boards at federal facility cleanup sites.

Goal: Enhance the State Role.

Initiative 9: Expand State Deferrals. The EPA and the states agree that the number of hazardous substance sites requiring cleanup is larger than either level of government can address alone. The EPA will be unable to address environmental threats at some sites for years, leaving PRPs in doubt regarding liability and local communities at risk from unremediated sites and without the productive use of affected land. Several states have developed increasingly sophisticated programs to clean up non-NPL sites, relying in part on EPA technical assistance and funding. The EPA can encourage more environmental cleanups sooner by expanding state authority to address sites of NPL-caliber and by enlisting state participation in a complementary cleanup program. The use of deferrals can encourage states to address NPL-caliber sites, thus accelerating cleanup, minimizing the risk of duplicative state-federal efforts, and assuring PRPs that only one agency will address the site. Deferrals provide a negotiated division of responsibility for pre-NPL sites and determine which agency will address a site. The EPA is planning several state deferral pilot projects in which states will take the lead for low- or medium-priority NPL-caliber sites that the EPA would not be able to address for several years. Sites would have state-identified PRPs. The EPA is developing policy-defining scope and standards for state deferrals along with the federal oversight role. Continuing Management Initiatives Over the past several

years, the EPA implemented the following reforms to improve the effectiveness, efficiency, and equity of the Superfund program:

Accelerated Cleanup. The technical complexity of hazardous waste sites coupled with complex Superfund site study and cleanup requirements give rise to concern about the slow pace of Superfund cleanups. These concerns resulted in development of the Superfund Accelerated Cleanup Model (SACM). After completing field demonstrations in 1993, the EPA intends to implement the model, which has the following major components:

. Integrated site assessment;

. A team approach to selecting sites for cleanup action;

. An increased number of early actions, with immediate threats to public health and safety to be eliminated first;

. Long-term remediation; and

. Enforcement actions and community relations activities throughout the process.

Enforcement First. Under this policy, adopted in 1989, the EPA, rather than spending the Superfund, uses enforcement authority to compel responsible parties to clean up hazardous sites. The total value of private party commitments to conduct site study and cleanup at Superfund sites exceeded $7.4 billion in 1993. In addition to testing ways to increase fairness, reduce transaction costs, and accelerate and complete cleanup, the EPA explores ways to encourage PRPs to conduct investigations and cleanups earlier in the process through actions such as the following:

. Unilateral Administrative Orders. Creative use of enforcement tools is essential to complete construction and accelerate cleanup. Settlements with PRPs are preferable, but when necessary the EPA uses unilateral administrative orders (UAOs) and judicial actions, including actions for temporary and preliminary injunctive relief, to compel PRPs to undertake response actions.

. Monitoring of PRP Compliance. Equally important is effective monitoring of PRP compliance with existing Consent Decrees, Unilateral Administrative Orders, and Administrative Orders on Consent. The EPA takes enforcement action in response to failure or refusal to comply.

Effective Contracts Management. Scrutiny of Superfund contracts by parties within and outside the EPA point to the need for good contract management. In 1993 the EPA implemented recommendations of the Agency Task Force on Alternative Remedial Contracting Strategy (ARCS) and implemented the Superfund Long-Term Contracting Strategy to assure reliable cost-effective contracts. The EPA trains personnel to oversee procurement and administration of Superfund contracts and involves senior management as essential for accountability.

Other Improvements. The EPA also is improving the Superfund program through the following initiatives:

. Accelerating cleanups to allow closing military bases to be used for other purposes;

. Promoting the use of innovative cleanup technology; and

. Improving the effectiveness of cost recovery.

Chemical Emergencies

Because of their proximity to hazardous waste facilities, minorities and low-income communities are at special risk from chemical emergencies. The EPA sponsors a cooperative program to prepare local communities for accidents involving hazardous materials, to reduce the number of such accidents, and to assist in mitigating effects on public health and the environment should they occur. Participants include state, tribal, and local governments, industry, labor groups, environmental groups, and other stakeholders. A number of laws and initiatives support state and local right-to-know and emergency response planning.

Emergency Planning and Community Right-to-Know Act

Included in the Superfund Amendments and Reauthorization Act of 1986 (SARA) was the Emergency Planning and Community Right-to-Know Act.

Community Right to-Know. This section of the law provides local governments and the public with information about chemical hazards in their communities. The EPA establishes national community right-to-know reporting requirements for inventories and releases of hazardous chemicals. Because of these requirements, many facilities have reduced inventories or substituted less hazardous chemicals thereby reducing risks.

Toxics Release Inventory

In May 1993 the EPA issued results of the fifth Toxics Releases Inventory (TRI), which covered the calendar year 1991. Under the TRI facilities are required to report on releases of listed chemicals into the air and water, on the land, and underground at the facility and transfers of chemicals off-site for the purposes of treatment, disposal, energy recovery, or recycling. According to the 1991 data, reported releases and transfers of listed toxic substances have declined for the fourth straight year.

TRI data for 1988 through 1991 are used to allow comparisons across years to help identify changes and trends. Although 1987 was the first year for TRI reporting, 1988 has been chosen by the EPA as the baseline year because of concerns about the quality of industry's submissions in the first year. In addition only those chemicals listed for all reporting years 1988 through 1991 are included in trend analysis; any chemical added or deleted during that time was not included. For example the seven chlorofluorocarbons (CFCs) and halons added to the list for the reporting year 1991 were not included. Similarly data on transfers for recycling and energy recovery, which were reported for the first time in 1991, were not included in the 1988-1991 trend analysis.

Since 1988 TRI-reported releases have declined nearly 31 percent and transfers have dropped 33.5 percent. Reported air, land, and underground releases declined each year after 1988; water releases first decreased and then increased in each of the last two reporting years due to runoff at several large facilities. Transfers to publicly owned treatment works and to other off-site locations for treatment and disposal also decreased during the 1988-1991 period. The greatest net change occurred between 1989 and 1990 when reported releases decreased nearly 16 percent and reported transfers decreased nearly

10 percent. Some of these decreases, however, may be explained by changes in reporting requirements and options.

Emergency Preparedness, Prevention, and Response. This section of the Community Right-to-Know Act encourages and supports emergency planning for chemical accidents. The act recognizes that the responsibility for understanding and reducing risk and for responding to a chemical emergency resides at the lowest level of government. Supportive mechanisms include State Emergency Response Commissions (SERCs) in each state and 3,400 Local Emergency Planning Committees (LEPCs) nationwide. Each LEPC uses facility-provided hazard information to plan for chemical emergencies, thereby reducing risk.

Clean Air Act Amendments of 1990

The Clean Air Act Amendments (CAAA) involve the EPA in chemical emergency programs, such as the following.

Accidental Release Prevention Program. To prevent accidental chemical releases and to minimize their consequences, Section 112® of the amendments established requirements for risk management programs. The EPA has listed hazardous substances and the threshold quantities for which these requirements apply. Facilities handling listed substances above the threshold quantity must conduct hazard assessment, develop accident prevention and emergency response programs, and prepare risk management plans. In 1993 the EPA approved eight grants to states, local communities, and one Native American tribe to assist in implementing Section 112®.

Hydrogen Fluoride Study. The amendments required a study of the hazards of hydrogen fluoride, which the EPA completed in 1993.

Review of Federal Authorities. The amendments called for the President to conduct a review of the chemical release prevention, mitigation, and response authorities of federal agencies. The EPA undertook this study with the National Response Team.

International Chemical Emergency Preparedness and Prevention

The United States has been successful in having fundamental democratic principles accepted as part of the foundation for international chemical accident programs such as the following:

Organization for Economic and Cooperative Development (OECD). OECD has developed Guiding Principles for Chemical Accident Prevention, Preparedness, and Response, in use by both developed and developing countries.

United Nations Environment Program (UNEP). The UNEP, in addition to adapting the OECD principles for industrializing nations, assists these nations in establishing chemical accident programs under a UNEP program, Awareness and Preparedness for Emergency at the Local Level (APELL).

Joint Contingency Plans. The United States worked with Mexico and Canada to develop Joint Contingency Plans (JCPs) and Joint Response Teams (JRTs) to ensure an effective, efficient, and coordinated response to a transboundary chemical accident.

United Nations Economic Commission on Europe. The UNECE has finalized the Convention on the Transboundary Effects of Industrial Accidents which codifies much of the U.S. principles dealing with chemical accident prevention, preparedness, and response.

Radiation

The average annual radiation exposure for a person living in the United States is 360 millirem. Naturally occurring radiation accounts for approximately 82 percent of public exposure, most of which comes from indoor radon (for a discussion of radon, see Chapter 1: Air Quality and Climate), followed by radiation from outer space, from the earth's crust, and from the naturally occurring radioactive element potassium in human bodies. Anthropogenic sources of radiation account for the remaining exposure: 3 percent from consumer products such as radon in drinking water and 15 percent from medical procedures such as x rays, mammograms, nuclear medicine, and gastrointestinal series. Additional annual exposure for people living near nuclear power plants is less than 1 millirem.

Radioactive Waste. Radioactive waste in the United States arises from five main sources:

. The commercial nuclear fuel cycle;

. Department of Energy-related activities;

. Institutions such as hospitals, universities, and research foundations;

. Industrial uses of radioisotopes; and

. Mining and milling of uranium ore.

Radioactive waste is broadly categorized as spent nuclear fuel, high-level waste (resulting from the reprocessing of nuclear fuel), transuranic waste (lower-level wastes resulting from fuel reprocessing and from the fabrication of plutonium weapons and plutonium-bearing reactor fuels), uranium mill tailings (earthen residues remaining after the extraction of uranium from ores), and low-level waste (radioactive waste not classified as one of the above).

Over time radionuclides decay to nonradioactive, stable isotopes. As an example the short-lived radionuclides found in spent nuclear fuel rapidly decay during the first few years after the fuel is removed from the reactor. Other radioactive wastes can remain radioactive for hundreds to thousands of years.

Pesticides and Other Food Contaminants

Although chemical contamination of food by pesticides and additives has declined over the last two decades, microbial contamination has increased. In 1993 the EPA, U.S. Department of Agriculture (USDA), and U.S. Food and Drug Administration (FDA) worked with the White House Domestic Policy Council to strengthen existing legislative authorities governing pesticides. The Administration supports legislation to increase the overall safety of the food supply that at the same time will make the various components of the food safety program more consistent and more efficient.

Pesticide Residues in Food

Diet is a major source of exposure to pesticides. To minimize exposure of the general public to pesticide residues in food, the federal government regulates pesticide use through such laws as the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA).

The EPA sets tolerance levels to limit levels of pesticide residues in foods. Tolerances-the maximum legal limit of a pesticide residue allowed in or on a raw agricultural commodity and some processed food-are set for all pesticides used on food crops. Tolerance concentrations, based primarily on the results of field trials by pesticide manufacturers, reflect the highest concentrations likely under normal conditions of agricultural use rather than health consideration.

The FDA monitors pesticide residues on domestically produced and imported foods. Two categories of samples are collected for analysis:

. Surveillance Samples. These samples are taken when the FDA has no prior knowledge or evidence that a food shipment contains illegal pesticide residues. Most foods contain some pesticide residues, but few samples violate EPA tolerance limits. For 30 years FDA testing has found 2-4 percent of foods tested for residues in violation of legal tolerances, and no samples have contained pesticides prohibited for use on food. In 1993 of the 5,703 domestic surveillance samples analyzed, 64 percent had no detectable residues, less than 1 percent had over-tolerance residues, and another 1 percent had residues of pesticides for which no EPA tolerance had been set for that particular pesticide-commodity combination. Of 6,463 import surveillance samples, 97 percent showed no violative residues.

. Compliance Samples. These samples are collected and analyzed as follow-up to the finding of an illegal residue or when other evidence indicates that a residue problem may exist. In 1993 a total of 223 domestic and 362 import compliance samples were collected and analyzed. The violation rates were expectedly higher than those for surveillance samples: 17 percent for domestic and 11 percent for import.

Aquaculture Survey. The FDA initiated an aquaculture survey in 1990 that has been continued in succeeding years. The survey focuses on persistent halogenated pesticides in aquaculture products. These chemicals, such as DDT, although no longer registered for food use, are present as a result of past agricultural uses. Of the 308 samples tested, 44 percent had no detectable pesticide residues. DDT was found in 35 percent of the samples at levels ranging from trace to 1.0 parts per million (ppm), but well below the 5 ppm FDA action level; chlordane was found in 3 percent at levels of 0.01 to 0.07, but lower than the 0.3 ppm action level. Residues of pesticides with no set tolerance levels were also found in a small number of samples: chlorpyrifos (trace-0.02 ppm), diazon (trace), and DCPA (an herbicide with the trade name Dacthal at 0.01-0.09 ppm).

Milk Survey. In addition to routine surveillance monitoring, the FDA analyzed 308 milk samples from 58 metropolitan areas for pesticide residues in 1993. Samples from 37 of the metropolitan areas had pesticide residues. Of the 308 samples, 35 percent had detectable residues. The most frequently found residues were the DDT derivative p,p-DDE (69 findings) and dieldrin (49 findings). The highest residue

level found was 0.01 ppm p,p-DDE. Results indicate low levels of these environmentally persistent chemicals in foods of animal origin.

Dietary Intakes of Pesticides. A major element of the FDA pesticide residue monitoring program is the Total Diet Study, in which foods are purchased from supermarkets or grocery stores four times a year, once from each of the four geographic regions of the country. Foods prepared table-ready are analyzed for pesticide residues as well as radionuclides, industrial chemicals, toxic elements, and essential minerals. Of the nearly 300 chemicals that can be determined by analytical methods, 99 pesticide and pesticide-related chemicals were found in foods analyzed between September 1991 and July 1993. Table 99, in Part II of this report, contains a summary of the findings of the Total Diet Study. Residues of two pesticides appeared most frequently in the samples:

. Malathion. The most frequently found pesticide residue, Malathion, is used on a variety of crops both pre and postharvest.

. DDT. Residues of DDT have been the next most prevalent residue, although occurrence is declining, which suggests the continuing degradation of this persistent environmental residue.

Pesticides in the Diets of Children

To learn more about infant and child sensitivity to pesticides, Congress commissioned the National Academy of Sciences (NAS) to study EPA risk-assessment processes and recommend improvements. On June 27, 1993, the NAS issued Pesticides In the Diets of Infants and Children, with the following major findings and recommendations:

. Infants and children eat types and proportions of foods that differ from those eaten by adults and, per unit of body weight, tend to eat more than adults. As a result their exposure to pesticides may differ substantially from adult exposure.

. Additional data should be collected on the food consumption patterns of infants and children.

. Children may be more or less sensitive than adults to toxic effects depending on the pesticide to which they are exposed.

. Toxicity testing procedures should be developed that specifically evaluate the potential vulnerability of infants and children.

. The process for setting tolerances should be modified so that it is based more on health considerations than on agricultural practices, using improved residue and toxicology information.

. EPA estimates of total exposure to pesticide residues should better reflect the unique characteristics of the diets of infants and children and should account also for the dietary intake of pesticides.

. Analytical methods and reporting procedures for tests of pesticide residues in food should be standardized and results should be collected in a centralized database.

The Delaney Clause. In 1992 the United States Ninth Circuit Court of Appeals issued a decision striking down the EPA interpretation of the Delaney Clause in the Federal Food, Drug, and Cosmetic Act (FFDCA). The clause regulates residues in processed foods for pesticides that cause cancer in laboratory animals.

In 1993 the EPA listed 32 pesticides, involving 80 chemical-crop combinations. A February 5, 1993, notice in the Federal Register requested comments on legal and policy issues necessary to implement the court decision. The EPA revoked and denied a number of emergency exemptions for pesticide uses and joined the USDA and FDA to issue a joint statement of policy on EPA review and approval of requests for emergency exemption under Section 18 of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The EPA revoked the food additive regulations for the four chemicals named in the decision and in 1994 will issue a proposal on the remaining pesticides potentially affected by the decision-on whether to revoke food additive regulations and raw food tolerances and possibly to cancel registrations.

Workplace Hazards

In August 1992 the EPA issued the Worker Protection Standard (WPS), a regulation to protect employees on farms and forests and in nurseries and greenhouses from occupational exposure to agricultural pesticides. To implement the rule, the EPA issued notices requiring registrants of pesticides to make label changes incorporating the new protective requirements. Label changes began to appear on pesticide products in 1993 and must be on all pesticides sold after October 23, 1995. In partnership with states and Native American tribes, the EPA took the following actions:

. Developed a manual, poster, and other materials to help agricultural employers comply with the WPS;

. Held a series of workshops to train EPA regional and state personnel in WPS requirements so that they, in turn, can train agricultural employers;

. Developed pesticide safety training materials for agricultural workers and pesticide handlers; and

. Developed a compliance monitoring checklist for state, tribal, and federal inspectors to enforce the WPS.

Microbial Contamination of Food

Microorganisms are naturally present in soils, water, and air. Many are beneficial, playing key roles in natural chemical and biological processes, but others are pathogens to humans. They gain access to human food sources through various routes:

. The Environment. For example exposure to contaminants in the terrestrial or aquatic environment may serve as a route;

. The Food Processing and Distribution System. For example entry routes may include shipping, slaughter, processing, mishandling of food after processing, temperature abuse, and cross-contamination;

. Food Preparation Stages. At retail food operations and in individuals households, mishandling food after cooking or not thoroughly cooking food prior to consumption can be a route.

Foodborne illness is a major cause of morbidity in the United States. Among outbreaks since the early 1970s in which the etiology was determined, bacterial pathogens caused the largest number of outbreaks (66 percent) and cases (87 percent). Chemical agents caused 25 percent of the outbreaks and

4 percent of the cases; parasites, 5 percent of the outbreaks and less than 1 percent of the cases; and viruses, 5 percent of the outbreaks and 9 percent of the cases.

Salmonella and Campylobater accounted for over half of the bacterial disease outbreaks and were the most frequently reported bacterial pathogens for each year since 1973. Fish poisoning because of ciguatoxin and scombrotoxin accounted for 73 percent of the outbreaks caused by chemical agents. T. spiralis and Giardia were the leading causes of parasitic disease outbreaks, and Hepatitis A caused 71 percent of viral food poisoning outbreaks.

The most commonly reported food-preparation practice that contributed to foodborne disease was improper storage or holding temperature, followed by poor personal hygiene of the food handler.

Inadequate cooking and contaminated equipment are also commonly reported causes. Food obtained from an unsafe source was the least commonly reported factor.

Food Safety Reform

Pesticide residues in food and outbreaks of food poisoning are risks that can be unevenly distributed across the population. Federal agencies conduct programs to alleviate these risks for all Americans, but special initiatives target the innercity and rural poor. Food safety reform is a collaborative effort by the EPA, USDA, and FDA in concert with farmers, environmentalists, consumer groups, and state agencies.

Environmental Justice

One of the first reports to document the correlation of risk, race, and income was the 1971 annual report of the Council on Environmental Quality. This report suggested that low-income racial and ethnic minorities are more likely to live in areas where they are exposed to environmental hazards. This report also recognized and highlighted the interaction between severe urban environmental problems and the social and economic conditions of the Nation.

A report by the U.S. General Accounting Office (GAO) found that, in EPA Region 4 (Alabama, Georgia, Florida, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee), three of the four commercial hazardous waste facilities in the region were in predominately African-American communities and the fourth was in a low-income community.

A follow-up study by the United Church of Christ Commission for Racial Justice, based on 1980 population data, expanded the GAO study to all EPA regions and found that in communities with two or more commercial waste facilities, the average minority percentage of the population was three times that of communities without such facilities. The report of this 1987 study concluded that race, not income, was the factor more strongly correlated to residence near a hazardous waste site. An update of the study, based on 1990 population data, was scheduled for release in 1994.

In addition minority and low-income communities face a number of other environmental risks. Low-income residents of dilapidated buildings are more suspectible to lead poisoning in their homes. Migrant farmworkers face a disproportionate likelihood of pesticide poisoning, and those who work without adequate protective clothing are even more likely to be exposed to pesticides and toxic hazards. Uranium-contaminated Navajo land and water are believed to contribute to the high incidence of organ

cancer-many times the national average-in Navajo teenagers. The level of exposure for minority and low-income communities is increased by poor housing conditions, unsafe water supplies, and inadequate sewage facilities.

Lead Exposure and Environmental Justice

Lead is an ubiquitous, persistent environmental pollutant. It enters the human environment through various pathways:

. Automobile and industrial emissions;

. Paint pigments and solder;

. Old lead water pipes, particularly in older northeastern cities;

. Leaching of lead solder applied to water pipes in homes prior to 1988; and

. Brass faucets that contain some lead.

Lead emitted into the air ultimately settles as soil dust and into waterways, where it can be recycled through the environment and into humans. Opportunities for lead to enter the human food chain are enhanced by animal grazing, home gardening, and general agriculture in areas where lead contaminates soils.

In major urban areas, lead poisoning among children is a persistent public health problem. Lead-based paint is the most common source of high-dose lead exposure for children. Children are exposed to lead from soil when they play outdoors in areas contaminated by deteriorating exterior lead-based paint, emissions from automobiles using leaded gasoline, and/or lead emissions from smelters. Urban atmospheric lead levels may be up to 20,000 times higher than those in rural regions. In addition to environmental sources, the use of folk medicines and pottery containing lead is prevalent among some minority groups and has caused severe cases of childhood lead poisoning. Studies indicate that African American children, followed by Hispanics, have a higher prevalence of elevated blood-lead levels than white children, regardless of age, household income, or degree of urbanization. Screening and abatement activities for homes with lead paint hazards, intensive education efforts, and decreased contributions from sources such as leaded gasoline may account for recently observed decreases in blood-lead levels and new cases of lead poisoning.

Although children are more at risk for lead exposure, lead-induced health effects are known to occur in adults across a wide range of exposures, including among others:

. Workers who process automobile and industrial batteries to reclaim their lead and plastic content;

. Workers who mix lead chromate-based pigments to formulate color concentrates for the plastics industry;

. Workers who solder or weld with lead;

. Workers who repair automobile radiators; and

. People who consume illicitly distilled alcohol, such as moonshine distilled in automobile radiators containing lead-soldered parts.

One outcome of a conference held by the University of Michigan in January 1990 in Ann Arbor, Michigan, was formation of the Michigan Coalition, a group of social scientists, civil rights leaders, and environmentalists interested in environmental justice as a public policy issue. In October 1991 an Environmental Leadership Summit was held in Washington, D.C., where 650 participants adopted Principles of Environmental Justice. These principles include the rights of a community to clean air, clean water, and a safe, healthy, and livable environment.

In response to the concerns of the U.S. Congressional Black Caucus and the Michigan Coalition, the EPA formed the Environmental Equity Workgroup. A cross-section of senior EPA staff reviewed and evaluated the evidence that low-income persons and minorities bear a disproportionate burden of environmental risks. The findings, published in a 2-volume report entitled Environmental Equity: Reducing Risk in All Communities, included the following:

. No clear differences were found between racial groups in terms of disease and death rates; however a general lack of data exists on environmental health effects by race and income. The notable exception is lead poisoning. A significantly higher percentage of African American children, compared to white children, have unacceptably high levels of lead in their blood.

. Minorities and low-income populations experience higher-than-average exposures to selected air pollutants, hazardous waste facilities, contaminated fish, and farm pesticides in the workplace.

. Data are not routinely collected on health risks posed by multiple industrial facilities, cumulative and synergistic effects, or multiple pathways of exposure.

In 1992 in response to recommendations of the workgroup, the EPA created the Office of Environmental Equity to coordinate agency efforts to address environmental justice issues.

Conditions and Trends

Where environmental remedies are not applied equitably across racial and socioeconomic groups, minority and low-income communities face a higher level of environmental risk, including direct exposure to hazardous materials and wastes during their production, disposal, and containment. Federal and state agencies set pollution standards to protect all of the environment and all of its inhabitants, but recent studies, such as those on lead poisoning in children, indicate that minority and low-income communities bear a disproportionate share of the nation's air, water, and waste problems.

In the past neither the extent nor the seriousness of environmental inequities and injustices were well documented or analyzed, but despite incomplete health effects data, federal agencies have begun to gather data on exposure and risle levels to determine whether there are disproportionally high and adverse human health environmental effects.

Program Accomplishments

Despite limited empirical data to document the extent of direct health impacts, support for action on environmental justice issues is mounting. In 1993 the President directed the EPA and DOJ to begin an interagency review of federal, state, and local regulations and enforcement that affect minorities and low-income communities with the goal of formulating an aggressive investigation of the inequities in exposure to environmental hazards. As part of this evaluation, the DOJ and EPA, in conjunction with the departments of Housing and Urban Development (HUD) and Labor (DOL), will identify examples of communities in which environmental decisionmaking may have affected minorities and low-income populations adversely.

Federal agencies have assumed leadership of environmental justice initiatives to ensure that the nation provides equal protection under the law. Realizing that environmental inequities can not be solved or even evaluated overnight, federal agencies are coordinating data collection, analysis, and remedial actions with states, municipalities, academia, industry, and the affected communities themselves and are directing compliance and enforcement at the most severe risks, which include those that disproportionately affect minorities and low-income groups.

EPA Office of Environmental Equity

Working through the Office of Environmental Equity (OEE), the EPA took the following actions in 1993:

. Expanded environmental justice education and outreach programs;

. Promoted community-based self-help programs such as economic- environmental development;

. Established a clearinghouse for environmental justice information; and

. Provided financial and technical assistance to groups involved in environmental justice initiatives, such as minority academic institutions, community organizations, and state and local governments.

Databases. The EPA is expanding databases on the demographics of Superfund and solid waste facilities in low-income communities disproportionately exposed to environmental hazards.

Equitable Enforcement and Rulemaking. Investigations are underway to determine if racial or socioeconomic inequities have influenced implementation and enforcement of environmental regulations and if such inequities have affected the speed and thoroughness of cleanups in low-income communities.

EPA Office of Environmental Equity

The EPA Office of Environmental Equity (OEE), established on November 6, 1992, to deal with environmental impacts affecting minorities and low-income communities, serves as the public point of contact for environmental justice outreach, technical assistance, and information. A separate senior executive committee, the Equity Cluster, was formed at the same time to develop policy guidance documents and an agenda for environmental justice. The OEE and the Cluster worked in concert to frame the issues and develop broad directives.

EPA regions have developed environmental justice policies, strategic plans, and action plans. The strategic plans outline regional commitment to ensure equitable environmental protection for all

communities; the action plan provides managers and staff with a framework on which to develop environmental justice efforts. Each region and program office initiated environmental justice work groups, quality action teams, advisory boards, or steering committees to oversee environmental justice activities.

Ethnic Study Groups made up of EPA personnel develop discussion topics and position papers on how environmental justice issues affect each ethnic group. Volunteers identified equity issues pertinent to the program in which they worked.

To better communicate with local communities and private-sector groups, OEE efforts include the following:

. An Environmental Justice Hotline is open on 1-800-962-6215;

. The Environmental Equity Update Memo, a status report published several times a year, highlights environmental justice activities and initiatives;

. Equity programs are sponsored on ethnic radio and TV networks, such as Hispanic Network Radio and the Black College Satellite Network;

. Public understanding of environmental justice is refined through interviews on public TV, technical advice to museum exhibits, sponsorship of booths at national conferences, and service as advisors to university drama clubs on creation of environmental justice dramas.

. Meetings were held with senior officials to discuss the concerns and listen to the suggestions of nongovernment environmental justice leaders. The EPA is formalizing input by establishing a Federal Advisory Committee on Environmental Justice.

. The EPA encouraged regions to reach out to community groups, industries, and state and local organizations to bring them together to discuss local environmental problems and solutions. The OEE sponsored pilot symposia as national models and coordinated projects and shared environmental justice information across media offices by forming networks in all program and regional offices. Each EPA region and program office has appointed an environmental justice coordinator.

. The EPA worked on plans for a 3-tiered environmental justice infrastructure to work with the OEE. The structure, set for initiation in January 1994, will establish an Executive Steering Committee, reconstitute the Equity Cluster as an Environmental Justice Policy Working Group, and strengthen Environmental Justice Coordinators.

. The Executive Steering Committee, comprised of Deputy Assistant Administrators and Regional Administrators from at least three regions, will provide agency direction on strategic planning to ensure environmental justice is incorporated into EPA operations and to provide direction to the Policy Group.

. The Policy Working Group will ensure cross-media coordination of environmental justice projects and technologies.

. Environmental Justice Coordinators will continue to provide education and outreach for environmental justice information in their offices and regions.

. The EPA is integrating environmental justice into its offices, as the agency moves toward a multimedia, holistic approach to protecting public health and the environment.

. Multimedia Component. As part of the evolving multimedia enforcement strategy, linking for instance air, water, and soil violations, the EPA and DOJ are developing an environmental justice component to focus on socioeconomic and racial fairness in future enforcement actions. They are targeting areas with a host of multimedia environmental problems for intensified enforcement.

. Embedded Injustices. In addition to analyzing rulemakings currently underway to preclude embedded injustices, the EPA is seeking to increase involvement of affected communities in the rulemaking process.

Multicultural Participation. Historically minority and low-income groups have not been involved in environmental issues, and few programs have been designed to reach out to these populations. As evidence of change, the following recently developed programs are designed to enfranchise low-income populations:

. Chesapeake Bay Program. Through better structuring of informational materials and educational programs, the program is involving minority and low-income communities in restoration of the Chesapeake Bay.

. Radon. The EPA is translating radon public information documents into Spanish and distributing them to Spanish speaking communities. A number of Indian tribes are using EPA grants to implement radon programs on their reservations. In a public survey to measure radon awareness, Native American tribes displayed the broadest knowledge of the issue.

. Environmental Management by Tribes. Native Americans have both a special relationship with the federal government and distinct environmental problems. In this day of multimedia pollution, tribes often lack the trained personnel and financial resources needed to protect their lands, health, and safety. Through a combination of outreach, training, and support, the EPA is working with tribes to educate their own environmental managers.

. Superfund and Federal Facilities. EPA efforts are involving minority and low-income communities located near Superfund and federal facility cleanup sites. In addition to providing educational materials and holding public meetings, the EPA administers local grants to hire outside experts to explain community rights under environmental laws (see Superfund Program section of this chapter).

. Teacher Training. The EPA offers training to teachers from culturally diverse school districts to assure that young people receive information on environmental issues to empower them to make sound environmental choices.

. Intern Programs. In 1993 three EPA-sponsored grants placed 150 culturally diverse summer interns in positions throughout the agency.

DOJ Civil Rights Division

In 1993 the Civil Rights Division of the Department of Justice used its computerized database to identify and evaluate low-income communities, and together the DOJ and EPA identified ongoing litigation in

which environmental justice goals can be implemented. This information is being used to establish enforcement priorities. The DOJ-EPA partnership is developing as a model of cooperation for other federal agencies.

National Institute of Environmental Health Sciences

Established as a part of the National Institutes of Health (NIH), the National Institute of Environmental Health Sciences (NIEHS) has supported research targeted at decreasing health inequities among minorities and low-income populations. The institute supported the research on lead poisoning that established the link between high blood lead concentration and IQ deficits in many innercity African-American communities. Research on migrant populations exposed to pesticides uncovered adverse health effects previously undiagnosed. Research on the health effects of air pollutants continues to yield solutions to the pulmonary problems found in areas of high ambient air pollution.

Equity in Environmental Health Workshop. In August 1992 the NIEHS, the EPA Office of Health Research, and the Agency for Toxic Substances and Disease Registry (ATSDR) cosponsored a 2-day workshop entitled -Equity in Environmental Health: Research Issues and Needs.- Participants examined scientific evidence of environmental justice and health effects resulting from prolonged environmental exposure and identified health research needs and opportunities.

Multidisciplinary Developmental Centers. On March 29, 1993, the NIH Office of Research on Minority Health and the EPA signed a Memorandum of Understanding that provided $25 million over five years to address minority environmental health concerns. One result has been the development of multidisciplinary developmental centers planned in close proximity to areas of minority communities with environmental concerns. In 1993 the first such center was established by Tulane and Xavier universities in New Orleans.

Agency for Toxic Substances and Disease Registry

Projects sponsored by the Agency for Toxic Substances and Disease Registry (ATSDR) to address minority health impact issues include the following.

First National Conference on Minority Health. A minority health program initiated in 1986 sponsored the first national conference on minority health and the impact of toxic substances on the health of minorities.

Applied Research. An ATSDR-sponsored program of applied research at Historically Black Colleges and Universities is evaluating the impact of toxic substances on the health of minority communities,

Mitigating Adverse Health Effects. The Mississippi Delta Project, conducted by ATSDR in collaboration with EPA, CDC, NIEHS, OSHA, and state and local agencies, seeks to prevent or mitigate adverse health efforts on minority populations living in communities near hazardous waste sites.

Demographical Data. The ATSDR has undertaken a 6-year effort to gather demographic data and information on environmental hazards faced by minorities and low-income community residents living near waste sites.

Demographics of Poverty

The United States is predominantly an urban nation. At the time of the 1990 census, 192.7 million persons or 77.5 percent of the U.S. population lived in inner cities of metropolitan areas and in their surrounding suburbs, an area which comprises only about 2.5 percent of the nation's land area. In contrast, nearly 56 million persons lived in nonmetropolitan or rural territories which comprise over 97.5 percent of the land.

Poverty is as much a fact of life in rural areas as it is in nation's inner cities. Although the rural poverty rate has exceeded the total metropolitan poverty rate over the past two decades, the public perception of poverty as an urban problem may result because most people live in or near urban areas where they observe urban poverty firsthand. The rural poor are more dispersed and less visible.

Innercity poor are much more likely to live in families headed by a woman than the poor in suburbs and rural areas, although poverty among woman-headed families is a growing problem in rural areas.

Urban and Rural Populations

Recent urban population growth continues to outpace rural growth. Metropolitan areas have a considerably higher rate of natural increase-births minus deaths-than do nonmetropolitan or rural areas; however, differential migration is the main reason for the more rapid increase in the metropolitan population.

Central Cities vs. Suburbs. In 1900 most of the urban population lived in central cities. Until 1930 both central city and suburban populations grew rapidly, increasing their national shares, but since then central cities as a group have grown more slowly, maintaining a steady share of the total U.S. population. At the same time, half of metropolitan growth took place in the suburbs. By the early 21st century, if not before, metropolitan suburban areas are likely to account for more than half of the U.S. population.

Farm Residents. Relatively few rural residents now live on farms. In the peak period of farm residence, from 1910 to 1920, some 32 million persons resided on farms, and as late as 1950, the nation had 23 million farm residents. The U.S. Bureau of the Census estimates that the farm population dropped below 10 million in 1970 and is now just under 5 million.

Nonfarm Rural Residents. Offsetting part of the loss of rural farm population over the past 20 years was an increase in nonfarm rural residents. During the rural renaissance of the 1970s, nonmetropolitan population grew by 15 percent, which is above the national average. The decreasing ability of rural areas to retain and attract residents resulted, however, in slower population growth during the 1980s, with a rate similar to the 3-percent increase of the 1960s.

Minorities continue to be disproportionately poor. Although poverty increased most among rural Hispanics in the 1980s, rural African Americans continue to have the highest poverty rate, 39.5 percent in 1990. The number of poor rural whites and their poverty rate also increased during the 1980s. Poverty is concentrated regionally, with the South having 55 percent of the nation's rural poor, 30 percent of the central-city poor, and 41 percent of the suburban poor. Rural poverty is concentrated in

counties with high poverty rates and persistently low incomes, such as Appalachia, and in areas with high proportions of African Americans, Hispanics, and Native Americans. Since 1980 the rural West has had the greatest increase in the poverty rate.

Poverty rates reflect the current growth and distribution of the U.S. population, as shaped by historical trends in births, deaths, immigration, and internal migration. The ongoing decline in mortality is a factor in the aging of the population through an increase in the proportion that are elderly and in the elderly poor. The impact of immigration is apparent in the changing racial and ethnic distribution of the population, with internal migration apparent in the regional distribution of the population and the increasing population density of coastal areas. Although population growth has been moderate and steady during the past several decades, settlement patterns varied for urban and rural sections and for coastal and noncoastal areas.

National Population Trends

The U.S. resident population as of December 31, 1993, was 258.2 million persons, 3.8 percent above the 1990 census count of 248.7 million. The population growth rate for the 1980-1990 decade was the second lowest in census history. Only in the Great Depression decade of the 1930s when the childbearing rate dropped to two births per woman and net immigration from abroad became negligible was the growth rate lower. In contrast the growth rate increased substantially in the 1950s, which included the peak of the post-World War II baby boom with a childbearing rate of three births per woman. Since 1990 the growth rate has increased, mostly as a result of natural increase (births minus deaths) but also because of a net gain in international migration and from U.S. armed forces returning from abroad.

Fastest Growing Age Groups. Over a third of the nation's poor are either children under 18 years or persons over 65, and these two age groups are among the fastest growing in the population. Although persons aged 35 to 44--the babyboomers-were the fastest growing age group in the last decade, the population under five experienced the second largest gain, reflecting an increase in the childbearing population. The third most rapidly increasing age group consisted of persons 75 to 84. Another group that increased rapidly with implications for poverty contained persons 85 and older. A higher proportion of elderly than nonelderly are -near poor,- living just over their respective poverty threshold.

Life Expectancy. For the U.S. population as a whole, life expectancy at birth continues to rise. This increase has managed to keep pace with the growth of the population over the past several decades. Between 1980 and 1990, overall life expectancy at birth increased from 73.7 years to 75.8 years.

Immigration. Each year since 1980, approximately 29 percent of the nation's population growth has resulted from net international migration. Among legal immigrants, including refugees, a major transition occurred in distribution by country of origin. Since 1969 Latin America has been the major source of legal immigration to the United States, with Mexico the primary country of birth. For legal immigrants other than Latin Americans, the country of birth has shifted from Europe to Asia.

Regional Population Trends

The western region of the United States has experienced the most rapid population increases throughout the twentieth century, with growth rates consistently higher than the nation as a whole. This trend has continued into the 1990s. Since World War II, five states have dominated the list of most rapidly growing states: Arizona, Florida, and Nevada led each decade through the 1980s, with Alaska and California missing as lead states only in the 1970s.

The West. Nevada has been the fastest growing state since 1980, with net immigration the dominant force behind the growth. Alaska is the second fastest growing state, with population change tied to trends in the energy industry. Population growth in California, where half of the population in the West resides, dropped considerably in the early 1990s.

The South. With 34 percent of the nation's inhabitants, the South is the most populous and second fastest growing region. The population in the South reached its lowest level in 1930 and 1960 and has increased each decade since. Half of the recent gains result from net immigration drawn by a relatively low cost of living, with inter-regional migration induced by the search for new employment. Generally the rate of growth in the South has slowed over the last ten years.

The Midwest. Since 1900 the Midwest's share of the U.S. population has declined more sharply than other regions. Although it is the second most populous region in the nation, the Midwest has lost population through out migration related to economic slowdowns in industrial and agricultural sectors. Since 1990, however, natural increase and international net migration has led to a moderate population increase in the region.

The Northeast. In 1910 and 1920, the northeastern portion of the nation's population reached its 20th century peak before declining in each subsequent decade. In the 1980s the Northeast grew by a modest degree despite net out migration of half a million persons. Its sluggish growth rate continued into the 1990s, precipitated by a population decline in New England.

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Chapter 9: Environmental Economics

You can't have a healthy economy without a healthy environment. We need not choose between breathing clean air and bringing home secure paychecks. The fact is, our environmental problems result not from robust growth, but from reckless growth. The fact is that only a prosperous society can have the confidence and the means to protect its environment. And the fact is healthy communities and environmentally sound products and services do best in today's economic competition.

President Bill Clinton

In 1993 the nexus between the economy and the environment was never more clear. Continued economic growth is based on the availability of material and energy resources and an environment that is clean and healthy. Protecting the natural environment requires a nation to be flexible, to make tradeoffs-a fundamental tenant of economics-and to recognize the benefits and costs of the choices made.

Markets are shaped by consumer's choices of goods and services and producer's choices of inputs. Although the market price of a product indicates its worth to consumers, the price of use of natural resources does not always have a monetary value that can be as easily quantified. Because the nation values the benefits provided by the environment, and is now acknowledging the costs associated with loss of environmental amenities, the federal government and the American people as a whole have taken action to protect the environment and continue on this path.

Conditions and Trends

In addition to environmental cost accounting, major trends in 1993 included a growing interest in sustainable development and in using an ecosystem approach to management as a way to achieve it.

Reinventing Environmental Management: Cost Accounting

In September 1993 the National Performance Review issued an accompanying report entitled, Reinventing Environmental Management, that calls for improved federal decisionmaking through environmental cost accounting. The NPR recommended the following actions:

The EPA, DOD, and OMB should develop pilot programs to demonstrate the use of environmental cost accounting by the federal government. The report calls for the EPA and the DOD Office of the Deputy Under Secretary for Environmental Security, in consultation with the OMB, to convene an interagency working group with the following responsibilities:

. Develop demonstration projects to test the applicability and effectiveness of environmental cost accounting in the federal government; and

. Formulate accounting guidelines for the demonstration projects.

The Environmental Cost Accounting Working Group should report on the demonstration projects and make recommendations on the use of environmental cost accounting in the federal government. The NPR calls for the interagency working group to report results of the projects and recommendations on

the extent to which environmental cost accounting could be implemented throughout the federal government.

The President should issue a directive to implement environmental cost accounting in the federal government. Based on the recommended guidelines from the interagency working group, the President should issue a directive to agencies to incorporate environmental cost accounting into the appropriate decisionmaking processes.

Sustainable Development

Sustainable development offers an opportunity to gauge the relationship between economic development and environmental protection. The 1987 report of the World Commission on Environment and Development (the Brundtland Commission) defines sustainable development as that which -meets the needs of the present generation without compromising the ability of future generations to meet their own needs.- Sustainable development ensures that future generations have access to the -social capital---human, natural, and physical capital-to create a life at least equal to that of this generation. Similarly, the National Environmental Policy Act declares that it is the continuing policy of the Federal Government to create and maintain conditions under which man and nature can exist in productive harmony and fulfil the social economic and other requirements of present and future generations.

Economic growth is a driving force for improved welfare and environmental quality. An improvement in either the environment or the economy need not be at the expense of the other. Since the aim of sustainable development is to achieve an equilibrium between economic and environmental resources to enable future generations to enjoy a standard of living at least equivalent to ours, improved methods for calculating the value of environmental resources are required. To meet the challenge of sustainable development, the federal government continued in 1993 to seek ways to integrate environmental, economic, and social policies to reduce the cost, reduce the conflict, and reap the benefits of environmental protection.

President's Council On Sustainable Development

Established by Executive Order 12852 on June 29, 1993, the President's Council On Sustainable Development is a 25-member partnership of high-ranking representatives from industry, government, environmental, labor and civil rights organizations. The partnership is charged with developing bold new approaches to integrate economic and environmental policies. By charter the Council shall have the following duties:

. Advise the President on matters involving sustainable development. In furtherance of the mission, the Council will develop and recommend to the President a national sustainable development action strategy to foster economic vitality.

. Advise the President on fashioning an annual Presidential Award

recognizing exemplary efforts in advancing sustainable development ideals; submit nominations for the award to the President.

. Advise the President on conducting a public awareness and participation campaign on appropriate uses of the nation's natural and cultural resources.

Expenditures and Revenues

The EPA estimates that U.S. public and private sector costs for 1993 pollution abatement and control were $123.7 billion. The estimated distribution of costs among economic sectors in 1993 revealed that private industry had the greatest total share (62 percent), followed by local governments (22 percent), the federal government (13 percent) and state government (3 percent). Of total U.S. expenditures, $67 billion (54 percent) were associated with operating, maintenance, and administrative expenses, and the remaining $57 billion (46 percent) reflected the annual depreciation of the stock of pollution control capital equipment.

Flow of Materials

The potential value of recycling materials that today are discarded as wastes has implications for the environment and the economy. Wastes are a byproduct of delivery and consumption of four basic commodities that support modern society: food, water, energy, and materials a catch-all term for everything else. The nation uses renewable and nonrenewable resources to manufacture materials. Forestry and agricultural products, for example, provide renewable materials, and minerals and fossil fuels provide nonrenewable materials. The use of these materials to manufacture the goods that have become an essential part of modern society-machines, housing, roads, cars, packaging, and other consumer products has increased over the years.

Material input to the U.S. economy in 1990 provides a snapshot of current material use patterns on a weight basis and their implications for environmental risk. Trends in material usage reflect historical consumption and recycling patterns. Of the 2.5 billion metric tons of materials consumed by the nation, only 10 percent were recycled. Without changes in technology, the quantity of residuals or waste produced increases directly in relation to material use. Three critical issues relate to this equation:

. Potential resource scarcity;

. The limited capacity of the environment to absorb residuals; and

. Environmental hazards associated with toxic residuals.

Of the 487 million metric tons of residuals released to the environment, excluding associated water or nonmineralized waste, 57 percent was post-consumer waste, 28 percent was waste from dissipated uses with limited potential for recovery, and 15 percent was processing waste.

As material flows increase, the waste products from extraction, processing, use, and ultimate disposal of materials also increase. A combination of change in industry practice, economic incentives, new technology development, shift in material use, and change in consumer behavior will change the growing residuals-producing trend. If not, current environmental problems will worsen unless the ability of the environment to absorb waste is increased with better and more costly methods of solid waste disposal.

Construction Materials. Construction minerals such as stone and gravel represented the nation's largest material use, with 1.8 billion metric tons or 70 percent of total U.S. apparent consumption. Of these minerals 7.8 percent were recycled. Of the total residual waste, 235 million metric tons or 48 percent were from construction materials released into the environment. These materials are essentially extracted and used without any change in their chemical composition and are associated with visibility, noise, and dust. Most of the residuals are post-consumer waste (135 million tons or 58 percent); processing creates 63 million metric tons; and dissipative use creates 37 million metric tons of residuals.

Industrial Minerals. Consumption of industrial minerals, such as those used to produce fertilizer and road salt, totaled 330 million metric tons, with 7.6 percent from recycled materials. Release of industrial mineral residuals totaled 129 million metric tons. Although these materials undergo processing that can alter physical and chemical properties and concentrations, they create a relatively small amount of processing waste (5 million metric tons). Most of the waste is related to dissipative uses (98 million metric tons), followed by post-consumer releases (26 million metric tons). Some commodities in this group are harmful to the environment such as cadmium, asbestos, fertilizers, and road salt.

Metals. Consumption of metals amounted to 112 million metric tons, but 54 percent were recycled materials. Residuals released to the environment by metal extraction and processing totaled 20 million metric tons. For several commodities in this group, releases associated with the processing and manufacturing phase and, to a lesser extent, post-consumer waste are cause for concern. Although not included in the residuals total, extraction waste near mining locations can cause environmental problems.

Plastics. The use of organic feedstocks to create plastic is growing rapidly and has created concern about the increasing volume of material in municipal landfills. Furthermore, plastics contain additives, such as colorants, stabilizers, and plasticizers, that may contain toxic constituents such as cadmium and lead; plastics contribute 28 percent of all cadmium found in municipal waste and approximately 2 percent of all lead. Plastics that contain heavy metal-based additives may contribute to the metal content of incinerator ash. Some feedstock producers are establishing collection networks and secondary markets that could improve recycling rates. Because only 2 percent of plastics are recycled, virtually all of these materials are landfilled or incinerated.

Renewable Organics. The total for renewable organic material consumption was 231 million metric tons, including wood products such as lumber and paper and nonfood agricultural products such as tobacco, vegetable oils, and cotton. Of these 8 percent were recycled materials. Residuals of renewable organics amounted to 80 million metric tons. Dissipative use represented 1.2 percent of the total, while post-consumer waste represented 99 percent. Renewable organics create environmental problems with the large quantity of paper in the post-consumer wastestream and the process wastes, including chemical releases, associated with papermaking. Other than wood pulp and tobacco, renewable organics do not create significant environmental problems.

Nonrenewable Organics. Consumption of nonrenewable organic materials derived from petroleum and natural gas, such as plastics, synthetic rubber, asphalt, and manmade textiles, totaled 113 million metric tons, with only 2.7 percent produced from recycled materials. Residuals from post-consumer waste totaled 21 million metric tons. Extraction wastes are generally low, but processing and manufacturing wastes can create local environmental problems. Data on the amount of releases during these stages are incomplete.

Animal Products. Consumption of nonfood animal products, such as leather and furs, was the lowest of all groups at 2 million metric tons, of which only 1 percent were recycled. Residuals nearly equaled the quantity of apparent consumption (2 million metric tons), with most residuals associated with dissipative uses. Processing waste discharged was 20,000 metric tons, and post-consumer waste, another 50,000 metric tons. These materials are renewable and normally biodegradable.

International Trade and the Environment

Among the growing number and scope of international activities concerned with environmental protection policies, a subject of increasing attention is the relationship of environmental policies and practice to international trade.

Federal Policymaking. In the United States, a number of federal departments and agencies, including the Office of the U.S. Trade Representative (USTR), State Department, Environmental Protection Agency, and the departments of Commerce, Treasury, Agriculture, Labor, Interior, Energy, and Health and Human Services, participate in trade environmental policymaking. Together these federal agencies are seeking to develop information to better understand the linkages between trade and the environment and to make trade and environmental policies compatible with sustainable development.

International Dialogues. The United States is actively participating in a number of international dialogues regarding trade and the environment, including the new World Trade Organization, Committee on Trade and the Environment; the Organization for Economic Cooperation and Development (OECD), Trade and Environment Joint Experts Committee; and the United Nations Environment Program/United Nations Commission on Trade and Development (UNEP/UNCTAD) joint work program on trade and environment.

Trade in Environmental Protection Equipment. A 1993 EPA report entitled *International Trade in Environmental Protection Equipment: An Assessment of Existing Data*, estimates total U.S. imports, exports, and trade balances for environmental protection equipment between 1980 and 1992. Estimates include trade levels in environmental protection equipment for air, water, and other environmental media. The EPA also examined bilateral trade flows between the United States and selected U.S. trading partners. The report found that the United States is a major exporter of environmental protection equipment, in general, and of air pollution control equipment in particular. Only 21 percent of the air pollution control equipment sold in the United States is supplied by imports. The United States enjoyed a surplus of trade in environmental equipment for all purposes of $1.1 billion in 1991, and this surplus has been increasing since 1989. Between 1989 and 1991, U.S. exports increased approximately 70 percent, while imports increased 45 percent. The nation has been operating positive trade balances with most of its major trading partners in environmental protection equipment since 1989. The largest surpluses in 1991 were held with Canada and Japan.

U.S. exports, imports, and trade balance for environmental

protection equipment, 1989-1991.

(thousands of current dollars)

Exports Imports Trade Balance

Country 1989 1990 1991 1989 1990 1991 1989 1990 1991

Canada 126, 945 383,331 420,399 94,3 91 117, 410 102,901 32,554 265,921 317,498

France 43,482 57,261 71,104 19,6 92 19,781 24,2 53 23,79 0 37,480 46,851

Germany 33,6 74 40,588 97,161 52,524 61,910 88,0 57 (18,8 50) (21,3 22) 9,104

Japan 142, 239 138,13 3 319,78 9 71,5 56 92,1 40 118, 102 70,68 3 45,993 201,687

Mexico 53,5 12 69,699 94,720 11,2 68 16,6 34 18,5 61 42,24 4 53,065 76,159

Republic

of Korea 50,182 49,152 57,959 1,58 9 3,073 4,680 48,57 3 46,079 53,279

Republic

of China 66,586 59,707 72,427 13,8 48 21,943 18,8 63 52,73 8 37,764 45,726

United

Kingdom 74,291 38,227 98,282 28,565 63,320 45,5 32 45,726 (25,093) 52,750

Total1 975,158 1,310,254 1,680,021 409,667 501,391 566,921 565,491 808,863 1,113,100

 1 Total includes other countries omitted from above list.

Source: U.S. Environmental Protection Agency, International Trade in Environmental Protection Equipment: An Assessment of Existing Data, EPA 230-R-93-006, (Washington, DC: EPA, July 1993), Table 6, page 29 and Table 8, page 25.

Program Accomplishments

In 1993 the federal government made progress in establishing methods of environmental accounting and valuation to characterize the benefits provided by the environment. A major component has been the recognition in recent years of the value of ecosystems.

Environmental Accounting and Valuation

In 1993 the EPA continued to support the work of the Ecological Economic Forum, a group of ecologists, economists, and other social scientists that began meeting in 1991 to advance the state of the art of ecosystem valuation methods. The deliberations of this forum led to recommendations for integrated research as a means to improve linkages between ecological and economic methods and to develop improved protocols for valuation studies.

The EPA has initiated a case study of the Patuxent River watershed in Maryland, intended to contribute to the general development of integrated ecological-economic modeling. The research will develop methods for valuing ecosystem configurations and services from them. The effort seeks to model the

interaction of the ecosystem and human activity, illustrating how humans intervene in the ecosystem and how different ecosystem configurations contribute to human welfare.

Environmental Accounting

In 1993 the Bureau of Economic Analysis prepared modified gross domestic product (GDP) national income and product accounts for publication in 1994. Prepared with support from the National Biological Survey in the Department of the Interior, these accounts reflect the depletion of selected natural resources and also the -discovery- of natural resources as a result of exploration. The national income and product accounts, designed to help government agencies interpret the processes that produce current income and future wealth, have been used as a tool for policy analysis for the last 50 years. In this regard incorporating elements of the environment into the national accounting framework will improve the quality of the accounts and the policy options available.

The EPA is exploring methods to introduce environmental considerations into conventional economic accounting systems. A pilot study of environmental accounting in the Chesapeake Bay region was conducted by the EPA and reviewed by the Science Advisory Board's Environmental Economics Advisory Committee (EEAC). Based on the EEAC review of the study, the EPA published a report evaluating the potential of environmental accounting to capture environmental concerns, as well as the difficulties in such an exercise in 1993. EPA environmental accounting work will focus on the approach proposed in the draft handbook on Integrated Environmental and Economic Accounting prepared by the United Nations Statistical Office. In particular the EPA is investigating the feasibility of expanding an ongoing economic input-output (I-O) study of environmental protection activities to include environmental measures such as air and water discharges. The I-O study follows protocols defined by the Department of Commerce and is used to measure who buys and sells goods and services from whom within defined industrial and governmental sectors found throughout the economy. The introduction of air and water discharges would make more explicit the non-priced economic service the environment provides as a result of its ability to assimilate pollutant discharges allowed under existing air and water permits. IF this approach is deemed feasible and reasonable, the EPA will develop set of environmental accounts using this framework.

Harnessing Market Forces

The nation has achieved considerable progress in protecting natural resources and the environment as the result of establishing environmental standards and regulations. Prior to passage of U.S. environmental laws, the absence of ownership of these public goods contributed to the decline in environmental quality. The development of standards succeeded in making more explicit the costs to the environment of human activity.

Much of the early environmental legislation and policies focused on developing standards and dictating engineering solutions to rectify the most obvious environmental hazards. Many of these environmental improvements led consumers and producers to invest in environmental pollution controls. The early emphasis on command-and-control solutions to environmental problems, while in many ways successful in achieving environmental goals, has proved to be expensive. Furthermore, many environmental problems do not easily lend themselves to these same control measures. The complexity of controlling

large numbers of dispersed pollution sources demands that alternative policies and economic tools be used to resolve these issues.

The federal government has moved to adopt more market-based incentives and other economic tools to help reduce the costs associated with environmental requirements. For example, using a market-based approach, the government specifies an environmental goal, such as a 50-percent reduction in emissions of a given compound within a geographic area, and then provides flexibility to the industry in choosing how to meet that goal in the most cost-effective manner.

As a result of these efforts, market-based incentives have moved from relative obscurity to a tool for improving the environment while departing from -command and control- regulations and sometimes offering opportunities to reduce cost. The 1990 Clean Air Act amendments has led the EPA to propose and promulgate incentive-based mechanisms for the control of acid rain, for the development of cleaner burning gasoline and less polluting vehicles, for states to use in controlling urban ozone and carbon monoxide, and to facilitate the reduction of toxic air emissions.

As other key environmental statutes-are up for reauthorization, incentive mechanisms promise to be actively considered as environmental legislative proposals make their way through Congress. The EPA is preparing analysis of numerous possible incentives to support this dialogue. Some states have implemented incentive programs, and others are considering such proposals.

The evidence on the environmental effects of economic incentives, while much less extensive than that on economic efficiency, suggests that incentive mechanisms are fully compatible with environmental objectives (see the incentives table, which describes different types of incentive instruments, some of which are further distinguished on the basis of when the incentive becomes effective). Incentives can establish a system of rewards for innovation through a variety of specific mechanisms. Some incentive mechanisms establish prices indirectly through market transactions. Within this group are information reporting requirements, such as Title III of the Superfund Amendments and Reauthorization Act. Others, such as pollution fees and various trading systems, including the EPA air emission trading program, transferrable development rights, and marketable effluent discharge credits, are other types of incentives.

Some new systems as yet not fully implemented hold out considerable promise for being both effective and efficient in reducing pollution. Beverage container deposits appear to have greatly reduced litter, but limited knowledge is available on the impact of other deposit-refund systems and virtually no analysis of the costs and benefits of any of the deposit-refund mechanisms is available.

As in the United States, official interest in economic incentives appears to be increasing in Europe. A review of the use of economic incentives outside the United States suggests a preference for a somewhat different mix of incentive mechanisms. The United States uses many more marketable permit systems than do European countries, but much less environmental labeling. Although charges and fees are used more widely in Europe, they tend to be revenue-raising instruments with few incentive impacts, just as in the United States. The lack of incentive impact of charges is due primarily to their low magnitude and because a number of the charges are not closely linked to waste generation or product consumption.

Trading Systems

In 1993 the Administration's National Performance Review identified the use of market systems as a tool to further investigate for achieving environmental standards in a cost-effective manner. Among the set of market-based tools, trading systems have drawn the greatest overall attention of environmental managers.

Although all trading programs require some involvement of a pollution control agency, the extent of that involvement varies substantially. The nature of the pollutants being controlled and the production practices of the firms being regulated serve to steer which types of trading are feasible. Besides these factors a number of general conditions can be used to differentiate among trading programs (see attributes table).

For example, trading programs can occur among different firms or different parts of an individual firm's production operations-both of which could take into account matters of quantity and timing of emissions. Trading among firms is often used to take advantage of relative cost efficiencies that may arise as a consequence of new, cleaner technologies not uniformly adopted by firms, such as an acid rain trading program. Trading within a firm's production process allows the firm to target those steps in the production process that can be modified to reduce emissions, or similarly, to select cost-effective solutions involving a number of processes in those cases where multiple outputs are produced, such as the steel industry effluent bubble.

Another factor in operating a trading program involves whether mass emissions limits are required. Mass emission limits prescribe the total emissions that a polluter may emit over a designated period of time. Issues concerning such limits include setting a baseline, the nature of the pollutant such as bioaccumulative and transport properties, accurate emissions monitoring, and defining penalties provisions that are limit-related. The geographic area for which trades are permitted is largely determined by the type of pollutant. If the pollutant spreads widely and has adverse effects at the low concentrations found at distant points, the geographic area is likely to be large, such as chlorofluorocarbons. Other pollutants such as wood stove emissions may have adverse effects primarily on a small local or regional area.

Most published studies on the subject have been based upon exante analysis of costs and anticipated market behavior. Because of the potential impacts nationwide of acid rain and climate change, the EPA is committed to assessing the cost savings of trading programs. The objective is to provide further empirical evidence of the efficacy of trading as a means of reducing the cost of environmental protection.

Environmental Concerns and Innercity Economics

The EPA is forging partnerships with other federal agencies and departments to provide innercity residents and minority businesses with opportunities connected to eliminating environmental hazards in their communities. Partnerships assist in carrying out the federal commitment to use programs and activities to advance environmental protection in urban communities. These programs also create minority business entrepreneurial opportunities, job training, and placement by stimulating economic

growth and development in the community. Innercity problems such as substandard water and air quality, toxics in the home (lead, asbestos, and indoor air pollution), and energy conservation are of paramount concern at the community, municipal, state, and federal levels.

The EPA Office of Environmental Equity (OEE) is sponsoring Community Economic Development Projects such as the following:

Mercado Project. An OEE training grant funds the California State University at Hayward to prepare a business management training program and business plan for its Mercado Project in the Asian-American community in the San Francisco Bay area. The project is developing a public education center and small business incubator for retail outlets and related manufacturing, such as assembly facilities of high-value-added products made using secondary materials as a feedstock. The project will train and employ diverse members of the community who would be less likely to have these entrepreneurial and job opportunities without such training and business development. Unemployed residents will learn to convert recyclable woods and plastics into furniture that can be sold to provide revenue for the community.

District of Columbia Lead Abatement. A memorandum of agreement among the EPA, departments of Housing and Urban Development and Commerce, and the District of Columbia has led to a project that trains unemployed residents of D.C. public housing units in lead paint remediation and abatement. Once trained and certified, the District has pledged to hire workers to start on remediating lead from the units. The partnership will help residents interested in forming their own small businesses or link them with existing small businesses. Any companies formed will be eligible for noncompetitive contracts through the HUD Title 3 program. In a closed system, residents are trained, certified, and hired to clean up their communities- own environments to reduce lead exposure and improve environmental quality in their neighborhood. The project could serve as a model for other urban areas with lead problems.

Hazardous Waste Management Technicians. The EPA Superfund Office is funding Cuyahoga Community College in Ohio to train unemployed residents as hazardous waste management technicians. Private industries in the area have agreed to employ trained residents in local cleanup efforts. The Cuyahoga project offers residents the option of working toward Associate of Arts degrees or of enrolling in 4-year degrees at a consortium college.

Xavier University Study. The EPA Office of Small and Disadvantaged Business Utilization (OSDBU) provided $115,000 of Clean Air Funds to Xavier University, a historically black university in New Orleans, Louisiana, to study clean air issues affecting small and disadvantaged businesses in small communities along a corridor with high incidence of cancer. Study results will provide the residents of these communities with a Plan of Action to determine their environmental needs. The OSDBU is evaluating other economic development initiatives to provide minority communities additional opportunities to participate in the environmental marketplace.

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Chapter 10: National Environmental Policy Act

We seek to set our course by the star of age-old values, not short-term expediencies; to waste less in the present and provide more for the future; to leave a legacy that keeps faith with those who left the Earth to us.

President Bill Clinton

The National Environmental Policy Act (NEPA) provides a broad mandate for federal agencies to create and maintain -conditions under which man and nature can exist in productive harmony and fulfill the social, economic, and other requirements of present and future generations of Americans.-

NEPA requires federal agencies to integrate environmental values into their decisionmaking processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. The form of these considerations is an environmental assessment (EA) or an environmental impact statement (EIS).

Title II of NEPA, which created the Council on Environmental Quality (CEQ) to oversee federal agency implementation of the act, requires the Council to report to the President annually on the conditions and trends in environmental quality. The 1993 edition of Environmental Quality is the 24th CEQ Annual Report.

NEPA Glossary

Section 102(2)© of the National Environmental Policy Act of 1969 requires federal agencies to prepare a -detailed statement- for proposed major actions which significantly affect the quality of the human environment. The statement must include the environmental impacts of the proposed action, alternatives to the proposed action, and any adverse environmental impacts which cannot be avoided should the proposal be implemented. In 1978 the CEQ issued binding regulations which implement the procedural provisions of NEPA. The following are key terms:

. Environmental Assessment (EA). A concise public document that analyzes the environmental impacts of a proposed federal action and provides sufficient evidence to determine the level of significance of the impacts.

. Finding of No Significant Impact (FONSI). A public document that briefly presents the reasons why an action will not have a significant impact on the quality of the human environment and therefore will not require preparation of an environmental impact statement.

. Environmental Impact Statement (EIS). The -detailed statement- required by Section 102(2)© of NEPA which an agency prepares when its proposed action significantly affects the quality of the human environment.

. Record of Decision (ROD). A public document signed by the agency decisionmaker at the time of a decision. The ROD states the decision, alternatives considered, the environmentally preferable alternative or alternatives, factors considered in the agency's decision, mitigation measures that will be implemented, and a description of any applicable enforcement and monitoring programs.

. Categorical Exclusion (CE). Categories of actions which normally do not individually or cumulatively have a significant effect on the human environment and for which, therefore, an EA or an EIS is not required.

. Cumulative Impact. The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency, federal or nonfederal, or what person undertakes the action.

Conditions and Trends

With the passage of NEPA in 1969, Congress recognized that technological, social, and economic forces were having a profound influence on the quality of the human environment. The act was prescient in its anticipation of future environmental problems that the nation would face. An effective linkage of NEPA sections 101 and 102 provides the framework for agencies to integrate environmental values into their programs and projects.

Section 101. Sets forth the nation's environmental goals and a broad national policy to achieve them, and serves as a blueprint for considering a range of environmental effects of proposed federal actions.

Section 102(2). Provides the process to ensure that federal agency decisionmakers are aware of Section 101 policies and the environmental consequences of proposed federal actions.

Section 102(2)©. Requires federal agencies to prepare -detailed statements- for actions -significantly affecting the quality of the human environment.- The detailed statements must include the environmental impacts of the proposed action, any adverse environmental effects which cannot be avoided, alternatives to the proposed action, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources which would be involved should the proposed action be implemented.

CEQ Regulations. In 1978 CEQ promulgated regulations implementing the procedural provisions of NEPA (40 C.F.R. Parts 1500-1508). These regulations reflect the vision of the act by defining the human environment-the natural and physical environment-and the relationship of people with the environment. The NEPA charge in 1969 to preserve and maintain an environment that supports diversity laid the groundwork for the biodiversity issue of the 1990s. Today NEPA provides a powerful tool for maintaining the sustainability and biodiversity of ecosystems, including human economies and communities (see Chapter 6).

Program Accomplishments

In 1993 the CEQ acknowledged efforts by federal agencies to integrate environmental values early in their planning and sought ways to integrate the NEPA process at home and abroad. In 1992, federal agencies filed 513 draft, final, and supplemental environmental impact statements.

Environmental Impact Statements filed

by Federal agencies, 1979-1992

Agency 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992

Agriculture 172 104 102 89 59 65 117 118 75 68 89 138 145 129

Commerce 54 53 36 25 14 24 10 8 9 3 5 8 13 12

Defense 1 1 1 1 1 0 0 0 2 0 0 0 0 1

Air Force 8 3 7 4 6 5 7 8 9 6 11 19 20 19

Army 40 9 14 3 6 5 5 2 10 8 9 9 21 14

COE 182 150 186 127 119 116 106 91 76 69 40 48 45 56

Navy 11 9 10 6 4 9 8 13 9 6 4 19 9 6

Energy 28 45 21 24 19 14 4 13 11 9 6 11 2 15

EPA 84 71 96 63 67 42 16 18 19 23 25 31 16 4

GSA 13 11 13 8 1 0 4 0 1 3 0 4 3 15

HUD 170 140 140 93 42 13 15 18 6 2 7 5 7 2

Interior 126 131 107 127 146 115 105 98 110 117 61 68 64 79

Transportation277 189 221 183 169 147 126 110 101 96 80 100 87 129

TVA 9 6 4 0 2 1 0 1 0 0 0 3 0 3

Other 98 44 76 55 22 21 26 15 17 20 23 18 24 29

TOTAL: 1273 966 1033 808 677 577 549 521 455 430 370 477 456 513

Environmental Impact Statements filed by

Federal agencies during 1992

Totals by Totals

Agency Subject Matter

Department of Agriculture 129

Natural Gas and Oil: Driling and Exploration 8

Forestry and Range Management 87

Comprehensive Management Plans 1

Parks, Recreation Areas, Wilderness Areas, 10

National Seashores

Land Acquisition or Disposal, Management/ 2

Jurisdiction Transfer

Watershed Protection and Flood Control 7

Municipal/Industrial Water Supply Systems 1

(Non Multi-Purpose Impoundments)

Irrigation, Desalination of Return Flows, 1

Agriculture Water Supply

Other Water Projects 1

Mining 2

Mining (Non-Energy) 8

Railroads 1

Department of Commerce 12

Wetlands, Estuary and Ocean Use (Sanctuary, 2

Disposal, etc.)

Fisheries 10

Department of Defense 1

Defense Systems 1

Department of the Air Force 19

Military Installations 15

(Conventional, Chemical, Nuclear, etc.)

Defense Systems 3

Nuclear Development (e.g., Fuel, Reactors) 1

Department of the Army 13

Military Installations 10

(Conventional, Chemical, Nuclear, etc.)

Defense Systems 1

Buildings for Federal Use 1

Housing Subdivisions and New Communities 1

Department of the Navy 6

Military Installations 4

(Conventional, Chemical, Nuclear, etc.)

Space Programs 1

Dredge and Fill 1

 Environmental Impact Statements filed by

 Federal agencies during 1992 (continued)

Totals by Totals

Agency Subject Matter

Department of the Marine Corps 1

Military Installations 1

(Conventional, Chemical, Nuclear, etc.)

Department of the Defense Nuclear Agency 1

Power Facilities: Conservation and Other 1

Department of the Army, Corps of Engineers 56

Military Installations 2

(Conventional, Chemical, Nuclear, etc.)

Beach Erosion, Hurricane Protection, 6

River/Lake Bank Stabilization

Navigation 7

Dredge and Fill 5

Watershed Protection and Flood Control 23

Other Water Projects 5

Fisheries 2

Bridge Permits 2

Natural Gas and Oil: Transportation, 1

Pipeline Storage

Roads 1

Special Development (Expos, Bicentennials, 1

Olympics, etc.)

Mining 1

Department of Energy 15

Regulatory: Allocation, Pricing 1

Building, Federally Licensed or Assisted 2

(Including Production Facilities)

Power Facilities: Transmission 4

Power Facilities: Fossil 1

Power Facilities: Hydroelectric 2

Power Facilities: Conservation and Other 2

Natural Gas and Oil: Transportation, Pipeline, 2

Storage

Radioactive Waste Disposal 1

Environmental Protection Agency 4

Sewage Treatment and Sewage Facilities 1

Wetlands, Estuary, and Ocean Use 2

(Sanctuary, Disposal, etc.)

Industrial Wastewater Facilities, Mining 1

Pollution Control

 Environmental Impact Statements filed by

 Federal agencies during 1992 (continued)

Totals by Totals

Agency Subject Matter

General Service Administration 15

Buildings for Federal Use 12

Buildings, Federally Licensed or Assisted 3

(Including Production Facilities)

Department of Housing and Urban Development 2

Buildings, Federally Licensed or Assisted 2

(Including Production Facilities)

Department of the Interior 79

Buildings, Federally Licensed or Assisted 2

(Including Production Facilities)

Natural Gas and Oil: Drilling and Exploration 9

Natural Gas and Oil: Transportation, Pipeline, 2

Storage

Municipal and Industrial Water Supply System 3

(Not Multi-Purpose Impoundments)

Multi-Purpose Impoundments 2

Watershed Protection and Flood Control 1

Land Acquisition or Disposal, Management 6

Jurisdiction Transfer

Parks, Recreation Areas, Wilderness Areas, 14

National Seashores

Forestry and Range Management 12

Mining (Non-Energy) 12

Comprehensive Resource Management 3

Housing Subdivisions and New Communities 1

Wildlife Refuges, Fish Hatcheries 4

Bridge Construction 1

Power Facilities: Transmission 1

Dredge and Fill 2

Radioactive Waste Disposal 1

Miscellaneous Information 2

Hazardous and Toxic Substance Disposal 1

Interstate Commerce Commission 2

Railroads 2

Nuclear Regulatory Commission 0

Tennessee Valley Authority 3

Pesticides, Herbicides Use 2

Miscellaneous Information 1

 Environmental Impact Statements filed by

 Federal agencies during 1992 (continued)

Totals by Totals

Agency Subject Matter

Department of Transportation 129

Road Construction 89

Airport Improvements 19

Bridge Permits 6

Mass Transportation 13

Aircraft, Ships and Vehicles 2

Federal Energy Regulatory Commission 6

Natural Gas and Oil: Transportation, Pipeline, 2

Storage

Power Facilities: Hydroelectric 4

Department of Justice 14

Buildings for Federal Use 14

Department of Veterans Affairs 5

Cemetery Development 4

Medical Center Development 1

Total Federal 0EISs: 512

Source: U.S. Environmental Protection Agency, Office of Federal Activities, unpublished data, 1993.

Federal Environmental Quality Awards

The CEQ regulations require federal agencies to develop NEPA procedures adapted to their individual regulatory and program activities. Federal agencies are striving to better integrate environmental values in their planning processes through the NEPA process. To recognize and encourage such efforts, the CEQ, in partnership with the National Association of Environmental Professionals (NAEP), announced in 1993 the recipients of the first Federal Environmental Quality Awards for the year 1992.

The awards recognize excellence in federal agency decisionmaking pursuant to the National Environmental Policy Act.

Each federal department and agency was asked to nominate one of its actions or programs that demonstrates exemplary performance in reaching environmental goals and values. A committee of prominent environmental professionals evaluated the nominations and made recommendations to the CEQ Chairman, who made the final selection. Two winners were selected in 1992:

. Tennessee Valley Authority. The TVA prepared an EIS for its Lake Improvement Plan, which is a strategic guide by which the agency operates the dams and reservoirs of the Tennessee River and its tributaries. The TVA incorporated extensive public participation throughout the NEPA process and made the public a full partner in its decisionmaking.

. U.S. Air Force. Under its Program for Environmental Excellence, the Air Force uses an Environmental Impact Analysis Process (EIAP) to integrate NEPA values throughout the decisionmaking process. The Air Force senior leadership considers EIAP to be its most valuable planning tool.

In 1993 the CEQ announced the following award winners:

. U.S. Army Corps of Engineers, Wilmington District. The Wilmington District developed an environmental impact statement for its -Atlantic Intracoastal Waterway Bridge Replacement Projects- to guide decisions about replacements of deteriorating and unsafe bridges. The District incorporated public concerns early in the planning process and altered its plans based on its NEPA analysis and public involvement. The analysis effectively used video simulation to display the environmental effects of alternative approaches to accomplishing the objectives. A monitoring plan was established to ensure the commitments outlined in the EIS were honored.

. Minerals Management Service, Department of the Interior. The MMS, which administers the nation's Outer Continental Shelf (OCS) natural gas and oil program, was cited for its commitment to excellence in environmental decisionmaking for 1993. This recognition was based on its development of an environmental impact analysis program to effectively implement the NEPA by integrating its planning process, incorporating extensive public involvement, committing to interdisciplinary environmental analysis, maintaining a staff of in-house experts committed to the scientific integrity of the analysis, and conducting monitoring to ensure implementation of defined mitigation measures.

NEPA Oversight

In 1993 the CEQ sponsored a number of initiatives as part of its NEPA oversight responsibilities. Among the highlights for the year were social and economic analysis in conjunction with environmental justice, cumulative effects analysis, and international efforts.

Howard University Conference on Social and Economic Impact Analysis. The CEQ implementing regulations reflect recognition by NEPA of the interrelationship of social and economic concerns with the environment. The act requires federal agencies to consider social and economic impacts in EISs when such impacts are interrelated with physical environmental effects. Increasingly, evidence suggests that environmental impacts fall disproportionately on disadvantaged communities (see Chapter 8). The Clinton Administration has made environmental justice a priority, including the assessment of federal activities on minority and low-income communities when such analysis are required under NEPA. To examine methods for integrating social and economic analysis into the NEPA, the CEQ, in cooperation with Howard University in Washington, D.C., brought federal agencies together to discuss environmental assessments. The July 1993 workshop was a first step in assessing federal agency practices as they affect environmental justice.

NEPA and Native Americans Workshop. In addition to improving the analysis of impacts, another way to address environmental justice concerns is to ensure that affected communities have the tools to fully participate in the NEPA process. In 1993 the CEQ held the first in a series of NEPA workshops aimed at

increasing the capacity of tribal environmental officials to use NEPA to assess the environmental effects of actions. Capacity-building can increase the meaningful participation of tribes in the decisionmaking process. The workshop was held in cooperation with the Tulalip tribe in Marysville, Washington, and drew participants from tribes in Washington, Oregon, Montana, and Idaho.

Cumulative Effects Analysis. Federal agencies routinely consider the direct and indirect environmental effects of their actions, yet they consistently identify cumulative effects analysis as the most difficult methodological challenge under the NEPA. Cumulative effects include the effects on the environment which result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions taken by an agency, federal or nonfederal, or an individual. With a growing emphasis on an ecosystem approach to management, NEPA and CEQ regulations are crucial for analysis by agency decisionmakers concerned about the long-term economic and environmental health of a region. In 1993 the CEQ began preliminary work on a cumulative effects handbook, which will have contributions from a number of NEPA practitioners from federal agencies. The handbook will address the following challenges associated with cumulative effects analysis:

. Assessing a proposed action at the appropriate scale-programmatic, policy, or project;

. Establishing an environmental baseline database;

. Determining the scope of geographic and temporal boundaries of the analysis; and

. Coordinating efforts with all players in an ecological region to determine the impacts of a proposal in context with future plans for the region.

International Activities

In 1993 the CEQ took part in several activities concerning international environmental impact assessment (EIA).

Environmental Impact Assessment in a Transboundary Context. In 1992 the United States signed the Convention on Environmental Impact Assessment in a Transboundary Context, negotiated under the auspices of the Economic Commission for Europe (ECE). In 1993 the CEQ, Department of State, and EPA worked together to develop implementing procedures for the convention.

Technical Assistance. Since NEPA is the world's first environmental impact assessment statute, numerous countries have modeled their EIA procedures after NEPA and the CEQ regulations. Accordingly other countries often turn to the CEQ for assistance in developing an EIA process. In 1993 the CEQ met with delegations from a number of countries including Japan, China, Australia, the former Soviet Union, and African nations. In addition the CEQ assisted in developing and teaching a course entitled, -Principles and Policies of Environmental Impact Assessment,- to government and nongovernment officials in the Republic of Turkey.

International Association of Impact Assessment. The CEQ continues to provide support and leadership to the International Association of Impact Assessment. In 1993 the CEQ presented a paper at the IAIA conference in Shanghai, China, on using EIA as a tool for sustainable development.

NEPA Training

Continuing its focus on NEPA training initiatives, the CEQ participated in federal courses and workshops, in addition to conducting its own NEPA courses. Highlights of NEPA training in 1993 include the following:

Duke University Course on Implementing NEPA. For the second consecutive year, the CEQ cosponsored a week-long NEPA course at the Duke University School of Environment. Through this short course, which is offered twice annually, 150 mid-level and senior managers have received NEPA training.

Department of Justice NEPA Course. The CEQ participated in teaching a NEPA course offered by the Legal Education Institute of the Department of Justice. The course, which is targeted to government lawyers, was held in February 1993 in Washington, D.C..

American Bar Association NEPA Course. CEQ and Department of Justice lawyers assisted in organizing a NEPA course as part of the American Law Institute of the American Bar Association held in April 1993 in Washington, D.C.

NEPA Implementation by Federal Agencies

In 1993 the CEQ continued to work with federal agencies to implement NEPA regulations.

Emergency Alternative Arrangements. Pursuant to 40 CFR + 1506.11 of the implementing regulations, the CEQ provides for alternative NEPA compliance arrangements in the event an agency needs to take an action with significant environmental impacts. In 1993 the CEQ consulted with the following agencies regarding emergency arrangements:

. Animal and Plant Health Inspection Service. In May 1993 the Animal and Plant Health Inspection Service-Animal Damage Control (APHIS-ADC) informed the CEQ of emergency circumstances identified by the Federal Aviation Administration (FAA) regarding laughing gull-aircraft interactions on the grounds of the John F. Kennedy International Airport (JFK) in New York. The agency had conducted bird-control activities at the airport for a number of years and was in the process of preparing a programmatic EIS for its gull-control program at the airport. In April 1993 the FAA issued an emergency advisory that drew attention to the severe bird-aircraft strike hazard conditions at the airport and called for -implementation of an effective bird mitigation program.- After discussions with representatives of other state and federal agencies involved in the issue and a site visit to JFK, the CEQ issued a number of conclusions and recommendations regarding arrangements in the context of the immediate action, the programmatic EIS, and the ultimate decisions to be made.

. Department of Energy. In October 1993 the CEQ approved the Department of Energy (DOE) proposal regarding alternative NEPA arrangements for the acceptance of 144 spent nuclear fuel elements from a reactor in Belgium and their shipment to the United States. The Belgian reactor was filled to storage capacity with spent nuclear fuel, and if not relieved of at least 144 spent fuel elements, the result would be a potentially permanent shutdown of the reactor or shipment of the elements to Scotland for reprocessing. Based on discussions with the Department of State and the written opinion of that department, the CEQ concurred with the DOE that failure by the United States to commit to accepting the spent fuel rods could lead to the potential diversion of materials in the fuel to nuclear weapons production. Such a diversion would undermine the long-standing U.S. nonproliferation policy of minimizing the use of highly enriched uranium for civil programs worldwide. Other foreign research reactors could lose confidence in the U.S. commitment to the Reduced Enrichment for Research and

Test Reactors program. Since the acceptance of spent fuel is a key element of this program, a U.S. refusal might lead other cooperating countries to cease cooperation. The matter came to a close in 1993, when the Belgians rejected the U.S. offer to accept the spent nuclear fuel elements.

Referral. The CEQ regulations at 40 CFR Part 1504 establish procedures for referring to the Council - interagency disagreements concerning proposed major federal actions that might cause unsatisfactory environmental effects.- Not later than 25 days after receipt of the referral, the CEQ must respond, such as publishing findings and recommendations. In January 1993 the CEQ received a referral submitted by the Advisory Council for Historic Preservation (ACHP) regarding Federal Highway Administration (FHWA) funding for the completion of Route 710 (Long Beach Freeway) in South Pasadena, California. The ACHP raised concerns over what it views as significant adverse impacts of the project on historic properties in the area. In April 1993 the CEQ determined that, based on commitments by the FHWA and the concurrence of the ACHP, the referral would be held in abeyance until after the Mitigation and Enhancement Advisory Committee created by the California Department of Transportation, the proponent of the proposed freeway construction, completes a report. The referral is currently pending.

Agency EIA Procedures. In 1993 after consultations with the CEQ, a number of federal agencies published proposed new or revised environmental impact assessment procedures. The agencies include the Air Force; Coast Guard; Office of Surface Mining, Reclamation, and Enforcement; Bureau of Mines; Federal Emergency Management Agency; Federal Energy Regulatory Commission; and U.S. Enrichment Corporation.

NEPA Consultations. As part of its NEPA oversight responsibilities, the CEQ consulted with various federal agencies on environmental issues, taking the following actions:

. Advised the Department of the Interior on strategies for proceeding with a draft EIS for a proposed program called Rangeland Reform 1994. Work included legal advice to DOI regarding the adequacy of the NEPA analysis and extensive advice to the EIS team regarding the adequacy of the environmental and economic analysis.

. Advised the National Security Council and Arms Control and Disarmament Agency on an EIS, in conjunction with the Administration's submission of the Chemical Weapons Convention to the U.S. Senate for advice and consent.

. Consulted with the Department of the Interior and the U.S. Forest Service to address NEPA implementation issues for their Pacfish Strategy, which addresses immediate and long-term actions to assure proper management of anadromous fish habitat in the Pacific Northwest.

. Worked with the Federal Energy Regulatory Commission to develop a more systematic and programmatic approach to addressing environmental impacts of the licensing and relicensing of hydropower projects.

. Provided consultation on NEPA compliance issues for post-Midwest flood work, at the request of the FEMA, Department of Housing and Urban Development, and Federal Railroad Administration.

Selected 1993 NEPA Case Law

Although 1993 NEPA-related court decisions covered a variety of issues, two key cases were decided which addressed the issue of the application of the NEPA for proposed federal actions having environmental impacts abroad.

Extraterritorial Application

Environmental Defense Fund v. Massey, 986 F.2d 528 (D.C. Cir. 1993). In 1991 the National Science Foundation (NSF), which had been burning food wastes in an open landfill at a research facility in Antarctica, decided to halt its open burning practices and develop an alternative method of disposal. Thereafter the NSF decided to resume burning in an -interim incinerator- until a state-of-the-art incinerator could be delivered.

The Environmental Defense Fund (EDF) objected, alleging that the planned incineration might produce highly toxic pollutants which could be hazardous to the environment. The EDF filed suit seeking declaratory and injunctive relief, arguing that the NSF failed to consider fully the impacts of its action under NEPA. The NSF argued that the presumption against the extraterritorial application of U.S. statutes applied in this case, therefore, NEPA did not apply.

The D.C. Circuit Court of Appeals explained that extra-territoriality is a jurisdictional concept providing that U.S. statutes, whether prescribed by federal or state authority, apply only to conduct occurring within, or having effect within, the territory of the United States. The primary purpose of the presumption against extraterritoriality is -to protect against the unintended clashes between our laws and those of other nations.- *Equal Employment Opportunity Commission v. Arabian American Oil Co.*, 111 S. Ct. 1227 (1991).

The court also noted:

[by definition, an extraterritorial application of a statute involves the regulation of conduct beyond U.S. borders. Even where the significant effects of the regulated conduct are felt outside U.S. borders, the statute itself does not present a problem of extraterritoriality, so long as the conduct which Congress seeks to regulate occurs largely within the United States.

The court noted that the application of the NEPA to federal actions is not limited to actions occurring in, or having effects in, the United States. Rather the NEPA is designed -to control the decisionmaking process ... not the substance of agency decision- that takes place almost exclusively in the United States. The court found, therefore, that the presumption against extraterritoriality did not apply in this case.

In holding that the NEPA did apply to the NSF actions in the Antarctic, the court ultimately relied on Antarctica's unique status as a place which was not a sovereign territory:

We find it important to note, however, that we do not decide today how NEPA might apply to actions in a case involving an actual foreign sovereign or how other U.S. statutes might apply to Antarctica. We only hold that the alleged failure of NSF to comply with NEPA before resuming incineration in Antarctica does not implicate the presumption against extraterritoriality.

Administration Response to EDF v. Massey. Subsequent to this decision, an interagency group established by Presidential Review Directive (PRD) 23, and chaired by the National Security Council, was formed to assist in developing an Administration position on EIAs overseas. The PRD reviewed various

tools for addressing environmental effects of activities of federal agencies taken abroad. As part of the PRD, the CEQ chaired an interagency working group on public participation and alternatives analysis.

NEPA Coalition of Japan v. Aspin, 837 F. Supp 466 (D. D.C. 1993). The district court held that NEPA does not apply to U.S. Navy operations at three bases in Japan. The court relied on the presumption against extraterritorial application of statutes and distinguished Environmental Defense Fund v. Massey, 986 F.2d 528 (D.C. Cir. 1993), noting that Massey expressly refrained from deciding whether NEPA applies to federal actions in foreign sovereign territory. Alternatively the court found that, even if NEPA did apply, no EIS would be necessary because -plausible assertions have been made that EIS preparation would impact upon the foreign policy of the United States,- and foreign policy interests outweigh the benefits from preparing an EIS.

NEPA and NAFTA

Public Citizen v. Office of U.S. Trade Representative, 5 F.3d 549 (D.C. Circ. 1993). Trade negotiations among the United States, Canada, and Mexico resulted in the North American Free Trade Agreement (NAFTA). The agreement was signed by the President and his counterparts on December 17, 1992. Under the Trade Acts, the U.S. Trade Representative (USTR) serves as the President's chief negotiator on trade matters. The President submitted the NAFTA together with implementing legislation and related materials to Congress under the -fast track- approval process, limiting the time both houses can debate and conclude on the legislation as submitted.

Public Citizen alleged that the Office of the United States Trade Representative (OTR) violated NEPA by failing to prepare an EIS to accompany the submission of NAFTA to Congress. At that time the negotiations on the trade agreement had not yet concluded, and the court noted that because the agreement was not yet complete, there was no final agency action on NAFTA. All NEPA actions are brought under the Administrative Procedure Act (APA), which requires final agency action.

After the treaty had been completed, plaintiffs filed suit, and the district court held that final agency action was then present because the treaty had been signed, negotiations completed, and under -fast track,- the agreement could not be changed before submission to Congress. The district court ordered the OTR to complete an EIS -with all deliberate speed.-

The U.S. Court of Appeals overturned the district court's decision, holding that despite the OTR's completion of its role as NAFTA negotiator:

the final agency action challenged in this case is the submission of NAFTA to Congress by the President...[H]is action, and not that of the OTR, will directly affect Public Citizen's members.

Accordingly because the President is not an agency, the D.C. Circuit held that his actions are not reviewable under the APA.

Standing

Fund for Animals, Inc. v. Espy, 814 F. Supp. 142 (D. D.C. 1993). Fund for Animals brought a suit under NEPA challenging a decision of the Department of Agriculture to fund, approve, and implement a research program on the communicability of brucellosis in bison. The program involved the capture of a number of pregnant wild bison from outside the boundary of their habitat, their transportation by truck 2,000 miles to Texas, and their ultimate slaughter.

Fund for Animals claimed standing based in part on a -procedural injury- suffered based on defendant's alleged failure to prepare an environmental analysis under the NEPA. The court rejected this argument but held plaintiffs had standing based on the charitable and scientific nature of the organization and its commitment to preserving animal species in their natural habitats. The court also found that plaintiffs had shown a likelihood of success on the merits and that defendant was not likely to succeed on its claim, invoked post hoc, that the research qualified for a categorical exclusion.

Resource Limited, Inc. v. Robertson, 8 F.3d 1394 (9th Cir. 1993). Resource Limited challenged the Flathead National Forest Land and Resource Management Plan and the forest-wide EIS. Resource Limited asserted the EIS was inadequate, and disputed the conclusion of the Forest Service that implementation of the plan would not jeopardize the survival of the several endangered species living in the forest. The district court determined that Resource Limited had no standing and that the matter was not ripe for adjudication.

The Ninth Circuit Court of Appeals, following its prior decisions in *Idaho Conservation League v. Mumma*, 956 F.2d 1508 (1992), and other similar cases, reversed the district court on the issues of standing and rifeness. The court held that plaintiffs were not required to allege a site-specific injury when challenging a forest-wide plan:

[I]f plaintiffs did not have standing to challenge a non-site-specific EIS, the program as a whole could never be reviewed. -To the extent that the plan pre-determines the future, it represents a concrete injury that plaintiffs must, at some point, have standing to challenge.- Quoting Mumma at p. 1516.

The Ninth Circuit also rejected the argument that a forest-wide plan was not ripe for review until the Forest Service authorizes a specific timber sale pursuant to the plan. The court held that, since the grievance was with the overall plan, the case was ripe for review.

The court then went on to consider the challenges to the adequacy of the EIS and found that the EIS contained a reasonably thorough discussion of cumulative impacts from both federal and nonfederal action, contained a comparative analysis of water quality impacts under each alternative that was adequate to allow the decisionmakers and public to make an informed choice, and was based on consideration of an adequate range of timber harvest levels.

Region 8 Forest Service Timber Purchasers Council v. Alcock, 993 F.2d 800 (11th Cir. 1993). Plaintiffs, which consisted of the Region 8 Forest Service Timber Purchasers Council and three timber purchase companies, filed this complaint for declaratory and injunctive relief, alleging that the Forest Service violated the NEPA, the Endangered Species Act (ESA), and National Forest Management Act (NFMA) by implementing emergency measures to protect the nesting and foraging habits of the endangered red-cockaded woodpecker. The District Court dismissed the NEPA and ESA claims for lack of standing and rejected the NFMA claims by granting the government's motion for summary judgment.

The court of appeals affirmed, holding that the Council lacked standing under all three statutes. The court found the Council's allegations of economic injury insufficient for purposes of standing because of the following findings:

. Relief for the Council's claims of contractual injuries could be obtained only under the Contract Disputes Act; and

. The Council's claims of a right to a certain amount of future timber incorrectly assumed a right to harvest a set amount of timber under a Forest Plan.

The court rejected the Council's claims of -quality of life- injuries as -simply attenuated versions of the economic injuries we have already considered.- The court further rejected the Council's claim to have suffered harm to environmental interests as improperly based on assertions of environmental interests of employees. Finally the court rejected the Council's allegations of procedural injuries for purposes of standing because, like the allegations held insufficient by the Supreme Court in Lujan v. Defenders of Wildlife, 112 S.Ct. 2130 (1992), the allegations of procedural injury had no connection to a separate cognizable concrete interest.

Decision to Supplement an EIS

Portland Audubon Society v. Babbitt, 998 F.2d 705 (9th Cir. 1993). Environmental groups sued for declaratory injunctive relief challenging the decision of the Secretary of the Interior not to supplement the Timber Management Plans (TMPs) prepared between 1979 and 1983 based on new information concerning the effect of those plans on the northern spotted owl. The district court enjoined logging operations on Bureau of Land Management (BLM) land with owl habitat pending preparation of a Supplemental Environmental Impact Statement. The Secretary of the Interior and other defendants appealed.

The Department of the Interior contended that its 1987 decision not to prepare a supplemental EIS was not arbitrary and capricious in light of the information available at the time of the decision and that legal developments occurring after 1987 relieved it from subsequently incurring an obligation to prepare an EIS. The court of appeals found that the record amply supported the district court's conclusion that defendant's decision not to supplement the EISs was arbitrary and capricious. The court stated that decisions made by the BLM in its TMPs:

involved a course of action that was to be taken over a ten-year period...the body of scientific evidence available in 1987 concerning the effect of continued logging on the ability of the owl to survive as a species raised serious doubts about the BLM's ability to preserve viability options for the owl if logging continued at the rates and in the areas authorized by the TMPs...A supplemental EIS should have been prepared because the scientific evidence available to the Secretary in 1987 raised significant new information relevant to environmental concerns, information bearing on the impacts arising from ongoing implementation of the land use decisions driven by the original TMPs.

The court also rejected defendant's argument that the court's holding in Headwaters, Inc. v. BLM, 914 F.2d 1174 (9th Cir. 1990), reh-g denied, 940 F.2d 434 (1991), supports the conclusion that the BLM decision not to supplement the EISs was reasonable. The court distinguished Headwaters, which held that a supplemental EIS was not necessary for a single site-specific sale (and a single pair of owls), as opposed to the instant case involving a challenge to the decision not to supplement EISs underlying the TMPs that control a large number of land use decisions. The new information relating to the possible extinction of a species through the systematic implementation of a timber-sale program throughout BLM lands influenced the finding.

West Branch Valley Flood Protection Ass-n v. Stone, 820 F. Supp. 1 (D. D.C. 1993). In 1975 the Army Corps of Engineers (COE) prepared an EIS for the construction of a levee-dike system on the

Susquehanna River and Bald Eagle Creek in Pennsylvania. The Corps later proposed revising the levee design and prepared an environmental assessment/finding of no significant impact for the proposed plan. Plaintiff's sued the Army Corps of Engineers for failure to submit a supplemental environmental impact statement, alleging that the EA inadequately considered important environmental impacts.

The court explained that supplemental EISs are triggered when new information presents a -*seriously* different picture of the environmental landscape- such that another in-depth look at the environment is necessary.- The court further stated that in reviewing the agency decision not to supplement, the court will reverse the decision only if the action was arbitrary and capricious. Accordingly the court held that the Corps was not required to prepare a supplemental EIS because of the following findings:

. The new information did not present a seriously different picture of the environmental landscape;

. The Corps discussion of mitigation measures demonstrated that the agency took a realistic look at the adverse impacts of the project;

. The Corps discussion of alternative designs was sufficient; and

. The threat of future Superfund liability resulting from the project was too speculative to support a claim of arbitrary and capricious action.

Standard for Exception to Categorical Exclusion

City of New York v. Interstate Commerce Commission, 4 F.3d 181 (2d Cir. 1993). The City of New York sought review of an Interstate Commerce Commission (ICC) order granting applications of four bus carriers to provide service to the Borough of Manhattan. The ICC had adopted a categorical exclusion for motor carrier licensing in its NEPA procedures, thus precluding any further environmental analysis.

At the ICC proceedings to consider the applications, the City filed protests alleging that the increased bus service would worsen the already unhealthy levels of air pollution in Manhattan. The ICC concluded that the City had not demonstrated that an environmental analysis under the NEPA was required and that it was the City's responsibility to take appropriate steps to address the air pollution problems that it raised in its protests. The ICC subsequently granted the licenses.

The City sought review in the court of appeals, where it argued that the ICC failed to consider the cumulative impacts of the proposal with other operations having environmental effects in the same geographic area. The court pointed out that the case did not pose the question of whether cumulative effects must be considered in determining whether the NEPA applied to a particular agency action. Rather the court stated it was a question of whether the ICC properly refused to except from its categorical exclusion of all motor vehicle licensing these four particular bus license applications.

The court found that the City had not shown and made no attempt to show that granting the licenses would involve the -extraordinary circumstances- necessary to trigger the ICC exception to its categorical exclusion. The court thus denied plaintiff's petition for review of the ICC's decisions.

Cumulative Effects Analysis

Alpine Lakes Protection Society v. U.S. Forest Service, 838 F. Supp. 478 (W.D. Wash. 1993). Plaintiff brought this action to compel the Forest Service to consider the connected and cumulative effects associated with the issuance of one of seven special use permits for temporary access roads when

deciding whether an EIS was required. The Forest Service had determined that neither an EA or an EIS was required because the action qualified as a categorical exclusion. Plaintiff argued that the Forest Service improperly limited its environmental considerations to a .23 mile section of the road which crossed federal land.

The district court held that:

. The access road permit and timber management activities were connected actions and therefore must be considered together in determining whether an EIS is required; and

. The seven access road permits were cumulative in nature, as the access road and the timber harvesting activities were -links in the same bit of chain- and therefore, connected actions.

The court emphasized that -the question of whether the related action must be considered does not turn on whether the action is federal or non-federal in nature.- The court concluded that the Forest Service's failure to consider the connected actions when determining that the access road alone qualified for a categorical exclusion was arbitrary and capricious. The court also determined that the seven applications for access roads were cumulative in nature and should be considered in a single EIS. The court reasoned that, although the Forest Service considered the cumulative impacts on wildlife species in a biological evaluation, it had not considered the cumulative impacts on any other aspect of the environment. For example the court noted that the projects had the potential to -interact on a variety of scales and resources,- particularly since the access roads were located in the same watershed, creating a potential for cumulative impacts on water quality and fisheries. The court granted plaintiffs motion for summary judgment, and remanded the case for further proceedings.