ENVIRONMENTAL QUALITY

The World Wide Web

The Council on Environmental Quality

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The 1997 Report of the Council on Environmental Quality

Printed on Recycled Paper

This report will be available on the White House web site (http://www.whitehouse.gov/CEQ).

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TO THE CONGRESS OF THE UNITED STATES

I am pleased to transmit to the Congress the 1997 Annual Report on Environmental Quality.

One of the foundations of good government is good information. This is especially true when it comes to decisions about our environment—decisions that often rest on the complex interplay of scientific, economic, and social considerations, with consequences that may last many lifetimes. Good information is all the more critical if these decisions are to be made democratically.

Thanks to a visionary act of Congress nearly 30 years ago, our Federal agencies and the American public today have the benefit of a wealth of information on the state of our environment and on the potential environmental impacts of major actions proposed by the Federal Government. The National Environmental Policy Act (NEPA) is, at its core, a mandate for informed, democratic decisionmaking. And its contribution to environmental protection is incalculable.

NEPA came at the very dawn of the information revolution—the rapid series of technological advances that today allow us instant access to reams of information on virtually any topic imaginable. But, as anyone who uses the Internet knows, this capability may be more a burden than a blessing if users do not have guideposts to find the information that is most helpful.

For those dedicated to studying and protecting our environment, this edition of the Annual Report on Environmental Quality is such a roadmap. Along with its customary compilation of environmental statistics and trends, the report provides a comprehensive guide to Federal environmental resources available via the Internet—everything from the latest nationwide measures of air and water quality to a detailed environmental profile of our individual communities.

By easing citizens' access to good information, we help to fulfill the vision of NEPA, strengthen our democracy, and ensure a clean, healthy environment for future generations.

William J. Clinton

THE WHITE HOUSE

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
WASHINGTON, D.C. 20503

LETTER OF TRANSMITTAL

The President:

Sir: The Council on Environmental Quality herewith transmits its Environmental Quality Report for 1997 in accordance with section 201 of the National Environmental Policy Act of 1969 (42 U.S.C. 4341).

Sincerely,

George T. Frampton
Chair

Part I

The National Environmental Policy Act

Using Information Technology to Improve NEPA Decisionmaking and Management

Since Vice President Gore's reinvention initiative began in 1993, there have been fundamental changes in the way federal agencies provide access to information and how information is shared within agencies. All this has been made possible through the widespread adoption of information technology using the Internet and especially the World Wide Web. The agencies with environmental decisionmaking authority have developed sites on the Internet where one can easily find information on environmental laws, guidance on environmental compliance, and notices on agency activity. Most of these sites are conveniently linked to environmental groups, data repositories, or electronic environmental journals and reports. Since 1993, the Council on Environmental Quality has focused on improving the effectiveness and efficiency of the assessment process mandated by the National Environmental Policy Act (NEPA). One way to do this is by providing easy access to information provided by CEQ and federal agencies through the Internet. The Internet provides users with on-line versions of environmental laws and regulations, facilitates increased interaction among agencies and their publics, and provides increased access to project information and environmental, spatial and demographic data.

Providing information is specifically mandated by NEPA. Following the goals described in Section 101[1], NEPA's Section 102 requires that significant environmental data be gathered prior to decisionmaking. Section 102 (2) (G) requires agencies to "make available to States, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment;" and sec-

[1] Section 101 of the National Environmental Policy Act specifies the following goals: 1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations; 2. assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings; 3. attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences; 4. preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice; 5. achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and 6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Box 1
CEQ's Home Page
(http://www.whitehouse.gov/CEQ/)

Features:

- What's New
- About CEQ
- Administration's Environmental Record
- NEPAnet
- Task Forces
- Search the White House Library
- Environmental Links

tion 102(2)(H) further requires agencies to "initiate and utilize ecological information in the planning and development of resource-oriented projects."

The purposes of this chapter are threefold: first, to illustrate the types of environmental information that are made available electronically by federal agencies; second, to show how such information is being enhanced and supplemented by information from nongovernmental sources such as environmental groups and professional organizations; and third, to identify useful Internet sites.

CEQ's Web Page and NEPAnet

CEQ's Home Page (Box 1) and NEPAnet (Box 2) were established on the World Wide Web in 1995. The site allows users to keep up to date with environmental activities of the administration, access a wealth of information about NEPA, search the White House Library and, through the environmental links, access data and information dealing with topics such as endangered species, pollution prevention, wetlands, meteorology, socioeconomics and agriculture. CEQ's annual reports, for example, are now placed on NEPAnet (http://ceq.eh.doe.gov/nepa/nepanet.htm). Users accessed NEPAnet hundreds of thousands of times throughout 1997. Users come to NEPAnet to review NEPA announcements; read the statute, regulations or guidance; search for environmental information; find out about NEPA training; or to be linked to a specific agency.

One of the key features of NEPAnet is the ability to stay abreast of CEQ activities by being able to read guidance documents, such as the publication "Considering Cumulative Effects Under the National Environmental Policy Act." NEPAnet also has an expanding list of other federal sites related to the environment. NEPAnet provides large volumes of information very quickly and at a very low cost.

Box 2
CEQ's NEPAnet on the World Wide Web
(http://ceq.eh.doe.gov/nepa/nepanet.htm)

Features:

- Full Text of Statute (NEPA)
- Regulations for Implementing NEPA
- Agency NEPA Web Sites
- Guidance Documents
- CEQ Annual Reports
- Environmental Impact Analysis
- Environmental Organizations
- International Environmental Impact Assessments
- NEPA Bibliographic Information
- NEPA Training Information
- Enviro Text Retrieval System

While CEQ's Home Page and NEPAnet provide links to federal activities, these sites are also links in a chain running throughout the federal agencies and the environmental community. Internet technology has made it possible to fulfill principles embedded in many of the environmental laws of the U.S., such as involving the public in the decisionmaking process, providing easy access to environmental information, and providing a method for interagency cooperation. The Internet also allows for quick dissemination of information such as Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," the "National Environmental Policy Act Effectiveness Study," and "Environmental Justice: Guidance under the National Environmental Policy Act."

CEQ recognizes that not all Americans have access to computer technology. Because of this, CEQ continues to recommend and follow a dual course of providing information in traditional paper format as well as on the Internet. Undoubtedly, the availability of reports, guidance documents and agency information online has dramatically increased the number of people reading and using the material and the timeliness with which they receive the material. As users become more accustomed to acquiring information through the Internet, requests for hard copies can be expected to decline. An additional benefit of online information is that the international environmental community can quickly and easily access information that, in the past, required correspondence, shipping costs and perhaps clearance through customs. This is critical as the U.S. enters into, and complies with, international environmental treaties and agreements.

Agency Internet Approaches

Federal agencies have moved quickly to provide information on environmental programs online. Because environmental programs are often embedded in program offices within agencies or delegated to regional offices, multiple Internet sites are often available within the same agency. Table 1 shows the agencies most active in producing Environmental Impact Statements under the National Environmental Policy Act. To simplify the presentation in Table 1, each agency's main WWW sites are identified first, with agency environmental sites listed below the main agency address. *WWW addresses are provided, but the reader must be cautioned that addresses do change. All Internet addresses provided in this chapter were active at the time of writing. In most cases, when an address changes, a note directing the user to the new site will appear at the obsolete address.*

Access to Laws, Regulations, and Guidance

A key starting point for sound environmental decisionmaking is a knowledge and understanding of environmental laws, regulations and agency procedures. The Internet has made the ever-changing body of U.S. laws, regulations, Executive Orders, and departmental directives/

Table 1: Summary of Key Agency Internet Addresses and Content

Agency	WWW Address	Laws/Regulations	Guidance Documents
EPA	http://www.epa.gov	Regulations & Proposed Rules, Codified Regulations, Laws and Current Legislation	National Center for Environmental Publications and Information (NCEPI)
- Office Federal Activities	http://es.epa.gov/oeca/ofa/index.html	NEPA, Clean Air International Environmental Agreements	http://www.epa.gov/epahome/publications.htm Pollution Prevention, Environmental Justice, Guide for Cross-cutting Environmental Laws
DOE (Energy)	http://www.doe.gov		
- Environment	http://tis.eh.doe.gov/		
- NEPA Web	http://tis.eh.doe.gov/nepa/	NEPA,CEQ Regs, DOE Orders,	Guidance documents in Digital Library
- Envirn. Mgmt.	http://www.em.doe.gov/	DOE Regs., Directives, Orders	Guides provided under “DOE Directives”
DoD (Defense)	http://www.defenselink.mil/	Provides link to Environmental Programs (DENIX - identified below)	
-Defense Envrn. Network and Information exchange)	http://denix.cecer.army.mil	Environmental Law Index, Current Executive Orders, Proposed Rules + links to environmental law library	Policy and Guidance Index
USDA (Agriculture)	http://www.usda.gov		
Forest Service	http://www.fs.fed.us/forum/nepa/	NEPA, Forestry Management Act, Environmental Justice Order	Environmental Policy Procedures Manual & Handbook and Staff Manuals
Federal Highways	http://www.fhwa.dot.gov/	FHWA Legislation + access to law libraries	Interim Guidance on Congestion Mitigation and Air Quality Improvement
Office of Environment & Planning	http://www.fhwa.dot.gov/environment/	Summary of Environmental Legislation affecting Transportation	Environmental Guidebook, Historic and Arch. Guidance
DOI (Interior)	http://www.doi.gov/oepc/oepchome.html	Summary of Laws, Links to Law Libraries and Court Opinions	
- NPS	http://www.nps.gov/planning		NPS NEPA procedures
- BLM	http://www.blm.gov/nhp/	Proposed and Final Rules	

orders easily accessible to both agency personnel and the public. Previously, these were available only through expensive subscription services or through traditional law libraries and public reading rooms. As can be noted from Table 1, all agencies listed provide access to laws and regulations related to their environmental programs. Some systems, such as the Department of Defense's (DoD) Defense Environmental Network Information eXchange (DENIX) (http://denix.cecer.army.mil), provide an index of environmental legislation with access to an online version of the actual laws through Cornell Law School's Legal Information Institute (http://www.law.cornell.edu/). Box 3 shows a list of virtual law libraries where Federal and state environmental laws can be read online.

In many cases, agencies provide guidance documents online to assist agency personnel as well as the public in understanding the environmental processes to be followed under specific regulations. Agencies provide a wide variety of information beyond that described above. Often the public becomes interested in environmental decisionmaking because an Environmental Impact Statement is for a specific project. The agencies listed in Table 1 provide information on environmental impact statements by providing news releases, Federal Register notices, announcements, annual reports, and sometimes summaries of EISs on the Internet. For example, in the case of the Department of Energy's NEPA Web (Box 4), NEPA announcements are updated regularly and identify all DOE NEPA activities. In addition, DOE makes more recent environmental assessments and environmental impact statements available on line (http://tis.eh.doe.gov/nepa/docs/docs.htm). An additional capability of DOE's NEPA Web is the ability to search a database for any Environmental Impact Statement done by the Department (http://tis.eh.doe.gov/nepa/eis/eis.htm). This database provides information necessary to find documents that may not be online.

Box 3
Virtual Law Libraries on the Internet

- U.S. House of Representatives
  http://law.house.gov/
- Cornell Law School
  http://www.law.cornell.edu
- FedLaw
  http://www.legal.gsa.gov/
- University of Indiana
  http://www.law.indiana.edu/law/v-lib/envlaw.html

Box 4
Department of Energy's NEPA Web Site (http://tis.eh.doe.gov/nepa/)

Features:
- DOE NEPA Announcements
- DOE NEPA Analyses
- NEPA Links
- DOE NEPA Tools
- DOE NEPA Process Information
- Internet Resources
- Web Utilities

Access to Data

Critical to sound environmental decisionmaking under NEPA is having environmental data available for analysis. Internet technology makes it possible for CEQ to fulfill NEPA's Section 205 (2), which requires CEQ to "utilize, to the fullest extent possible, the services, facilities and information (including statistical information) of public and private agencies and organizations, and individuals, in order that duplication of effort and expense may be avoided, thus assuring that the Council's activities will not unnecessarily overlap or conflict with similar activities authorized by law and performed by established agencies."

CEQ's Home Page, as well as CEQ's NEPAnet provide a link (under "Environmental Links") to the U.S. Geological Survey's (USGS) Environmental Impact Analysis Data Links (Box 5). This site (menu and address shown in the text box) provides online access to such diverse data sets and data centers as the U.S. Department of Agriculture's Economics and Statistics System, the USGS Hydro-climatic Data Network Streamflow Data Set, National Oceanic and Atmospheric Administration National Oceanographic Data Center, U.S. Census demographic data sets and the Earth Resources Observation Systems Data Center.

Box 5

USGS Environmental Impact Analysis Data Links

(http://h2o.usgs/.gov/public/eap/env_data.html)

- Agricultural
- Endangered Species
- Energy
- Hydrologic
- Meterologic
- Pollution Prevention
- Socio-economic
- Spatial
- Wetlands
- State and Regional
- International

Geographic Information Systems (GIS) are now widely used in NEPA analyses and elsewhere. These systems allow the marriage of computer mapping with place-based data. For instance, digitized Census data can be used to map the distribution of minorities around an existing airport while "overlaying" a noise contour from a proposed airport expansion. The Census Bureau has designed a simple, easy-to-use mapping system (Landview III), which includes population, income and ethnicity data combined with the database extracts from the Environmental Protection Agency, the Bureau of the Census, the U.S. Geological Survey, the Nuclear Regulatory Commission, the Department of Transportation, and the Federal Emergency Management Agency. The Landview III system is available on CD-ROM and can be viewed and ordered online (http://www.census.gov/ftp/pub/geo/www/tiger/).

One can also create maps online combining demographic data with geographic information at the Census Home Page (http://www.census.gov) or using a mapping program called DDViewer, which is maintained by the Consortium for International Earth Science Information Network (CIESEN) and Social and Economic Data Center (SEDAC) through grants from NOAA and NASA respectively (http://plue.sedac.ciesin.org/plue/ddviewer/). DDViewer allows users to create maps online by selecting variables from the U.S. Census and creating maps using Census map files. CIESEN/SEDAC is particularly useful for global change research; the main site includes real-time mapping of stratospheric ozone, ultraviolet dose estimates, and integrated population, land-use and emissions data.

Spatial data, necessary to carry out these types of analyses, are increasingly available (primarily by order) over the Internet. Links to spatial data are provided by the USGS, and include such sites as the Earth Resources Observation Systems (EROS) Data Center (http://edcwww.cr.usgs.gov/eros-home.html). The EROS Data Center archives millions of aerial and satellite photographs, a number of which are distributed as US GeoData files at no charge. These types of images are critical in analyzing environmental change over time, such as time series photos of shoreline erosion on the Chesapeake Bay, changes in vegetative cover, or shrinkage of wetlands. They can also show the effects of natural phenomenon (such as hurricanes) or the effects of such activities as urbanization and agricultural development. For high resolution satellite imagery, the SPOT Corporation can be accessed online (http://www.spot.com/).

The National Spatial Data Infrastructure (in which the USGS participates) develops policies, procedures and standards for organizations to cooperatively produce and share spatial data (http://nsdi.usgs.gov/). In addition to the above, other examples of Internet sites with spatial information include the Bureau of Land Management's Geographic Coordinate Data Base (http://www.blm.gov/gcdb/), Geographical Information Systems (GIS) WWW Resource List (http://www.geo.ed.ac.uk/home/giswww.html), and the World-Wide Web Virtual Library: Remote Sensing (http://www.vtt.fi/aut/ava/rs/virtual/).

Access to Models

Models that simulate the complex interactions of the physical setting and natural environment are valuable tools in projecting the effects of human activity or natural events on the environment. Section 102 (2) (A) of NEPA requires federal agencies to "utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment."

Complex computer models have been created to study all aspects of the environment, including ocean circulation, air dispersion, noise propagation, storm water runoff, erosion, groundwater flow, traffic circulation and human migration. Computer models allow analyses to be both systematic and interdisciplinary by allowing modeling of complex interactions. During 1997, relatively few models were available over the Internet. Increasingly, however, agencies have included brief descriptions of models and the model

Box 6

Examples of Libraries and Information Centers on the Internet

- EPA National Center for Environmental Publications
  http://www.epa.gov/epahome/publications.htm
- GPO
  http://www.access.gpo.gov/su_docs/aces/aaces002.html
- Library of Congress
  http://lcweb.loc.gov/homepage/lchp.html
- University of California—Berkeley
  http://www.lib.berkeley.edu/
- Indiana University School of Law Library and WWW Virtual Library
  http://www.law.indiana.edu/law/v-lib
- The Argus Clearinghouse
  http://www.clearinghouse.net/

development process on the WWW. EPA has identified many media-specific tools available on the Internet and made these available (http://www.epa.gov/epahome/dmedia.htm). An example of how to effectively use the Internet for model development is the Bureau of Transportation Statistics "Travel Model Improvement Program" (TMIP), which is a multi-agency program to develop new travel demand modeling procedures that will forecast travel demand (http://www.bts.gov/tmip/tmip.html). This is important in light of the Transportation Efficiency Act for the 21st Century (TEA21), because numerous transportation projects will be in the planning stages and subject to NEPA analysis.

Libraries Online

One of the important changes produced by the National Partnership for Reinventing Government has been the availability of online libraries (Box 6). The availability of environmental information from publicly maintained libraries on the WWW is robust. The EPA National Center for Environmental Publications provides access to the National Environmental Publications Internet Site with over 6,000 EPA documents available to browse, view or print online. The Government Printing Office (GPO) provides extensive access to Federal online databases including the *Federal Register*, *Congressional Record*, *Code of Federal Regulations*, Congressional bills, budgets and other libraries. General Services Administration provides links to environmental libraries (http://www.gsa.gov/pbs/pt/call-in/links.htm). CEQ's Regulations for Implementing NEPA Sec. 1502.21 states: "Agencies shall incorporate material into an environmental impact statement by reference when the effect will be to cut down on bulk without impeding agency and public review of the action. The incorporated material shall be cited in the statement and its content briefly described. No material may be incorporated by reference unless it is reasonably available for inspection by potentially interested persons within the time allowed for comment..." Online libraries offer an efficient and low cost way of providing EIS references to a wide audience in a timely manner.

Nongovernmental Organizations

NEPA Section 101(a) states: "The Congress declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, 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."

Sound environmental management of federal assets requires collaboration with members of Congress, federal agencies, interest groups, informed publics and professionals. Nongovernmental organizations (NGOs) have made tremendous strides in providing information via the Internet and thus enhanced the flow of information to and interaction with federal agencies. Most environmental groups now have sites on the WWW and provide information on current environmental issues, program publications and announcements of upcoming events.

NGOs include universities and other types of nonprofit associations. Duke University's Nicholas School for the Environment has a useful WWW site, which includes environmental links, information on the center for Environmental Education, and environmental publications and newsletters (http://www.env.duke.edu/). Harvard University (http://environment.harvard.edu/HERO/wrapper/pageid%3Dhome.html) maintains an environmental science and public policy archive and an environmental information center on the Internet.

Professional associations are also using the Internet to link members with information, with each other and to individuals and institutions seeking assistance (Box 7). The International Association for Impact Assessment (IAIA) provides a web site with a membership directory, links to international environmental sites, environmental impact assessment learning exchange, and access to online discussion groups where professionals routinely ask for guidance on a specific topic (http://ndsuext.nodak.edu/IAIA/). Nine different discussion groups are main-

Box 7
Examples of Professional Associations Online

- International Association for Impact Assessment
  http://ndsuext.nodak.edu/IAIA
- Soil Science Society of America
  http://www.soils.org
- North American Association of Environmental Education
  http://naaee.org/index.htm
- American Fisheries Society
  http://www.fisheries.org
- Ecological Society of America
  http://www.sdsc.edu/ESA/esa.htm
- Society for Environmental Toxicology and Chemistry
  http://www.setac.org/
- American Planning Association
  http://www.planning.org
- Links to Other Ecology Associations
  http://www.pnl.gov/ecology/links/index.htm

tained and include topics such as ecology, social impact assessment, urban environmental issues and health impact assessment. IAIA also has a database of training courses offered nationally and internationally that is available at http://www.erin.gov.au/portfolio/epg/eianet/iaia/search.html. In expanding the availability of environmental research, IAIA also made the entire proceedings from its 1998 conference available on CD-ROM and sent copies to all its members.

The National Association of Environmental Professionals maintains a web site (http://www.enfo.com/NAEP/), which includes a library (including an electronic reading room with links to other organizations), a list server and Internet resources. The Geological Society of America maintains a web site located on the WWW at http://www.geosociety.org/. Like many of the larger associations, the Geological Society allows access to their journal abstracts, lists jobs available, identifies grants for students, and provides for education and outreach. Examples of other professional associations with WWW sites are listed in the text box. The list of professional associations related to environmental studies is too lengthy for this discussion but a link to such a list is provided in the text box under “Links to Other Ecology Associations”.

Electronic Journals

NEPA’s Section 102 (2) (A) requires agencies to “utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making which may have an impact on man’s environment;” and (B) “identify and develop methods and procedures... which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations.” These requirements put a heavy burden on environmental analysts to be knowledgeable about the evolving state of science. Environmental training, professional associations and professional journals are all critical to environmental professionals remaining current in their fields. Increasingly, journals related to the environment are available online (often only in summary form) (Box 8). The Committee for the National Institutes for the Environment maintains a list of environmental journals on the Internet. This list includes journals available in full text and those available with abstracts, table of contents or some articles. The list of environmental journals available online can be found at the following Internet address: http://www.cnie.org/Journals.htm.

The American Association for the Advancement of Science has a summary version of their publication *Science* available on line. If an environmental analyst is interested in a complete article, one can subscribe online (http://www.sciencemag.org/). Like *Science*, one can access summaries of articles in *Nature: An International Journal of Science* (http://www.nature.com/). *Issues in Ecology* is an online series designed to deal with major ecological issues and is published by the Pew Scholars in Conservation Biology Program and the Ecological Society of America (http://esa.sdsc.edu/issues.htm). Some publications are emerging as online journals, such as *The World Wide Web Journal of Biology* available at http://www.epress.com/w3jbio/wjbhome.htm (subscription required). Other publications represent research centers and make available their newsletter, such as the Natural Hazards Center at the University of Colorado, which publishes *The Natural Hazards Observer* online (http://www.colorado.edu/hazards/o/o.html). While statistics are not available for each electronic publication, statistics on the use of the journal *The Scientist: The News Journal for the Life Scientist* (http://www.the-scientist.library.upenn.edu/) indicate 50,000 to almost 80,000 requests for pages per month. While these statistics may indicate the same user requesting multiple pages, the use is significant and likely to grow as more and more people come online. An important aspect to online publications is that the same information available to environmental professionals is also easily accessed by environmental groups and interested citizens, thus making for a better informed public.

The Future

It is clear that federal agencies are making progress in "reengineering through information technology." The growth in the use of the World Wide Web by agencies and NGOs has meant that many more people within and outside federal agencies are only a "click away" from the information they may need. It is expected that federal agencies will continue to incorporate web-based technologies in their routine processes and make more and more information available over the WWW. In addition, it is expected that international partners, federal agencies and NGOs will coordinate the development of standards for data sets, provide geo-reference points (latitude and longitude) for their projects and data sets, more comprehensively link web sites to related sites, develop data archives, provide metadata for data archives, and explore web-based assessment tools. Increasingly, it is expected that directories of environmental web sites and online environmental assessment tools will be more and more useful as the volume of information, availability of data sets, and the number of environmental Internet sites increase. Subscriptions to discussion groups, listservers and mailing lists will likely increase in popularity, allowing interested people to receive information from federal agencies and NGOs without requesting it each time. Online libraries and guidance documents, agency web pages, online document retrieval, and access to data centers and professional associations means that environmental information can more easily flow through the environmental community and that environmental professionals can be more easily linked to each other and the resources they need to do their jobs. Increasing the ease with which data and information flows and increasing the ease with which links are made between interested parties (and the data and tools they need) has and will lead to increased efficiency and effectiveness of environmental management.

Selected NEPA Cases in 1997

Purpose and Need and Range of Alternatives

In 1997, the Seventh Circuit Court of Appeals, in Simmons v. United States Army Corps of Engineers, 120 F.3d 664 (7th Cir. 1997), reversed and remanded the district court's approval under NEPA of an Army Corps of Engineers permit issued to the City of Marion, Illinois for the building of a dam and reservoir to supply water to the city and six counties. The Seventh Circuit held that the Corps had failed to issue its own definition of purpose and need and, therefore, failed to consider reasonable alternatives to accomplish the general goal of the proposed action.

In 1989, the City of Marion applied to the Corps of Engineers, as required by the Clean Water Act, for a permit to build a dam and reservoir to supply water to the city and a water district encompassing six counties. The proposed dam would block one of the last free-flowing streams in southern Illinois, create a four-mile long lake, flood 1.5 square miles of wetlands and obliterate the riverine habitats of several species. The proposed action was a federal action triggering NEPA. In 1991 the Corps issued a permit, an environmental assessment and a Finding of No Significant Impact, which was challenged in court. The plaintiffs prevailed, and the Corps was ordered to prepare an environmental impact statement. The district court decision also found the environmental assessment "incomplete and flawed" and noted that the Corps had failed to consider the feasibility of alternatives. In particular, the court noted that the Corps had always assumed that both Marion and the water district needed to receive water from a single source.

Years later, after completion of an EIS, another challenge was brought to the adequacy of the EIS. Plaintiffs maintained that the Corps had defined the project's purpose too narrowly, based on the city's request, and had again failed to consider ways to supply the city and counties water from multiple sources. In response, the Corps maintained that the applicant, the City of Marion, only sought a single reservoir. Second, the Corps maintained that it was reasonable to look only to single-source alternatives because it represented an obvious solution. Although these arguments were accepted by the district court, they were rejected by the Seventh Circuit.

First, the court made clear that an agency bears the responsibility of defining the project's purpose. This is a very important responsibility, because, as the court stated: "One obvious way for an agency to slip past the strictures of NEPA is to contrive a purpose so slender as to define competing 'reasonable alternatives' out of consideration (and even out of existence). The federal courts cannot condone an agency's frustration of Congressional will. If the agency constricts the definition of the project's purpose and thereby excludes what truly are reasonable alternatives, the EIS cannot fulfill its role." 120 F.3d at 667. The Corps, here, improperly accepted the applicant's definition of a project. By doing so, the Corps skewed the "evaluation of 'alternatives' mandated by NEPA is to be an evaluation of alternative means to accomplish the general goal of an action." 120 F.3d at 669, quoting from Van Abbema v. Fornell, 807 F.2d 633, 638 (7th Cir. 1986) and 40 C.F.R. 1502.13. The general goal of the Marion application was to supply water for Marion and the water district—not to construct a single-source reservoir. Further, an agency cannot "restrict its analysis" to the means by which a particular applicant has set forth to reach its goals. 120 F.3d at 669. Finally, the Corps' own regulations require that the Corps "exercise independent judgment in defining the purpose and need for the project from both the applicant's and the public's perspective." 120 F.3d at 669, quoting from 33 C.F.R. Pr. 325, App. B, (9)(b)(5), (4).

Second, even if the Corps were correct in claiming that a single source was the "obvious solution," the "Corps and, more important, the public cannot know what the facts are until the Corps has tested its presumption." 120 F.3d 669. Looking to logic, the court held that "supplying Marion and the Water District from two or more sources is not absurd—which it must be to justify the Corps' failure to examine the idea at all." Id. In fact, at least one concrete, reasonable alternative was advanced by plaintiffs, that of feeding water from the existing Rend Lake. The court concluded that other alternatives may be reasonable, but "[w]hat other alternatives exist we do not know, because the Corps has not looked." 120 F.3d at 670.

In conclusion the court stated: "If NEPA mandates anything, it mandates this: a federal agency cannot ram through a project before first weighing the pros and cons of the alternatives." 120 F.3d at 670. Finding that the Corps had "executed an end-run around NEPA's core requirement," the EIS was deemed inadequate. Id.

Cumulative Impact Analysis

For years, the California Department of Transportation and the Federal Highway Administration had worked on a proposed project to address the congestion on California State Highway 1. In fact, the Carmel stretch of highway was one of the most heavily traveled two-lane highways in California, and efforts to solve the highway's traffic problems dated back to the 1940s. One proposal sought to realign Highway 1 from the City of Carmel to the nearby wilderness area of Hatton Canyon. In 1991, an EIS and ROD were issued. Shortly thereafter, plaintiffs City of Carmel-by-the-Sea, Monterey Peninsula Regional Park District, Hatton Canyon Coalition, and the Sierra Club filed an action, alleging violations of NEPA. The district court granted summary judgment to the defendant agencies in 1994, and the

Ninth Circuit reviewed the district court's decision in 1996. One year later, in 1997, the Ninth Circuit withdrew its earlier decision and issued a new decision, affirming in part and reversing in part.

The Ninth Circuit held that the EIS wetlands discussion and mitigation plan were reasonably thorough, despite some inaccuracies and misstatements. 123 F.3d at 1151. Further, failure to account for new wetlands created by the 1989 Loma Prieta earthquake would adequately be addressed by the planned mitigation. 123 F.3d at 1152. The EIS adequately addressed the environmental effects of the proposed project on the largest of the three remaining native Monterey pine forests, and the adopted mitigation plan for replanting of seedlings was also held to be adequate. 123 F.3d at 1154-55. The purpose and need for the project, the alternatives studied, and the analysis of highway growth-inducing effects were also upheld as adequate. 123 F.3d at 1155-56. The court noted, "The district court aptly described the Final Environmental Impact Statement/Report as 'not perfect' . . . . At most times, however [it] is sufficiently thorough in its discussions to satisfy" NEPA. 123 F.3d at 1168.

On the issue of cumulative effects, however, the Ninth Circuit reversed and remanded for entry of an order directing the Federal Highway Administration—together with the State transportation agency—to review the contents of the administrative record and determine whether the EIS must be supplemented to provide the necessary cumulative impacts analysis. Citing 40 C.F.R. 1508.7, the court determined that the EIS failed "both to catalogue adequately past projects in the area, and to provide any useful analysis of the cumulative impact of past, present and future projects and the Hatton Canyon freeway on the wetlands, Monterey pine and Hickman's onion." 123 F.3d at 1160. Although the impacts on these resources were dealt with in individual sections, the "analyses are not lengthy, and taken either separately or together they fail to provide sufficient information to satisfy the National Environmental Policy Act." 123 F.3d at 1160.

The court pointed out that past projects were only described "with generalities insufficient to permit adequate review of their cumulative impact." 123 F.3d at 1160. This was done, despite the EIS's "acknowledgment that the Carmel area has experienced 'substantial growth' over 'the last 30 years,' including development on 'both sides of the Hatton Canyon.'" Id. The EIS better addresses planned future projects, but still omits "any discussion of how these projects together with the proposed Hatton Canyon project will affect the wetlands, Monterey pine and Hickman's onion." 123 F.3d at 1160.

The Federal Highway Administration argued that the cumulative impacts discussion was adequate, particularly in the absence of a direct challenge by the plaintiffs to a specific action that the EIS failed to consider, and plaintiffs had not adequately shown that specific projects needed to be considered. That argument was rejected by the court. "[T]he Federal Highway Administration . . . failed first; [it] did not properly describe other area projects or detail the cumulative impacts of these projects." 123 F.3d at 1161. The court held that the Federal Highway Administration bears this burden under NEPA and quoted language from City of Davis v. Coleman, 521 F.2d 661, 671 (9th Cir. 1975), stating that the primary duty of every federal agency to fulfill its NEPA "responsibility should not depend on the vigilance and limited resources of environmental plaintiffs." 123 F.3d 1161.

Statute of Limitations

A six-year statute of limitations for NEPA challenges under the APA was upheld in Sierra Club v. Slater, 120 F.3d 623 (6th Cir. 1997), which involved challenges to both the adequacy of an EIS and the decision not to prepare a supplemental EIS. Plaintiffs sued to prevent construction of an urban redevelopment project and 3.5 miles of a highway in Toledo, Ohio. Federal defendants argued that these claims were time barred. Plaintiffs, however, maintained that NEPA contains no statute of limitations and, based on its equitable remedies, the only time limitation that should apply is the doctrine of laches. Further, plaintiffs maintained that a subsequent decision not to supplement the original EIS reopened the earlier decisions for statute of limitations purposes.

The Federal Highway Administration, considering funding a highway project, completed an EIS in February 1984 and issued a Record of Decision in April 1984. The applicant City of Toledo then applied for a special permit from the Army Corps of Engineers in 1990, and the permit was granted in 1992. Based on the amount of time that had elapsed between the approval of the EIS and the start to construction, the Federal Highway Administration's regulations required a reevaluation to determine whether a supplemental EIS was required. In January 1995, the agency decided that no supplemental EIS was necessary.

The Sixth Circuit reiterated that federal jurisdiction over NEPA claims arises under the Administrative Procedure Act, 5 U.S.C. 701-706. Further, APA actions are subject to the six-year statute of limitations imposed by 28 U.S.C. 2401(a), which states that complaints under the APA are reviewed as a "civil action" within the meaning of 2401(a). In addition, the court noted that the Tucker Act, 28 U.S.C. 1491, contains a six-year statute of limitations for every civil action commenced against the United States. 120 F.3d at 629. Therefore, a statute of limitations, and not merely an equitable defense of laches, was appropriate.

Therefore, plaintiffs' rights of action which accrued outside the six-year limitations period are time-barred. Those, however, accruing within six years of the plaintiffs' filing of their complaint, would not be time-barred. Under the APA, a right of action accrues at the time of "final agency action." 28 U.S.C. 704. The court determined that for purposes of statute of limitations, "it appears well-established that a final EIS or the ROD issued thereon constitute the 'final agency action' for purposes of the APA." 120 F.3d at 630. Therefore, the circuit court affirmed the district court's dismissal of challenges to the 1984 EIS and the 1984 ROD, and also affirmed the district court's decision not to dismiss the challenges to the Federal Highway Administration's decision in 1995 not to issue a supplemental EIS. Similarly, challenges to the Corps' issuance of a permit in 1992 was also not time-barred. The 1995 decision not to supplement the EIS did not permit plaintiffs to reach back and challenge the 1984 decision.

Major Federal Action

In Marbled Murrelet v. Babbitt, 111 F.3d 1447 (9th Cir. 1997), the plaintiff filed an action against the Department of the Interior and logging companies, seeking to protect habitat of the marbled murrelet and northern spotted owl. The district court issued a preliminary injunction and enjoined logging activities under eight timber harvest plans. The Ninth Circuit vacated the injunction, stating that a mere concurrence letter from the Fish and Wildlife Service indicating its opinion that timber harvest plans submitted for state approval would avoid the take of protected species did not trigger any requirements under NEPA or the Endangered Species Act. That is so, because the submission of a concurrence letter is neither a "major federal action" under NEPA or an "agency action" under the ESA.

The sole discretion for approval of timber harvest plans rests with the California Department of Forestry and Fire Protection. The Fish and Wildlife Service opinion may be credited with some deference by the California State agency, but it also may not. But, the issuance of such an opinion does not "force 'agency action' onto the federal government." 111 F.3d at 1450. Further, the court indicated that once it has determined there is no "agency action" under ESA, it "necessarily" also determines that there is no "major federal action" under NEPA. Id.

In Fund for Animals, Inc. v. Thomas, 127 F.3d 80 (D.C. Cir. 1997), plaintiffs challenged a U.S. Forest Service decision to allow states to continue to regulate game baiting on federal forest lands. At issue in the case was "bear baiting", the practice of placing food or scent to attract wild game to a particular hunting location. Bear baiting is prohibited in most states, but remains lawful in nine states. At one time the Forest Service regulated the practice in some states. The Forest Service prepared an EA in 1993 to consider various options for regulating baiting on Forest System lands in Wyoming and issued a Decision Notice and FONSI to transfer regulation of baiting to the State of Wyoming. The Forest Service specifically concluded that the change to Wyoming regulation was not a "major federal action" and would "not significantly affect the quality of the human environment." The new Wyoming policy, however, was never implemented.

The Forest Service, under threat of further litigation, banned all bear baiting on Forest System lands in Wyoming while it prepared a comprehensive national baiting policy. In 1995, the Forest Service issued an EA on a nationwide policy that would eliminate all Forest Service involvement with bear baiting and would rely solely on State regulation of baiting game on National Forest System lands. In the Decision Notice and FONSI, the Forest Service stated that its actions were not major federal actions and no EIS was required.

Plaintiffs challenged the Forest Service's view of major federal action. The D.C. Circuit affirmed the district court and determined that the Forest Service was correct, because even if there were some type of federal action, there was "not a 'major' federal action under NEPA." 127 F.3d at 83. The court found that by 1995 baiting remained federally regulated only in Wyoming and the shift from federal to state regulation had no effect outside Wyoming. Even in Wyoming, though, the effect was minimal because the substantive requirements of Wyoming were significantly similar to the Forest Service permits they replaced. Because "the new national policy maintained the status quo, it cannot be characterized as a major federal action' under NEPA." 127 F.3d at 84.

By contrast, the court in Ross v. Federal Highway Administration, 972 F. Supp. 552 (D. Kan. 1997), determined that an entire federally funded highway demonstration project was a major federal action subject to NEPA, despite the claim that no federal funds were requested or approved for one portion of the project. Following a 1993 decision that a Supplemental EIS was necessary on the Trafficway project, the Kansas Department of Transportation requested the Federal Highway Administration to segment the Trafficway into four parts. The eastern leg, at issue here, was found to have independent utility by the federal agency. After much disagreement on the SEIS proposals, the Kansas Department of Transportation began construction of the eastern leg of the Trafficway without federal funds in 1997.

Plaintiffs filed this action to stop construction, and the court held a hearing to determine jurisdiction. The court noted that "NEPA can be invoked only if a major federal action has affected significantly the quality of the human environment." 972 F. Supp. at 558. This includes both federal actions and non-federal actions "subject to Federal control and responsibility." Id. The court reviewed the clear language and congressional intent of two other statutes at issue—he Surface Transportation and Uniform Relocation Assistance Act of 1987 and the Intermodal Surface Transportation Efficiency Act of 1991. Under these statutes, demonstration projects were to be treated differently than routine highway projects, because Congress had selected these projects and the state no longer had discretion whether to seek Federal Highway Administration funding. Based on that, the $10 million in demonstration funds appropriated for the Trafficway could not be divided into segments. The entire Trafficway was, therefore, a major federal action over which federal defendants had control. 927 F. Supp. at 561.

Adequacy of an EIS

Adequacy of an EIS was at issue in Association of Public Agency Customers, Inc. v. Bonneville Power Administration, 126 F.3d 1158 (9th Cir. 1997). The BPA, part of the Department of Energy, has marketing authority for power produced by federal facilities in the Pacific Northwest. It also has certain responsibilities for non-federal power. Petitioners here sought review of the BPA's actions under various utility laws and NEPA resulting form the 1992 renegotiation of long-term industrial power contracts with a simultaneous EIS, which was completed in 1995.

Anticipating a June 1993 deadline, BPA began the renegotiation of its long-term power sales contracts in early 1992. BPA also began a parallel NEPA process, publishing a Notice of Intent to prepare an EIS. The renegotiations participants established working groups to consider specific issues. When the working groups identified additional issues for consideration, BPA proposed to expand the scope of the EIS in August 1993. Based on public comments, the BPA further expanded the EIS in December 1993 to encompass more issues. New negotiations commenced in September 1994, and a Supplemental Draft EIS was announced in December 1994. The Draft SEIS was issued in March 1995, and in April several short-term contracts were finalized. These contracts were circulated for public review. The Final EIS was published in June 1995, and in August 1995 the Record of Decision issued. Long-term contracts were then signed.

Petitioners maintained that BPA violated NEPA on a number of grounds. The court, however, approved of BPA's handling of its EIS. The court approved of the six alternatives considered and the analysis of cumulative effects. 126 F.3d at 1184. The scope of the EIS, focusing on time periods ending around 2002 and BPA's methodology for assuming that their conclusions would hold true in the future, was also held to be adequate. 126 F.3d at 1188. Id. The BPA was not required to consider signing no contracts at all as a "no action" alternative; continuation of present power sales contracts would suffice for the "no action" alternative. 126 F.3d at 1188.

Further, BPA did not need to examine the economic consequences of its actions. 126 F.3d at 1186. The theme of NEPA is "sounded by the adjective 'environmental.'" 126 F.3d at 1186, citing Metropolitan Edison Co. v. PANE, 460 U.S. 766, 772 (1983). Accordingly, the court held that BPA was not required to examine the economic effects of its actions, based on the well-established rule that economic effects by themselves do not require an EIS. 126 F.3d at 1186, noting the CEQ regulation at 40 C.F.R. 1508.14. The court did not, however, discuss the rest of that regulation, which states that an EIS will discuss economic effects once an EIS is triggered by environmental effects.

Petitioners argued that the decision to offer some kind of cost protection required analysis on variations, alternatives and mitigation. The court, however, rejected that and cited a list of considerations. First, "BPA had to act quickly to secure [certain] power contracts or lose the contract opportunity for five years." 126 F.3d at 1185. Second, petitioners failed "to champion the environmental concerns associated with stranded cost protection" in the administrative proceedings. Id. Third, the petitioners "advance little evidence that offering stranded cost protection seriously endangers the environment in any area." Id.

Petitioners also argued that the EIS did not discuss the global warming implications from the effects of greenhouse gases released for increased operations. The court held, however, that the EIS's discussion of environmental impact included a discussion of carbon dioxide output, and this discussion satisfied the requirements of NEPA and petitioners' concerns about global warming. 126 F.3d at 1187.

Finally, petitioners asserted that the BPA had failed to discuss the transboundary impacts in Canada of continued Canadian gas exploration. The court found, however, that the environmental effects of Canadian gas exploration had been examined and cited to the EIS section. 126 F.3d at 1187.

In sum, the court acknowledged that widespread deregulation of the electricity industry had transformed the power markets. After, however, full review of the record, the Administrator of BPA's decisions "in response to market forces were not arbitrary or capricious, and were in accordance with applicable law." 126 F.3d at 1189.

Adequacy of an EA and FONSI

In Oregon Natural Desert Association v. Green, 953 F. Supp. 1133 (D. Or. 1997), plaintiffs challenged the Bureau of Land Management's EA and FONSI on a management plan under the Wild and Scenic Rivers Act and NEPA. The court held that BLM violated NEPA by failing to prepare an EIS to analyze the impact of grazing in the river area, as well as decisions to construct new parking lots and roads. Based on the scientific evidence presented to the court, grazing, parking lots and roads all have a significant impact on the river area.

As one of its defenses, BLM maintained that an EIS was not required because livestock grazing in the Donner and Blitzen River area was the status quo, and an EIS is not required for an agency's continued management activities that have been in existence for many years. The court disagreed. First, the Wild and Scenic Rivers Act "sets forth affirmative duties on the part of federal agencies charged with managing rivers in the System." 953 F. Supp. at 1147. Therefore, BLM had to prepare a management plan "to protect and enhance the outstandingly remarkable values of the Donner and Blitzen River." Id. Second, because of the new duties under the Wild and Scenic Rivers Act, BLM's decisions to authorize continued cattle grazing becomes a new decision under a new mandate and "more than merely continuing activities." Id.

By contrast, the Forest Service's adoption of interim policies did not require an EIS. In Prairie Wood Products v. Glickman, 971 F. Supp. 457 (D. Or. 1997), the Forest Service's adoption of temporary policies for timber harvests in nine national forests, pending completion of a long-term forest plan, did not require an EIS where the EA and FONSI considered the policies' potential to affect future actions. The interim policies concerned management of lands in the Columbia River Basin in seven states, where salmon and tout had declined dramatically and forests near riparian habitats were protected. The interim policies were to be replaced with long-term strategies.

Plaintiffs maintained that the science, the controversy, the precedential effect, the adverse economic effects and the uncertainty of the environmental impacts all warranted the preparation of an EIS. The court, however, reviewed each claim and determined that the "Forest Service took the requisite 'hard look' at the environmental effects of its decision and at the factors specified in 40 C.F.R. 1508.27." 971 F. Supp. at 470.

Continuing adequacy of an EA and FONSI was raised in Price Neighborhood Association v. DOT, 113 F.3d 1505 (9th Cir. 1997), where plaintiffs challenged DOT's failure to supplement an EA after modifying the original freeway proposal design. The court, noting that "CEQ regulations do not address when an EA must be supplemented," concluded that an "environmental reevaluation" as conducted by the Federal Highway Administration was an appropriate method to determine whether the design change would be significant so as to warrant further assessment. 113 F.3d at 1509.

Similarly, in Western Radio Services Co. V. Espy, 123 F.3d 1189 (9th Cir. 1997), plaintiff sued to prevent the Forest Service from allowing a competitor to build a tower in Ochoco National Forest based on an existing EA. Plaintiff maintained that a new EA was necessary to reissue a permit. The new reissued permit was identical to the original one, and renewal was necessary because construction had not been completed by the time the original permit expired.

The court ruled that the new permit did not require a new EA, even where plaintiffs maintained that a new proposed access road had changed the action. "Because the reissued permit is identical in every material respect to the original permit, and because construction of the tower is not in any way conditioned on construction of the new access road, we hold that it was not arbitrary, capricious or an abuse of discretion for the [Forest] Service to reissue the special use permit without preparing a new EA." 123 F.3d at 1195, citing Abenaki Nation of Missisquoi v. Hughes, 805 F. Supp. 234, 240-42 (D. Vt. 1992), aff'd, 990 F.2d 729 (2d Cir. 1993).

Part II

Environmental Quality Trends and Access to Information Resources

Introduction

One of the most remarkable developments of the 1990s is the explosive growth of information on the World Wide Web. For those with a computer and access to the Internet, this is an extraordinary new opportunity to easily and quickly obtain a wide variety of studies, reports, and data.

In response to this development, the 1997 edition of *Environmental Quality* reports on environmental trends and provides a guide to additional online materials on those topics that are available to the general public. The particular focus of this guide is sites within the U.S. government dealing with environmental quality, natural resources, energy, and other environmentally related issues.

This report can help steer readers to the voluminous amounts of online material provided by the U.S. government, other governments, nongovernmental organizations, international institutions, universities and research institutions. *Environmental Quality 1997* is a valuable starting point for students, researchers, and the general public to find out more about environmental quality in the United States and around the world. It is useful way for the public to access the diverse online resources of the federal government that pertain to environmental issues.

This report serves several purposes. First, it will be published as the 1997 edition of *Environmental Quality*. Second, it will be placed on the White House website in PDF format as *Environmental Quality 1997*. In addition, the statistical tables in Part III of this report and the list of online resources for each chapter will appear as part of CEQ's new *Environmental Quality Statistics* web page (currently under construction) in HTML format. The HTML format will enable users to download the statistical tables and link to hundreds of other government and nongovernment sites with useful information on environmental quality.

As a Web document, *Environmental Quality 1997* will be periodically updated to include new reports, new website addresses, and new data as soon as they become available. In this way, users will have instant access to the latest data on environmental quality and will be able to easily download and analyze the data.

In this context, it is important to note that this report is only a starting point. Particularly in its listings of nongovernmental organizations, it is intended to be suggestive rather than exhaustive. In its future life on the World Wide Web, this report will be periodically updated and additional organizations will be added. Suggestions for additional website listings or other comments are welcome and can be sent to Council on Environmental Quality, Administrative Officer, 722 Jackson Place, NW, Washington, DC, 20503.

This report is organized to correspond to the tables that have been published in *Environmental Quality* in the past. Each chapter includes a brief introduction, a section describing current environmental trends, and a section describing some useful online sources of information on the subject.

A few websites provide comprehensive guides to environmental and other data. These sites are described in this chapter.

DIRECTORIES

A Guide to Selected National Environmental Statistics in the U.S. Government
(http://www.epa.gov/ceisweb1/ceishome/digitallib/estatgov.html)

A Guide to Selected National Environmental Statistics in the U.S. Government (1993) was prepared by members of the Environmental Statistics and Information Division in the Office of Policy, Planning, and Evaluation at the U.S. Environmental Protection Agency. The *Guide* is a reference to selected, frequently sought after, national level, time-series environmental statistics that are compiled and distributed by the U.S. government on a regular basis. It is a directory to various environmental statistical programs and the data they collect, but it is not intended to supplant information that can be obtained directly from the government agencies.

The statistical programs in the *Guide* are arranged by government department, agency and program title. The *Guide* also contains an index of over 150 key words and phrases and an index of 55 databases. Statistical coverage includes data related to state-of-the-environment (e.g., air and water quality, status of biotic resources), pressures on the environment (e.g., energy use, mining, transportation, etc.), human health and welfare issues (e.g., exposure to toxic chemicals), and societal responses to environmental problems (e.g., pollution abatement expenditures, cleanup of toxic wastes, etc.).

The 1993 publication is the second edition of the *Guide*. A third edition is in preparation.

Guide to Global Environmental Statistics
(http://www.wri.org/sdis/global-g/index.html)

The *Guide to Global Environmental Statistics* (1998), which was produced by the World Resources Institute, is an electronic directory that provides summary information on 68 environmentally related statistical programs in 36 different international organizations.

There are several ways to find information. There is a table of contents organized alphabetically by organization and an index of key subject terms. The *Guide* includes a general description of the purpose and major activities of the institution housing the statistical program, detailed information on the data being compiled and reported and the units of measurement, information about the time period covered by each measurement, and information on how the data was collected and what type of processing and analysis was used.

Federal Interagency Council on Statistical Policy (FedStats)
(http://www.fedstats.gov)

More than 70 agencies in the U.S. government produce statistics of interest to the public. The Federal Interagency Council on Statistical Policy maintains this site to provide easy access to the full range of statistics and information produced by these agencies for public use. All of the statistical information available through FedStats is maintained and updated solely by federal agencies on their own Internet servers.

LIBRARIES

NEPANet
(http://ceq.eh.doe.gov/nepa/nepanet.htm)

This site, maintained by the White House Council on Environmental Quality, is a comprehensive source of information about the National Environmental Policy Act. The site includes the full text of the statute; regulations for implementing NEPA from CEQ and the agencies; agency NEPA web sites; guidance on scoping, NEPA regulations, pollution prevention, and environmental justice; recent CEQ annual reports; information about environmental impact analysis (where and how to file an EIS, EIS's available for review, statistics on EIS activity, EIS data links, and agency NEPA points of contact); environmental organizations; international environmental impact assessments; NEPA bibliographic information; and NEPA training information.

The site also includes two recent CEQ reports: *Considering Cumulative Effects under the National Environmental Policy Act*, and *NEPA—A Study of its Effectiveness After 25 Years*.

In addition, the site includes Enviro-Text, a searchable library that provides easy access to environment, safety, and health data, federal and state statutes and regulations, as well as Indian Tribal Codes and Treaties and international agreements.

Center for Environmental Information and Statistics (CEIS) Digital Library of Environmental Quality
(http://www.epa.gov/ceisweb1/ceishome/digitallib/)

The CEIS Digital Library of Environmental Quality offers links to numerous state of the environment reports plus EPA documents grouped by category. The groupings include air, water, toxics, waste, living resources, data quality, and state of the environment reports.

The air category includes a guide to radon, several reports on climate change, information about measuring air quality, and the most recent National Air Quality and Emissions Trends Reports. The water category includes information about environmental indicators of water quality, an index of watershed indicators, and information about the Safe Drinking Water Act, the Clean Water Act, and the quality of the nation's water. The toxics category includes the current toxics release inventory data report, a report on municipal solid waste trends, and the national report on the Resource Conservation and Recovery Act (RCRA).

The living resources category includes a national summary of wetland resources. The data quality category includes a descriptive profile of the RCRA information system and the toxics release inventory.

The state of the environment reports category includes reports on communities, states, regions, the United States, other nations, and the world. The U.S. category includes the CEQ annual report, a State Department report on the environment and U.S. foreign policy, EPA's 25th Anniversary report, and NOAA's *Our Changing Planet*. The world category includes the United Nations Environment Programme's *Global State of the Environment Report 1997*, the Worldwatch Institute's *State of the World 1997*, and *World Resources 1996-97*.

National Library for the Environment
(http://www.cnie.org)

The Committee for the National Institute for the Environment (CNIE) was formed to promote a proposal for a nonregulatory science institute with a mission to improve the scientific basis for making environmental decisions. CNIE's website includes a National Library for the Environment. The site includes briefing books on climate change, ocean and coastal resources, and electric utility restructuring, plus information about educational resources, environmental journals, meetings and conferences, environmental laws and treaties, and a virtual library on biodiversity and ecology.

CNIE also has obtained and put on its website (http://www.cnie.org/nle/crs_catg2.html) many Congressional Research Service reports on environment, energy, and natural resources topics. These nontechnical reports, prepared for members of Congress and not widely distributed, contain objective and nontechnical information that can be useful to people interested in environmental policy.

National Transportation Library
(http://www.bts.gov/ntl/ntlmain.html)

This site, maintained by the Bureau of Transportation Statistics of the U.S. Department of Transportation, contains several thousand full-text documents, and provides links to numerous other libraries addressing transportation issues. It includes publications on air pollution and other environmental effects of transportation, on transportation of hazardous materials, and on transportation-related energy use, including alternative fuels.

MULTI-MEDIA DATABASE QUERIES

Center for Environmental Information and Statistics Environmental Profiles
(http://yosemite.epa.gov/ceis/CEIS.nsf)

The CEIS site includes a section that enables users to obtain an environmental profile of their locality. The profile contains graphs and brief descriptions that summarize existing information on air quality, drinking water systems, surface water quality, hazardous waste, and reported toxic releases. Profiles are available for every state, county, and territory in the United States. Data in the profiles have been aggregated at the county level. Users can select a geographic area by selecting a state and county or by typing in their zip code.

EPA EnviroFacts Warehouse
(http://www.epa.gov/enviro/index_java.html)

EPA's *EnviroFacts Warehouse* provides a single point of access to select EPA environmental data, including Superfund data, safe drinking water information, hazardous waste data, toxics release inventory, water discharge permits, and air releases. The site allows users to obtain an overview of available data, to query the database and generate reports from the data, and to produce maps of environmental information on demand.

EPA Environmental Indicators Website
(http://www.epa.gov/indicators/)

EPA's *Environmental Indicators Website* provides EPA data aggregated nationally or by state, county, or zip code as well as links to indicator reporting by other federal agencies, states, and other geographic areas. The site provides access to environmental data for the following subject areas: air quality nonattainment areas; solid and hazardous waste management; water quality inventory; safe drinking water indicators; wetland losses; toxics release inventory; and pesticides (Ecological Incident Information System).

FAOSTAT
(http://apps.fao.org)

FAOSTAT, maintained by the Food and Agriculture Organization of the United Nations, is an online and multilingual database currently containing over 1 million time-series records covering international statistics in the following areas: production, trade, food balance sheets, food aid shipments, fertilizer and pesticides, land use and irrigation, forest products, fishery products, population, and agricultural machinery.

FAOSTAT has recently added a new database (Codex Alimentarius) on maximum limits for pesticide residue in foods. It also provides quarterly updates of agricultural production and production indices data.

BRIEFING ROOMS

Social Statistics Briefing Room
(http://www.whitehouse.gov/fsbr/ssbr.html)

This White House site provides easy access to current federal social statistics, including statistics on crime, demography, education, and health. The information is maintained and updated by the statistical units of the relevant federal agencies.

Economic Statistics Briefing Room
(http://www.whitehouse.gov/fsbr/esbr.html)

This White House site provides access to current federal economic indicators and links to information produced by a number of federal agencies. The categories in this briefing room include: production, sales, orders, and inventories; output; income, expenditures, and wealth; employment, unemployment, and earnings; prices; money, credit, and interest rates; transportation; and international statistics.

ERS Briefing Room: Agricultural Resources and Environmental Indicators
(http://www.econ.ag.gov/Briefing/arei/)

The Economic Research Service produces numerous indicators that summarize the status of natural resource use in agriculture and associated environmental quality. Periodically these indicators are integrated into a single comprehensive report, *Agricultural Resources and Environmental Indicators*. As new data and information are collected, ERS publishes AREI updates to supplement and update information contained in AREI.

DATA ACCESS

More and more federal agencies are providing access to data in electronic format. Federal agencies utilize a variety of tools to enable users to access data on the Internet, either for viewing online, or for downloading to a local disk. Similarly, agencies package the data in different formats, ranging from raw data, to summary statistics in tabular form, to processed data in the form of charts and maps. Some of the data are available as flat "read only" files while other data are compiled "on the fly" using a database query/retrieval mechanisms. Some agencies offer more than one way to access data. Also online are footnotes that clarify and support the table data, table data sources, data quality profiles, and links to related information and tables.

In some cases, previously published data reports are now only available online. These data are updated on a regular basis (e.g., monthly, annually) to coincide with reporting schedules or periodically as new statistics are compiled. In addition, many agencies provide data and source information on CD-ROM and diskettes, which are sold for a nominal fee.

Some of the user-friendly technologies that CEQ uses to access data for annual reports are described below.

Viewing Data Tables Online

TEXT, ASCII, and HTML are the most common formats used for statistical data that can be viewed online using an Internet browser. Data tables in Adobe PDF format (Portable Document Format) can also be viewed online with the help of Adobe Acrobat Reader (The Adobe PDF Reader program is available for downloading free from Adobe). Data tables in these file formats can be saved to local disk and opened with appropriate software. For example, TEXT files can be opened with WordPerfect©, Microsoft Word©, or other wordprocessing programs; HTML files can be opened with Internet browsers; and PDF files can be opened with Adobe Acrobat Reader.

Some of the table data that are available in TEXT or ASCII format include the Energy Information Administration's *Annual Energy Review*, the Bureau of Transportation Statistics' *National Transportation Statistics*, the Bureau of the Census' *Census of Population and Housing*, and most of the Carbon Dioxide Information and Analysis Center (CDIAC) digital databases.

The National Center for Health Statistics' *Data Warehouse*, the National Agricultural Statistics' *Statistical Highlights*, the Department of Energy's *Integrated Data Base (IDB) Reports: U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, the U.S. Geological Survey (USGS) Water Resources Division's *National Water Conditions*, and data tables supporting the Natural Resources Conservation Service's *State of the Land* maps are some of the tabular resources available online in HTML format.

A growing number of data tables are available in PDF format, including CEQ's statistical appendix to several recent *Environmental Quality* annual reports, Office of Management and Budget's historical statistics from the *Budget of the United States*, the Bureau of Land Management's *Public Lands Statistics*, the USGS Water Resources Division's *Estimated Use of Water in the United States in 1995*, the USGS Geologic Division's *Mineral Commodity Summaries*, the Federal Highway Administration's *Highway Statistics*, Bureau of the Census' *Statistical Abstract of the United States*, the National Marine Fisheries Service's *Fisheries of the United States*, and tables from the Environmental Protection Agency's *Toxics Release Inventory Report*, *Municipal Solid Waste Characterization Report*, *National Air Pollutant Emission Trends Report*, and *National Air Quality and Emissions Trends Report*.

Downloading Data to Local Disk

In addition to viewing data online, several agencies also provide an option to download data in spreadsheet format, either as an entire chapter, appendix, or book, or as a single file, so that the user can perform calculations on the data or produce charts and maps. Excel© and LOTUS 1-2-3© are the two most commonly used formats. The sponsoring agency usually saves the table data in a lower version of the software (e.g., Excel version 5.0 or LOTUS version 3.1) to enhance the likelihood that users can open the data files even if they do not have the latest version of Excel or LOTUS, or open them with other spreadsheet programs such as Quattro Pro© or Harvard Graphics©. Some agencies offer a choice between data in Excel or LOTUS spreadsheet formats. (It should be noted that TEXT and ACSII data tables also can be opened using spreadsheet programs, although the user may encounter problems with the format of the downloaded file). Most of the agencies provide instructions to aid the user in downloading files.

Data tables that are available for downloading in spreadsheet format include the Energy Information Administration's *Annual Energy Review*, the Bureau of Transportation Statistics' *National Transportation Statistics*, Federal Highway Administration's *Highway Statistics*, Appendix B of the Council of Economic Advisor's *Economic Report of the President*, and the Office of Management and Budget's historical statistics from the *Budget of the United States*.

Other online data formats that can be imported into common computer spreadsheet programs after downloading include data saved in "delimited format," where characters such as tabs, commas, space, or semicolons separate each field; or data saved in "fixed width" format, where fields are aligned in columns with spaces between each field. Examples include the National Agricultural Statistics' annual *Agricultural Statistics Report* and U.S. Geological Survey's *1995 Estimated Water Use in the United States.*

Database Retrieval Systems

Several agencies make data and information available through an interactive database query that will produce user-defined tables, charts or maps for the nation or a particular geographical area. Instructions are provided to guide the user through a choice of output formats (standard or custom; online or downloaded), the area for which the summary data will be produced (such as states or counties), what type of data will be included in the output, and for what years. After selecting the desired variables, the user submits the query and the requested information is retrieved from the database. The data output can then be viewed online or downloaded to local disk.

Among the many environmental data retrieval systems provided by federal agencies are the U.S. Forest Service's *Forest Inventory and Analysis Database Retrieval System* and its *Timber Product Output (TPO) Database Retrieval System*; the National Marine Fisheries Service's *Annual and Monthly Commercial Landing Statistics*; the National Park Service's *Visitation Database*; the USGS Biological Resources Division's *North American Breeding Bird Survey: Results and Analysis 1966-1996*; the National Register for Historic Preservation's *National Register Information System*; the USGS *National Atmospheric Deposition Program / National Trends Network (NADP/NTN) Database Retrieval System*; and EPA's *CEIS Environmental Profiles, EnviroFacts Warehouse, Environmental Indicators Website*, and *Aerometric Information Retrieval System* (AIRS).

(Note: Reference to software products in this chapter does not reflect any endorsement by the federal government.)

SELECTED FEDERAL AGENCYWEB PAGES (as of December 31, 1998)

Executive Office of the President

Council of Economic Advisors
(http://www.whitehouse.gov/WH/EOP/CEA/html/CEA.html)

Council on Environmental Quality
(http://www.whitehouse.gov/CEQ/)

Office of Management and Budget
(http://www.whitehouse.gov/OMB)

Office of Science and Technology Policy
(http://www.whitehouse.gov/OSTP)

Department of Agriculture

(http://www.usda.gov)

Economic Research Service
(http://www.econ.ag.gov/)

National Agricultural Statistics Service
(http://www.usda.gov/nass/)

Natural Resources Conservation Service
(http://www.nrcs.usda.gov/)

U.S. Forest Service
(http://www.fs.fed.us/)

Department of Commerce

(http://www.doc.gov)

Bureau of Economic Analysis
(http://www.bea.doc.gov/)

Bureau of the Census
(http://www.census.gov/)

National Oceanic and Atmospheric Administration
(http://www.noaa.gov/)

National Ocean Service
(http://www.nos.noaa.gov/)

Coastal Ocean Program
(http://www.cop.noaa.gov/)

National Marine Fisheries Service
(http://www.nmfs.gov/)

Office of Oceanic and Atmospheric Research
(http://www.oar.noaa.gov/)

Office of Global Programs
(http://www.ogp.noaa./gov)

National Weather Service
(http://www.nws.noaa.gov/)

National Environmental Satellite, Data and Information Service
(http://www.nesdis.noaa.gov)

National Climatic Data Center
(http://www.ncdc.noaa.gov/)

Department of Defense

U.S. Army Corps of Engineers
(http://www.usace.army.mil/)

Engineering Division
(http://www.usace.army.mil/inet/functions/cw)

Department of Energy

(http://www.doe.gov)

Energy Information Administration
(http://www.eia.doe.gov/)

Environmental Management Program
(http://www.em.doe.gov/)

Oak Ridge National Laboratory
(http://www.ornl.gov/)

Carbon Dioxide Information Analysis Center
(http://cdiac.esd.ornl.gov/)

Center for Transportation Analysis
(http://www-cta.ornl.gov/)

Department of Health and Human Services

Centers for Disease Control and Prevention
(http://www.cdc.gov/)

National Center for Health Statistics
(http://www.cdc.gov/nchswww/)

Agency for Toxic Substances and Disease Registry
(http://atsdr1.atsdr.cdc.gov:8080/atsdrhome.html)

Food and Drug Administration
(http://www.fda.gov/default.htm)

Department of the Interior

(http://www.doi.gov/)

Bureau of Land Management
(http://www.blm.gov/)

Bureau of Reclamation
(http://www.usbr.gov/main/index.html)

National Park Service
(http://www.nps.gov/)

Office of Surface Mines
(http://www.osmre.gov/osm.htm)

U.S. Fish and Wildlife Service
(http://www.fws.gov/)

Division of Endangered Species
(http://www.fws.gov/r9endspp/endspp.html)

National Wetlands Inventory
(http://www.nwi.fws.gov/text.html)

Office of Migratory Bird Management
(http://www.fws.gov/r9mbmo/homepg.html)

U.S. Geological Survey
(http://www.usgs.gov/)

Biological Resources Division
(http://www.nbs.gov/)

Geologic Division
(http://geology.usgs.gov/index.shtml)

Mapping Division
(http://mapping.usgs.gov/)

Water Resources Division
(http://water.usgs.gov/)

Department of Transportation
(http://www.dot.gov/)

Bureau of Transportation Statistics
(http://www.bts.gov/)

Federal Highway Administration
(http://www.fhwa.dot.gov/)

U.S. Coast Guard
(http://www.uscg.mil/welcomex.html)

U.S. Environmental Protection Agency
(http://www.epa.gov/)

Office of Air and Radiation
(http://www.epa.gov/oar/)

Office of Air Quality Planning and Standards
(http://www.epa.gov/oar/oaqps/)

Office of Atmospheric Programs
(http://www.epa.gov/oar/oap.html)

Office of Mobile Sources
(http://www.epa.gov/docs/OMSWWW/omshome.htm)

Office of Radiation and Indoor Air
(http://www.epa.gov/oar/oria.html)

Office of Policy
(http://www.epa.gov/oppe/oppe.html)

Center for Environmental Information and Statistics
(http://www.epa.gov/ceis/)

Office of Prevention, Pesticides, and Toxic Substances
(http://www.epa.gov/internet/oppts/)

Office of Pollution Prevention and Toxics
(http://www.epa.gov/opptintr/index.htm)

Office of Pollution Prevention Lead Page
(http://www.epa.gov/lead)

Office of Pesticide Programs
(http://www.epa.gov/pesticides)

Office of Solid Waste and Emergency Response
(http://www.epa.gov/swerrims/)

Office of Water
(http://www.epa.gov/OW/)

Office of Wetlands, Oceans and Watersheds
(http://www.epa.gov/OWOW/)

Office of Science and Technology
(http://www.epa.gov/OST/)

Office of Wastewater Enforcement and Compliance
(http://www.epa.gov/OW-OWM.html/)

Office of Ground Water and Drinking Water
(http://www.epa.gov/safewater/)

National Science Foundation
(http://www.nsf.gov)

National Aeronautics and Space Administration
(http://www.hq.nasa.gov)

CHAPTER ONE

Population

Population size, distribution, mobility, age structure, and rate of growth all affect the environment. They affect what resources are used, where, when, how, and at what rate, and with what attendant waste or conservation. An increase in population will heighten demand for food, energy, water, health care, sanitation, and housing. Those demands can be met in a variety of ways, with potentially significant differences in environmental impact.

The relationships between population, environment, and resources have been the subject of a long debate. One of the earliest contributors was the 18th Century English economist Thomas Malthus. Noting that population was growing faster than agricultural production, Malthus theorized that population growth would ultimately be constrained by the amount of land available for food production. He described a feedback process in which overpopulation would produce widespread famine, illness, and death, which in turn would reduce population size. Malthus' *Essay on the Principle of Population* is available online (http://www.trmalthus.com/essay.htm).

Since Malthus' time, many other researchers have examined population-environment-development linkages. Some have stressed the role of rising affluence and per capita consumption as greatly exacerbating sheer population size; others have stressed the role of population density in combination with economic conditions; and still others have stressed the role of technological innovation and substitution of materials in ameliorating the impacts of population growth.

For example, some environmental trends may be associated with changes in per capita income. The economist Simon Kuznets studied the relationship between income inequality and per capita income. He found an inverted-U relationship: income inequality increased for low-income countries as per capita income increased, but at some point, the inequality leveled off and then began to fall as per capita income rose to the level of a more developed country. Kuznets' work has since been applied to trends in pollution as a function of per capita income. In this case, patterns of emissions of air and water pollutants across countries seem to increase when income per capita is low, and fall when income per capita rises. Thus, countries that experience a certain level of development should experience declining pollution with economic growth, because of increased demand for environmental protection with higher income.

This theory has drawn some criticism and certainly does not apply to all environmental problems. For example, greenhouse gas emissions, which have no local effects, seem to increase with income at all income levels. Furthermore, a number of studies have found that turning points in the relationship between economic growth and environmental quality usually result from explicit policy actions. This suggests that countries cannot expect that growth alone will automatically result in improvements in environmental quality.

Government policies and technological advances can significantly alter the population-environment linkage. For example, industrial efficiency improvements can offset rising consumption caused by population growth. In the case of wood, many sawmills today produce twice as much usable lumber and other products per log input as they did a century ago. Another example is pollution controls on cars and trucks, which—by lowering emissions per vehicle—have helped to offset pollution caused by the rising number of cars and trucks on the nation's roads.

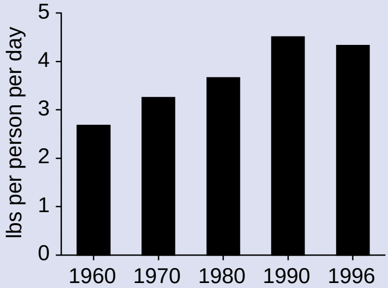
Apart from the issue of linkages, population data and demographics can be a useful tool for understanding trends in some environmental problems. For example:

- In the case of radon, knowing population size and rate of change will help in estimating national or regional exposure rates. Migration trends can indicate the potential for increasing radon exposure in certain geographic regions.

- Even if per capita generation of solid waste is constant, population growth generally leads to greater waste generation. Per capita waste generation in the U.S. increased from 1960 to 1990, but has declined slightly since then (Figure 1.1).

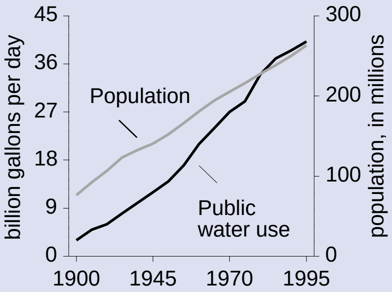
- Increasing population size implies increasing demand for drinking

Figure 1.1 U.S. Per Capita Solid Waste Generation, 1960-1996



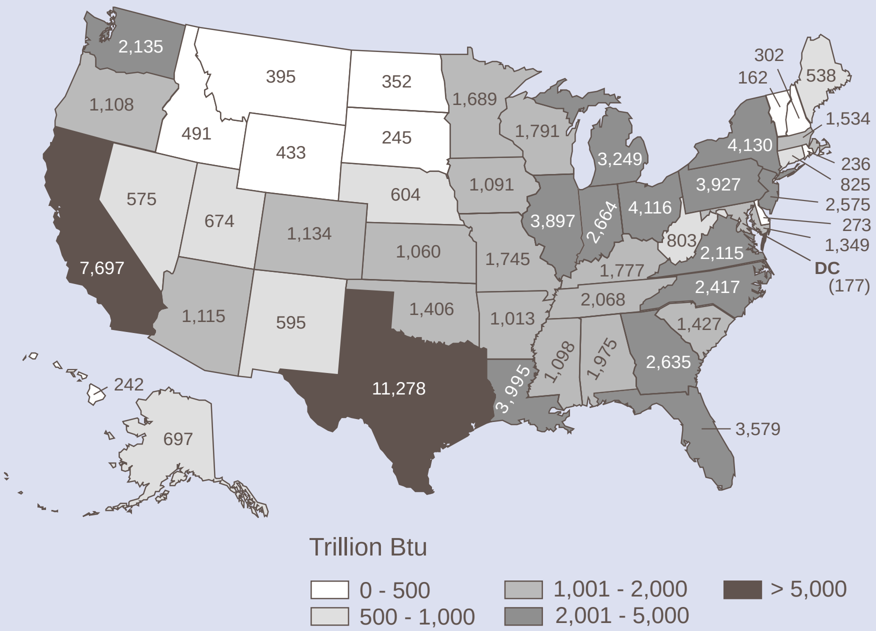
Source: See Part III, Table 8.1.

Figure 1.2 U.S. Public Water Use, 1900-1995



Sources: See Part III, Table 1.1 and Table 6.3.
Notes: Public water use refers to public supply provided for households, municipalities, commercial establishments, etc. Does not include self-supplied water (e.g., wells).

Figure 1.3 Energy Consumption Estimates by State, 1996



Source: U.S. Department of Energy, Energy Information Administration, *State Energy Data Report 1996* (DOE, EIA, Washington, DC, 1999).

water (Figure 1.2). Population distribution also affects local and regional demand for water and the distribution of sources of pollution. Similar patterns are seen in energy consumption (Figure 1.3).

- In coastal and estuarine areas, population growth implies greater potential for pollution of water resources and habitat/land use alteration. Population growth in upstream areas or near sensitive areas can adversely affect estuarine and coastal water quality.

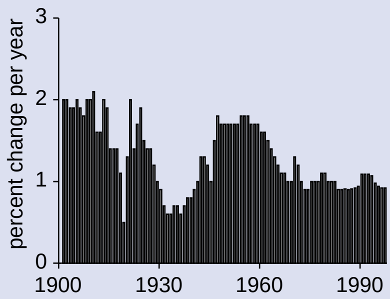
These connections are described in *The Population-Environment Connection*, a report of the Battelle Seattle Research Center prepared for the Environmental Protection Agency. The report is available online (http://www.seattle.battelle.org/services/e&s/pop-env/index.htm).

TRENDS

U.S. Population

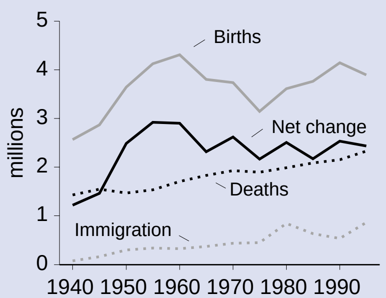
Unlike most other developed nations, the U.S. population is continuing to increase, though at the relatively slow pace of about one percent per year. This is about half the rate of the baby boom years following World War II; in 1950, for example, U.S. population increased 2.05 percent. Annual percentage increases continued at more than 1.5 percent through

Figure 1.4 U.S. Population Growth Rate, 1900-1997



Source: See Part III, Table 1.1.

Figure 1.5 Components of U.S. Population Change, 1940-1997



Source: See Part III, Table 1.2.

1962, and then dropped quickly to the 1 percent level by 1968 (Figure 1.4).

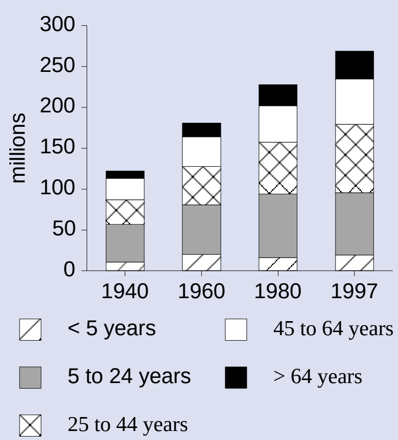
In absolute numbers, the Commerce Department's Bureau of the Census estimates the U.S. population in 1997 at 267.64 million, an increase of about 18 million people since 1990. (Part III, Table 1.1.)

Births continue to be by far the largest factor in U.S. population increase. In 1997, there were 3.9 million births and 2.3 million deaths. Net immigration was estimated at 868,000, resulting in a net increase in population of 2.44 million (Figure 1.5). (See also Part III, Table 1.2.)

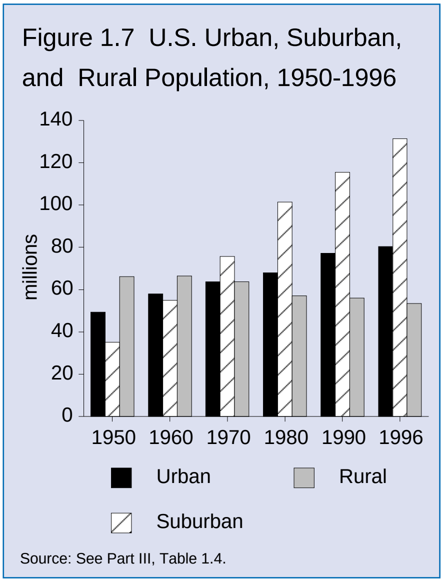
Over the period from 1940 to 1997, the proportion of the population in older age groups has increased considerably (Figure 1.6). In 1940, there were an estimated 9 million people over the age of 64; in 1997, there were 34 million people in that category. Growing elderly populations in popular retirement areas like Florida have significant environmental implications. (Part III, Table 1.3)

Over the course of this century, the nation's population has changed from primarily rural to primarily urban and suburban (Figure 1.7). Since 1950, suburban areas have grown dramatically, increasing from 35 million people (23 percent of the total population) to 131 million (50 percent of the total in 1996). Rural population has shrunk from 66 million people in 1950 (44 percent of the total) to 54 mil-

Figure 1.6 U.S. Population Distribution by Age, 1940-1997



Source: See Part III, Table 1.3.



Over the period from 1969 to 1997, the number of people living below the poverty line has fluctuated from a low of 23 million in 1973 (11 percent of the population) to a high of 39 million in 1993 (15 percent of the population). In 1997, the total was estimated at 35.6 million, or 13.3 percent of the population. The number of people in poverty declined for all races, pointing to the widespread benefits of a growing economy across the population. In terms of residence, about 15 million poor people were living in urban areas, 12 million in suburbs, and 8 million in rural areas (Figure 1.10). (Part III, Table 1.7)

lion people in 1996 (20 percent of the total). (Part III, Table 1.4.)

Population has increased in all regions of the country, but the rate of increase has been fastest in the West—growing from 4 million to 59 million from 1900 to 1997—and the South—growing from 25 million to 94 million over the same period (Figure 1.8). (Part III, Table 1.5) In terms of regional migration, the pattern since 1960 has been characterized by movement from the Northeast and Midwest to the South and West.

For the U.S. as a whole, average population density in 1997 was 77 people per square mile. Densities in coastal regions (except in the Pacific) are much higher, however. (Part III, Table 1.6) For example, average population density was estimated at 418 per square mile in 1997 along the Atlantic coast and 231 per square mile in the coastal counties of the Great Lakes (Figure 1.9).

Global Trends

The United Nations Population Information Network (POPIN) (http://www.undp.org/popin) is a comprehensive source of information on global population trends.

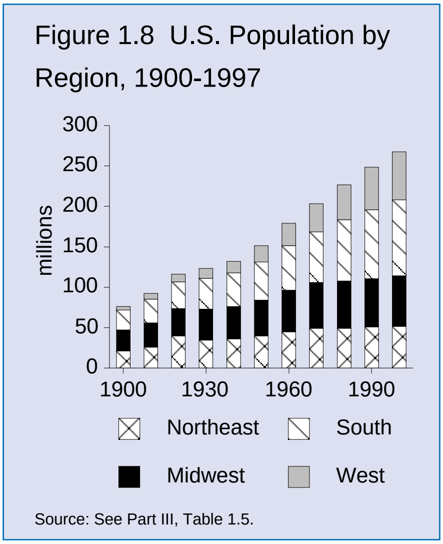
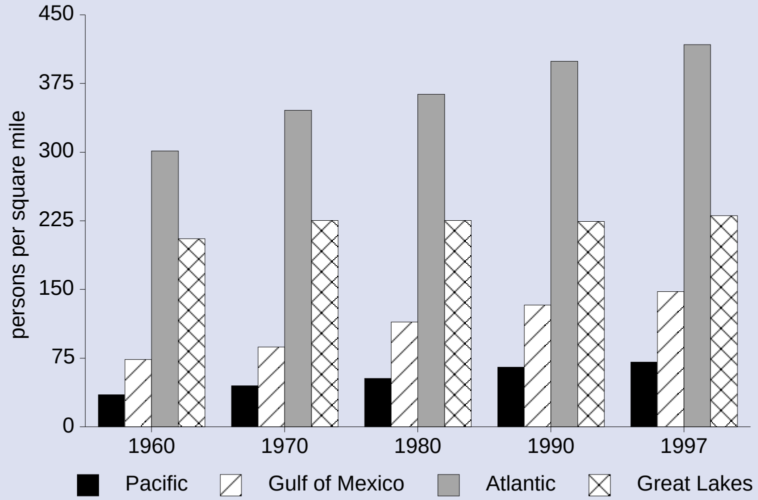


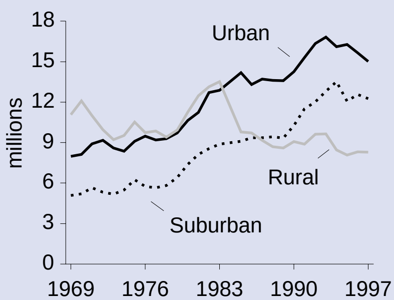
Figure 1.9 U.S. Coastal Population Density, 1960-1997



Source: See Part III, Table 1.6.

The site includes information on world population projections to the year 2150, trends in fertility rates, additional deaths due to AIDS, child mortality, urbanization, migration flows, and urban agglomerations. *World Population Prospects: The 1998 Revision*, which is prepared by the Population Division of the Department of Economic and Social Affairs at the United Nations Secretariat, provides estimates and projections for the global population for the period 1950-2050.

Figure 1.10 U.S. Population Below Poverty Level by Place of Residence, 1969-1997



Source: See Part III, Table 1.7.

A recent UN study, *World Population Projections to 2150*, provides several different scenarios for future global population, with the differences attributable to different assumptions about future scenarios in total fertility rates (Figure 1.11).

Slight differences in assumptions about fertility yield large differences in the ultimate global population. According to the medium fertility scenario, world population will grow from 5.7 billion in 1995 to 9.4 billion by 2050, 10.4 billion by 2100, and 10.8 billion by 2150. Under the high-fertility scenario, which assumes that total fertility rates will converge at around 2.5 children per woman by 2050, population will grow to 11.2 billion by 2050, 17.5

billion by 2100, and 27 billion by 2150. Under a low-fertility scenario, which assumes that total fertility rates will eventually stabilize at levels between 1.35 and 1.6 children per woman, population would increase to 7.7 billion by 2050, but then decline to 5.6 billion in 2100 and to 3.6 billion by 2150.

The different rates of population growth will lead to a substantial redistribution of global population. Under the medium-fertility scenario, the share living in the currently developed world will decrease from 18 to 9 percent during the 1995-2150 period.

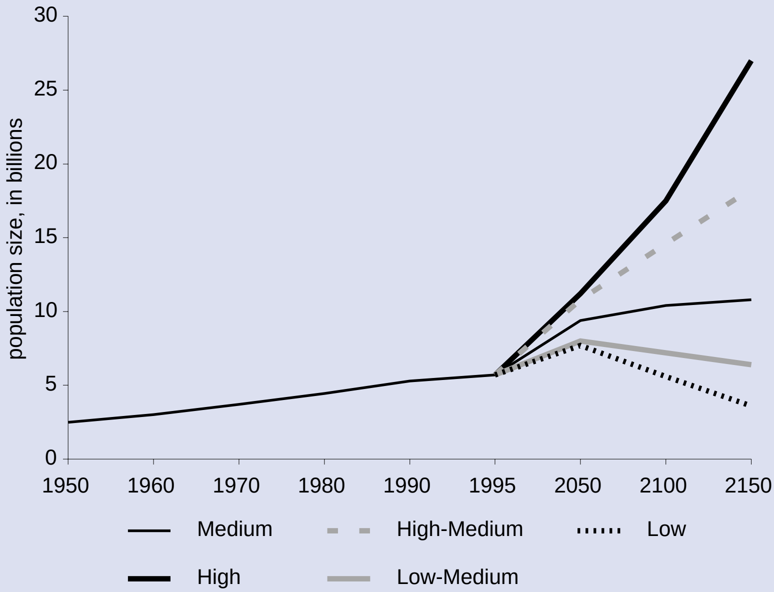
Declining fertility and mortality rates will lead to a dramatic population ageing. In the medium-fertility scenario, the share aged 60 years or more will increase from 9 to 30 percent of the world population between 1995 and 2150.

ONLINE RESOURCES

The website maintained by the U.S. Census Bureau (http://www.census.gov) provides a vast quantity of information on U.S. population, housing, and economic indicators.

For example, the tables printed in the *Statistical Abstract of the United States* are available online (http://www.census.gov/prod/3/98pubs/98statab/cc98

Figure 1.11 World Population Size According to Main Fertility Scenarios, 1950-2150



Source: United Nations, Department of Economic and Social Affairs, Population Division, *World Population Projections to 2150* (UN, New York, 1998).

stab.htm). The U.S. population census also is available (http://www.census.gov/population/www/), including information on population counts by race and Hispanic origin, age groups by sex, and household characteristics.

The Census Bureau also has published numerous studies on migration and geographic mobility, including three recent reports in *The Current Population Survey*. A guide to these sources is available (http://www.census.gov/population/www/socdemo/migrate.html).

For studies relating to population and the environment, the web site maintained by the Population Reference Bureau (http://www.prb.org) is particularly valuable. PRB manages PopNet (http://www.popnet.org), which presents information on topics such as demographic statistics, economics, education, environment, gender, and reproductive health. It includes links to government and international organizations, non-government organizations, university centers, and associations.

PopNet's population and environment category provides a long list of links to other sites, including the Center for International Earth Science Information (CIESIN), the Food and Agriculture Organization of the United Nations (FAO), the International Institute for Applied Systems Analysis (IIASA), the International Institute for Sustainable Development, the National Academy of Sciences, the National Audubon Society's Population and Habitat Campaign, the United Nations Development Programme (UNDP), the World Bank, the World Resources Institute (WRI), and the Worldwatch Institute.

These sites provide a massive amount of information related to population, resources, and environment. For example, the CIESIN site provides access to thousands of resources related to population and the environment. The "Gridded Population of the World" includes world and continental population counts and population density.

PopNet's section on demographic statistics provides links to global, national, and institutional demographic databases. It includes links to most national demographic statistics, along with other links to the CIA World Factbook, Demographic and Health Surveys (an important source of information on fertility, knowledge and use of family planning, and maternal and child health in developing countries), EUROSTAT (the home page of the Statistical Office of the European Communities), a mortality database produced by the World Health Organization, and the weekly mortality and morbidity report produced by the U.S. Centers for Disease Control and Prevention.

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Global Population

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CORE DATA

CHAPTER TWO

Economy and Environment

Over the past several decades, a great deal has been learned about the linkages between environmental policy and economic activity in the United States.

In the 1970s, when many federal environmental laws were first enacted, the main emphasis was on "command-and-control" mechanisms. Command-and-control meant three primary approaches:

- Ambient standards, which specify a minimum level of environmental quality that would be achieved through limits on sources, products, or other sources of pollution. For example, the Clean Air Act required EPA to set national ambient air quality standards to protect human health without regard to cost.

- Emission or effluent limits, which apply to individual sources as a means of achieving health or environment-based ambient standards.

- Technology requirements, which specify the techniques or equipment that sources must use to control pollution, i.e., the requirement that automobiles must be equipped with catalytic converters.

Over several decades, these approaches generally succeeded in reducing pollution. In the case of air quality, for example, national emissions of five of the six major air pollutants have fallen dramatically since 1970.

While admittedly successful in terms of results, command-and-control approaches have been criticized as economically inefficient. In the case of national ambient air quality standards, for example, EPA is required to set standards to protect human health with an adequate margin of safety. In many cases, relatively small amounts of some air pollutants can be shown to have measurable effects on health or the environment. Critics say standards that require eliminating such pollutants may incur large costs for relatively small incremental improvements in environmental quality.

Furthermore, command-and-control approaches generally provide no mechanism for focusing emissions reductions where they are cheapest. In addition, they generally do not provide strong incentives to search for more cost-effective ways to reduce emissions or for new methods to reduce emissions *below* the current standard.

As noted in the *1999 Economic Report of the President*, some technology and performance standards have led to cost-effective innovations. For example, one way to increase the incentive to innovate under performance standards is for regulators to adopt a strict standard for the future. Such "technology-forcing" performance standards raise the value of innovations that lower pollution control costs, in addition to providing time for the development and adoption of new technologies. For example, in 1970 the California Air Resources Board adopted stringent air emissions standards for new cars that took effect in 1975. This contributed to the development of an emerging technology, the catalytic converter, which cut automobile emissions dramatically and is widely used today.

In the case of environmental regulations requiring the phaseout of chlorofluorocarbons (CFCs) to protect the stratospheric ozone layer, a new method was found for cleaning electronic circuit boards that not only eliminated the use of CFCs but increased product quality and lowered operating costs as well.

Nevertheless, over the past 10 to 15 years the federal government has moved toward a new regulatory approach, known as incentive-based mechanisms. Examples of incentive-based approaches include tradable permit systems, emissions taxes, subsides to reduce pollution, and liability rules.

Tradable Permit Systems

Tradable permit systems take advantage of the fact that the cost of reducing emissions by a given amount differs from firm to firm. A tradable permit system caps total emissions from all firms. After an initial allocation, firms may freely buy or sell permits among themselves. Firms that can reduce emissions for less than the going price of a permit thus have an incentive to do so and then sell their unused permits to other firms facing more costly emissions reductions.

Emissions trading also gives firms an incentive to innovate. Firms that develop effective and cheaper pollution control measures can sell not only their unused permits but the technology itself.

EPA's sulfur dioxide (SO_2) emissions reduction program is a significant example of this new approach. The 1977 Clean Air Act Amendments required new fossil fuel-fired electrical generating plants to remove 90 percent of SO_2 from their smokestack emissions (70 percent if the plants used low-sulfur coal). This policy effectively mandated the use of scrubbers, devices that remove SO_2 from the exhaust gases produced by burning coal.

The 1990 Clean Air Act Amendments established a tradable permit program for SO_2 emissions. Under Phase I, which began in 1995, permits were allocated to 110 electric utility plants around the country. Under Phase II, which begins in 2000, the program will be extended to cover virtually all fossil-fuel-burning electric generating plants. Plants that can reduce emissions cheaply, such as by switching to low-sulfur coal, can sell permits to plants that face more expensive emissions reductions. The program is expected to reduce SO_2 emissions to 50 percent of 1980 levels.

It is estimated that the trading system may produce cost savings of 25 to 43 percent. In addition, the tradable permit system may spur innovation that results in additional savings. There is already evidence of dramatically falling costs. In 1990, EPA forecast that the total annual compliance cost for SO_2 emissions reduction in 2010 would be in the range of $2.6 billion to $6.1 billion (in 1995 dollars), whereas a 1998 study estimated costs at just over $1 billion (also in 1995 dollars).

Several factors help explain the rapid decline in costs. One contributing factor was a greater-than-expected decline in rail freight rates, which made low-sulfur coal from the Powder River Basin in Wyoming more competitive with locally mined, high-sulfur coal in Midwestern markets. Switching to low-sulfur coal proved to be substantially less costly than installing smokestack scrubbers. A second factor was lower-than-predicted costs of using scrubbers, in part because of unexpectedly high utilization rates.

Another example of incentive mechanisms is the federal government's efforts to reduce ground-level ozone concentrations. Studies have found that ozone and nitrogen oxides (NO_X) can travel hundreds of miles and contribute to nonattainment of air quality standards in downwind areas. Under traditional regulatory approaches, nonattainment areas had to make costly emissions reductions within their borders even if comparable upwind reductions were available at lower cost.

To address this problem, EPA in 1998 announced a program to reduce NO_X in 22 states and the District of Columbia by an average of 35 percent during May through September (when ozone levels are highest) by 2007. The program allows for emissions trading among electric utilities that are sources of NO_X emissions.

An important distinction between the SO_2 and NO_X programs is that utilities currently account for only about 30 percent of NO_X emissions, compared with about 65 percent of SO_2 emissions. Since the increased opportunity to trade emissions permits tends to lower costs, it would appear desirable to consider expanding the scope of the program to include transportation or nonutility combustion sources. However, the scope of the program may be limited by the need to ensure accountability.

In the area of water pollution, several state and local governments have experimented with programs that are similar in principle to the air pollution trading programs. For example, it may be considerably less expensive to improve water quality by reducing pollution from non-point sources than from point sources. Trading programs would allow point sources of pollution to meet environmental standards by paying non-point sources (such as farms) to adopt practices to reduce pollution. Agencies administering these programs rely on verifying that non-point sources have adopted land management practices that are linked with pollution reduction. Experience with such programs is still limited, but cost savings could be substantial.

Other Incentive Programs

Over 3,400 communities in 37 states have instituted new variable pricing programs for household waste in recent years. These programs take several forms. For example, pre-paid garbage bags or stickers to affix to bags can be required for collection, or collection fees can be based on the number and/or size of cans. Such systems are relatively easy and inexpensive and provide a stable source of revenue for collection services.

Education and recycling programs have been important contributing factors in the success of many variable pricing programs. Many communities implement public education, curbside recycling, yard waste, and holiday greenery programs as well. For example, an estimated 8,937 curbside recycling programs were in operation in 1997—a roughly ninefold increase since 1988. Over the same period, there was a similarly dramatic increase in the number of facilities handling "yard trimmings" (grass, leaves, and brush). These complementary programs can be an important factor in the success of variable rate pricing efforts.

In most areas where variable rate programs have been introduced, amounts of waste collected have declined. A 1992 survey of 14 cities with variable rate programs found that the amount of waste destined for disposal decreased by an average of 44 percent. A study in Maine found that cities and towns with variable rate systems disposed of less than half as much waste per capita as cities and towns without such systems. Other studies have found that variable rate programs encourage consumers to think of ways to reduce waste generation, including altering their purchasing habits.

Assessing Costs and Benefits

An important issue connected to economic efficiency policies concerns whether the benefits of environmental protection laws outweigh their costs.

In the case of the Clean Air Act, Congress added to the 1990 amendments a requirement that EPA conduct periodic, scientifically reviewed studies to assess the benefits and the costs of the act.

The first report in this series, *The Benefits and Costs of the Clean Air Act: 1970 to 1990*, examines the benefits and costs of the original 1970 act and the 1977 amendments. Estimates are derived by examining the differences in economic, human health, and environmental outcomes under two alternative scenarios. The "control" scenario reflects actual historical implementation of clean air programs and is based largely on historical data. The "no-control" scenario assumes that no air pollution controls would be established beyond those in place prior to enactment of the 1970 amendments.

The study includes a detailed discussion of two difficult aspects of cost-benefit analysis—quantifying non-market benefits and health benefits.

The study found that:

- The total monetized benefits of the Clean Air Act realized during the period from 1970 to 1990 range from 5.6 to 49.4 trillion dollars, with a central estimate of 22.2 trillion dollars.
- By comparison, the value of direct compliance expenditures over the same period equals approximately 0.5 trillion dollars.
- Subtracting costs from benefits results in net, direct, monetized benefits ranging from 5.1 to 48.9 trillion dollars, with a central estimate of 21.7

trillion dollars, for the 1970 to 1990 period.

- The lower bound of this range may go down and the upper bound may go up if analytical uncertainties associated with compliance costs, macroeconomic effects, emissions projections, and air quality modeling could be quantified and incorporated in the uncertainty analysis. While the range already reflects many important uncertainties in the physical effects and economic valuation steps, the range might also broaden further if additional uncertainties in these two steps could be quantified.

These results indicate that the benefits of the Clean Air Act and associated control programs substantially exceeded costs. Even considering the large number of important uncertainties permeating each step of the analysis, it is extremely unlikely that the converse could be true.

The study also found that a large proportion of the monetized benefits of the Clean Air Act derive from reducing two pollutants: lead and particulate matter. The study provided no evidence to support or reject the possibility that other Clean Air Act programs and standards might not have exceeded measurable costs. It did note, however, that most control programs yielded a variety of benefits, many of which included reductions in other pollutants such as ambient particulate matter.

The report notes that, in a final brief interagency review organized in August 1997 by the Office of Management and Budget, several agencies held different views pertaining to several key assumptions in the study. The concerns included: 1) the extent to which air quality would have deteriorated from 1970 to 1990 in the absence of the Clean Air Act; 2) the methods used to estimate the number of premature deaths and illnesses avoided due to the Clean Air Act; 3) the methods used to estimate the value that individuals place on avoiding those risks; and 4) the methods used to value non-health related benefits. These concerns were not resolved during this review. Therefore, the report reflects the findings of EPA and not necessarily other agencies in the Administration.

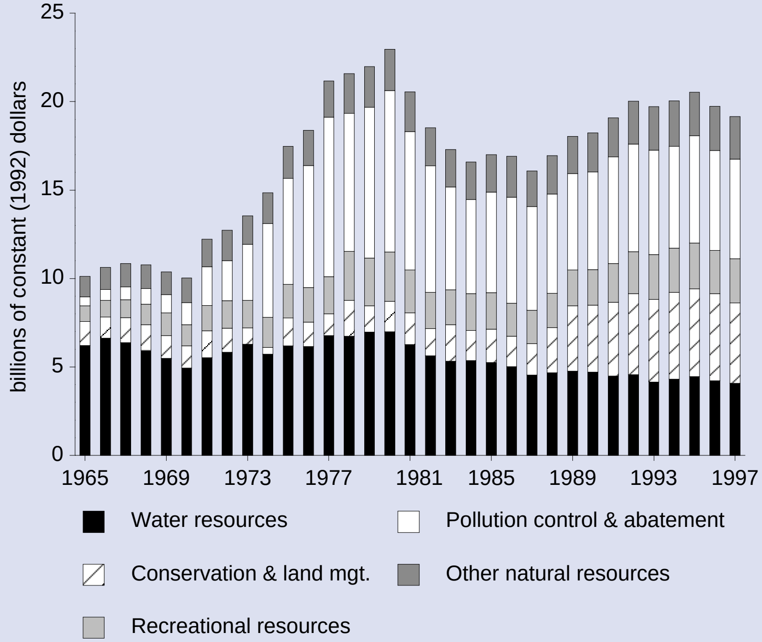
TRENDS

The United States' economy has grown impressively for several decades. In 1997, U.S. gross domestic product (in constant 1992 dollars) stood at $7.27 trillion, which is about 36 percent higher than the 1985 total. (Part III, Table 2.1)

Federal spending on natural resources and environment (in constant 1992 dollars) grew from $10 billion in 1970 to $20 billion in 1992, but since then has remained at about the $20 billion level (Figure 2.1). This represents about 1.3 percent of total federal outlays. Of the $19 billion spent in 1997, 30 percent was for pollution control and abatement, 24 percent for conservation and land management, and 21 percent for water resources. (Part III, Table 2.2)

State and local governments are spending substantially more on natural resources and environment than the fed-

Figure 2.1 Federal Government Expenditures on Natural Resources and Environment, 1965-1997



Source: Executive Office of the President, Office of Management and Budget, *The Budget of the United States Government, Fiscal Year 1999* (OMB, Washington, DC, 1998).

eral government, and spending has continued to rise in the 1990s. Total spending (in constant 1992 dollars) more than doubled between 1970 and 1995 (Figure 2.2). Of the $66.7 billion spent in 1995, sewerage accounted for one third and parks and recreation for one fourth of the total. (Part III, Table 2.3)

Including private sector spending, total U.S. pollution abatement and control expenditures (in constant 1992 dollars) were estimated at $115.9 billion in 1994, the last year for which estimates are available. (Part III, Table 2.4) By type, spending for air pollution controls, water pollution controls, and solid waste management each accounted for roughly one third of the total. (Part III, Table 2.5) Business accounted for about 63 percent of the total, followed by government at 25 percent. (Part III, Table 2.6) Figure 2.3 shows pollution abatement expenditures by selected industries through 1994; the chemical and petroleum/coal sectors accounted for the largest shares of pollution abatement spending in 1994. (Part III, Table 2.7)

U.S. environmental industries generated $168 billion (in constant 1992 dollars) in revenues in 1996, more than triple the 1980 amount. Solid waste management, water treatment works, and water utilities are the largest revenue generators. Solid waste management also is the largest employer (234,600 people in 1996), followed by consulting and engineering (160,000 people). (Part III, Table 2.8)

In 1995, environmental companies generated over $95 billion (in constant 1992 dollars) in products and services for environmental purposes, led principally by the solid waste and water/wastewater treatment sectors. (Part III, Table. 2.9)

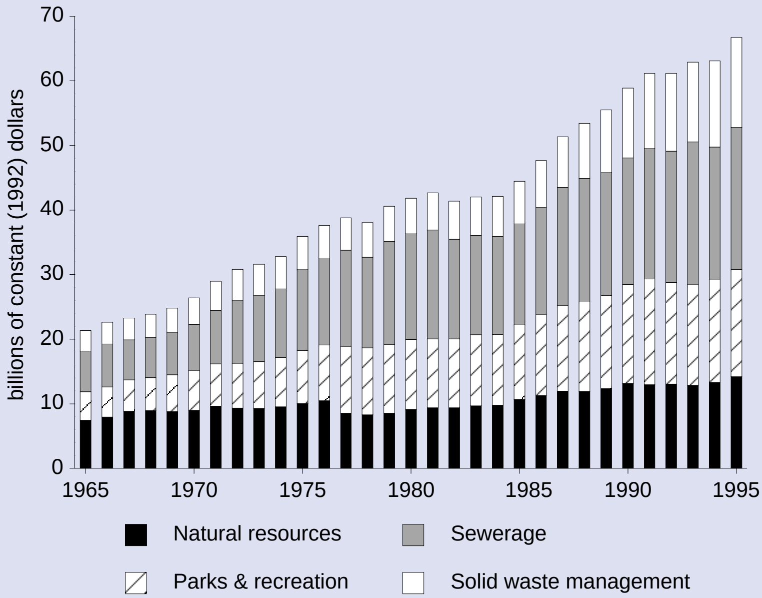
According to an EPA report, expenditures for air pollution controls for stationary sources, mobile sources, and other expenditures (less recovered costs) totaled $20 billion (in constant 1992 dollars) in 1990. (Part III, Table 2.10)

ONLINE RESOURCES

A good place to begin exploring online resources is EPA's Economy and the Environment website (http://www.epa.gov/economics).

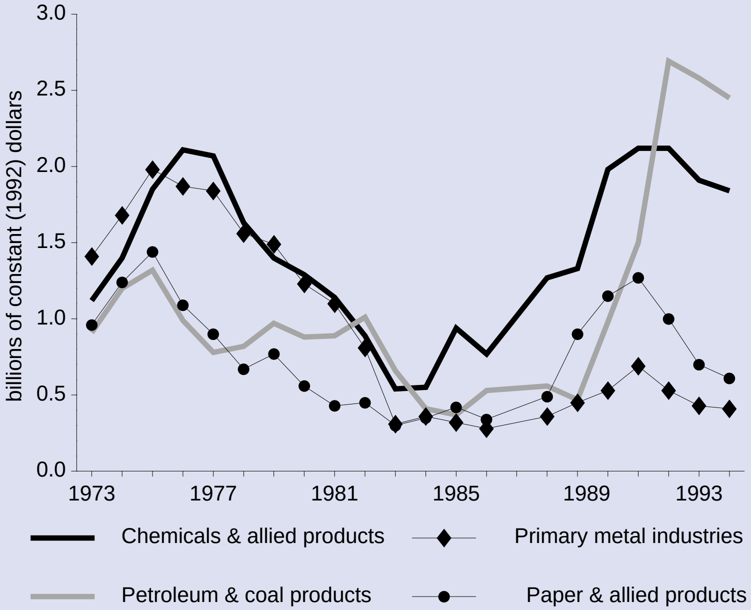
The website includes a Report Inventory of over 500 economic research reports done by or for EPA. These are organized by author, title, subject, research organization, and media, includ-

Figure 2.2 State and Local Government Expenditures on Natural Resources and Environment, 1965-1995



Sources: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics on Government Finances and Employment* (data for years 1965 to 1981), *Government Finances* (data for years 1982 to 1987), and *United States State and Local Government Finances by Level of Government* (Internet accessible data for years 1988 to 1995).

Figure 2.3. Capital Expenditures for Pollution Abatement by Selected U.S. Industries, 1973-1994



Source: U.S. Department of Commerce, Bureau of the Census, *Pollution Abatement Costs and Expenditures*, Current Industrial Reports (GPO, Washington, DC, annual).

Note: This survey was discontinued after 1994.

ing eight reports that can be read online, over 135 that can be downloaded by title and subject, and about 500 that can be ordered in hard copy form. In addition, the site houses a Working Papers Inventory of unpublished papers on the economics of environmental pollution control, which is organized by author, title, institution, media, and subject. The Inventory includes over 125 downloadable working papers. Finally, the site has an inventory of over 1200 Regulatory Impact Analyses and similar cost-benefit analyses of EPA regulations organized by media, title, EPA office, document type, and assessment topic, with over 10 that can be downloaded.

The eight online reports include titles on estimating benefits of environmental regulations, an introduction to environmental economics research at EPA, a Resources for the Future (RFF) report on measuring the benefits of clean air and water, a report on methods development for assessing air pollution control benefits, an Environmental Law Institute (ELI) report on the United States' experience with economic incentives in environmental pollution control policy, and a summary of a report on valuation of reductions in human health symptoms and risks. The eight online reports can be reached through the Report Inventory under Resources.

The site's "Internet Links" is a selection of primarily non-EPA sites that are particularly relevant to the environmental economics field. The sites can be sorted by titles, categories, subjects, or by media.

The site's Internet Links also include links to a number of journals, including the *Journal of Environment and Development*, *Journal of Environmental Economics and Management*, *Environmental Economics Abstracts*, *Environmental and Resource Economics*, *Environment and Development Economics*, and *Agricultural and Resource Economics Review*. It is also linked to some annual surveys conducted by the U.S. Census Bureau. The *Industrial Air Pollution Control Equipment Survey* (http://www.census.gov/ftp/pub/econ/www/ip3100.html) provides detailed annual data since 1971 on new orders, shipments, and backlog orders of air pollution control equipment. The *Survey of Pollution Abatement Costs and Expenditures* (http://www.census.gov./econ/www/mu1100.html) was conducted annually from 1973 to 1994 and provides comprehensive data on pollution abatement control expenditures, operating costs, and costs recovered by private industries.

The Commerce Department's Bureau of Economic Analysis provides a list of articles on national economic accounts (http://www.bea.doc.gov/bea/an1.htm). The list includes the last report on the pollution abatement and control expenditures survey in the *Survey of Current Business*. Other reports focus on accounting for mineral resources and on alternative measures of gross product by industry.

The Agriculture Department's Economic Research Service has an article entitled "Exploring Linkages Among Agriculture, Trade, and the Environment: Issues for the Next Century" (http://www.econ.ag.gov/epubs/pdf/aer738).

Basic material on budget issues can be found at the Office of Management and Budget site (http://www.whitehouse.gov/OMB/), including descriptions and analysis of the fiscal 1998 federal budget. The site includes OMB's circular on discounting and benefit-cost analysis.

The 1998 and 1999 issues of the *Economic Report of the President* prepared by the President's Council of Economic Advisers have provided detailed assessments of policies designed to promote economically sound environmental protection (http://www.access.gpo.gov/eop/index.html#page1).

Several policy research institutes maintain large websites with material on economy/environment issues. The World Resources Institute (WRI) (http://www.wri.org) has published several studies on natural resource accounting. Recent reports have assessed the relationship between environmental protection and productivity growth, sustainable trade expansion in Latin America, how a tax shift can work for the environment and the economy, and the linkages between population, poverty, and environmental stress. Another significant WRI study is devoted to resource flows—the total use of natural resources that national economic activity requires.

Resources for the Future (http://www.rff.org) has published numerous studies on non-market valuation and cost-benefit analyses. One 1997 RFF study is entitled

Cost-Benefit Analysis and Regulatory Reform: An Assessment of the Science and Art.

An overview of the modeling and estimates of the economic values of environmental resources—*Pricing What is Priceless: A Status Report on Non-Market Valuation of Environmental Resources*—is available through the Duke Economics Working Paper series (http://www.econ.duke.edu/Papers/Abstracts96/abstract.96.30.html).

Many sites focusing on global environmental issues include materials on environmental accounting, linkages, and costs and benefits.

The World Bank Environmental Economics and Indicators Unit (http://www-esd.worldbank.org/eei/) serves as an electronic focal point for new thinking on measuring and valuing the environment. A major focus has been development of indicators, including new estimates of national wealth and savings. New initiatives include a multi-year program on trade, macro-reform and the environment, and work on the development of indicators of rural sustainability. Major publications include *Expanding the Measure of Wealth*, which continues and expands the work on environmental indicators begun in the 1995 report *Monitoring Environmental Progress*.

New Ideas in Pollution Regulation, sponsored by the World Bank (http://www.worldbank.org/nipr), is another site with useful material on economy-environment relationships.

The United Nations Environment Programme's Environment and Economics Unit has a publications database (http://unep.unep.org/unep/products/eeu/eeupub.htm) with the following categories: environmental impact assessments, valuation of environment and natural resources, environmental and natural resource accounting, economic policy instruments, and trade and environment.

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CORE DATA

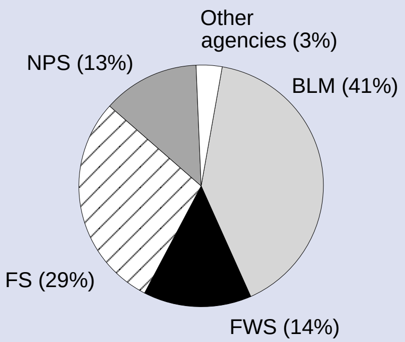
CHAPTER THREE

Public Lands and Recreation

The United States encompasses a vast land area with a wide variety of landscapes and land uses.

The 48 contiguous states comprise about 1.9 billion acres of land, of which about three-fourths is in private hands and the rest owned by the federal, state, and local governments. With the addition of Alaska and Hawaii as states, total land area jumped to about 2.26 billion acres, including about 662 million acres owned by the federal government. Most of this land is managed by a relatively few federal agencies—the Interior Department's Bureau of Land Management (BLM), Fish and Wildlife Service (FWS), and National Park Service (NPS), and the Agriculture Department's Forest Service (FS) (Figure 3.1).

Figure 3.1 Federal Land by Agency, 1997



Source: See Part III, Table 3.1.
Notes: BLM = Bureau of Land Management. FS = U.S. Forest Service. FWS = U.S. Fish and Wildlife Service. NPS = National Park Service. Total federal land = 662 million acres. Excludes trust properties.

BLM manages 264 million acres of federal land, mostly in 12 Western states (including Alaska), for a variety of public uses and values, including grazing, outdoor recreation, watershed protection, wildlife habitat conservation, timber harvesting, and mining.

Many commercial activities occur on BLM lands. There are some 340,000 unpatented mining claims, 51,000 oil and gas leases, and grazing is authorized on 169 million acres. About 42,000 wild horses and burros roam BLM lands, and about 8,700 are adopted annually.

As with the other federal land management agencies, BLM is often faced with trying to minimize conflicts across a mix of ecological, aesthetic, and economic values.

The Forest Service manages 188 million acres of federal lands in the National Forest System in 44 states, Puerto Rico, and the Virgin Islands and about 4 million acres in the National Grasslands System in

12 states. The agency's mandated management objectives include watershed management, wildlife habitat and biodiversity protection, outdoor recreation, and range and timber management.

The Fish and Wildlife Service manages the 93-million-acre National Wildlife Refuge System, which comprises more than 500 national wildlife refuges, thousands of small wetlands, and other special management areas. The agency enforces federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores national significant fisheries, and conserves and restores wildlife habitat such as wetlands.

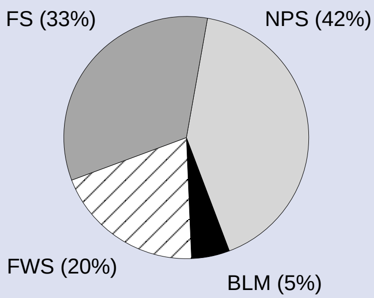
The National Park Service manages about 83 million acres in 376 natural, cultural, and historical sites around the nation. There are a wide variety of units —national parks, national monuments, national preserves, national historic sites, national battlefields, national seashores, national recreation areas, etc.—but all units of the system have equal legal standing. The largest area is Wrangell-St. Elias National Park and Preserve in Alaska, which at 13.2 million acres is more than 16 percent of the entire system.

Under the original National Park Service Organic Act of 1916, the agency is directed to manage the parks "to conserve the scenery and the natural and historical objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Several other laws provide special protections for portions of the nation's lands. The Wilderness Act of 1964 established the National Wilderness Preservation System. Wilderness is land retaining its primeval character and influence, affected primarily by the forces of nature, with human influence substantially unnoticeable. Wilderness areas are designated by Congress and are composed of existing federal lands that have retained a wilderness character and meet criteria found in the act. The U.S. Forest Service, National Park Service, and Bureau of Land Management manage most of the wilderness land (Figure 3.2). Federal land managers are required to manage wilderness areas to retain their wilderness character.

The Wild and Scenic Rivers Act of 1968 preserves certain selected rivers that possess outstanding scenic, recreational, geological, cultural, or historic values and maintain their free-flowing condition. Rivers like Maine's Allagash, the Snake in Oregon and Idaho, Colorado's Cache La Poudre, the Saline bayou in Louisiana, and the Kings of California are among the designated. The Clinton Administration

Figure 3.2 Wilderness Area Management by Agency, 1997



Source: See Part III, Table 3.2.
Notes: BLM = Bureau of Land Management. FS = U.S. Forest Service. FWS = U.S. Fish and Wildlife Service. NPS = National Park Service. Total wilderness land = 103.6 million acres

Box 3.1
The American Heritage Rivers Initiative

Following his 1997 State of the Union address, President Clinton signed an executive order establishing the American Heritage Rivers Initiative. The initiative will integrate the economic, environmental, and historic preservation programs and services of federal agencies to benefit communities engaged in efforts to protect their rivers.

The program is intended to support outstanding community-based efforts designed to ensure the vitality of the river in community life for future generations. Participation is voluntary and must be initiated by the community. Designation will not impose any new regulations or other new requirements.

Following the president's call for nominations, the Administration received 126 applications from communities in 46 states and the District of Columbia. Each application included a detailed action plan describing the communities' vision for protecting natural resources, promoting economic revitalization, and preserving cultural heritage.

In July 1998, President Clinton designated 14 American Heritage Rivers. Communities along these rivers will receive federal support over the next five years to carry out their plans for revitalizing their rivers and riverfronts.

For more information, visit the American Heritage Rivers homepage (http://www.epa.gov/OWOW/heritage/rivers.html) or the CEQ web site (http://www.whitehouse.gov/CEQ/Rivers/).

recently established the American Heritage Rivers Initiative, a new program to help communities restore and revitalize waters and waterfronts (See Box 3.1.)

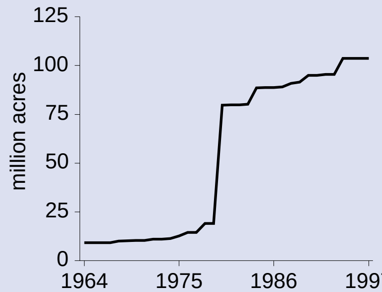
The National Trails System Act of 1968 establishes a national system of recreational, scenic, and historic trails and prescribes the methods and standards for adding components to the system.

TRENDS

Since the early 1980s, the area of land managed by the various federal land management agencies has been fairly stable. (Part III, Table 3.1)

The National Wilderness Preservation System grew from slightly over 10 million acres in 1970 to nearly 80 million acres in 1980. The dramatic increase was largely attributable to the designation of national parks, wildlife refuges, and wilderness areas in Alaska. Over the 1980-89 period, the wilderness system gained about 11 million acres, growing from 80 to 91 million acres; since 1989, it has

Figure 3.3 National Wilderness Preservation System, 1964-1997

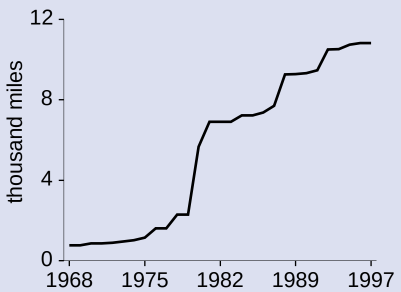


Source: See Part III, Table 3.2.
Notes: Data reflect year-end cumulative totals. The large increase in acreage in 1980 is largely attributable to designation of wilderness areas in Alaska.

jumped about 12 million acres, reaching 103.6 million acres in 1997 (Figure 3.3).

The National Wild and Scenic River System continued to expand in the 1980s and 1990s. In 1980, there were 5,662 river-miles in the wild and scenic river system. By 1989, the system had grown by 63 percent, to 9,281 river miles. Over the 1990-97 period, the system grew another 16 percent, to 10,815 river miles (Figure 3.4). (Part III, Table 3.2)

Figure 3.4 National Wild and Scenic Rivers, 1968-1997



Source: See Part III, Table 3.2.
Notes: Data reflect year-end cumulative totals. The large increase in river mileage in 1980 is largely attributable to designation of wild and scenic rivers in Alaska.

Since the mid-1970s, the nation has developed new systems to protect estuaries and sensitive marine areas. By 1997, there were 21 National Estuarine Research Reserves totaling 427,520 acres, and 12 National Marine Sanctuaries totaling 13,837 square nautical miles (Figure 3.5). (Part III, Table 3.3). The 21 reserves provide a nationwide network of protected areas dedicated to enhancing research, education, and scientific understanding of the nation's diverse estuarine and coastal habitats. The 12 sanctuaries conserve, protect, and enhance the biodiversity, ecological integrity, and cultural legacy of the nation's marine environment. Ranging from American Samoa to New England, they include Pacific and Atlantic haunts of whales, sea lions, sharks, rays, and turtles; significant coral reefs and kelp forest habitats; and the remains of the Monitor Civil War shipwreck off North Carolina.

Historic properties are also protected under the National Historic Preservation Act. By 1997, over 68,000 properties were listed on the National Register of Historic Places. (Part III, Table 3.4) Included among the listings are: all historic areas in the National Park System; over 2,200 National Historic Landmarks, which have been designated by the Secretary of the Interior because of their importance to all Americans; and properties across the country that have been nominated by governments, organizations, and individuals because they are significant to the nation, to a state, or to a community. A few properties are lost each year as a result of fire, flood, wind, or other natural causes or as a result of demolition.

In addition, the National Scenic Byways program recognizes outstanding byways that exemplify the regional characteristics of our nation. These outstanding qualities can be archeological, cultural, historical, natural, recreational, or scenic. The finest byways are designated as All-American roads. The Secretary of Transportation designated the first All-American roads and National Scenic Byways in 1996 (http://www.byways.org).

In 1996, nearly 77 million U.S. residents, about 36 percent of the U.S. population 16 years old and older, enjoyed some activity relating to fish and wildlife. Almost 40 million people spent time fishing and/or hunting and 63 million people enjoyed wildlife activities such as observing, feeding, or photographing wildlife. The trend in fishing and hunting participation from 1991 to 1996 was level while participation in wildlife watching dropped 17 percent. However, the trend in spending for all wildlife-related recreation increased sharply. Sportsmen spent over $72 billion dollars in 1996 and wildlife watching participants spent nearly $30 billion for the year. Participation rates and expenditures varied across the country (Figure 3.6) (Part III, Table 3.5).

The popularity of saltwater fishing continues to be strong. The estimated number of Atlantic and Gulf coast fishing trips made between 1993 and 1997 remained at about 58 million while the number of fish caught and total weight of fish declined from the highs in the mid-1980s (Figure 3.7). (Part III, Table 3.6) Along the Atlantic and Gulf coast in 1997, 7 million marine recreational fish-

Figure 3.5 National Marine Sanctuaries and National Estuarine Research Reserves, 1997

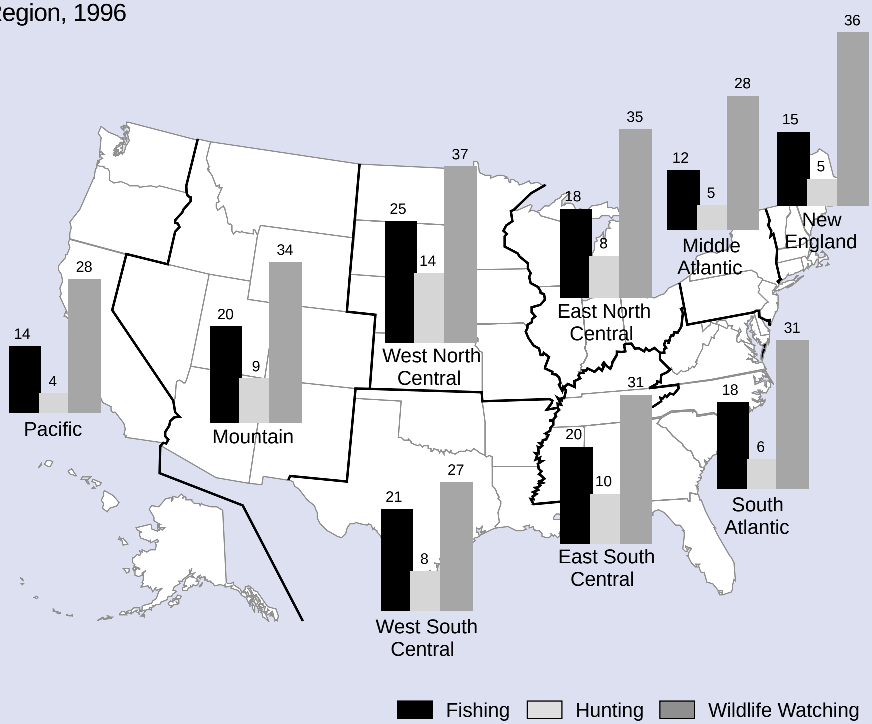
National Marine Sanctuaries

1. Olympic Coast NMS
2. Cordell Bank NMS
3. Gulf of the Farallones NMS
4. Monterey Bay NMS
5. Channel Islands NMS
6. Hawaiian Islands Humpback Whale NMS
7. Flower Garden Banks NMS
8. Florida Keys NMS
9. Gray's Reef NMS
10. USS Monitor NMS
11. Stellwagen Bank NMS
12. American Samoa Fagatele Bay NMS (not shown)

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Sanctuaries and Reserves Division, Washington, DC, 1998.

Notes: Locations of sanctuaries and reserves are approximate. Jobos Bay, Puerto Rico NERR not to scale. Numbers are a point of reference only.

Figure 3.6 Participation in Fishing, Hunting, and Wildlife-Associated Recreation by Region, 1996



Source: U.S. Department of the Interior, Fish and Wildlife Service, *1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: State Overview* (DOI, FWS, Washington, DC, 1997).

Note: Numbers refer to percent of regional population.

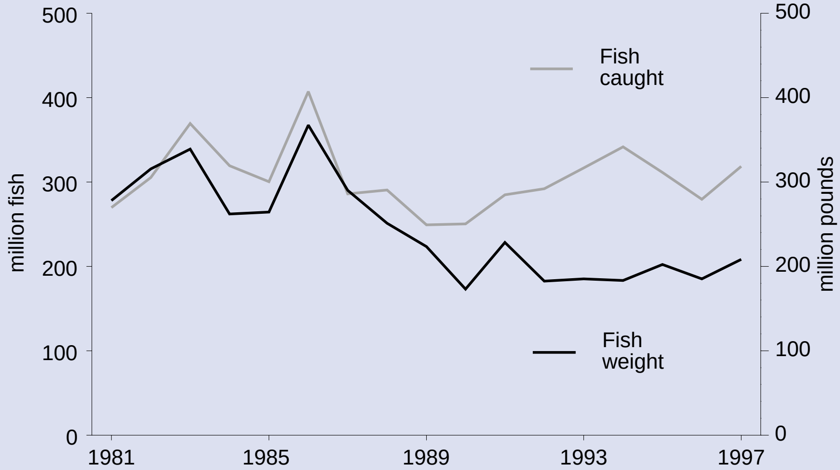
ing participants took 61 million trips and caught a total of 337 million fish. By subregion, the Gulf of Mexico accounted for the highest numbers of fish caught followed by the Mid-Atlantic. Along the Pacific coast in 1997, 1.8 million marine recreational fishing participants took 7.2 million trips and caught a total of 29 million fish. Seventy-two percent of the trips were made in California, followed by 20 percent in Washington, and 8 percent in Oregon.

Visits to federal recreation areas, particularly national parks and national forests, have increased significantly since 1977. For the National Park System, visits rose from 211 million in 1977 to 275 million in 1997, or about 30 percent. In National Forests, the number of visitors rose from 205 million in 1977 to 341 million in 1996, or about 66 percent. (Part III, Table 3.7)

ONLINE RESOURCES

The Department of Interior maintains a large website with a vast amount of

Figure 3.7 Marine Recreational Fishing Along the Atlantic and Gulf Coasts, 1981-1997



Source: See Part III, Table 3.6.

information. The site (http://www.doi.gov) includes a category on the agency's various bureaus and links to the National Park Service, Fish and Wildlife Service, Bureau of Land Management, U.S. Geological Survey, Minerals Management Service, and others. Another category, "About DOI," includes a history of the agency, organization chart, and strategic plan (http://www.doi.gov/about.html).

The Fish and Wildlife Service maintains an Internet site with extensive information on the National Wildlife Refuge System (http://refuges.fws.gov). Information ranges from wildlife habitat and management programs to visitor activities, cultural resources, history of the refuge system, overviews of legislative operating authorities, and phone numbers and mailing addresses of individual refuges.

Within the National Park Service site, one can find numerous sites with useful information on public lands and recreation, such as information on the National Wild and Scenic Rivers System (http://www.nps.gov/rivers/). The site includes a Wild and Scenic Rivers List and text of the Wild and Scenic Rivers Act, along with information about the Wild and Scenic Rivers Council, rivers and trails assistance, river managing agencies, state programs, and other information. The site links to state programs in Minnesota, New Hampshire, Ohio, and South Carolina.

The site also includes links to a long list of organizations with an interest in rivers, including America Outdoors, the American Canoe Association, American Rivers, the Canadian Heritage Rivers System, the International Rivers Network, the Izaak Walton League, the Pacific Rivers Council, and River Network.

The NPS site provides information about the National Trails System (http://www.nps.gov/htdocs1/pub_aff/naltral.htm), including a list of National Scenic Trails and National Historic Trails. Many other sites provide information about trails and hiking. The American Hiking Society (http://www.americanhiking.org/) is a national nonprofit organization dedicated to promoting hiking and to establishing, protecting, and maintaining foot trails in America. Another noteworthy site is maintained by the Rails-to-Trails Conservancy (http://www.railtrails.org), which is interested in converting abandoned railroad tracks into public biking and walking trails.

The National Park Service site also provides access to the National Register of Historic Places (http://www.cr.nps.gov/nr/nrhome.html). This site includes a link to the National Register Information System, which houses data on all places listed in or determined eligible for the National Register. Also noteworthy is the site maintained by the National Trust for Historic Preservation (http://www.nationaltrust.org/).

The other principal federal government site is the U.S. Department of Agriculture (http://www.usda.gov), which through the Forest Service manages the National Forest System. The Forest Service site (http://www.fs.fed.us), under its data and information category (http://www.fs.fed.us/database/), provides information and databases on national forests, land areas of the national forest system, and forest land distribution data for the United States. The agency's "links" category (http://www.fs.fed.us/links/topics.shtml) includes topics such as forest management, cooperative forestry, national forests, NEPA, state and private forestry, and forest health.

Within the Department of Transportation, the Coast Guard's Recreational Boating Safety Program assists states and U.S. territories with programs to protect recreational boaters (http://uscgboating.org).

Many private and nonprofit groups have a strong interest in public lands and recreation. Several web directory sites provide access to many of these groups, including the Environmental Organization Web Directory (http://www.webdirectory.com/) and EcoNet (http://www.igc.org/econet/index.html).

Recreation.Gov (http://www.recreation.gov) is a one-stop resource for information about recreation on federal lands. Recreation.Gov offers information from all of the federal land management agencies and allows visitors to search for recreation sites by state, by agency, or by recreational activity. The agencies participating in the system include the Army Corps of Engineers, Bureau of Land Management, Bureau of Reclamation, Fish and Wildlife Service, Forest Service, and National Park Service.

One organization with a particular interest in the National Park System is the National Parks and Conservation Organization (http://www.npca.org/home/npca/). This site includes links devoted to the National Parks and to park activist groups. Similarly, the National Wildlife Refuge Association is an advocacy organization for the National Wildlife Refuge System (http://refugenet.org).

The Trust for Public Land promotes the importance of public land, helps communities establish land-protection goals, and has pioneered new ways to finance parks and open space (http://www.igc.apc.org/tpl/). The Nature Conservancy (http://www.tnc.org) also has been active in providing innovative ways to protect important public lands.

The Sierra Club (http://www.sierraclub.org) has had a longstanding interest in parks, wilderness, and natural resource issues. The Wilderness Society (http://www.wilderness.org) has an equally long history and a special interest in the National Wilderness Preservation System. The National Audubon Society (http://www.audubon.org) and the National Wildlife Federation (http://www.nwf.org) also have a strong interest in land issues, particularly those dealing with wildlife conservation and the National Wildlife Refuge System.

Many businesses have an active interest in outdoor recreation activities. One way to access many of these groups is through the Outdoor Recreation Coalition of America (http://www.orca.org).

Other groups with an interest in public lands include the Land Trust Alliance (http://www.lta.org), National Park Foundation (http://www.nationalparks.org), Ducks Unlimited (http://www.ducks.org), Friends of the Earth (http://www.foe.org), Natural Resources Defense Council (http://www.nrdc.org), and the Public Lands Foundation (http://www.publicland.org).

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CORE DATA

CHAPTER FOUR

Ecosystems and Biodiversity

Species and ecosystems provide a vast array of valuable services. For example, about one third of U.S. agricultural output is from insect-pollinated plants. Nature provides many other services, such as producing raw materials, purifying water, storing waste, and regulating climate.

Despite the huge value of species and ecosystem services, many such services are threatened by human activities. Pollinators such as wild honeybees, for example, are declining as a result of habitat fragmentation, loss of nesting sites, exposure to pesticides, and many other factors.

Ecosystems are defined as the collection of species and processes that comprise such recognizable units as tallgrass prairies, coastal salt marshes, redwood forests, or high desert. Ecosystems are usually described as geographically defined ecological units, consisting of groupings of plants and animals and their surrounding environment.

Ecosystems can be classified in a number of different ways. In *Our Living Resources*, a 1995 Interior Department report, ecosystems are organized in four broad categories: terrestrial, aquatic/freshwater, coastal/marine, and riparian. Within these four broad categories are many smaller ecological units.

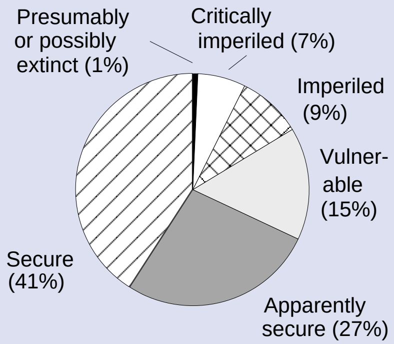
Vegetation structure and plant species composition are being used by The Nature Conservancy and the state and federal agencies participating in the Network of Natural Heritage Programs (in collaboration with the Federal Geographic Data Committee) to develop a framework for the classification of terrestrial ecological communities in the United States. Approximately 4,000 ecological communities have been identified using this framework.

Biodiversity

As defined by the Convention on Biological Diversity, biodiversity is "the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems."

The Nature Conservancy and Natural Heritage Network maintain databases with information on more than 28,000 U.S. species and an additional 11,000 subspecies and varieties. In 1997, The Nature Conservancy reported on the conservation status of 20,439 native US species, representing 13 major groups of plants and animals that have been classified and studied

Figure 4.1 Status of U.S. Plant and Animal Species, 1997



Source: The Nature Conservancy, *Priorities for Conservation: 1997 Annual Report Card for U.S. Plant and Animal Species* (TNC, Arlington, VA, 1997).
Note: Total = 20,439 species; chart does not include 296 species not yet ranked.

in sufficient detail to allow a status assessment for each of their species. The analysis revealed that, based on their global rarity, about one third of the species surveyed were in some danger of extinction. About 1.2 percent were presumed to be extinct, 6.5 percent were classified as critically imperiled, another 8.8 percent were imperiled, and 15.4 percent were classified as vulnerable (Figure 4.1). The greater number of imperiled species are in the Southeast, Southwest, Hawaii, and California.

Those animals that depend on freshwater habitats—mussels, crayfish, fishes, and amphibians—are in the worst condition overall. In many national waterways, mussel populations have suffered badly from habitat loss as a result of dam construction, channelization, dredging operations, and water pollution. Dam construction alone has wiped out 30 to 60 percent of native mussel populations in some rivers. Competition from nonnative mollusks, notably the Asian clam and the zebra mussel, also have contributed to the decline. It is estimated that about two thirds of all native mussel species are in danger.

Freshwater fishes also are experiencing relatively rapid changes in their habitats, often causing risks to their survival. Of the roughly 800 native freshwater species in the United States, The Nature Conservancy estimates that about 35 percent are imperiled or vulnerable. (See *Environmental Quality 1994-95*, pp. 149-165.)

The number of threatened and endangered species has risen steadily since 1980 (Figure 4.2). By the end of 1997, there were a total of 896 U.S. species on the endangered list, including 553 plant species, and another 230 U.S. species (115 plants) on the threatened list. (Part III, Table 4.6)

The news is not all bad, however. Among raptors, populations of ospreys, bald eagles, and peregrine falcons have increased in number as they recover from the past effects of pesticides. The bald eagle population increased from a low of 400 nesting pairs in 1963 to just over 4,700 nesting pairs in 1995 within the contiguous United States (there are an estimated 20,000-25,000 pairs within Alaska). The 1972 ban on DDT was a significant factor in this recovery.

TRENDS

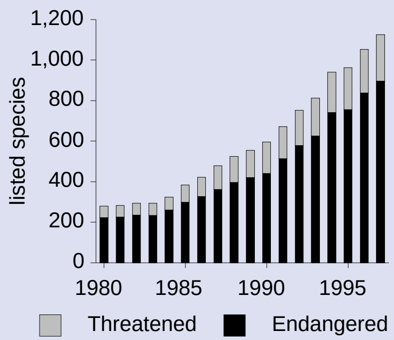
At the species level, roughly 1.75 million of the world's estimated 13 to 14 million species have been described. The best known groups are terrestrial vertebrates and higher plants. Even among those, there is sufficient information about population trends for only a few groups, including trees (from the Forest Service's long-term monitoring plots), birds (from annual censuses), commercially exploited species (e.g., certain marine fish species), and certain terrestrial and marine endangered species.

Ecosystems

At the ecosystem level, work is now underway to develop a systematic methodology for identifying ecosystems and determining trends in terrestrial ecosystems. Rough estimates have been made for certain relatively accessible ecosystems such as forests and wetlands.

Ecosystems and biodiversity are threatened by a variety of factors, including conversion of natural lands for other uses, pollution, exploitation, and invasions of non-indigenous species.

Figure 4.2 Threatened and Endangered U.S. Plant and Animal Species, 1980-1997



Source: See Part III, Table 4.6.

In 1995, Defenders of Wildlife listed the 21 "most-endangered" ecosystems in the United States. The three highest ranking ecosystems were the South Florida landscape, Southern Appalachian spruce-fir forest, and longleaf pine forest and savanna. The ranking was based on four criteria: decline in original area since European settlement, present area (rarity), imminence of threat, and number of federally listed threatened and endangered species. In addition, states were ranked with an "overall risk index" according to how many endangered ecosystems they contain, how many imperiled species they harbor, and how much development they face (Figure 4.3).

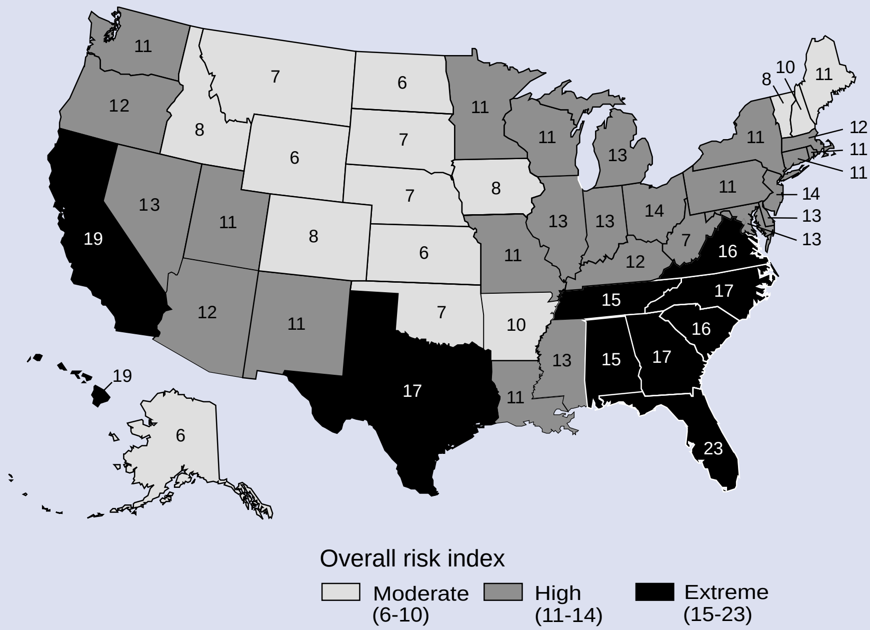
Aquatic ecosystems have been severely degraded in the last century in the United States. Natural aquatic systems have been altered for transportation, diverted for agricultural and municipal needs, and straightened, dammed, and polluted.

There is relatively little information about trends in marine ecosystems. Perhaps the best known systems are coral reefs. Coral reefs are the world's most biologically diverse marine ecosystems, home to one third of all marine fish species and tens of thousands of other species. It is estimated that 10 percent of the world's coral reefs have already been degraded beyond recovery, and another 30 percent are likely to decline in the next 20 years.

Terrestrial Species

Many U.S. resident and neotropical migrant bird species are declining in numbers, some drastically so. Forty-eight percent of the 421 bird species monitored

Figure 4.3 Overall Risk to Ecosystems



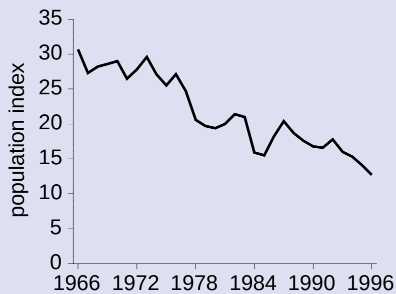
Source: R.E. Noss and R.L. Peters, *Endangered Ecosystems: A Status Report on America's Vanishing Habitat and Wildlife* (Defenders of Wildlife, Washington, DC, 1995).

Notes: The overall risk to ecosystems is calculated by combining three factors: overall development pressure, the percentage of species in the state that are imperiled, and the number of most endangered ecosystems. Values range from 6 to 23, with 23 signifying the most extreme risk.

by the U.S. Fish and Wildlife Breeding Bird Survey have decreased in numbers over the past 31 years. Some species, such as northern bobwhite (Figure 4.4) and loggerhead shrike (Figure 4.5) are so consistently declining that few question the trend.

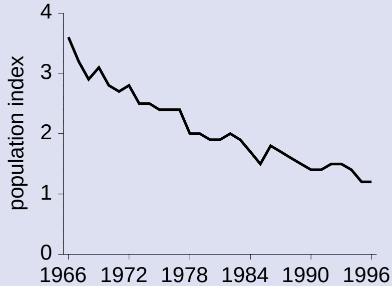
In general, though, species populations tend to be cyclical, decreasing in some time periods (or locations) and increasing in other periods (or locations) (Part III, Table 4.1). For example, populations of permanent resident and short-distance migrant (birds wintering primarily in the U.S. and Canada) species are adversely affected by periodic episodes of unusually harsh winter weather. Examples include the Carolina wren (Figure 4.6)

Figure 4.4 Northern Bobwhite Population Trends, 1966-1996



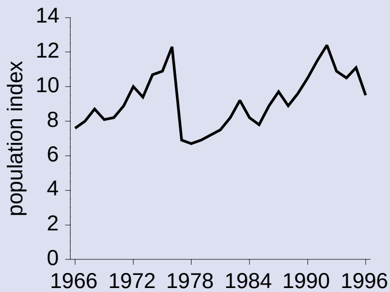
Source: U.S. Fish and Wildlife Service, Breeding Bird Survey, Interactive Graphing Program on the Internet.

Figure 4.5 Loggerhead Shrike Population Trends, 1966-1996



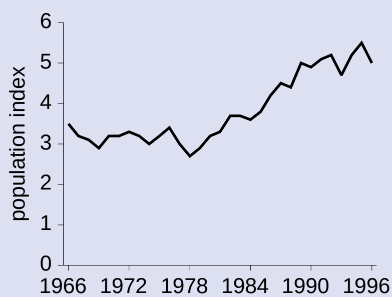
Source: U.S. Fish and Wildlife Service, Breeding Bird Survey, Interactive Graphing Program on the Internet.

Figure 4.6 Carolina Wren Population Trends, 1966-1996



Source: U.S. Fish and Wildlife Service, Breeding Bird Survey, Interactive Graphing Program on the Internet.

Figure 4.7 Eastern Bluebird Population Trends, 1966-1996



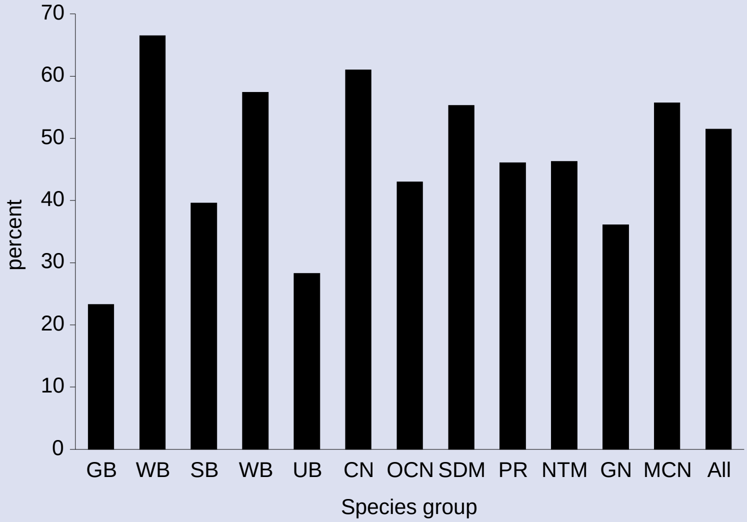
Source: U.S. Fish and Wildlife Service, Breeding Bird Survey, Interactive Graphing Program on the Internet.

and eastern bluebird (Figure 4.7) whose populations dramatically declined during the harsh winters of 1976-77 and 1977-78 but rapidly recovered during the 1980s.

Analyses of population trends based on groups of species that share similar attributes, such as breeding habitat, nest type, migration status, and nest location, provide “big picture” summaries that are useful in identifying major patterns of population change. For example, only about one fourth of all grassland-breeding bird species have shown positive population trends during the 1966-96 period (Figure 4.8). But this approach can hide detail within groups, such as the steep decline in forest-dwelling neotropical migrants. Declines are quite severe for some individual species, such as the wood thrush (Figure 4.9) and the cerulean warbler (Figure 4.10), which are declining at rates of 1 to 3 percent per year over the period, and for certain regions, especially the Adirondacks and the Great Smoky Mountains, where many or even most forest songbirds are declining over this period. Possible causes include changes in land use that reduce or alter summer breeding habitat and loss of winter habitat.

Populations of some North American duck species during the period from 1955 to 1997 are shown in Part III, Table 4.2. The 1997 estimated breeding population of 10 duck species surveyed by the U.S. Fish and Wildlife Service was 42.1 million birds, a figure 31 percent higher than the long-term average (Figure 4.11). This increase is consistent with habitat conditions favorable for production in 1996 and good-to-excellent habitat conditions throughout most of 1997. Although

Figure 4.8 Proportion of U.S. Bird Species with Positive Population Trend Estimates by Species Group, 1966-1996

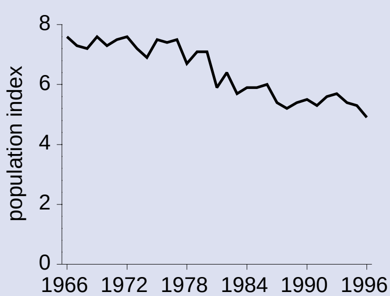


Source: U.S. Department of the Interior, National Biological Service, Breeding Bird Survey database. Notes: GB = Grassland Breeding. WB = Wetland Breeding. SB = Successional or Scrub Breeding. WB = Woodland Breeding. UB = Urban Breeding. CN = Cavity Nesting. OCN = Open-Cup Nesting. SDM = Short Distance Migrant. PR = Permanent Resident. NTM = Neotropical Migrant. GN = Ground or Low Nesting. MCN = Mid-story or Canopy Nesting. All = 421 species. Each bar denotes the percentage of species in the group that have shown positive population trends over the period from 1966 to 1996.

two species (scaup and northern pintail) were below their long-term average, most species appear to have responded to favorable weather and habitat conditions with record numbers of broods. Approximately 66 percent of the ducks were found in the prairie-pothole region of the United States and Canada, a percentage slightly higher than the 1970s (60 percent) when conditions in this ecologically important region were considered good.

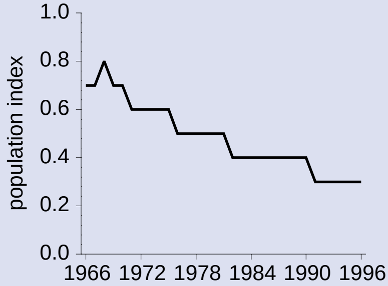
The status of the American black duck is less optimistic. Mid-winter surveys conducted in states of the Atlantic and Mississippi flyways suggest that in 1997 black ducks were 20 percent below the most recent 10-year average. The count in the Mississippi Flyway was the lowest recorded since 1955. Many factors may play a

Figure 4.9 Wood Thrush Population Trends, 1966-1996



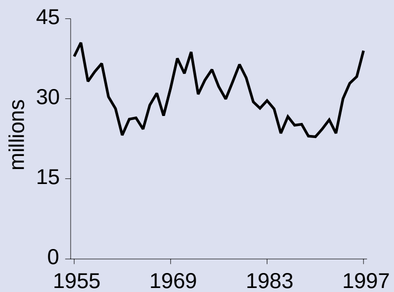
Source: U.S. Fish and Wildlife Service, Breeding Bird Survey, Interactive Graphing Program on the Internet.

Figure 4.10 Cerulean Warbler Population Trends, 1966-1996



Source: U.S. Fish and Wildlife Service, Breeding Bird Survey, Interactive Graphing Program on the Internet.

Figure 4.11 Breeding Population Estimates for North American Ducks, 1955-1997



Source: See Part III, Table 4.2.

role in the decline, including blood parasites, lead poisoning, red tide, oil spills, habitat losses, shooting, pesticide residues, predators, weather conditions, heavy metals, and hybridization with mallards.

Most goose and swan populations in North America remain numerically sound (Part III, Table 4.3). Favorable weather and habitat conditions for most nesting geese in 1997 led to better-than-average production (an exception was Emperor geese, where spring flooding interrupted nesting). Tundra swan populations continue to increase despite reduced production in 1997 due to less favorable weather conditions during the nesting period.

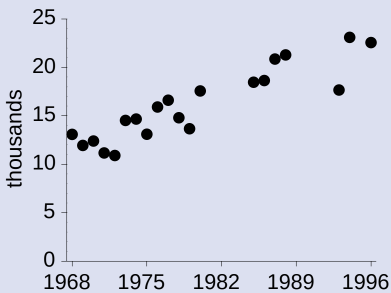
Freshwater and Marine Species

Knowledge about marine species and ecosystems lags far behind that of terrestrial systems. Best known are commercially exploited fish species, protected marine mammals, turtles and fishes (protected under the Endangered Species Act or Marine Mammal Protection Act), and certain commercially significant and accessible coastal ecosystems such as wetlands and coral reefs.

Compared to birds, less is known about the status of marine mammal stocks in U.S. waters. For example, trends are not known for 66 percent of 163 managed individual stocks in the Western North Atlantic, Gulf of Mexico, Hawaii, and Eastern Tropical Pacific. For the stocks where there was sufficient information to determine a trend, eight stocks were decreasing, 24 were stable, and 23 were increasing. A few noteworthy examples are given below.

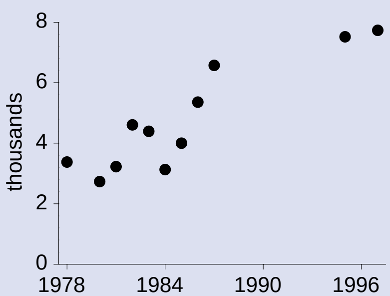
- Gray Whale. The gray whale, under the protection of the Marine Mammal Protection Act, has now recovered and has been removed from the list of endangered species. The stock has increased at a rate of 2.5-3.2 percent per year (Figure 4.12) in spite of direct competition with humans for coastal habitat, and a subsistence catch

Figure 4.12 Gray Whale Population Trends, 1968-1996



Sources: U.S. Department of Commerce, National Marine Fisheries Service, *Our Living Oceans* (NMFS, Washington, DC, 1996).
Hill, P. & D. DeMaster, *Alaska Marine Mammal Stock Assessements1998* (NMFS, Seattle, WA, 1998).

Figure 4.13 Bowhead Whale Population Trends, 1978-1997



Sources: U.S. Department of Commerce, National Marine Fisheries Service, *Our Living Oceans* (NMFS, Washington, DC, 1996).
Hill, P. & D. DeMaster, *Alaska Marine Mammal Stock Assessements1998* (NMFS, Seattle, WA, 1998).

of 167 whales per year (5,006 total) by the Soviet Union during the past 30 years.

- **Bowhead Whale.** All stocks of bowhead whales were severely depleted during intense commercial whaling prior to the 20th Century, declining from an estimated 10,400-23,000 in the Western Arctic stock to less than 3,000 at the end of commercial whaling. Since 1978, the Western Arctic stock of bowhead whales has increased at a rate of 3.1 percent per year (Figure 4.13). Native subsistence harvest in Alaska authorized by the International Whaling Commission removes approximately 0.1-0.5 percent of the population per year.

- **Northern Right Whale.** The northern right whale is the large whale species most in danger of becoming extinct in the near future, despite being protected from hunting for over fifty years. It is estimated that there are approximately 300 northern right whales remaining in the Northwest Atlantic Ocean. Even in the best of circumstances, it may take a hundred years for the right whale population to recover. Humans still present a problem for the slow moving right whale, as one of the major causes of death for this species is collisions with ships.

- **Steller Sea Lion.** An unprecedented and continuing decline in the Western U.S. stock of Steller sea lion has caused a recent change in listing from threatened to endangered. Although many theories have been suggested (overfishing, environmental change, El Niño, disease, etc.), it is not clear what is causing the decline. In contrast, the Eastern U.S. stock has been relatively stable since the 1980s (Table 4.1).

- **Florida Manatee.** Scientists are cautiously optimistic about recent increases in the Florida manatee population, a subspecies of the West Indian manatee. Although the number of manatee deaths has exceeded 10 percent of the estimated total population each year since 1974, the Florida population was estimated to be more than 2,600 animals in 1996. Human-related incidents cause most manatee deaths, although cold weather and red tide outbreaks have also taken a severe toll on the Florida manatees (Table 4.2).

The populations of sea turtles in the Pacific and Atlantic are in perilous condition, despite increases in some population estimates. As shown in Part III, Table 4.5, populations of the loggerhead, green, Kemp's ridley, leatherback, olive ridley, and hawksbill are all listed as either endangered or threatened. While trends are particularly difficult to assess, a decline in many nesting sea turtle populations is accepted by most researchers, with the most serious threats being coastal development, commercial fisheries interactions, pollution, and harvest of eggs, juveniles, and adults. In the case of the Kemp's Ridley turtle, it is estimated that there were once more than 40,000 females nesting annually. Though now numbering only about 1,000 nesting

Table 4.1 Counts of Adult and Juvenile Steller Sea Lions Observed at Alaskan Rookery and Haulout Trend Sites by Year and Geographical Area from the Late 1970s and Early 1980s Through 1996

	Western U.S. Stock					
Area	late 1970s[1]	1990	1991	1992	1994	1996
			number			
Gulf of Alaska	65,296	16,409	14,603	13,179	11,871	9,782
Bering Sea/Aleutians	44,584	14,116	14,141	14,107	12,248	12,434
Total	109,880	30,525	28,744	27,286	24,119	22,216
	Eastern U.S. Stock					
Area	early 1980s	1990	1991	1992	1994	1996
			number			
California/ Oregon[2]	3,286	3,128	3,358	3,631	3,221	3,294
British Columbia	4,711	6,109[3]	nd	7,376	8,091	nd
Southeast Alaska	6,898	7,629	7,715	7,558	8,826	8,181
Total	14,895	--	--	18,565	20,176	--

Source: Hill, P.S. and D.P. DeMaster. *Alaska Marine Mammal Stock Assessment 1998* (NOAA, NMFS, National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, 1998), and primary sources cited therein.

Notes: nd = no data. [1]Counts from 1976-1979 were combined to produce complete regional counts which are comparable to the 1990-1996 data. [2]Trend site counts in California include only Ano Nuevo Island and St. Georges Reef. Trend counts in Oregon include only Rouge and Orford Reefs. British Columbia data include counts from all sites. [3]Count was conducted in 1987.

Table 4.2 Manatee Causes of Death, 1974-1997

Year	All watercraft	Flood gate/ canal lock	Other human related	Perinatal	Other natural	Unde- termined	Total
				number			
1974	3	0	2	0	0	2	7
1975	6	1	1	7	1	13	29
1976	10	4	0	14	2	32	62
1977	13	6	5	9	1	80	114
1978	21	9	1	10	3	40	84
1979	24	8	9	9	4	23	77
1980	16	8	2	13	5	19	63
1981	24	2	4	13	9	64	116
1982	20	3	1	14	41	35	114
1983	15	7	5	18	6	30	81
1984	34	3	1	25	24	41	128
1985	33	3	3	23	19	38	119
1986	33	3	1	27	13	45	122
1987	39	5	2	30	16	22	114
1988	43	7	4	30	24	25	133
1989	50	3	5	38	32	40	168
1990	47	3	4	44	67	41	206
1991	53	9	6	53	14	39	174
1992	38	5	6	48	20	46	163
1993	35	5	6	39	24	36	145
1994	49	16	5	46	37	40	193
1995	42	8	5	56	35	55	201
1996	60	10	0	61	118	166	415
1997	54	8	8	61	46	65	242

Source: Florida Department of Environmental Protection, Florida Marine Research Institute, Internet Accessible Database, updated November 23, 1998.

females, the critically endangered Kemp's Ridley nesting population has shown steady increases in the number of nests from approximately 700 in the mid-1980s to over 3,000 in 1997 (Figure 4.14). Also of critical concern are populations of Pacific leatherbacks—nesting populations in Pacific Central America are severely depleted and the extinction crisis for these populations cannot be overstated. (Part III, Table 4.5)

The current lists of endangered species suggests the severity of the situation for freshwater and marine fishes and crustaceans. Of the nation's 343 endangered animal species (as of the end of 1997), 163 (47 percent) were aquatic—9 amphibians, 67 fishes, 16 crustaceans, 15 snails, and 56 clams. (Part III, Table 4.6)

ONLINE RESOURCES

The National Biological Information Infrastructure, a website (http://www.nbii.gov) maintained by the US Geological Survey's Biological Resources Division (http://biology.usgs.gov/), is a rich source of information on the nation's biological resources. The site provides simplified searching, with a "Search the NBII Web" horizontal button to search all the NBII web pages plus a catalog of biological information from different sources around the nation ("Search the NBII Metadata Clearinghouse"). The site also includes a number of topic areas, including "Hot Topics, Invasive Alien Species, United States, Programs and Organizations, Education, International, and Biodiversity, Systematics, and Collections."

In its Programs and Organizations category, the NBII provides links to numerous federal agencies, including the departments of Defense, Interior, Agriculture, Commerce, Energy, State, EPA, the National Academy of Sciences, National Science Foundation, Smithsonian Institution, and various inter-agency programs such as the Global Change Data and Information System and the Native Plant Conservation Initiative.

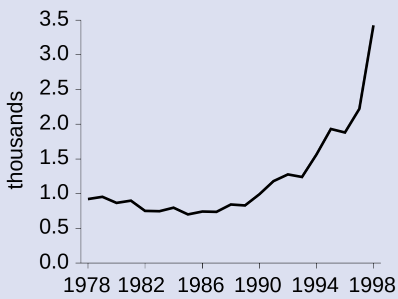
Within Interior's Fish and Wildlife Service, the Office of Migratory Bird Management undertakes a number of surveys in conjunction with Fish and Wildlife Service regional offices, the Canadian Wildlife Service, and state and provincial wildlife management agencies. Links to some of these surveys are available (http://www.fws.gov/r9mbmo/statsurv/mntrtbl.html). For example, the North American Breeding Bird Survey (http://www.mbr.nbs.gov/bbs/bbs.html) provides summary information on population change by region and period, annual indices of abundance for any species in any region, relative abundance maps, and programs to estimate and plot population change for any species on any BBS route or in any region covered by the BBS.

The Department of Agriculture manages a PLANTS National Database that provides a single source of standardized information about plants. This site (http://plants.usda.gov/plants) also provides standardized plant names, symbols, and other plant attribute information.

The NBII site has many nongovernment links, including the Biodiversity Forum at the University of California-Santa Barbara, Bio Web at California State University, the Center for Aquatic Plants at the University of Florida, the Ecological Society of America, the Fish and Wildlife Information Exchange, the U.S. Long-Term Ecological Research Network, and the Natural Heritage Network.

The National Marine Fisheries Service (NMFS), Office of Protected Resources

Figure 4.14 Kemp's Ridley Sea Turtle Nests, 1978-1998



Source: Gladys Porter Zoo, *Report on the Mexico and United States of America Population Restoration Project for the Kemp's Ridley Sea Turtle, Lepidochelyskempii, on the Coasts of Tamaulipas and Veracruz, Mexico* (DOI, FWS, 1997) and R. Marquez (unpubl. data).
Note: Nest counts include those from Rancho Nuevo, Tepehuajes, and Barra del Tordo only.

website (http://www.nmfs.gov/prot_res.html) offers a wealth of information on marine mammals, sea turtles, and threatened and endangered anadromous and marine fish. This website includes information on why various species are listed as threatened and endangered, accounts of their life history, some of the causes of species decline, and links to additional information about species that are under the jurisdiction of NMFS. Other useful information on marine resources can be found at NOAA's *State of the Coast* site (http://state-of-coast.noaa.gov).

Global links include the Convention on Biological Diversity, European Centre for Nature Conservation, Inter-American Biodiversity Information Network, UNESCO's Man and the Biosphere program, the Biodiversity Conservation Information System, the Biodiversity Forum, the International Organization for Plant Information, and the World Conservation Monitoring Centre.

The World Conservation Monitoring Centre (http://www.wcmc.org.uk/) is another site with a vast amount of information on ecosystems and biodiversity. WCMC's latest products include *The World List of Threatened Trees* and the *1997 IUCN Red List of Threatened Plants*.

It also includes a variety of databases and statistics on forests, coasts, species, protected areas, and national biodiversity. The World Conservation Union (IUCN) site (http://www.iucn.org) includes a World Conservation Bookstore, with over 1,300 titles published by IUCN, the Convention on International Trade in Endangered Species, Ramsar Convention on Wetlands, TRAFFIC, and WCMC.

Another valuable website in this area is maintained by The Nature Conservancy (TNC) (http://www.tnc.org). TNC has been active in studying which species, ecological communities, and ecosystems are most threatened. TNC's Conservation Science programs have created a network of databases—the Natural Heritage Program and Conservation Data Center Network—to help identify those species and communities. In the case of plants and animals, TNC's analysis indicates that in the United States alone, close to 4,500 species are faced with possible extinction unless viable habitat is protected and managed.

TNC is using new tools, such as geographic information systems, which can overlay sets of information—on an area's hydrology, vegetation cover, and land-use patterns, for example—to help analyze a particular site. TNC is also trying to assess biodiversity protection at both multiple scales of biology and geography—from rare species to ecosystems, and from nature preserves to landscapes.

TNC's Natural Heritage Program and Conservation Data Center Network comprises 85 biodiversity centers throughout the Western Hemisphere. Since its founding, the Heritage Network has grown to cover all 50 states, five Canadian provinces, and 14 countries in Latin America and the Caribbean. Domestically, these programs are called Natural Heritage Programs; internationally, they are called Conservation Data Centers. Those in the United States are housed various within state government agencies (84 percent), public universities (12 percent), and the Conservancy itself (4 percent).

The Conservancy serves as the principal network organizer, providing technical support and continually updating procedures, methods, and technologies.

The Natural Heritage Network Central Server (http://www.heritage.tnc.org) provides an overview of Natural Heritage Programs, information about the value of biodiversity, plus links to state Natural Heritage programs and other biodiversity-related web sites. The links to Natural Heritage Programs include seven programs in Canada, five in South America, and seven in the Caribbean.

Background on the value of biodiversity can be found in a number of locations on the World Wide Web. Two good explanations can be found at the Environmental Resources Information Network in Australia (http://www.erin.gov.au/life/general_info/op1.html) and the World Resources Institute in Washington (http://www.wri.org/wri/biodiv/cwb-i.html).

The USGS Biological Resources Division has produced several important surveys on the status and trends of the nation's biological resources. *Our Living Resources*, which was published in August 1995, includes more than 200 contributions on monitoring and population trends for many plant, invertebrate, and vertebrate species. The book also includes summaries on the status of several biological communities and ecosystems. It is available in electronic form (http://biology.usgs.gov/s+t/index.htm).

Status and Trends of the Nation's Biological Resources (http://biology.usgs.gov/s+t/SNT/index.htm) includes seven chapters that discuss the factors that affect the nation's ecosystems and biodiversity, including natural processes, harvest exploitation, contaminants, land use, water use, nonindigenous species, and climate change. A second section includes 13 regional chapters on the status and trends of biological resources and ecosystems. A second volume will include a large chapter about the status and trends of the nation's marine resources.

Other groups with an interest in ecosystems and biodiversity include American Rivers (http://www.amrivers.org), International Association of Fish and Wildlife Agencies (http://www.sso.org/iafwa), National Audubon Society (http://www.audubon.org), National Parks and Conservation Association (http://www.npca.org), National Wildlife Federation (http://www.nwf.org), Center for Marine Conservation (http://www.cmc-ocean.org), Defenders of Wildlife (http://www.defenders.org), Ducks Unlimited (http://www.ducks.org), Friends of the Earth (http://www.foe.org), and The Wilderness Society (http://www.wilderness.org).

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CORE DATA

CHAPTER FIVE

Air Quality

Air quality has a variety of significant impacts on both human health and the environment.

In terms of human health, some air pollutants may cause lung cell damage, inflammation, acute changes in lung function and respiratory systems, as well as more long-term lung cell changes. Acute and chronic exposure to air pollutants is also associated with increased mortality and morbidity. Yet much remains to be understood, including, for instance, the role of air pollution in observed increases in asthma cases and deaths from lung disease.

Atmospheric particles may pose major concerns for human health. These include effects on breathing and respiratory systems, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissue, and carcinogenesis. Some research indicates that particles may contribute to premature death. Hazardous air pollutants, such as benzene and chlorine, also are believed to pose a significant threat to human health.

Air pollutants also have a variety of impacts on environmental quality. For example, atmospheric-borne nitrogen is a major contributor to nitrogen loadings in many estuaries. About 27 percent of the nitrogen in the Chesapeake Bay is from the atmosphere, while the atmospheric contribution to nitrogen levels in the Albemarle/Pamlico Sound is estimated at about 44 percent.

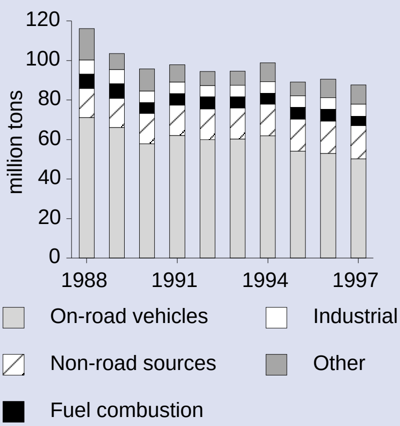
TRENDS FOR CRITERIA POLLUTANTS

Emissions of criteria pollutants and ambient air quality are reported by the Environmental Protection Agency in the *National Air Quality and Emissions Trends Report, 1997*, which describes trends in emissions and air quality during the period from 1988 to 1997. EPA also has recently published *National Air Pollutant Emission Trends, 1970-1997*, which is also available on CD-ROM. (See Selected Resources.)

Carbon Monoxide

Over the past decade, national emissions of carbon monoxide have declined from 116.08 million tons in 1988 to 87.45 million tons in 1997 (Figure 5.1). More than half of total carbon monoxide emissions are from on-road vehicles. In that category, carbon monoxide emissions have declined from 71.08 million tons in 1988 to 50.26 million tons in 1997, despite a

Figure 5.1 U.S. CO Emissions by Source, 1988-1997

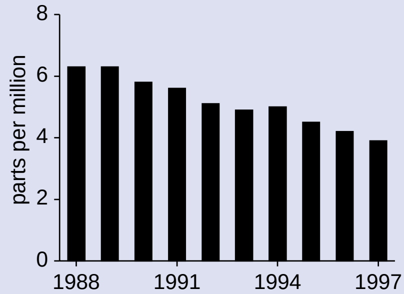


Source: See Part III, Table 5.1.
Notes: CO = carbon monoxide. Non-road sources include non-road gasoline engines (e.g., industrial, lawn and garden, light commercial, and recreational marine vessels), non-road diesel (e.g., construction and farm), aircraft, and railroads. Industrial refers to industrial processes. Other = structural, agricultural, and slash/prescribed fires.

25-percent increase in vehicle miles traveled over the period.

Among other sources, the most significant increase has occurred in the category of non-road sources, where emissions have increased from 14.70 million tons to 16.76 million tons over the 1988-97 period. Non-road sources include non-road gasoline engines (e.g., industrial, lawn and garden, light commercial, and recreational marine vessels), non-road diesel (e.g., construction and farm), aircraft, and railroads. Fires, including forest wildfires, agricultural fires, and slash/prescribed burning, are an unpredictable but occasionally significant source of carbon monoxide emissions; in 1988, for example, fires accounted for 15.90 million tons

Figure 5.2 U.S. Mean Ambient CO Concentrations, 1988-1997

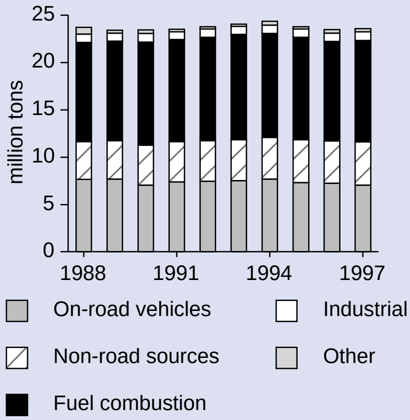


Source: See Part III, Table 5.10.
Note: CO = carbon monoxide.

of carbon monoxide emissions. For trends in other sources, see Part III, Table 5.1.

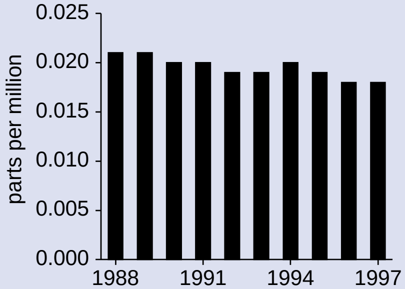
Ambient atmospheric concentrations of carbon monoxide decreased during the decade by 38 percent (Figure 5.2), indi-

Figure 5.3 U.S. NO_x Emissions by Source, 1988-1997



Source: See Part III, Table 5.2.
Notes: NO_x = nitrogen oxides. Non-road sources include non-road gasoline engines, non-road diesel (e.g., construction and farm), aircraft, marine vessels, and railroads. Industrial refers to industrial processes. Other includes other combustion, health services, cooling towers, and fugitive dust.

Figure 5.4 U.S. Mean Ambient NO_2 Concentrations, 1988-1997



Source: See Part III, Table 5.10.
Note: NO_2 = nitrogen dioxide.

cating that long-term improvements in air quality are continuing.

Nitrogen Oxides

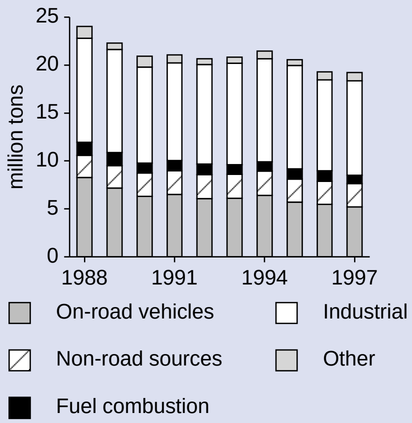
Over the period from 1950 to 1980, national emissions of nitrogen oxides (NOx) rose from 10.09 million to 24.87 million tons. Since 1988, total annual emissions have declined slightly (Figure 5.3). In 1997, emissions were 23.58 million tons, or 1 percent lower than the 1988 total, although changes in data availability and methodology between 1989 and 1990 (in the other combustion category) introduce some uncertainty in this comparison. The principal sources are fuel combustion from electric utilities and industrial processes (10.72 million tons in 1997), on-road vehicles (7.04 million tons in 1997), and non-road sources, which include non-road gasoline engines, non-road diesel (e.g., construction and farm), aircraft, marine vessels, and railroads (4.56 million tons in 1997). For emissions by source, see Part III, Table 5.2.

The trend in atmospheric concentrations of nitrogen dioxide across the country between 1988 and 1997 shows a 14-percent decrease in the national composite mean (Figure 5.4). Since most monitors of nitrogen dioxide are located in urban, population-oriented areas, the trend in ambient concentrations is primarily representative of highway emissions of nitrogen oxides, which decreased 8 percent between 1988 and 1997.

VOCs and Ozone

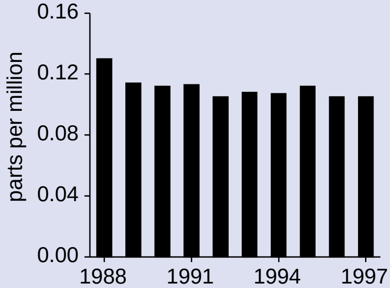
National emissions of volatile organic compounds (VOCs), which along with nitrogen oxides are precursors to ground level ozone formation, peaked at 30.6 million tons in 1970 and have since fallen to 19.21 million tons in 1997 (Figure 5.5).

Figure 5.5 U.S. VOC Emissions by Source, 1988-1997



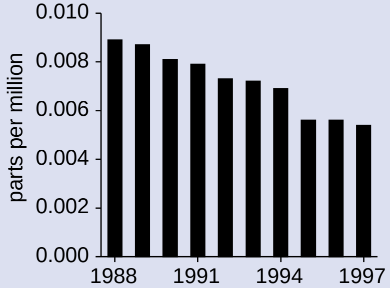
Source: See Part III, Table 5.3.
Notes: VOC = volatile organic compounds. Non-road sources include non-road gasoline engines (e.g., lawn and garden and recreational marine vessels), non-road diesel (e.g., construction and farm), and aircraft. Industrial refers to industrial processes. Other includes fires, other combustion, and natural geogenic sources.

Figure 5.6 U.S. Mean Ambient O_3 Concentrations, 1988-1997



Source: See Part III, Table 5.10.
Note: O_3 = ozone. Data refer to ground-level ozone.

Figure 5.7 U.S. Mean Ambient SO_2 Concentrations, 1988-1997



Source: See Part III, Table 5.10.
Note: SO_2 = sulfur dioxide.

Industrial processes accounted for 9.84 million tons of emissions, on-road vehicles for 5.23 million tons, and non-road sources, which include non-road gasoline engines (e.g., lawn and garden equipment and recreational marine vessels), non-road diesel (e.g., construction and farm), and aircraft, for 2.43 million tons in 1997. For emissions by source, see Part III, Table 5.3.

Ambient atmospheric ozone trends are influenced by year-to-year changes in meteorological conditions, population growth, VOC-to-NOx emissions ratios, and by changes in emissions from ongoing control measures. Hot, dry meteorological conditions, such as occurred in 1988 and 1995, are highly conducive to ozone formation. Despite increases in these years, the 10-year trend shows a 19 percent decline in composite national average daily maximum 1-hour atmospheric ozone concentration (Figure 5.6). Although the general pattern of ozone trends across urban, suburban, and rural areas of the country is similar, the highest concentration levels are typically found at suburban sites. In mid-1997, EPA announced new primary and second 8-hour ozone standards (See Box 5.1).

Sulfur Dioxide

Progress toward reducing ambient atmospheric concentrations of sulfur dioxide during the past 20 years was accom-

Box 5.1
Primary and Secondary 8-hour Ozone Standards

On July 18, 1997, EPA established an 8-hour O_3 primary standard to protect against longer exposure periods that are of concern for both human health and vegetation. The level of the national 8-hour primary and secondary ambient air quality standards for ozone is 0.08 ppm. The standards are met when the 3-year average of the annual fourth-highest daily maximum 8-hour ozone concentration is less than or equal to 0.08 ppm. EPA will designate ozone nonattainment areas for the 8-hour ozone NAAQS by July 2000.

plished by installing flue-gas control equipment in coal-fired electric utilities, reducing emissions from industrial processing facilities, reducing the average sulfur content of fuels burned, switching to low-sulfur coal, and using cleaner fuels in residential and commercial burners. Between 1988 and 1997, annual mean concentrations of sulfur dioxide decreased 39 percent (Figure 5.7), with the largest single-year reduction (19 percent) occurring between 1994 and 1995 (See Box 5.2). The trend has since leveled off, declining only 4 percent from 1996-97.

National emissions of sulfur dioxide have fallen to about two thirds the 1970 level of 31.16 million tons, reaching 20.37 million tons in 1997 (Figure 5.8). The principal sources of sulfur dioxide emissions are fuel combustion, primarily from electric utilities and industrial processes. Emissions from electric utilities have declined to 13.08 million tons in 1997, about two thirds the 1970 level of 17.40 million tons. National SO_2 emissions decreased 12 percent between 1988 and 1997, with a sharp decline between 1994 and 1995, similar to the decline in the ambient concentrations. Unlike the

Box 5.2
The Acid Rain Program

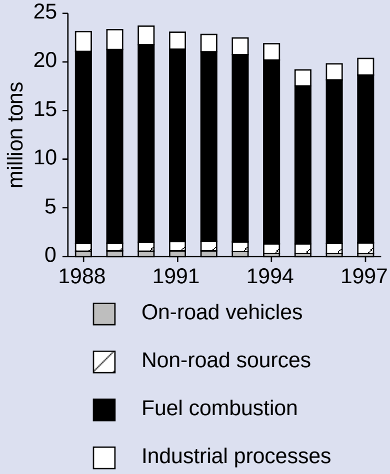
The 1994-95 national reductions in emissions and ambient concentrations of SO_2 are due mainly to Phase I implementation of the Acid Rain Program. Established by EPA under Title IV of the Clean air Act Amendments, the Acid Rain Program's principal goal is to achieve significant reductions in SO_2 and NO_x emissions. Phase I compliance for SO_2 began in 1995 and significantly reduced emissions from the participating electric utilities (See Box Table 5.1). Since 1995, however, total SO_2 emissions from electric utilities have increased. The majority of the increase is attributed to those units not yet participating in the Acid Rain Program. Most of these units will be included in Phase II of the Program, which begins in 2000. The rest of the increase came from some Phase I plants which over-complied in 1995 and were able to use their banked emission allowances in 1996 and 1997. When fully implemented, total SO_2 emissions from electric utilities are capped at 8.9 million tons per year.

Box Table 5.1 Total SO_2 Emissions from Phase I Electric Utility Units and Non-Phase I Electric Utility Units, 1994-1997

Utility Units	1994	1995	1996	1997	1994-95	1995-97
			thousand tons			
Phase I Units	6,915	4,938	5,259	5,304	-1,977	+366
Non-Phase I Units	7,974	7,142	7,373	7,778	-832	+636
All Units	14,889	12,080	12,632	13,082	-2,809	+1,002

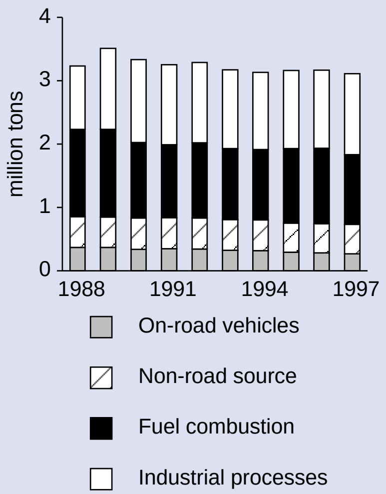
Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Quality and Emissions Trends Report, 1997,* Table 2.5 (EPA, OAQPS, Research Triangle Park, NC, 1998).

Figure 5.8 U.S. SO_2 Emissions by Source, 1988-1997



Source: See Part III, Table 5.4.
Note: SO_2 = sulfur dioxide. Non-road sources include marine vessels and railroads.

Figure 5.9 U.S. PM-10 Emissions by Source, 1988-1997



Source: See Part III, Table 5.5.
Notes: PM-10 = particulate matter with a diameter 10 micrometers or less. Does not include natural sources or fugitive dust. Non-road sources include non-road diesel (e.g., construction and farm) and railroads.

air quality trend, however, the emissions trend increased from 1995 to 1997, as explained in Box 5.2.

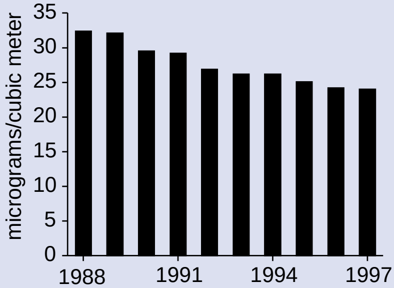
Particulate Matter

Nationally, PM-10 direct emissions decreased 12 percent between 1988 and 1997. Direct PM-10 emissions are generally examined in two separate groups. Of the more traditionally inventoried sources (fuel combustion, industrial processes, and transportation), the fuel combustion category saw the largest decrease over the 10-year period (Figure 5.9), with most of the decline possibly attributable to a decrease in emissions from residential wood burning. Local control programs to curtail the use of residential wood heaters during times when the air was stagnant and to replace old woodstoves with new, cleaner burning models are responsible for the decrease in residential wood burning, along with lower natural gas and fuel oil prices. Emissions from industrial processes changed very little over the 10-year period, while the on-road vehicles category decreased 27 percent and non-road sources decreased 4 percent.

The second group of direct PM-10 emissions is a combination of miscellaneous and natural sources including agriculture and forestry, wildfires and managed burning, fugitive dust from paved and unpaved roads, and wind erosion. These miscellaneous and natural sources actually account for about 90 percent of the total direct PM-10 emissions nationwide, although they can be difficult to quantify compared to the traditionally inventoried sources. Because the emissions in the miscellaneous/natural group tend to fluctuate a great deal from year to year, the trend from one year to the next or over several years may not be particularly meaningful. See Part III, Table 5.5 for emissions by source and Part III, Table 5.6 for miscellaneous sources.

Mean annual PM-10 concentrations have decreased 26 percent since 1988, which was the first year of PM-10 data for most monitors (Figure 5.10). Urban, suburban, and rural areas have similar trends, although concentrations in rural areas are significantly lower. Several factors have played a role in reducing PM-10 concentrations since 1988. Where appropriate, states required emissions from industrial sources and construction activities to be reduced to meet the PM-10 standards. Measures were also adopted to reduce street dust emissions, including the use of clean anti-skid materials like washed sand, better control of the amount of material used, and removal of the material from the street as soon as the ice and snow melted. In addition, cleaner burning fuels like natural gas and fuel oil have replaced wood and coal as fuels for residential heating and industrial and electric utility furnaces.

Figure 5.10 U.S. Mean Ambient PM-10 Concentrations, 1988-1997



Source: See Part III, Table 5.10.
Note: PM-10 = particulate matter with a diameter 10 micrometers or less.

In July 1997, the standards for PM-10 were revised (See Box 5.3).

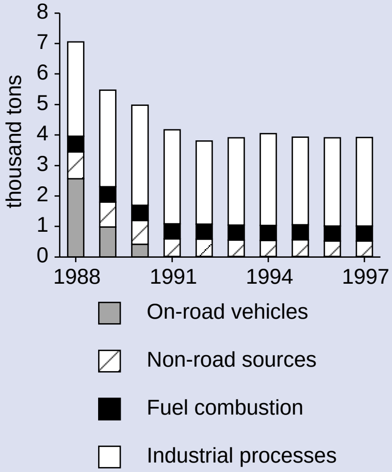
Lead

Annual national emissions of lead have declined spectacularly, dropping from the 1970 level of 221,000 tons to the 1997 level of less than 4,000 tons. Emissions from on-road vehicles, estimated at

Box 5.3
Primary and Secondary PM-10 Standards

The original standards for PM, established in 1971, were for total suspended particulate (TSP) matter. In 1987, EPA replaced the TSP standards with PM-10 standards to focus on smaller particles of aerodynamic diameter less than or equal to 10 micrometers. These smaller particles caused the greatest health concern because of their ability to penetrate into sensitive regions of the respiratory tract. The most recent review of the PM standards concluded that still more protection from adverse health effects was needed. In July 1997, the primary (health-based) PM standards were revised to add two new PM 2.5 standards, set at 15 µg/m^3 for the annual standard and 65 µg/m^3 for the 24-hour standard, and to change the form of the 24-hour PM-10 standard. The secondary (welfare-based) standards were revised by making them identical to the primary standards.

Figure 5.11 U.S. Lead Emissions by Source, 1988-1997



Source: See Part III, Table 5.7.
Note: Non-road sources include non-road gasoline engines and aircraft.

172,000 tons in 1970, dropped to about 19 tons in 1997 as a result of the federal phaseout of lead in gasoline. Emissions from metals processing also have dropped sharply, from the 1970 level of 24,000 tons to 2,038 tons in 1997. Over the period 1988-1997, total lead emissions decreased 44 percent (Figure 5.11). Part III, Table 5.7, which lists lead emissions by major source category, shows that on-road vehicles accounted for 82 percent of the 10-year emissions decline.

Over the past 10-year period, atmospheric lead concentrations decreased 67 percent at population-oriented monitoring sites (Figure 5.12). Air quality trends segregated by location (urban, suburban, and rural) show similar declines over the period.

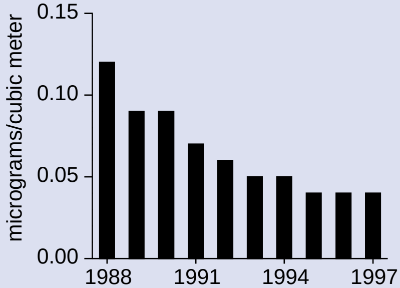
Reductions in lead emissions and atmospheric concentrations are a direct result of the phase-out of leaded gasoline. Because industrial processes are now responsible for all violations of the lead standard and account for 74 percent of total lead emissions, the lead monitoring strategy is now focused on these emissions point sources. On-road vehicles now account for only one-half of a percent of total 1997 lead emissions, while non-road sources account for about 13 percent.

OTHER AIR QUALITY TRENDS

Acid Rain

The National Acid Deposition Program (NADP) monitors wet atmospheric deposition at over 220 National Trends Network (NTN) sites throughout the United States. The program is a partnership between the US Geological Survey and over 100 other federal, state, local and private organizations. USGS supports 72 of the NADP/NTN sites.

Figure 5.12 U.S. Mean Ambient Lead Concentrations, 1988-1997

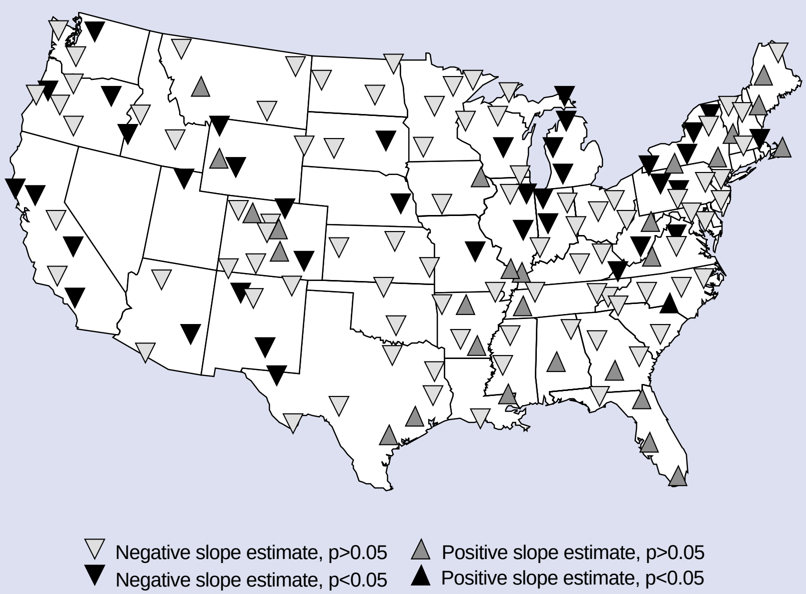


Source: See Part III, Table 5.10.

Based on data collected at NADP/NTN sites, recent studies by Lynch, et al (1996) and other researchers support the conclusion that the Acid Rain Program (Title IV) mandated by the Clean Air Act Amendments of 1990 has, wholly or in part, reduced acid deposition, particularly in the eastern United States. Reductions in the acidity (as represented by hydrogen ion concentration) and sulfate concentration of precipitation occurred in the Ohio River Valley region, where many of the largest emitters of sulfur dioxide targeted by Phase I of Title IV are located, as well as to the east of this region—across the Mid-Atlantic region and north through Maine (Figures 5.13 and 5.14). For example, the average reduction in sulfate concentrations in Ohio was approximately 21 percent, in Maryland, 27 percent, and in Pennsylvania, 15 percent. The largest decrease (32 percent) occurred in the northern portion of West Virginia. Nitrate concentrations at NADP/NTN sites were not appreciably different in 1995–1996 from historical levels. See Part III, Table 5.9.

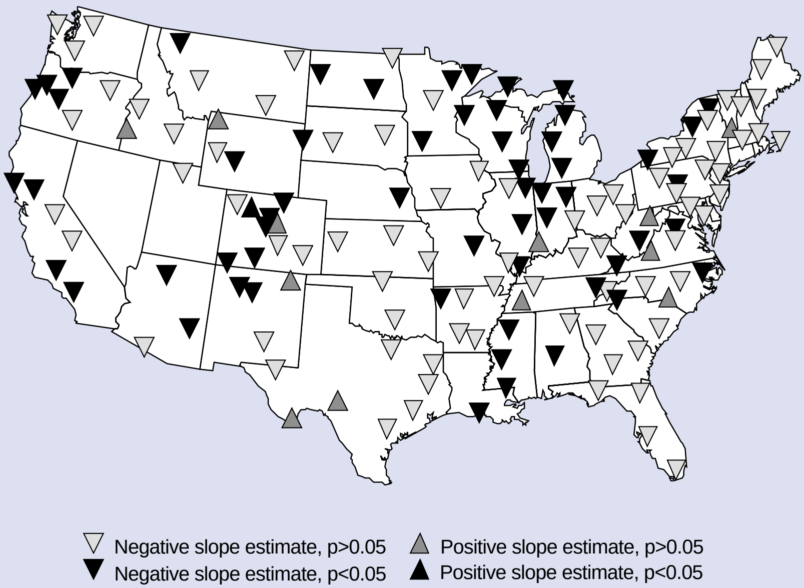
Another important source of information on acid rain is the National Acid Precipitation Assessment Program (NAPAP), an interagency scientific research, monitoring and assessment program on the effects of sulfur and nitrogen oxides on the environment and human health. NAPAP acts as a coordinating office between six Federal agencies. The

Figure 5.13 Trends in Hydrogen Ion Concentrations, 1983-1994



Source: Lynch, J.A., V.C. Bowersox & J.W. Jeffrey. *Trends in Precipitation Chemistry in the United States,1983-94: An Assessment of the Effects in 1995 of Phase I of the Clean Air Act Amendments of 1990, Title IV*. USGS Open File Report 96-0346 (USGS, Reston, VA, 1996).

Figure 5.14 Trends in Sulfate Ion Concentrations, 1983-1994



Source: Lynch, J.A., V.C. Bowersox & J.W. Jeffrey. *Trends in Precipitation Chemistry in the United States, 1983-94: An Assessment of the Effects in 1995 of Phase I of the Clean Air Act Amendments of 1990, Title IV.* USGS Open File Report 96-0346 (USGS, Reston, VA, 1996).

participating agencies are the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, the Department of Energy, the Department of the Interior, the Department of Agriculture, and the National Aeronautics and Space Administration.

In 1996, NAPAP conducted an integrated assessment of the costs, benefits and effectiveness of acid rain controls specified in Title IV of the 1990 Clean Air Act Amendments. The results of the assessment were published in the *NAPAP Biennial Report to Congress: An Integrated Assessment*. The report found that:

- SO_2 emissions have declined since 1980 and especially in 1995, the first year of Title IV.
- The acidity of and sulfate concentrations in precipitation have decreased in the Midwest, Mid-Atlantic, and the Northeast United States.
- Since 1980, lakes and streams throughout many areas of the United States have experienced decreases in sulfate concentrations.
- Although there is evidence of recovery from acidification in New England lakes, additional reductions in sulfur and nitrogen deposition would be required to fully recover sensitive Adirondack lakes.
- Sulfur and nitrogen deposition have caused adverse impacts on certain highly sensitive forest ecosystems in the

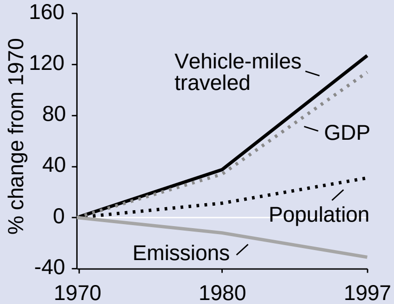
United States, especially high-elevation spruce-fir forests in the eastern United States. Most forest ecosystems are not currently known to be adversely impacted by acid deposition. However, if deposition levels are not reduced in areas where they are presently high, adverse effects may develop in more forests due to chronic, multiple-decade exposure.

- Reduced SO_2 emissions are expected to reduce sulfate concentrations and, in turn, their contribution to haze.
- Decreased emissions are expected to reduce fine-particulate sulfate and nitrate concentrations in air, possibly leading to reductions in adverse health effects.
- Quantifiable economic benefits could be relatively large in the areas of human health and visibility and exceed the costs of reducing emissions.
- The market-based approach to reducing emissions of SO_2 has reduced compliance costs for utilities below those of a traditional command-and-control approach.

Mobile Sources

Notable reductions in air pollutant emissions and air quality concentrations have occurred since 1970 (Figure 5.15), despite significant increases in population, economic and industrial activity, and vehicle miles traveled. Much of the improvement in air quality is due to reductions in pollutant emissions from mobile sources.

Figure 5.15 U.S. Aggregate Emissions, Demographic, and Economic Trends, 1970-1997



Source: U.S. Environmental Protection Agency, *Air Quality and Emissions Trends Report, 1997* (EPA, Research Triangle Park, NC, 1998).
Note: GDP = Gross Domestic Product.

Visibility

Visibility impairment, as measured by the amount of haze during summer months at 280 monitoring stations located at airports across the country, increased greatly between 1970 and 1980, and decreased slightly between 1980 and 1990. These trends follow overall trends in emissions of sulfur oxides during these periods. In more recent studies, aerosol and light extinction data have been collected for 10 consecutive years (1988-1997) at 29 sites in the Interagency Monitoring of Protected Environments (IMPROVE) network (consisting primarily of national parks and wilderness areas), and for 6 consecutive years (1992-1997) at 8 additional sites. These data show that in the East, the haziest visibility days do not appear to be getting any better and the best visibility days appear to be relatively flat or improving slightly. In contrast, there appears to be steady visibility improvement in the West.

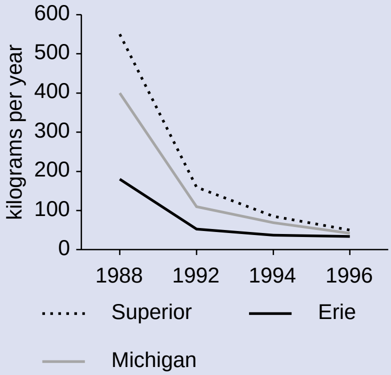
Air Toxics

In 1993, there were approximately 8.1 million tons of hazardous air pollutants (HAPS) released to the air, according to EPA's National Toxics Inventory (NTI). The 1993 NTI includes emissions information for 166 of the 188 HAPs from 958 point-, area-, and mobile-source categories. Emissions data from the Toxic Release Inventory (TRI) were used as the foundation of the 1993 NTI. EPA is currently compiling the 1996 NTI.

Air toxics are emitted from all types of manmade sources, including large point sources such as industrial facilities and utilities, area or smaller stationary sources such as neighborhood dry cleaners, and mobile sources (automobiles and trucks). Point sources that emit more than 10 tons per year of an individual HAP or 25 tons per year of aggregate emissions of HAPs account for approximately 61 percent of the total HAP emissions, nationally, while area sources contribute approximately 18 percent, and mobile sources contribute 21 percent.

People can be exposed to air toxics by breathing contaminated air or ingesting food from contaminated waters where air toxics are deposited. Potential health effects resulting from exposure to hazardous air pollutants include leukemia and other cancers; reproductive and developmental effects such as impaired development in newborns and young children, miscarriage, decreased fertility; and damage to the pulmonary system.

Figure 5.16 PCB Deposition to the Great Lakes, 1988-1996



Source: Intergrated Atmospheric Deposition Network.

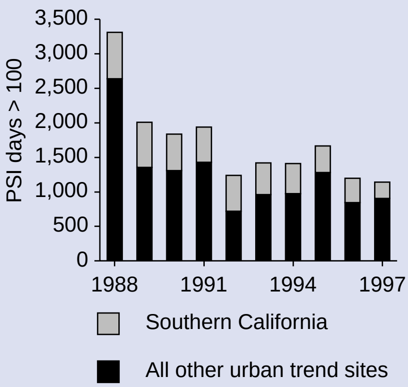
The extent to which these effects actually occur in the population depends on a number of factors, including the level and duration of exposure. Air toxics can also adversely impact ecosystems; in some cases, deposited air pollutants can be significant contributors to overall pollutant loadings to waterbodies such as the Great Lakes (See Figure 5.16 for an example). Many of these pollutants are responsible for fish consumption advisories in lakes and inland waterways.

Pollutant Standards Index

The Pollutant Standards Index (PSI) is derived from pollutant concentrations and reported daily in all metropolitan areas of the United States with populations exceeding 200,000. The PSI is reported as a value between zero and 500; these values are associated with general descriptions of air quality. (See Part III, Table 5.11) A PSI value greater than 100 indicates that at least one criteria pollutant (with the exception of NO_2) exceeded the level of the NAAQS, therefore indicating unhealthful air. Relatively high PSI values activate public health warnings. The number of days with PSI values greater than 100 is used as an indicator of urban air quality. Analysis of PSI trends in the nation's 94 largest metropolitan areas over the period 1988 through 1997 show a 56 percent decrease in PSI values greater than 100 in Southern California and 66 percent decrease in the remaining major cities across the United, concomitant with improvements in ambient air (Figure 5.17).

While progress has been made, it is important not to lose sight of the air pollution problems that still remain. Though air quality trends are improving nationally, there are still areas, both urban and rural, with concentrations above the level of the national standard and even areas with worsening trends. Based upon monitoring data submitted to EPA's Aerometric Information Retrieval System (AIRS) data base, approximately 107 million people in the United States reside in counties with air quality concentrations above the level of the NAAQS in 1997. (Note: Population estimates are intended to provide a relative measure of the extent of the problem for each pollutant in a single year. An individual living in a county that had a measured concentration above the level of the NAAQS may not actually be exposed to unhealthy air.) See Part III, Table 5.12.

Figure 5.17 U.S. Urban Air Quality, 1988-1997



Source: See Part III, Table 5.11.
Notes: PSI = Pollutant Standards Index. PSI days > 100 are within the unhealthy range. See notes for Table 5.11. Because of their magnitude, PSI totals for Los Angeles, CA, Riverside, CA, Bekersfield, CA, and San Diego, CA are shown separately as Southern California.

Nonattainment Areas

When an area does not meet the air quality standard for one of the criteria pollutants it may be subject to EPA's formal rule-making process that designates it as nonattainment. As of September 1998, there were a total of 130 nonattainment areas on EPA's condensed nonattainment list. The areas on the condensed list are on the Internet (http://www.epa.gov/airs /nonattn.html). The list is updated as areas are redesignated.

There are approximately 113 million people living in areas currently designated as nonattainment. (Note: These population estimates differ from those presented in the previous paragraph because formal nonattainment designations are based on multiple years data rather than a single year and generally do not follow county boundaries. For example, ozone nonattainment areas typically compose the entire metropolitan area, which may include additional counties that do not contain air quality monitors.) See Part III, Table 5.13.

Indoor Air Quality

Research indicates that air in homes, schools, and workplaces can have higher levels of pollution than outdoor air. Common indoor pollutants include radon, lead, environmental tobacco smoke (ETS), household chemicals and pesticides, and biological pollutants such as bacteria, viruses, mold, dust mites, and animal dander.

Radon, a naturally occurring gas, is the country's second leading cause of lung cancer, accounting for 15,000-22,000 deaths per year. Radon can be managed with readily available technology.

ETS is responsible for approximately 3,000 lung cancer deaths in nonsmokers annually, as well as 150,000 to 300,000 lower respiratory tract infections in infants, resulting in up to 15,000 hospitalizations per year. It also affects from 200,000—1,000,000 asthmatic children per year. Levels of asthma appear to have increased in the past decade or more.

ONLINE RESOURCES

The Environmental Protection Agency maintains a vast quantity of material on its website. Many of these resources are listed in the sections on selected resources below. Other federal agencies with air-quality-related material include the Department of Energy's Energy Information Administration, the Department of Transportation's Bureau of Transportation Statistics, the Department of Interior's National Park Service, and the Department of Labor's Occupational Safety and Health Administration (OSHA).

Many other websites provide valuable information about air quality. For example, the site maintained by the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO) offers a wealth of information (http://www.4cleanair.org/links.html). STAPPA/ALAPCO's "Air Links" site includes links to local, state, and federal agencies, and other organizations. It also includes information by topic. The topics include acid rain, the Clean Air Act, climate change, enforcement, motor vehicles, particulate matter, permits, pollution prevention, smog, stratospheric ozone, toxics, and training.

The Air and Waste Management Association's (A &WMA) online publications provide information on environmental science, research, and policy issues (http://www.awma.org). The *Journal of the Air and Waste Management Association* site contains hundreds of peer-reviewed technical articles on environmental science and research.

Acid Rain

EPA's Acid Rain Program is online (http://www.epa.gov/docs/acidrain/ardhome.html). The program's system of tradable SO_2 allowances is a landmark use of market incentives in environmental protection. The site includes information on SO_2 emissions trading and allowance data, on EPA's NOx reduction program, and on emissions monitoring and reporting.

The Department of Energy's Clean Coal Technology Program began in 1986 with a mandate to expand the list of innovative pollution control options to curb the release of acid rain pollutants. The program has sponsored 45 first-of-a-kind projects, which are underway in 21 states (http://www.doe.gov/html/fe/cct.html).

The National Atmospheric Deposition Program, which is housed at the Illinois State Water Survey at the University of Illinois, operates a nation-wide atmospheric deposition monitoring network through collaborative relationships with federal, state, academic, and private organizations. The website offers information on the program as well as access to acid rain data and isopleth maps (http://nadp.sws.uiuc.edu). The National Acid Precipitation Assessment Program (NAPAP) also is online (http://www.oar.noaa.gov/admin/napap.html).

Environment Canada (http://www.ec.gc.ca/envhome.html) provides a wide range of information on acid rain. For example, the *1996 Annual Report on the Federal-Provincial Agreements for the Eastern Canada Acid Rain Program* is available in PDF format (http://www.ec.gc.ca/pdb/can_us/easteg96.pdf). Environment Canada's National Environmental Indicator Series includes data on emissions of sulfur dioxide, emissions of nitrogen oxides, wet sulphate deposition, and trends in lake acidity in southeastern Canada (http://199.212.18.79/~ind/english/AcidRain/default.cfm).

Mobile Sources

EPA's Office of Mobile Sources site (http://www.epa.gov/omswww) contains information on mobile vehicles, fuels, and nonroad engines. The site includes information on transportation/air quality planning, including material on trading and market incentives. The Department of Transportation's Bureau of Transportation Statistics (http://www.bts.gov) also provides a variety of statistical and research materials on transportation and clean air issues. For information specifically about highways, the Federal Highway Administration's Office of Highway Information Management (http://www.fhwa.dot.gov/ohim/) includes selected documents, periodicals, and highway-related data from federal, state, and local sources.

California, one of the most active states on transportation and air quality, has several valuable sites. The California Air Resources Board (http://www.arb.ca.gov/homepage.htm), a department of the California Environmental Protection Agency, includes a buyer's guide to cleaner cars that can help consumers identify new or used vehicles that produce particularly low levels of emissions.

The South Coast Air Quality Management District (http://www.aqmd.gov/) is the smog control agency for all or portions of Los Angeles, Orange, Riverside, and San Bernardino counties in the Los Angeles area, where 14 million people breathe the dirtiest air in the nation.

The site includes information on smog levels, compliance programs, clean air plans, rules and regulations, business assistance, transportation programs, the permitting process, and clean air technologies. The site includes a table showing historic ozone air quality trends in the South Coast Air Basin from 1976 to 1996. The table shows a significant reduction in the number of days ozone levels exceeded health standards in the basin area over the two-decade period.

Visibility

The National Park Service's NatureNet (http://www.aqd.nps.gov) provides information about environmental and other issues related to the National Park System. The site includes the "AIR-Web" (http://www.aqd.nps.gov/ard), which includes information on air quality in parks and refuges and air quality legal mandates. NPS also has devised a prototype park.

The NPS Visibility Monitoring Program includes information about visibility monitoring, visibility impairment photos, and related resources (http://www.aqd.nps.gov/ard/vis/vishp.html).

Indoor Air Quality

Information on indoor air quality is available at EPA's indoor air homepage (http://www.epa.gov/iaq) and on OSHA's homepage (http://www.oshaslc.gov/SLTC/indoorairquality/index.html).

OTHER WEBSITES OF INTEREST

AirNow - real-time air pollution data, information about the public health and environmental effects of air pollution, and information about ways to protect public health and reduce air pollution. This website, which is also known as the Ozone Mapping Project, currently focuses on ground-level ozone (smog). Future plans for this website are to expand the geographic coverage of the current ozone maps and to include other pollutants (http://www.epa.gov/airnow/).

AIRSData - access to key measures of air pollution that EPA uses to assess the Nation's air quality; measurements of ambient air quality for the past five years from 4,000 air monitoring sites across the nation; air pollutant emissions and regulatory compliance status for 9,000 point sources regulated by EPA. Reports and maps are generated on demand from a database refreshed monthly with the latest information from AIRS (http://www.epa.gov/airsweb/).

Atmospheric Integrated Research Monitoring Network (AIRMoN) - an array of stations maintained by the National Oceanic and Atmospheric Administration (NOAA) designed to provide a research-based foundation for the routine operations of the nation's deposition monitoring networks—the National Atmospheric Deposition Program (NADP) for wet deposition, and the Clean Air Status and Trends Network (CASTNet) for dry. A subprogram is specifically designed to detect the benefits of emissions controls mandated by the Clean Air Act Amendments of 1990, and to quantify these benefits in terms of deposition to sensitive areas (http://www.arl.noaa.gov/research/programs/airmon.html).

Environmental Radiation Ambient Monitoring System (ERAMS) - a national network of monitoring stations that regularly collect air, water, precipitation, and milk samples for analysis of radioactivity (http://www.epa.gov/narel/erams.html).

Green Book: Nonattainment Areas for Criteria Pollutants - extensive information about nonattainment areas and National Ambient Air Quality Standards for the six criteria pollutants. Updated lists identify areas of the country where air pollution levels persistently exceed the national ambient air quality standards and are designated "nonattainment" (http://www.epa.gov/oar/oaqps/greenbk/).

Mercury Deposition Network - a subnetwork in NADP with 30 sites in operation to collect weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition. The data will be used to develop information on spatial and seasonal trends in mercury deposited to surface waters, forested watersheds, and other sensitive receptors (http://nadp.sws.uiuc.edu/mdn/).

NOAA/EPA UltraViolet Index (UVI) - access to daily, annual, and archived bulletins, graphs, and maps of UVI (http://nic.fb4.noaa.gov/products/stratosphere/uv_index/index.html).

Ozone Depletion - information about the science of ozone depletion, regulations in the U.S. designed to protect the ozone layer, information on methyl bromide, and flyers about the UV index (http://www.epa.gov/ozone/index.html).

Technology Transfer Network (TTNWeb) - a collection of related websites containing information about many areas of air pollution science, technology, regulation, measurement, and prevention. In addition, the TTNWeb serves as a public forum for the exchange of technical information and ideas among participants and EPA staff (http://www.epa.gov./ttn).

Toxics Release Inventory - access to data from EPA's Toxics Release Inventory (http://www.epa.gov/opptintr/tri/index.html).

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CORE DATA

CHAPTER SIX

Aquatic Resources

The nation's aquatic resources—water, coasts, oceans, wetlands, fish and shellfish—are generally abundant, though there are significant geographic and seasonal differences. In many cases, aquatic resources are under stress, threatened either by development, resource exploitation, or impaired water quality.

Water Resources

The United States is a water-rich nation, blessed with 3.6 million miles of rivers and streams, 41 million acres of lakes, almost 40,000 square miles of estuaries (excluding Alaska), and 33,000 trillion gallons of groundwater.

There is significant geographic and seasonal variation in precipitation. For example, the area east of the Mississippi River typically receives more than twice as much annual rainfall as the area west of the Rocky Mountains (Figure 6.1).

Surface waters provide about three fourths of overall freshwater requirements and groundwater one fourth. Groundwater is the source of drinking water for about half the general population and nearly all the rural population. The renewable water supply is more than 4 times the amount withdrawn and almost 15 times the amount consumed. But some parts of the country, especially the West and Southwest, are beginning to approach the physical limits of their water resources. Continued growth will require some combination of importing more water and/or managing water more efficiently.

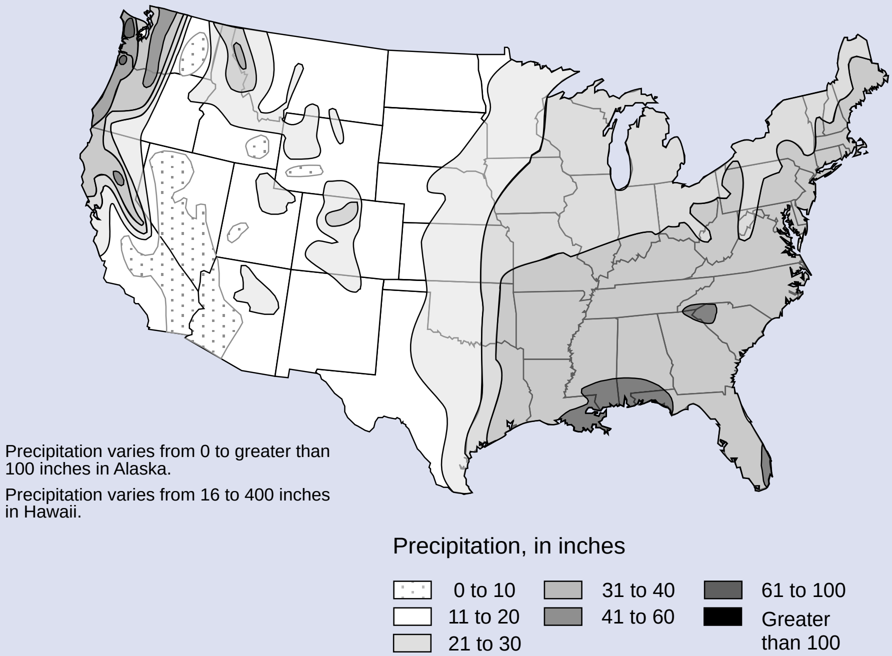
For the nation as a whole, precipitation trends have been generally above normal during the 1970-97 period. In 1997, according to preliminary estimates, 3.5 percent of the country experienced severe to extreme drought, while 25.7 percent was characterized by severe to extreme wetness.

Water Quality

Since passage of the Clean Water Act in 1972, most of the conspicuous water pollution of the later 1960s and 1970s has been eliminated. Over the 1972-92 period, despite population growth and an increase in the amount of sewage entering wastewater treatment plants, biochemical oxygen demand from treatment plants declined by 36 percent. Direct discharges of toxic pollutants are also down dramatically since 1988 (Figure 6.2).

In EPA's 1996 National Water Quality Inventory, states, territories, and tribes evaluated water quality in 19 percent of the nation's river and stream miles, 40 percent of lake areas, and 72 percent of estuary square miles. The results showed that, for the assessed waters, 64 percent of the river

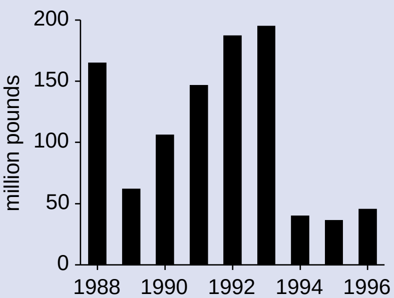
Figure 6.1 Mean Annual Precipitation in the United States



Source: Adapted and generalized from National Climatic Data Center, *Climatography of the United States No. 81.*

and stream miles, 61 percent of lake, pond, and reservoir acres, and 62 percent of estuary square miles are fully supporting their designated uses.

Figure 6.2 Toxic Discharges to U.S. Surface Waters, 1988-1996



Source: See Source for Part III, Table 8.6.
Note: Data are based on "core chemicals" to account for changes in reporting requirements.

These estimates should be treated with some caution. Since different states use different standards for evaluating the support of designated uses, and the sampling approaches also vary across states, the aggregate picture drawn by the National Water Quality Inventory may not appropriately depict the actual status of the nation's waters.

Aquatic life impacts are caused by persistent toxic pollutant burdens in waters and sediments, habitat degradation and destruction, and competition from and predation by nonnative species. Metals, priority toxic organic chemicals, pesticides, and oil and grease are among the leading persistent toxic pollutants cited as causing water quality impairments. Siltation, nutrient enrichment, and oxygen-depleting substances are among the leading causes of habitat degradation and destruction (aside from wetlands losses). Noxious aquatic plants are the leading type of non-native species cited as causing impairments, although specific regions like the Great Lakes have significant problems with other non-native aquatic organisms.

Drinking Water

The United States enjoys one of the best, safest supplies of drinking water in the world. The federal-state approach to drinking water protection emphasizes protection of groundwater and surface water supplies and improved drinking water monitoring, treatment, and distribution.

Under the Safe Drinking Water Act, EPA has developed maximum contaminant levels (MCLs) and treatment technique requirements for more than 80 contaminants in drinking water. (MCLs are contaminant concentrations set at or near levels at which there are no known human health effects. Treatment techniques are developed instead of MCLs for contaminants that are difficult to measure.) Public water systems must use appropriate treatment and conduct routine monitoring to ensure that the water provided to consumers consistently meets health-based standards at the tap.

The 1996 SDWA amendments strengthen and improve efforts to protect the quality of drinking water. Among the new provisions are better approaches for preventing contamination of drinking water (e.g., wellhead and watershed protection programs), improved consumer information, improved regulatory strategies, and new funding mechanisms for infrastructure.

Public water systems are classified according to the number of people they serve, the source of their water, and whether they serve the same customers year-round or only on an occasional basis (Table 6.1). State and federal managers supervise approximately 171,000 public water systems in the United States. Most of the information on trends refers to the nation's 55,000 community water systems (CWSs) which serve about 248 million people or 91 percent of Americans.

Coasts

The nation's coastal and marine domain is vast. It includes some 34,000 square miles of estuaries (excluding Alaska) and about 59,000 miles of ocean shoreline.

Coasts and estuaries are stressed by a wide range of human activities. They receive pollutants from farmland and developed areas; support marinas, commercial fishing fleets, and recreational activities; and are highly prized areas for both commercial and residential development. These pressures have increased over the past few decades as the population in coastal areas has grown. The U.S. coastal zone represents only about one fourth of total U.S. land area, yet the Bureau of the Census estimates that in 1997 over 141 million people—roughly

Table 6.1 U.S. Public Water System Inventory Data, 1996

Water Source	Community Water Systems		Non-Transient Non-Community Water Systems		Transient Non-Community Water Systems	
	Systems	Population Served	Systems	Population Served	Systems	Population Served
	(number)	*(millions)*	*(number)*	*(millions)*	*(number)*	*(millions)*
Surface	10,500	160.0	760	0.8	2,143	0.9
	(19%)	(64%)	(4%)	(13%)	(2%)	(6%)
Ground	44,219	89.0	19,300	5.3	94,009	15.3
	(81%)	(36%)	(96%)	(87%)	(98%)	(94%)
Total	54,728	249.0	20,061	6.1	96,153	16.2
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)

Source: U.S. Environmental Protection Agency, Office of Water, Office of Ground Water and Drinking Water, Office of Enforcement and Compliance Assurance. *Providing Safe Drinking Water in America: 1996 National Public Water System Annual Compliance Report and Update on Implementation of the 1996 Safe Drinking Water Act Amendments* (EPA, OECA, Washington, DC, 1998).

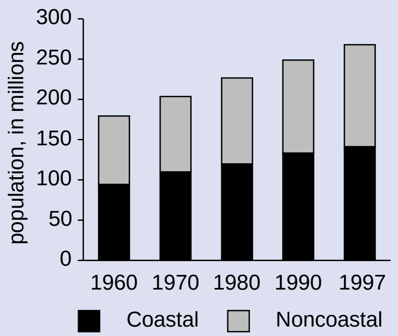
Notes: Data for the report cited above are from EPA's Safe Drinking Water System (SDWIS) for the 12-month period ending December 1996, as reported to EPA by the states as of June 1998. Populations are not summed because some people may be served by multiple systems and counted twice. Community Water System = supplies water to the same population year round. Non-Transient Non-Community Water System = regularly supplies water to at least 25 of the same people at least six months per year, but not year-round. Some examples are schools, factories, office buildings, and hospitals which have their own water systems. Transient Non-Community Water System = provides water in a place such as a gas station or campground where people do not remain for long periods of time.

53 percent of the total U.S. population—were living within the coastal zone area (Figure 6.3).

Many coastal areas continue to suffer from overutilization, loss of important habitats, and damage from pollution. More than one third of the nation's assessed estuarine waters do not fully support designated uses.

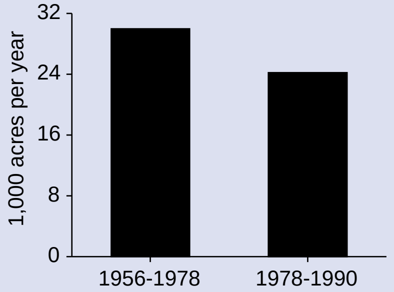
Important coastal habitats include estuaries, salt and fresh water marshes, tidal flats, estuarine forested wetlands, sandy beaches, barrier islands, seagrass beds, coral reefs, and deltas and dunes. These habitats are nurseries and spawning

Figure 6.3 U.S. Population by Coastal and Noncoastal Place of Residence, 1960-1997



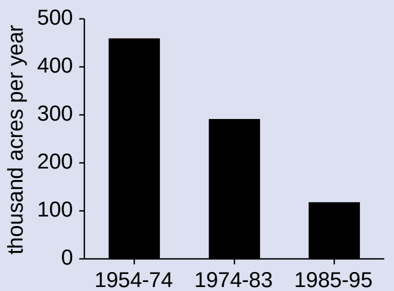
Source: See Part III, Table 1.7.

Figure 6.4 Louisiana Wetlands Losses, 1956-1990



Source: Johnson et al., "Gulf of Mexico Coastal Wetlands: Case Studies of Loss Trends," In: *Our Living Resources,* LaRoe et al, eds., U.S. Department of the Interior, National Biological Service (GPO, Washington, DC, 1995).

Figure 6.5 Average Annual Rate of U.S. Wetlands Losses, 1950s to 1990s



Source: See Part III, Table 6.14.

grounds for many commercially valuable species.

Along the Gulf of Mexico, for example, coastal wetlands and seagrass beds are diminishing. This loss is of special interest because of the role these coastal habitats play in supporting fish and shellfish of economic importance. It is estimated that the loss of wetlands in Louisiana is the largest of any state and accounted for 67 percent of the nation's total loss for the period 1978-90 (Figure 6.4).

Long-term survey data by the U.S. Geological Survey show that coastal erosion is affecting each of the 30 coastal states. About 80 percent of U.S. coastal barriers are undergoing net long-term erosion at rates ranging from less than 3.3 feet to as much as 65 feet per year.

Wetlands

Wetlands in the United States support about 5,000 plant species, 190 amphibian species, and one third of all bird species. In addition, they provide habitat for nearly one half of the fish, one third of the birds, one fourth of the plants, and one sixth of the mammals on the threatened and endangered species list.

Until the mid-1980s, conversions to cropland accounted for most wetlands losses. In the 1954-74 period, 87 percent of the annual net losses of 458,000 acres were converted to cropland. In the 1974-84 period, estimated annual losses dropped to an average of 290,000 acres, with agriculture still accounting for over half of the total. Since the early 1980s, wetlands losses have slowed significantly. Over the 1985-95 period, total net losses of wetlands dropped to an estimated 117,000 acres per year (Figure 6.5).

Among regions, there are a variety of different threats to wetlands. In the Southeast, which has more wetlands area and has lost more wetland acres than any other region, remaining wetlands are declining in quality because of nutrient loading, altered hydrology, and urban encroachment. In the Northern Plains, nearly half of the original wetlands in the prairie pothole region have been drained; of those remaining, many are cropped when the weather permits.

Fish and Shellfish

At the global and national level, there are many signs that fishery resources are imperiled. The Food and Agriculture Organization of the United Nations estimates that, of 200 stocks fished worldwide, more than 25 percent are overexploited, depleted, or recovering, while 38 percent are fully exploited.

The situation for U.S. fishery resources is similarly troubling. Of the 201 stock groups whose biological status is monitored by the National Oceanic and Atmospheric Administration, 36 percent (73 groups) are currently below estimated optimum long-term levels.

By the late 1900s, for example, west coast salmon abundance had declined to only 10 to 15 percent of what it had been in the late 1800s. In recent years, precipitous salmon declines have hurt the economies of fishing-dependent coastal and rural inland communities throughout the Pacific Northwest and northern California. Along the Pacific Coast, 15 distinct population segments of Pacific salmon and anadromous trout are listed as either endangered or threatened under the Endangered Species Act. Others are proposed for listing.

While no “species” of anadromous trout or salmon is in danger of near-term extinction, individual population segments within these species have declined substantially or have even been extirpated. The American Fisheries Society considers at least 214 Pacific Coast anadromous fish populations to be “at risk,” while at least 106 historically abundant populations have already become extinct.

The Northeast’s valuable crustacean and bivalve molluscs, both offshore (lobsters, sea scallops, etc.) and inshore (blue crabs, oysters) are fully or overexploited. In the Southeast, the three major shrimp species (brown, white, and pink) are considered fully utilized in both the Gulf of Mexico and the Atlantic.

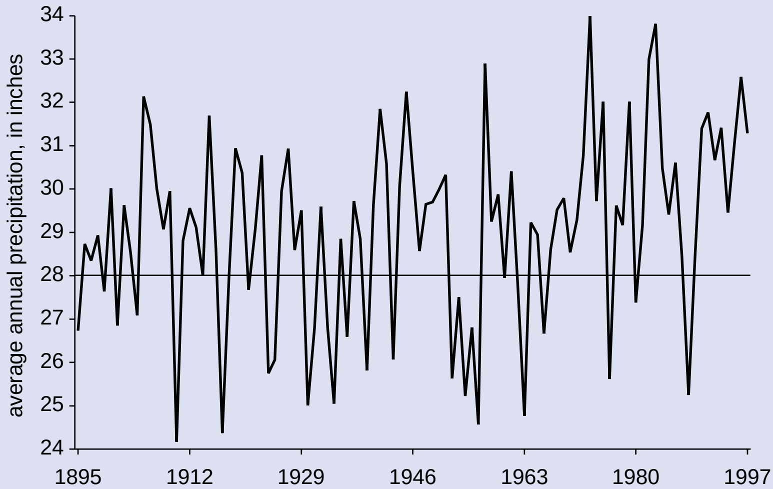
TRENDS

Precipitation

The contiguous United States usually receives about 28-30 inches of precipitation annually. In dry years, average annual precipitation may drop to 24-25 inches; in wet years, average annual precipitation can rise to 32-33 inches (Figure 6.6). Data indicate that annual 1997 precipitation averaged across the contiguous United States was above the long-term mean, ranking as the 43rd wettest year on record. Each of the last eight years has averaged near to much wetter than the long-term mean. (Part III, Table 6.1)

The national precipitation index, another indicator of trends, expresses precipitation departure from the 60-year mean in terms of standard deviations, thus indicating how precipitation across the country compares to the local normal (60-year average) climate. Each year’s value is computed by standardizing the annual precipitation in each of 344 cli-

Figure 6.6 U.S. Precipitation Trends, 1895-1997



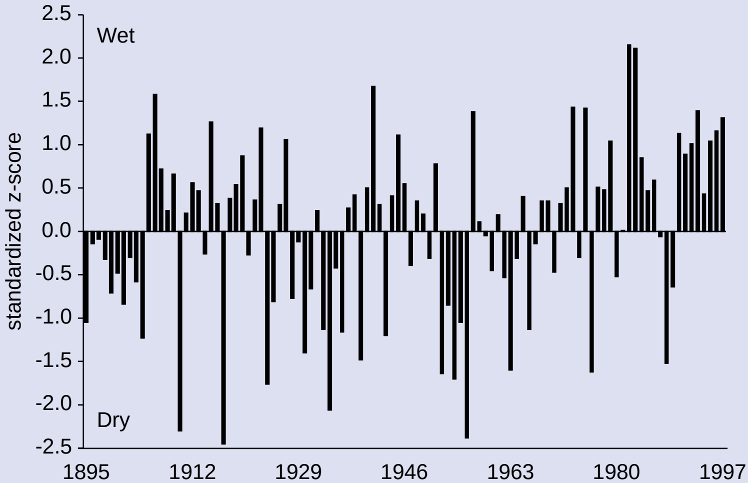
Source: See Part III, Table 6.1.

mate divisions across the U.S. using the gamma distribution over the 1931-90 period. The gamma statistical distribution takes into account heavy precipitation years and extremely dry years in the historical record (in mathematical parlance, “a zero-bounded skewed distribution”). These gamma-standardized divisional values are then weighted by area and averaged to determine a national standardized value for each year. These national values are normalized over the period of record. Negative values are drier and positive values are wetter than the mean. The national standardized precipitation index ranked 1997 as the 26th wettest year on record. About twelve percent of the country averaged much wetter than normal for the year, with only five percent averaging much drier than normal (Figure 6.7).

In an average year, about 9 percent of the contiguous United States is severely to extremely dry and about 9 percent is severely to extremely wet. But there is considerable variation in these numbers. In 1983, 36 percent of the country experienced unusually wet weather. In the Dust Bowl year of 1934, almost half the country—48.8 percent—was unusually dry.

In both 1995 and 1996, roughly one fourth of the country experienced unusually wet weather. In addition, much of the country has been struck by natural disasters in the past few years. During July and August 1993, devastating floods hit the lower Missouri River, the upper Mississippi River, the Illinois River, and many of their tributaries. Thirty-eight lives were lost, and estimated damages were between $10 billion and $16 billion. In 1997, according to preliminary data, 3.5 percent of the conterminous United States experienced severe to extreme drought and 25.7 percent of the nation

Figure 6.7 U.S. Precipitation Index, 1895-1997



Source: See Part III, Table 6.1.
Note: The standardized z-score is an index computed from precipitation records. It expresses precipitation departure from the 60-year mean in terms of standard deviations. See notes for Table 6.1.

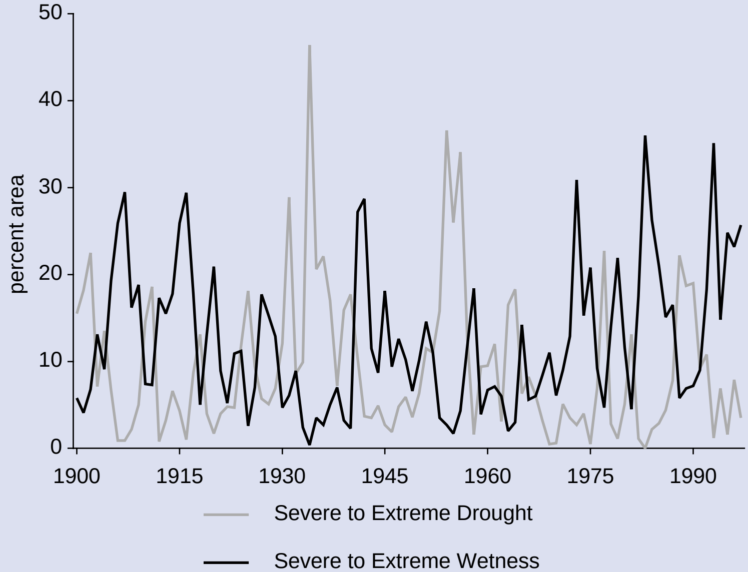
experienced severe to extreme wetness (Figure 6.8). (Part III, Table 6.2) Core wet areas included the Northern Rockies, Central and Southern Plains, and portions of the Southeast. Core dry areas included portions of the Southwest, Ohio valley, Northern Great Lakes, and portions of New England.

On a global scale, 1997 was the warmest year of this century, based on land and ocean surface temperature data analyzed by NOAA's National Climatic Data Center. (Also see Chapter 11). In the United States, however, the annual 1997 temperature averaged across the lower 48 states was near the long-term mean, due primarily to the strong El Nino conditions that resulted in milder-than-normal conditions over much of central North America. In 1997, nearly fourteen percent of the country was much cooler than normal for the year while over ten percent of the country was much warmer than normal. Nine out of the last 13 years have averaged near to much warmer than the long-term mean.

Water Use

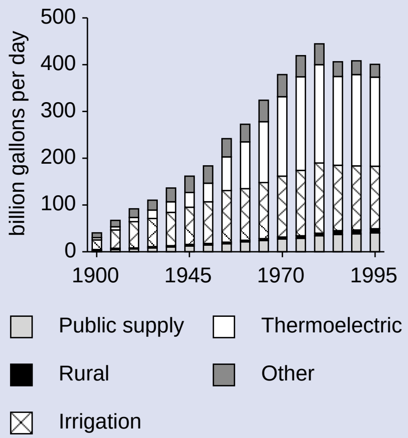
From 1900 to 1980, national water use grew by more than a factor of 10, rising from 40 to 445 billion gallons per day. From 1980 to 1995, water use declined from 444 to 401 billion gallons per day. This decline occurred even though population increased 16 percent over the period. Among sectors, the largest declines were in irrigation and thermoelectric utilities (Figure 6.9). In 1995, about 80 percent of total water use—323 billion gallons per day—was from surface water, with the remainder from groundwater. (Part III, Table 6.3) On a per capita basis,

Figure 6.8 Severe to Extreme Wetness and Drought in the Contiguous United States, 1900-1997



Source: See Part III, Table 6.2.

Figure 6.9 U.S. Water Use by Sector, 1900-1995



Source: See Part III, Table 6.3.

total water use declined from 1,916 gallons per day to 1,498 gallons per day.

The "Public supply" and "Rural domestic and livestock" categories are the only two categories to show continual increases from 1950 to 1995, largely because of continual increases in population. The 4 percent increase in public-supply withdrawals from 1990 to 1995, compared to a 7 percent increase in population served by public supply, indicates that conservation programs have been effective in lowering public supply per capita use. The 13 percent increase in rural domestic and livestock withdrawals is attributable to an increase in livestock withdrawals, especially animal specialities withdrawals (such as fish farms), which were 43 percent higher during 1995 than during 1990.

More water (fresh and saline) continues to be withdrawn for thermoelectric power generation than for any other category, peaking in 1980 at 210 billion gallons per day and fluctuating around 190 billion gallons per day since then. Instream use (hydroelectric power) increased steadily from 1950 to 1975 and has fluctuated above 3,000 billion gallons per day since then. Changes in hydroelectric power water use are closely related to the availability of surface water.

Industrial withdrawals declined from 1980 to 1995 after remaining about the same for the years reported between 1965 and 1980. Lower industrial withdrawals are the result of new industries and technologies that require less water, improved plant efficiencies, increased water recycling, changes in laws and regulations to reduce the discharge of pollutants, and conservation measures.

Irrigation withdrawals during 1995 were 2 percent less than during 1990 and 1985. The 1995 irrigation application rate—2.1 acre-feet per acre—was slightly less than the 1985 average of 2.2 acre-feet and well below the 1975 and 1980 average of 2.5 acre-feet per acre. The decline in irrigation rates is the result of improved irrigation techniques, implementation of more efficient irrigation systems, and application rates in the eastern United States that tend to be less than in the western United States.

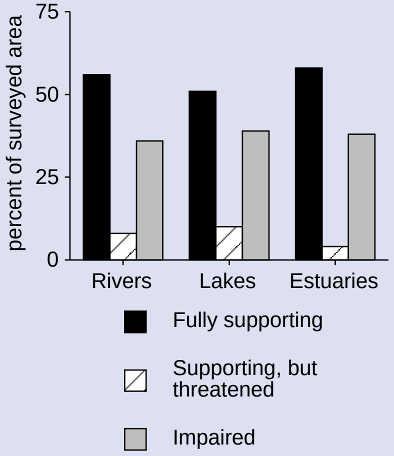
Total freshwater consumptive use—that part of water withdrawn that is evaporated, transpired, or incorporated into products or crops—is estimated to have been 100 billion gallons per day during 1995, or 6 percent more than during 1990. Consumptive use for irrigation accounts for the largest part of total consumptive use—an estimated 81 bgd for 1995. Freshwater consumptive use is about 12 percent of withdrawals in the East and 47 percent of withdrawals in the West. The higher consumptive use in the West is attributable to the 90 percent of water withdrawn for irrigation.

The use of reclaimed wastewater is estimated at 1,020 million gallons per day in 1995, which is more than double the amount used in the 1970s and 1980s. Wastewater is water released from private and public wastewater treatment facilities after use. The releases can be returned either to the natural environment or reclaimed for beneficial uses, such as irrigation of golf courses and parks. Illinois, Ohio, Florida, California, and Arizona all reported large uses of reclaimed wastewater.

Water Quality

Environmental Protection Agency surveys provide useful insights into the quality of the nation's surface waters. The latest *National Water Quality Inventory* was conducted in 1996. It compiles data reported by states, territories, and tribes. Of 693,905 river and stream miles surveyed (about 19 percent of the total), about 64 percent were supporting their designated uses, while about 36 percent were impaired. In the case of lakes, ponds, and reservoirs, 40 percent of the 41 million acres were surveyed. About 61 percent of the 16.8 million acres surveyed were supporting their

Figure 6.10 Overall Use Support in U.S. Surface Waters, 1996



Source: See Part III, Table 6.4.
Note: Based on an assessment of 19% of U.S. river and stream miles, 40% of U.S. lake acres, and 72% of U.S. estuary square miles.

designated uses. Of the 28,819 square miles of estuaries surveyed (about 72 percent of the total), about 62 percent were supporting their designated uses (Figure 6.10). (Part III, Table 6.4)

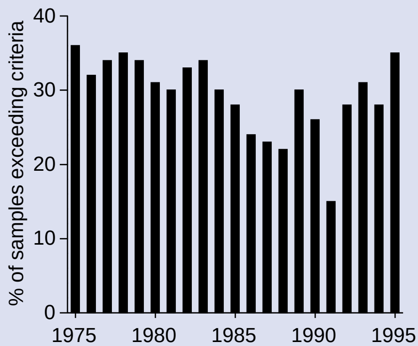
Trends for selected water quality indicators in streams during the period from 1980 to 1989 were compiled at the U.S. Geological Survey's National Stream Quality Accounting Network (NASQAN) stations. For most stations, water quality indicators stayed about the same during this period. (Part III, Table 6.5)

Ambient water quality seems to be generally improving in U.S. rivers and streams. The percentage of measurements exceeding state water quality criteria has declined for dissolved oxygen, total phosphorus, total cadmium, and total lead. The one exception is fecal coliform bacteria, where violation rates have remained in the 30-35 percent range (Figure 6.11). (Part III, Table 6.6)

EPA's 1996 Clean Water Needs Survey includes detailed estimates of the capital costs eligible for funding under the State Revolving Fund (SRF) provisions of the 1987 Amendments to the Clean Water Act (CWA). The survey covers publicly owned, municipal wastewater collection and treatment facilities, facilities for the control of combined sewer overflows (CSOs), activities designed to control storm water (SW) runoff and nonpoint source (NPS) pollution, and programs designed to protect the nation's estuaries. The primary objective of the survey is to update and expand the documented costs for all program categories eligible for SRF funding.

Nationally, 16,024 wastewater treatment facilities are identified in the 1996 survey. These facilities provide service to 190 million people, representing 73 percent of the total population. When all

Figure 6.11 Coliform Bacteria Violation Rates, 1975-1995



Source: See Part III, Table 6.6.

Table 6.2 Improvements in Treatment Level of Wastewater Treatment Facilities, 1988-1996

Level of Treatment	1988	1992	1996	1996 facilities design capacity	1996 population served	
		number of facilities		*mgd*	*millions*	*%*
Non-discharge	1,854	1,981	2,032	1,421	7.66	2.9
< Secondary	1,769	868	176	3,054	17.18	6.5
Secondary	3,536	9,086	9,388	17,734	81.94	31.0
> Secondary	3,412	3,678	4,428	20,016	82.93	31.4
Total	15,591	15,613	16,024	42,225	189.71	71.8

Source: U.S. Environmental Protection Agency, Office of Wastewater Management, *1996 Clean Water Needs Survey Report to Congress* (Washington, DC, 1998), and earlier reports in this series.

Notes: mgd = millions of gallons per day. Non-discharge = facilities that do not discharge effluent to surface waters (e.g., spray irrigation, ground water recharge). A secondary treatment level is defined as an effluent biochemical oxygen demand (BOD) of between 25 and 30 milligrams per liter.

needs are met in 2016, there will be an estimated 18,303 publicly owned wastewater treatment facilities serving 275 million people, or 90 percent of the projected population of 305 million.

According to the 1996 survey, the level of treatment has changed significantly over the last eight years. The number of facilities providing less than secondary treatment has declined by 90 percent since 1988. In 1988, 1,789 (11 percent) of the 15,591operational facilities were providing less than secondary treatment. This declined to 868 (6 percent) in 1992 and to 176 (1 percent) in 1996.

At the same time, there has been a steady increase in the proportion of facilities providing secondary and greater than secondary treatment. The number of facilities providing secondary treatment has increased by 10 percent, while those providing advanced wastewater treatment increased by almost 30 percent since 1988. In 1996, 28 percent (4,428 out of 16,024) of the operational treatment facilities are providing greater than secondary treatment (Table 6.2).

From 1992 to 1996, total needs decreased by $15.5 billion. This reflects, in part, progress made in meeting the nation's water quality infrastructure needs. For a given facility, a reduction in need may signify completion of project construction, reduction in the original project scale, or elimination of the need for projects included in previous surveys. In contrast, an increase in need signifies entirely new facilities being required or new projects to upgrade or expand existing facilities. Underlying factors that influence these changes include continued population growth, deterioration of existing facilities, and increasingly stringent water quality requirements. Changes in needs also reflect efforts to improve the quality of the data in the needs survey database through a substantial redocumentation effort.

The largest needs occur in New York, Illinois, and California. New York has $16 billion in needs, while California and Illinois have needs in excess of $11 billion. Sixteen additional states have needs in excess of $2 billion. Needs continue to be generally concentrated in the highly populated northeastern states (New Jersey, New York, and Pennsylvania) and in the Great Lakes states (Illinois, Michigan, and Ohio) as well as in Florida and Texas. The less populated states, generally located in the Rocky Mountains and the Plains, have lower levels of needs.

Most combined sewer overflow (CSO) needs are concentrated in the northeastern states (Massachusetts, New Jersey, New York, and Pennsylvania) and in the Great Lakes states (Illinois, Indiana, Michigan, and Ohio). Illinois has the largest documented CSO needs ($9.4 billion), indicating that considerable effort has gone into documenting this state's CSO problems and into developing municipal CSO program plans. Indiana, Massachusetts, Michigan, New Jersey, New York, Ohio, and Pennsylvania all have CSO needs in excess of $2 billion. This geographical concentration of CSO needs reflects the age of the infrastructure in these areas and the fact that combined sewers were considered acceptable practice at the time many older sewer systems were built.

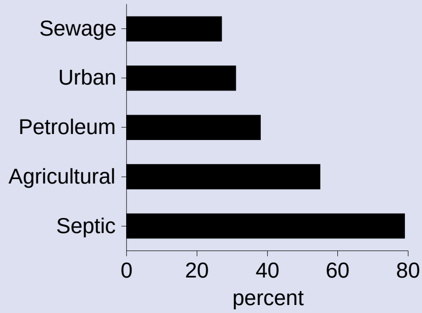
Water quality program needs for small communities are significant, reflecting, in part, the continuing efforts to extend wastewater collection and treatment to small communities. The total documented needs for communities with populations less than 10,000 are $13.8 billion, representing 11 percent of the total documented needs for the nation.

Drinking Water

Today, most people drink water that meets federal and state standards, but there are continued threats to the safety of some drinking water supplies. Figure 6.12 shows potential sources of contamination within two miles of community water system supply intakes or wells.

Most large community water systems, 95 percent of medium-size systems, and between 70 and 88 percent of small systems provide some treatment of drinking water supplies. Of those reporting no treatment, 80 percent rely on groundwater as their only source. Over one third of all community systems participate in

Figure 6.12 Percentage of CWSs Reporting Potential Sources of Contamination by Source, 1995



Source: U.S. Environmental Protection Agency, Office of Water, *Community Water System Survey*. Volume I. EPA 815-R-97-001a (EPA, OW, Washington, DC, 1997).
Notes: CWSs = Community Water Systems. Data refer to potential sources of contamination within two miles of CWS supply intake or wells.

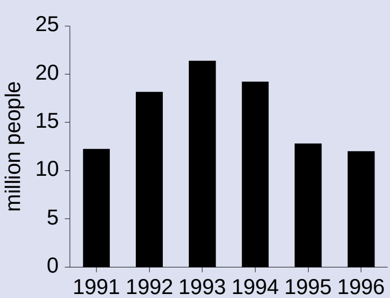
some type of source water protection, primarily zoning or land use controls, best management practices, and education on land use impacts.

In 1996, of the 248 million people served by community systems, 86 percent drank water from systems that reported no violations of any health-based drinking water standards. Small systems have the largest number of violations, but a much larger population is served by large systems with violations.

The population served by systems violating the Total Coliform Rule MCL peaked in 1993 (Figure 6.13) and decreased thereafter as systems, particularly those serving very large populations, took action to correct treatment or operational deficiencies causing the violations. The population served by systems violating the Surface Water Treatment Rule remains stable at around 11 million people. The reason is that installation of filtration treatment, which was required by Safe Drinking Water Act to be in place by 1993 for a number of large systems, has taken longer than anticipated for a variety of reasons, including planning, design and construction of the complex infrastructure needed. Violations of both the total coliform and surface water treatment rules indicate a potential for contamination by microbial pathogens, rather than the actual presence of such pathogens in drinking water. Of the 12,000 total coliform violations in 1996, about 19 percent included detections of either fecal coliforms or *E. coli*, which are considered more direct indicators of pathogen contamination.

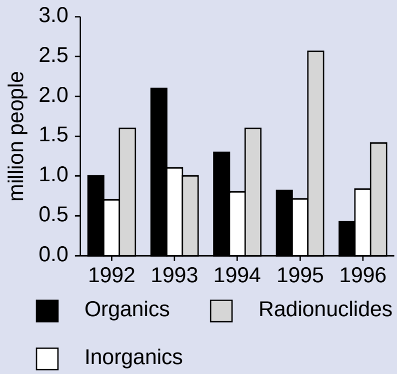
The population served by community systems violating one or more of the chemical and radiological MCLs is relatively small (Figure 6.14). These standards cover volatile and synthetic organic

Figure 6.13 Population Served by CWSs with Violations of the MCL for Total Coliform, 1991-1996



Source: U.S. Environmental Protection Agency, Safe Drinking Water Information System.
Notes: CWSs = Community Water Systems. MCL = Maximum Contaminant Level.

Figure 6.14 Population Served by CWSs with Violations of Chemical and Radiological MCLs, 1992-1996



Source: U.S. Environmental Protection Agency, Safe Drinking Water Information System.
Notes: CWSs = Community Water Systems. MCLs = Maximum Contaminant Levels.

compounds (e.g., benzene and atrazine), inorganic compounds (e.g., nitrate), and radionuclides (e.g., radium).

Some 22 million people were served by community systems with significant violations in monitoring and reporting requirements in 1996. The rules pertaining to total coliform, surface water treatment, organic chemicals, and nitrate accounted for most of these violations. While monitoring and reporting violations do not necessarily indicate a health risk, if a system fails to monitor it may not be aware of the potential health risk posed by a contaminant that may be present but undetected.

In its first report to Congress from the 1996 Drinking Water Infrastructure Needs Survey, EPA concludes that much of the nation's drinking water infrastructure suffers from long-term neglect and serious deterioration and that significant investments (Figure 6.15) are needed to protect public health and ensure the availability of safe drinking water.

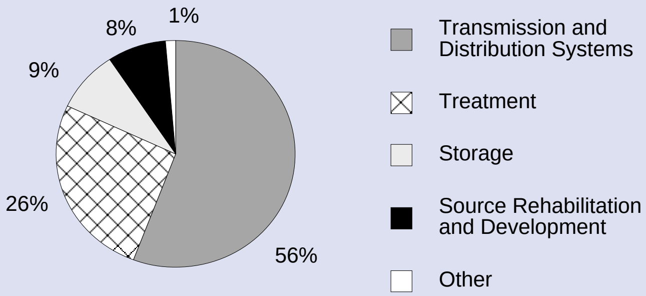
Oil Pollution

Oil polluting incidents in and around U.S. waters have fluctuated somewhat since 1970, but the recent trend in the annual number of incidents is down. In the 1970s, typically 8-10,000 incidents per year resulting in an annual total of 10-20 million gallons of spilled oil were reported annually. In 1997, about 8,624 incidents were reported involving 942,574 gallons (Figure 6.16). (Part III, Table. 6.8)

Fish and Shellfish

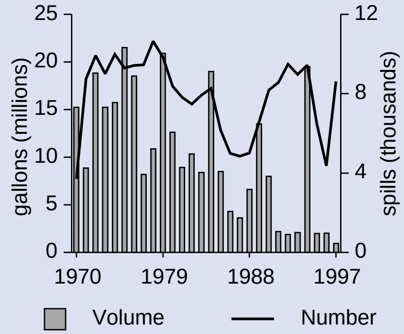
NOAA's National Shellfish Register collects data on the number of shellfish-rearing areas with harvest restrictions.

Figure 6.15 Total 20-Year Estimated Needs of Community Drinking Water Systems by Category



Source: U.S. Environmental Protection Agency, Office of Ground Water and Drinking Water, *Drinking Water Infrastructure Needs Survey: First Report to Congress* (EPA, OGWDW, Washington, DC, 1997).
Notes: Total needs = $138.4 billion (1995) dollars. Data are estimates based on a survey of 4,000 of the 55,000 U.S. Community Water Systems. Other includes projects to protect water systems against earthquake damage, automate treatment plant operations, and improve laboratory facilities.

Figure 6.16 Oil Spills In and Around U.S. Waters, 1970-1997



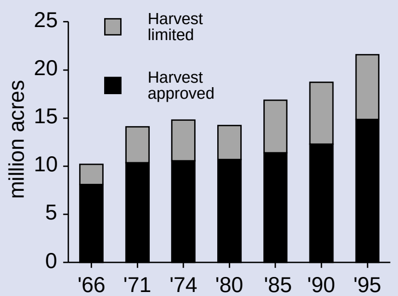
Source: See Part III, Table 6.8.

The number of acres of restricted shellfish-growing acres seems to be increasing, both in percentage and absolute terms. In 1980, for example, 25 percent (3.5 million acres) of the 14.2 million acres reported to NOAA were harvest-limited. In 1995, 31 percent (6.7 million acres) of 21.5 million acres were harvest-limited, including 2.8 million acres that were prohibited (Figure 6.17). (Part III, Table 6.9)

Commercial harvests of shellfish, crabs, and lobsters were mixed in 1997. Landings of all clams totaled 114.2 million pounds of meats, down 7 percent from 1996. Landings of all species of crabs were 430 million pounds, up 10 percent from 1996. The American lobster catch totaled 83.9 million pounds, up 17 percent. U.S. landings of bay, calico, and sea scallops totaled 15.5 million pounds of meats, down 17 percent from 1996.

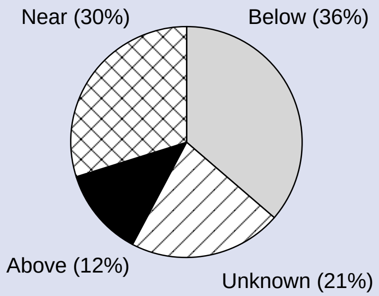
Of the 201 fish stock groups in high seas waters whose biological status is monitored by NOAA, 36 percent (73 groups) are currently below estimated optimum long-term levels (i.e., productivity is below the estimated long-term potential yield) and the fishery is overutilized. Another 30 percent are near optimum long-term levels (Figure 6.18). Of the 73 overutilized stocks, fully one third (19 stocks) occur among the demersal fisheries (groundfish and flounder) in the Northeast. A notable trend in the Northeast is the continued decline in landings of the region's traditional groundfish species (cod, haddock, and flounder) (Figure 6.19). One by one, many of the most productive stocks collapsed in the wake of an unprecedented fleet build-up from the mid-1970s to mid-1980s, increasingly efficient fishing methods, competition between fleet sectors employing various gears, and failure to heed scientific advice before stocks declined to historically low levels. When quota management systems, controls on net mesh size, closed fishing areas, and minimum fish sizes proved ineffective, additional efforts to restrict entry into the fishery, days at sea, and where vessels can fish as well as a multi-million dollar, government-spon-

Figure 6.17 Classified U.S. Shellfish Waters, 1966-1995



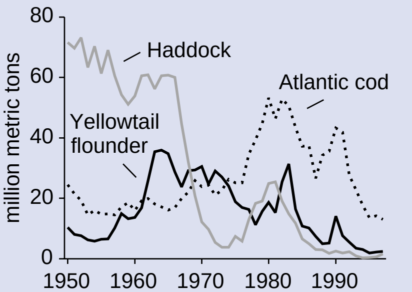
Source: See Part III, Table 6.9.
Note: Harvest limited = sum of conditionally approved, restricted, conditionally restricted, and prohibited.

Figure 6.18 Status of U.S. Fishery Resources Relative to Abundance Levels That Would Produce Sustainable Yield, 1994



Source: See Part III, Table 6.10.
Note: Based on 201 monitored stocks.

Figure 6.19 Commercial Landings of Northeast Groundfish, 1950-1997



Source: National Marine Fisheries Service (NMFS), *Fisheries of the United States* (NMFS, Washington, DC, annual).

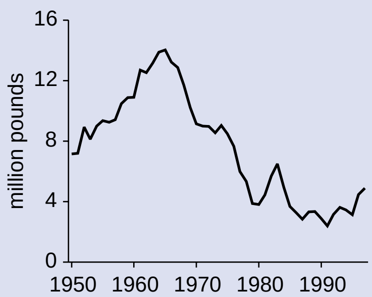
sored vessel buy-out and job retraining program were initiated in an attempt to salvage the fishery.

In addition, 9 stocks or stock groups of Atlantic and Gulf of Mexico reef fish are overutilized at dockside. (Part III, Table 6.10) One of the species in this group, the red snapper, is seriously depleted (Figure 6.20), due in part to incidental bycatch of juveniles by the shrimp fishery in the Gulf of Mexico. NOAA estimates that red snapper stocks cannot recover unless the mortality from shrimp trawling can be reduced by at least 50 percent. Management strategies being considered to achieve this goal include area closures, seasonal closures, and the use of bycatch reduction devices on shrimp trawls.

Wetlands

In the mid-1950s, it was estimated that the nation had about 107.5 million acres of wetlands, including 55 million acres of palustrine forested wetlands and 33 million acres of palustrine marshes. By the mid-1990s, the total had slipped by 6 percent to 100.9 million acres. (Part III, Table 6.12) This continues a long trend of wetland losses. Between the 1780s and 1980s, some 22 states lost more than 50

Figure 6.20 Commercial Landings of Red Snapper in the Atlantic and Gulf, 1950-1997



Source: National Marine Fisheries Service (NMFS), *Fisheries of the United States* (NMFS, Washington, DC, annual).

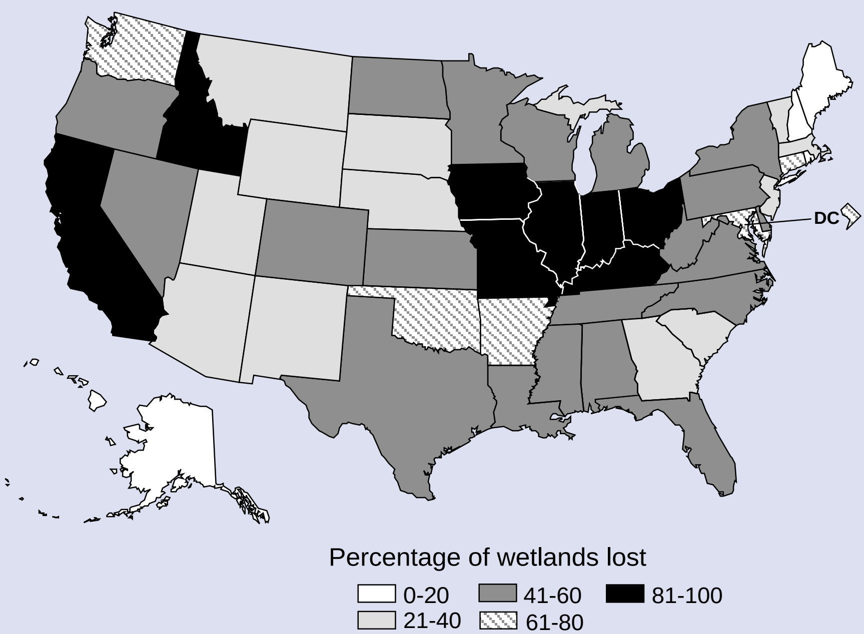
percent of their wetland area (Figure 6.21). (Part III, Table 6.13)

Historically, conversion of wetlands to cropland has been the single biggest factor in wetland losses. Recently, however, agricultural conversion has declined sharply, largely as a result of numerous federal laws and programs designed to preserve wetlands. (Part III, Table 6.14) The Wetlands Reserve Program, established in 1990, and the Emergency Wetlands Reserve Program, established in response to the 1993 flooding in the Upper Mississippi River and Lower Missouri Basins, were established to restore wetlands through the purchase of conservation easements from willing sellers. As of July 1997, 533,026 acres had been enrolled in 43 states. Fifty-eight percent (308,648 acres) of the total was enrolled in Louisiana, Mississippi, Missouri, Arkansas, and Iowa (Figure 6.22).

ONLINE RESOURCES

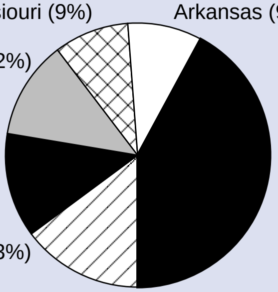
A good site for information on water resources is the Department of Interior's U.S. Geological Survey (http://water.usgs.gov). This site provides information about national water conditions, historical water data, fact sheets on a variety of water-related topics, and many other features.

Figure 6.21 Wetland Losses by State, 1780s to 1980s



Source: See Part III, Table 6.13.

Figure 6.22 States with Largest Acreages in Wetlands Reserve Programs, July 1997



Source: USDA, ERS, *Wetlands Reserve Programs*, AREI Updates 1997, No. 6 (Washington, DC, 1997).
Note: Data refer to percentage of total enrollment (533,026 acres).

Another valuable source of information is EPA's Office of Water (http://www.epa.gov/ow) and the new Watershed Information Network (http://www.epa.gov/win), which was developed by EPA in partnership with a number of other federal agencies. Within the Office of Water is the Office of Wetlands, Oceans, and Watersheds. This site includes special pages on wetlands (http://www.epa.gov/owow/wetlands) and oceans and coastal protection (http://www.epa.gov/owow/ocean). Interior's Fish and Wildlife Service also maintains a useful site devoted to wetlands (http://www.nwi.fws.gov).

The Office of Water also has posted selected chapters of the latest National Water Quality Inventory (http://www.epa.gov/OWOW/monitoring/wqreport.html). Information on the 1996 Clean Water Needs Survey is online (http://www.epa.gov/owm/toc.htm).

For information on drinking water, visit EPA's Office of Ground Water and Drinking Water online (http://www.epa.gov/OGWDW/) and the 1998 Drinking Water Infrastructure Needs Survey (http://www.epa.gov/OGWDW/docs/needs/).

At the Department of Commerce, the National Oceanic and Atmospheric Administration (http://www.noaa.gov) has a valuable website with information on coastal issues and fisheries, a does NOAA's "State of the Coast" site (http://state-of-coast.noaa.gov). NOAA's National Marine Fisheries site is also valuable (http://www.noaa.gov/nmfs). Information on fisheries is available from each NMFS regional office.

The U.S. Coast Guard maintains several sites devoted to marine environmental protection, including a general site on marine environmental protection programs (http://www.uscg.mil/hq//g-m), and a site with information on pollution incidents in and around U.S. waters (http://www.uscg.mil/hq/gm/nmc/response/stats/aa.htm). The Coast Guard's Sea Partners campaign is an environmental education and outreach program designed to increase awareness of maritime pollution and marine environmental laws (http://www.uscg.mil/hq/g-m/nmc/seapart.htm).

Globally, there are many valuable online sites. The Food and Agriculture Organization of the United Nations (http://www.fao.org) monitors the condition of global fisheries (http://www.fao.org/WAICENT/FAOINFO/FISHERY/FISHERY.HTM). The site also includes information about trends in world fish trade and management issues.

DG XIV (http://europa.eu.int/comm/dg14/dg14.html) is the European Commission's Directorate-General responsible for the Common Fisheries Policy, which covers all fishing activities under Article 39 of the Treaty of Rome. DG XIV maintains a large links site (http://europa.eu.int/comm/dg14/site.htm) that provide access to dozens of research institutes, academic sites, and government sites.

The International Center for Living Aquatic Resources Management (ICLARM), which is a member of the Consultative Group on International Agricultural Research, maintains a website (http://www.cgiar.org/iclarm). This site provides a variety of information on the management and conservation of aquatic resources.

NGOs with an interest in aquatic issues include American Rivers (http://www.amrivers.org), National Audubon Society (http://www.audubon.org), National Wildlife Federation (http://www.nwf.org), Center for Marine Conservation (http://www.cmc-ocean.org), Ducks Unlimited (http://www.ducks.org), and The Nature Conservancy (http://www.tnc.org).

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CORE DATA

CHAPTER SEVEN

Terrestrial Resources

The nation's rural areas are environmentally significant in a number of ways. They are storehouses of biological resources, water resources, soil resources, and wildlife habitat. They provide a great many environmental services, and—in the form of farmland, grazing land, and forests—they are commercially valuable.

How rural areas are managed has far-reaching impacts on the state of the environment, from air and water pollution to biodiversity and stable ecosystems. Yet all these resources are entrusted to a relatively small share of the nation's population. The total rural population in 1996 was 53.5 million, or about one fifth of the national total. Only about 2 percent of the U.S. population grows much of the nation's food and fiber, with enough excess to export quantities to other countries.

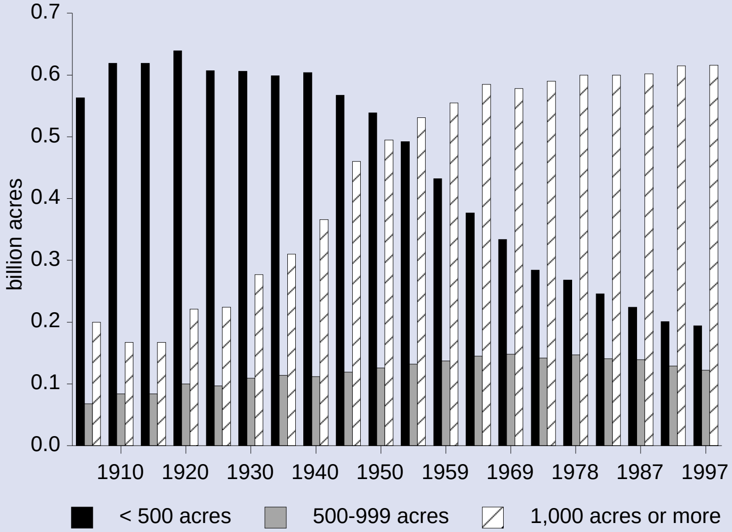
The general trend in U.S. agriculture for the past several decades is to grow more food on less land. The 932 million acres of farmland currently in use is about 20 percent less than the total in 1950. Small and mid-sized farms of less than 500 acres once managed about half the nation's farmland, but they currently manage only about 20 percent of the total. Large farms over 1,000 acres now control about two thirds of the nation's farmland (Figure 7.1).

U.S. agriculture also is increasingly specialized, mechanized, labor-efficient, and capital-intensive. In the past decade, U.S. farm output per unit of input increased by 20 percent. The factors responsible for this growth include use of fertilizers and pesticides, plus improvements in hybrid plant varieties and animal breeding practices.

The most intensively used and most valuable agricultural land is generally that planted to crops and known as cropland. Four out of every five cropland acres produces either corn, wheat, hay, or soybeans in a given year. The percentage of total land used for crops is largest in the Northern Plains and Corn Belt, followed by Lake States, Mountain, and Southern Plains regions (Figure 7.2). Most of the corn and virtually all of the hay is fed to livestock. Corn, wheat, and soybeans also are major export commodities.

In the 1970s, high worldwide demand for U.S. farm commodities, fueled by crop shortages abroad, encouraged a federal farm policy that emphasized increased production. At the same time, an emerging national interest in environmental protection increased concerns about soil erosion from cropland and the environmental impact of fertilizer and pesticide use.

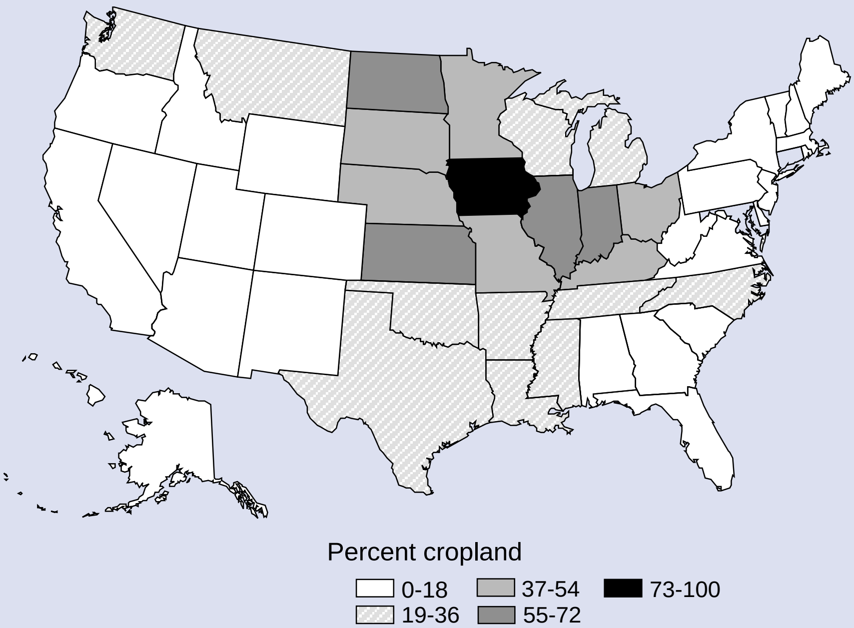
Figure 7.1 Land in U.S. Farms by Farm Size, 1900-1997



Source: See Part III, Table 7.3.

Note: Data are reported for years coinciding with the Census of Agriculture.

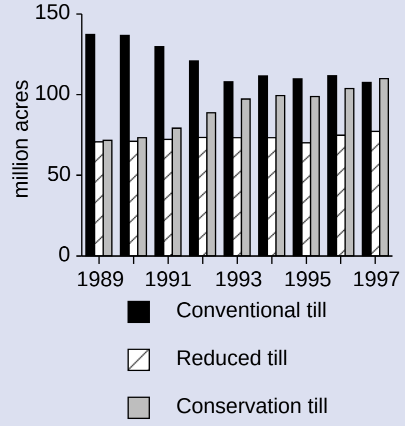
Figure 7.2 Proportion of State Land Area in Cropland, 1992



Source: Daugherty, A.B., *Major Uses of Land in the United States, 1992* (USDA, ERS, Washington, DC, 1995).

Since that time, a wide variety of federal programs have been developed to encourage better management of soil resources, fertilizers, and pesticides. Conservation tillage practices, which were rarely practiced in the 1970s, are now used on about 37 percent of all planted acres (Figure 7.3). Federal programs encourage farmers not to plow highly erodible lands or convert wetlands to croplands. Practices such as integrated pest management are also more widely used.

Figure 7.3 U.S. Cropland Tillage Practices, 1989-1997



Source: See Part III, Table 7.5.

Grazing Lands

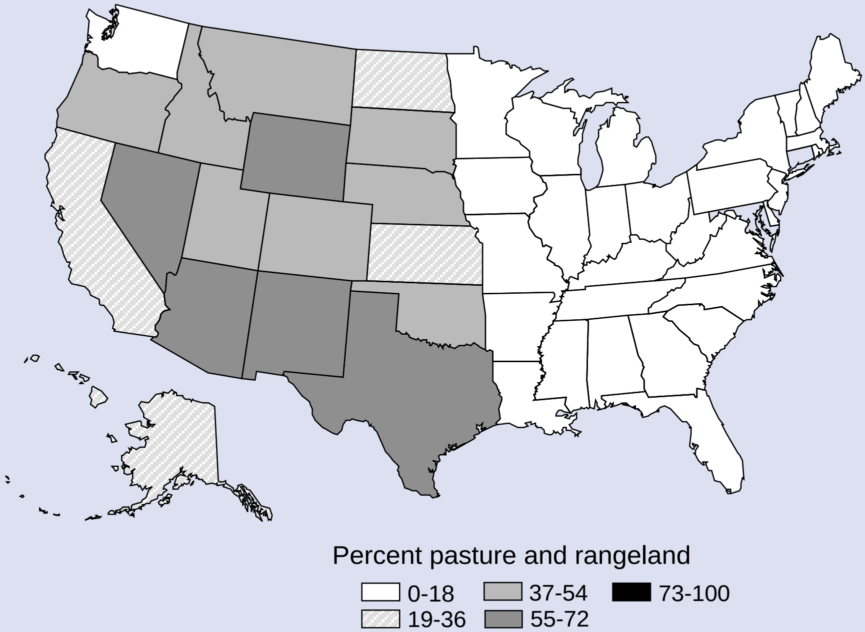
The nation has about 803 million acres of grazing lands, including 591 million acres of grassland pasture and range, 145 million acres of grazed forestland, and 67 million acres of cropland used for pasture. About 55 percent of grazing lands are privately owned, with the rest on federal lands in 11 western states and Alaska (36 percent), on state and local government land (5 percent), and on land managed by the Bureau of Indian Affairs held in trust for Indian tribes and individuals (4 percent). Most of the nation's grazing land is found west of the Continental Divide (Figure 7.4).

Though the condition of rangeland has improved somewhat in recent years, much of the nation's rangeland is degraded. The Bureau of Land Management, which manages about 169 million acres of land for grazing, estimated in 1997 that fully 50 percent of its grazing lands were in fair or poor condition. On nonfederal rangelands, it is estimated that about 59 percent of rangelands are either in fair or poor condition. For both BLM and nonfederal rangelands, the share of land in poor condition has declined sharply since the 1960s. For nonfederal lands, rangeland in poor condition declined from 40 percent of the total in 1963 to 15 percent in 1992. For BLM lands, rangeland in poor condition dropped from 30 percent to 13 percent over the 1966-97 period.

Forests

During the past 25 years, the United States has maintained a relatively stable area of forestland. Today, forests cover about 732 million acres in the United States. Roughly two thirds of all public and private U.S. forests (490 million acres) are classified as timberland—forests capable of producing 20 cubic feet per acre of industrial wood annually and not reserved from timber harvest. Another 36 million acres that could qualify as timber-

Figure 7.4 Proportion of State Land Area in Pasture and Rangeland, 1992



Source: Daugherty, A.B., *Major Uses of Land in the United States, 1992* (USDA, ERS, Washington, DC, 1995).

land are reserved from harvesting and managed as parks or wilderness.

The Southeast and South Central states have most of this resource, with 199 million acres of public and private timberland (Figure 7.5). The Northeast and Midwest have 157 million acres, followed by the Pacific Coast with 69 million acres (including 15 million acres in Alaska), and the Rocky Mountain states with 62 million acres.

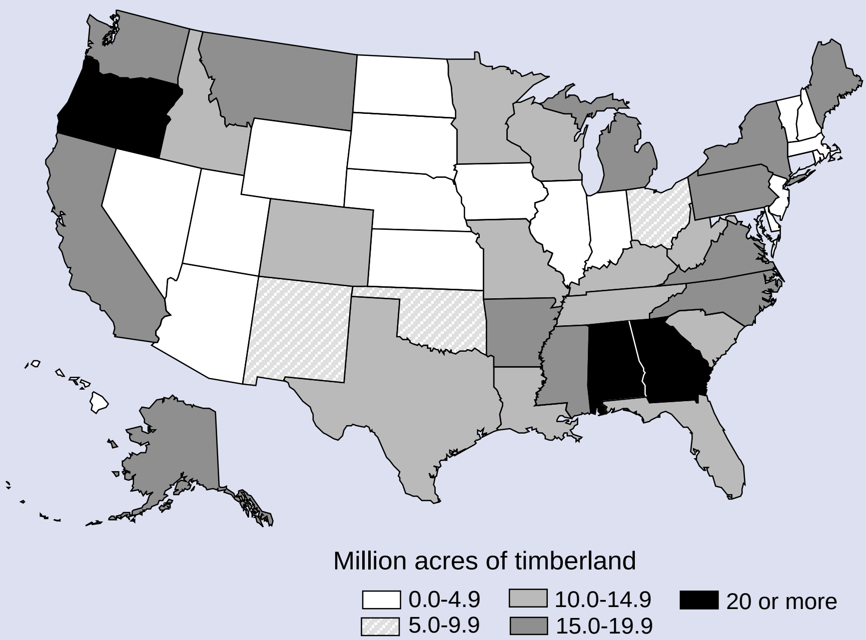
TRENDS

The total land area of the contiguous United States is approximately 1.9 billion acres, and the three major current uses of this land are grassland pasture and range, forest-use land, and cropland, in that order (Figure 7.6). (Alaska has 365 million acres, with 24 percent of it in forest-use and 75 percent classified as miscellaneous other land, which includes tundra. Hawaii has 4 million acres nearly evenly divided between grassland pasture and range, forest-use land and special use land, which includes parks, wildlife areas, and urban; only 7 percent of Hawaii's land is used for cropland.)

Grassland pasture and range has generally declined throughout this century. Reasons for the decline include conversion of pasture to cropland, improved for-age quality and productivity of existing grazing lands, and decline in the number of domestic animals, particularly sheep and draft animals. Much of the apparent decline in forest-use land results from the designation of large acreages of forest land as parks, wilderness areas, and wildlife areas, which prohibit forestry uses such as timber production. There was a slight increase in forest-use land from 1987 to 1992, primarily in commercial timberland. The total acreage classified as cropland (cropland used for crops, used for pasture, and idle) has not changed greatly for several decades; however, considerable changes have occurred in component acreages (as will be discussed later in this chapter). (See Part III, Table 7.1)

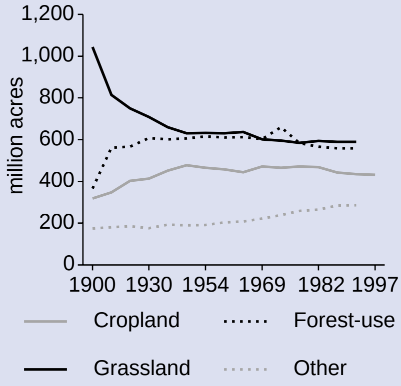
Though a relatively small fraction (3 percent) of all land in the nation, land devoted to urban areas has increased rapidly. In response to an expanding U.S. population, land in urban uses—for homes, schools, office buildings, shopping centers, and other commercial and industrial uses—increased 285 percent from 15.0 million acres in 1945 to 58.9 million acres in 1992 (Figure 7.7). Land converted to urban uses comes from several different major land uses. From 1982 to 1992, 46 percent of new urban land came from cropland and pasture, 15 per-

Figure 7.5 U.S. Timberland Acreage by State, 1992



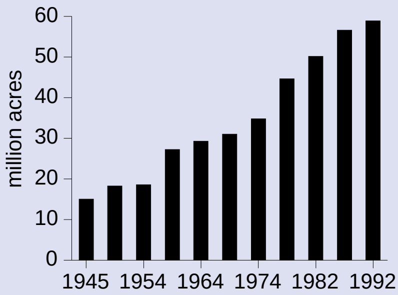
Source: Powell, D.S., et al., *Forest Resources of the United States, 1992* (USDA, FS, Washington, DC, 1993).

Figure 7.6 Major Uses of Land in the Contiguous United States, 1900-1997



Source: USDA, based on data in Part III, Table 7.1 and Table 7.4.
Note: 1997 data for forest-use, grassland, and other not available.

Figure 7.7 U.S. Urban Area, 1945-1992



Source: See Part III, Table 7.2.
Note: Estimates are based on Census data.

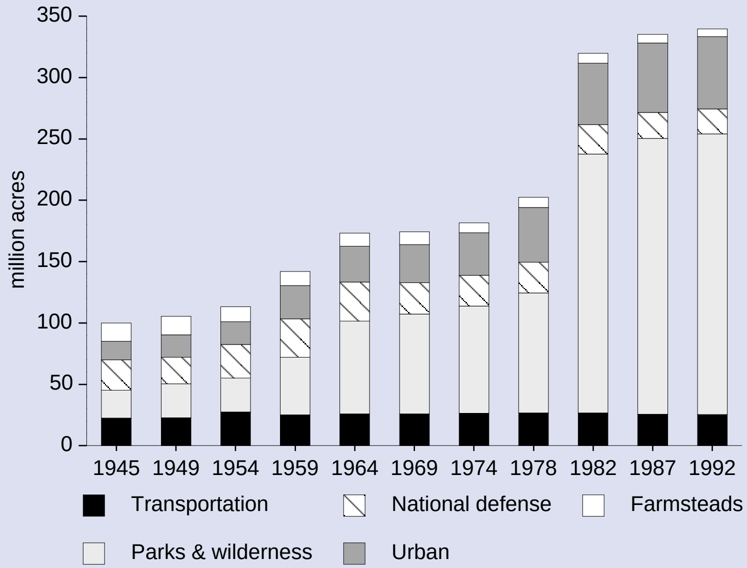
cent from rangeland, and 38 percent from forestland.

Land use for recreation and wildlife areas also increased nearly 10-fold from 1945 to 1992, mostly from the conversion of federal lands to meet the greater public demand for such areas and the establishment of wilderness areas and national parks in Alaska. Land in transportation uses increased between 1945 and 1982 as the U.S. built more highways, roads, and airports in rural areas; land in this category has since declined, primarily due to the abandonment of railroad facilities and the inclusion of some transportation uses into urban areas. Land in defense and industrial use declined 20 percent from 1945 to 1992, with some conversion to urban use, while miscellaneous farmland declined more than 50 percent, mirroring a trend towards fewer, but larger, more consolidated farms and an increasing tendency for farm families and workers to live off the farm. (See Figure 7.8 and Part III, Table 7.2)

Farmland Trends

Decades-long trends in decreasing farm numbers and increasing farm size continue. (Part III, Table 7.3) Since the turn of the century, the number of farms in the United States has declined by more than 60 percent while the average farm size has nearly tripled. American agriculture is now dominated by large farms of 500 acres or more, which represent an increasing percentage of total farm numbers (Figure 7.9). Meanwhile, the percentages represented by farms of 1-49 acres and 50-499 acres have moved in opposing directions, indicating a shift from the former to the latter in the 1950s and 1960s followed by a reversal in the late 1970s and 1980s. Of the 1.9 million farms in 1997, over half were smaller than 180 acres, while farms of 500 acres or more represented 20 percent of all farms

Figure 7.8 Special Uses of Land in the United States, 1945-1992



Source: See Part III, Table 7.2.

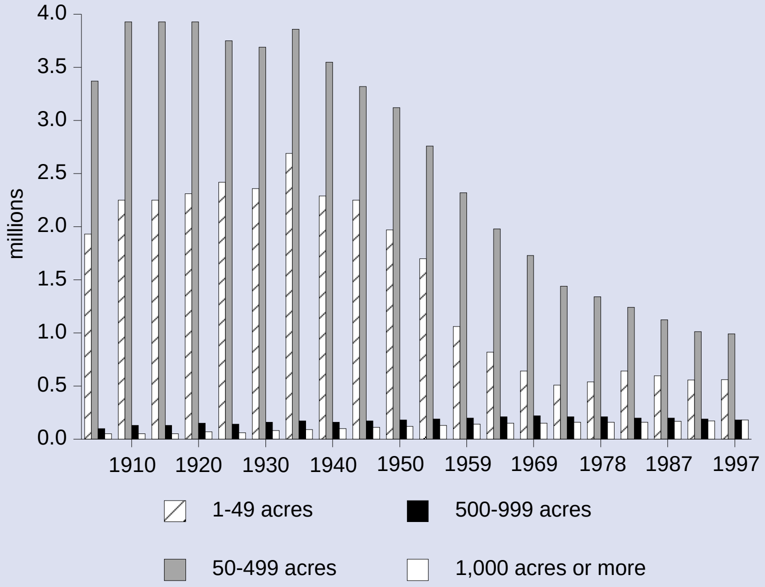
Note: The large increase in park and wilderness land after 1978 was due in part to the Congressional designations, especially in Alaska.

but accounted for nearly 80 percent of all land in farms. In 1997, the average farm size was 471 acres (Figure 7.10).

Total cropland has been rather stable, fluctuating around the 450-million-acre level since 1945 (Figure 7.11). Uses within the cropland base principally fluctuate with changes in cost-price relationships, foreign demand for U.S. grains, natural disasters like severe floods and drought, and farmers' participation in federal acreage adjustment programs, many of which are being phased out by provisions in the 1996 Farm Bill. More cropland was used for crops—cropland harvested, failed, and summer fallow (excludes idle cropland and cropland pasture) in 1997 than during most of the 1980s and early 1990s when more cropland was idled by federal farm programs (Figure 7.12). In 1997, one or more crops were harvested from an estimated 309 million acres of land, the largest area harvested since 1985. The increase resulted from a continued increase in land previously idled by annual federal programs and the longer-term Conservation Reserve Program (CRP) moving back into production and because of a smaller crop failure than in previous years. Due to changes in federal farm programs, no new cropland was idled in annual federal commodity programs in 1996 or in 1997. (Part III, Table 7.4)

The use of reduced tillage and conservation tillage practices has increased in

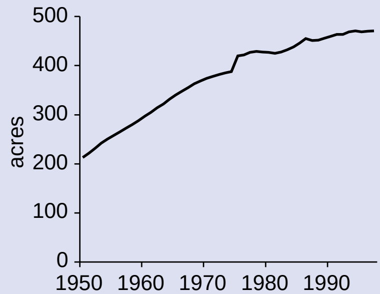
Figure 7.9 Number of U.S. Farms by Farm Size, 1900-1997



Source: See Part III, Table 7.3.
Note: Data are reported for years coinciding with the Census of Agriculture.

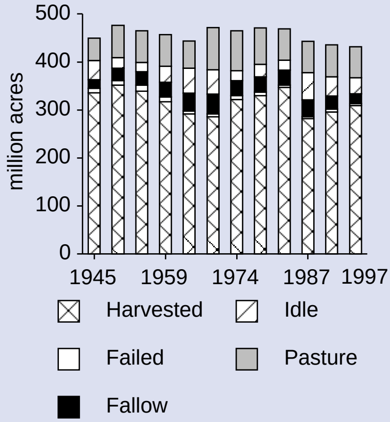
the past decade. (Part III, Table 7.5) Reduced tillage is now used on 77 million acres (26.2 percent of the total). Conservation tillage is used on about 110 million acres, or 37.3 percent of all planted acres. The conservation tillage category is dominated by no-till (46 million acres) and mulch-till (60 million acres) (Figure 7.13). In contrast, conventional tillage is now used on only 36.5 percent of all planted acres, down from nearly 50 percent in 1989. Advantages of reduced tillage and conservation tillage management systems over conventional systems include fuel and labor savings, lower machinery investments, and long-term benefits to soil structure and fertility. These practices provide sufficient residue cover to help protect the soil surface from wind and water erosion, slow surface water runoff and enhance infiltration, improve runoff water quality by intercepting nutrients and pesticides, and improve soil productivity.

Figure 7.10 Average U.S. Farm Size, 1950-1997



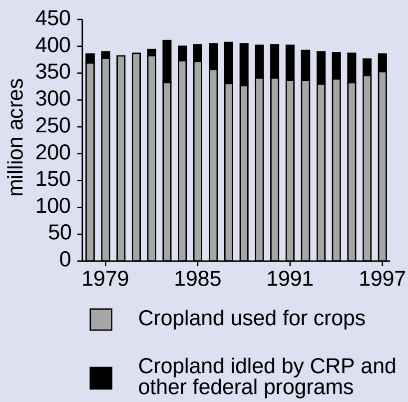
Source: USDA, National Agricultural Statistics Service, *Farms and Land in Farms* (USDA, NASS, annual).

Figure 7.11 Major Uses of U.S. Cropland, 1945-1997



Source: See Part III, Table 7.4.
Notes: Data are reported for years coinciding with the Census of Agriculture. Does not include cropland idled by federal programs.

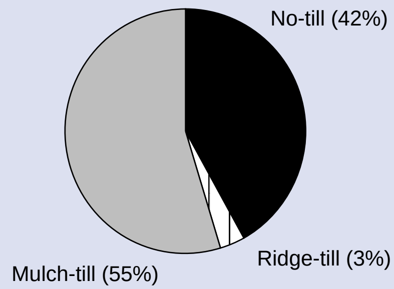
Figure 7.12 Used and Idled U.S. Cropland, 1978-1997



Source: See Part III, Table 7.4.
Note: Does not include cropland pasture or idle land not in federal programs and normally included in the total cropland base shown in Figure 7.11.

Erosion, the wearing away of soil by water, wind, and other forces, occurs naturally on all land. About 40 percent of all

Figure 7.13 U.S. Conservation Tillage by Type, 1997

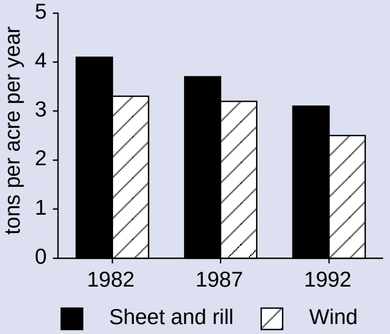


Source: See Part III, Table 7.5.

erosion in the United States results from such activities as construction, logging, and off-road vehicle use, or natural events such as fire, flooding, or drought; the rest comes from cropland and range. Erosion has long been considered a major agent in soil degradation, reduction in soil productivity, and contributor to water and air quality problems (See Chapter 5, Air Quality, for discussion on fugitive dust). Erosion on U.S. cropland has declined sharply in recent years. Over the 1982-92 period, sheet and rill erosion decreased from 4.1 to 3.1 tons per acre per year, while losses from wind erosion declined from 3.3. to 2.5 tons per acre per year (Figure 7.14). (Part III, Table 7.6) Farmers have also reduced erosion on nonfederal pasture and rangeland (Figure 7.15), although the soil savings have not been as great as on cropland.

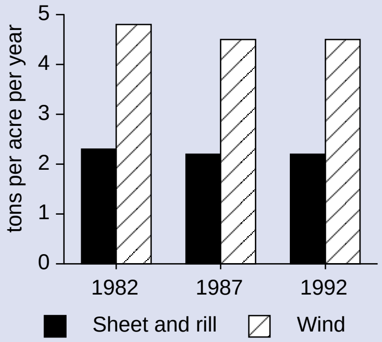
Agriculture has one of the highest rates of productivity growth of all U.S. industries, growing at an average annual rate of 1.94 percent from 1948 to 1996 (Figure 7.16). Sources of these gains were both internal and external to agriculture.

Figure 7.14 Erosion on U.S. Cropland, 1982-1992



Source: See Part III, Table 7.6

Figure 7.15 Erosion on U.S. Pasture and Range, 1982-1992

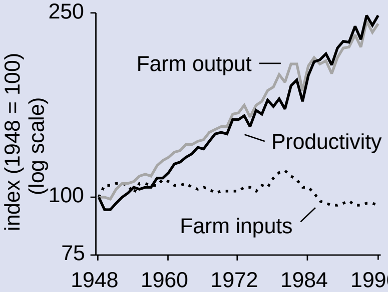


Source: See Source for Part III, Table 7.6.

Weather is a major, unpredictable factor affecting year-to-year variation in productivity, while shocks to the economy indirectly affect relative prices and resource allocations in agriculture. Technological changes after World War II, such as the transition from animal power to tractors, the use of hybrid seeds, improved livestock breeding, and more agricultural chemicals, and the demand for U.S. exports translated into increased farm output, 1.65 percent annual growth for livestock products and a 2 percent rate for crops. Farmers were able to hold production costs down by substituting capital (primarily durable equipment) and purchased inputs (mainly pesticides, fertilizer, energy, seeds, feed, and livestock) for labor. The fairly stable total input level over 1948-96 disguises shifts in particular inputs, such as the nearly 5 percent per year increase in pesticide use and the average annual drop of 2.7 percent in the labor index. (Part III, Table 7.7)

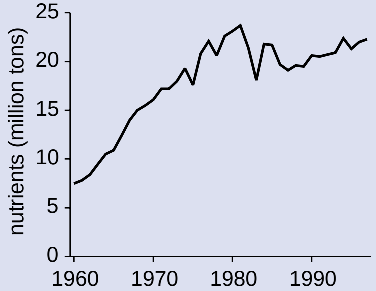
U.S. commercial fertilizer use (nitrogen, phosphate, and potash) for all purposes rose from 7.5 million nutrient tons in 1960 to a record 23.7 million tons in 1981. Total nutrient use dropped from this level to 21.3 million tons in 1995, along with total crop acreage. The numbers have been increasing lately (Figure 7.17), reflecting higher corn acreage, which uses 40 to 45 percent of all fertilizers. Purchased natural processed and dried organic materials historically have represented about 1 percent of total nutrient use. In

Figure 7.16 U.S. Agricultural Productivity, 1948-1996



Source: See Part III, Table 55.

Figure 7.17 U.S. Commercial Fertilizer Use, 1960-1997



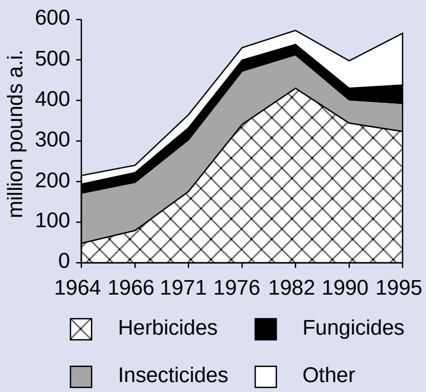
Source: See Part III, Table 7.8.

terms of total fertilizer materials (which includes secondary and micro nutrients and filler material), the 1997 total of 55 million tons is the most used in one year over the 1960-97 period. These figures also include fertilizer use on lawns, golf courses, home gardens, and other non-farm lands. (Table Part III, Table 7.8)

Synthetic pesticides were initially developed for commercial use in the late 1940s and 1950s and were widely adopted by the mid-1970s. USDA surveys show that the quantities applied to major field crops, fruits, and vegetables first peaked in 1982, reflecting increased planted acreages, greater proportion of acres treated with pesticides, and higher application rates per treated acre. Between 1982 and 1990, pesticide use declined as commodity prices fell and large amounts of land were taken out of production by federal programs. Since 1990, total quantities of pesticides used on major crops have generally increased (Figure 7.18), but continue to fluctuate with changes in planted acreage, pest and weed infestation levels, adoption of new products, and other factors. (Part III, Table 7.9)

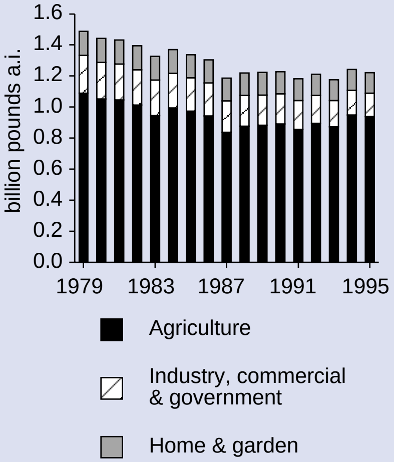
EPA estimates that between 1975 and 1995 pesticide use declined slightly in all sectors—agriculture, industry and commercial, and home and garden. (Note that data in Tables 7.9 and 7.10 are not directly comparable because of different survey methodologies. In addition, EPA's estimates for agricultural pesticide use cover all agricultural uses and USDA's estimates cover major crop use only.) Over the 1979-95 period, total agricultural pesticide use dropped about 14 percent, from 1,089 to 939 million pounds of active ingredients. Over the same period, pesticide use in the industry and commercial sector dropped by about 40 percent, from 243 to 150 million pounds of active ingredients, while use in homes and gardens decreased by 14 percent, from 155 to 133 million pounds (Figure 7.19). (Part III, Table 7.10)

Figure 7.18 U.S. Farm Pesticide Use on Major Crops, 1964-1995



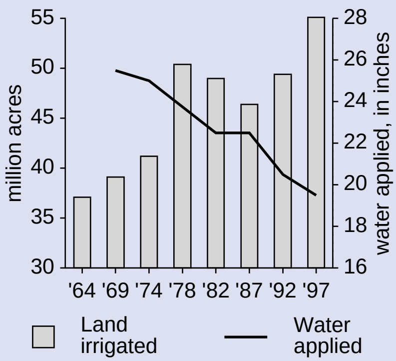
Source: See Part III, Table 7.9.
Note: a.i. = active ingredients.

Figure 7.19 U.S. Pesticide Use by Sector, 1979-1995



Source: See Part III, Table 7.10.
Note: a.i. = active ingredients.

Figure 7.20 U.S. Irrigation Trends, 1964-1997



Source: See Part III, Table 7.11.
Note: Water applied = national seasonal average. 1997 estimate reflects 1996 average amount applied.

Irrigated farmland is predominantly in the 17 western states. In 1997, 43.0 million acres were irrigated in the West, up slightly from the early 1990s but still less than the 43.2 million acres that were irrigated in 1978. Irrigated acreage in other states has increased steadily in recent decades, growing from 7.2 million acres in 1978 to 12.1 million acres in 1997. By 1997, the nation had a total of 55.1 million acres of irrigated farmland (Figure 7.20). (Part III, Table 7.11) Changes in irrigated acreage are partially attributable to regional weather patterns, but also to competing urban and environmental demands to reduce irrigated acreage, changes in federal farm programs, and shifts in crop mix on irrigated cropland. Much of the increase in irrigated acreage is due to changes in federal commodity programs that idled irrigated area in the past. Paradoxically, the 25 percent reduction in irrigation water application rates since 1969 has been enough to offset the increase in irrigated acreage and maintain total water applied near the level of 25 years earlier. Application rates vary regionally and in accordance with crop water requirements (e.g., from less than 6 inches for soybeans in Atlantic states to as much as 5 feet for rice in the Southwest).

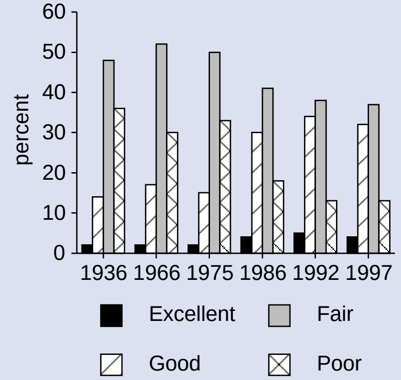
Rangeland Conditions

Though still substantially degraded, rangeland on nonfederal and Bureau of Land Management lands is showing signs of improvement. Particularly notable is the decline in the amount of rangeland classified as "poor." On nonfederal land, the percent of rangeland in the poor category dropped from 40 to 15 percent of the total over the 1963-92 period (Figure 7.21); on BLM land, the share dropped from 30 to 13 percent over the 1966-97

Figure 7.21 U.S. Nonfederal Rangeland Condition, 1963-1992

Source: See Part III, Table 7.12.

Figure 7.22 BLM Rangeland Condition, 1936-1997



Source: See Part III, Table 7.12.

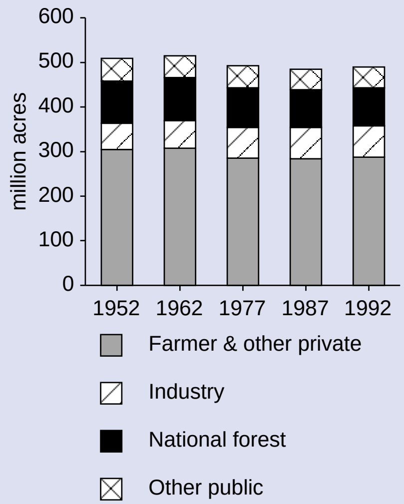
period (Figure 7.22). Still, only 40 percent of nonfederal rangelands and 36 percent of BLM lands are rated in the excellent or good categories. (Part III, Table 7.12)

Forest and Timberland

Of the 490 million acres of timberland in the United States, about 14 percent (70 million acres) is owned by the forest industry while about 59 percent (287 million acres) is owned by farmers and other private landholders. About one fourth of the total (131 million acres) is publicly owned, including 17 percent (85 million acres) in the National Forest System. Since 1952, the total area of timberland has decreased 4 percent as a result of withdrawals for wilderness or other land uses that do not permit commercial timber harvest. At the same time, timberland acreage owned by the forest industry has grown, while that of other landowners has declined (Figure 7.23). (Part III, Table 7.13)

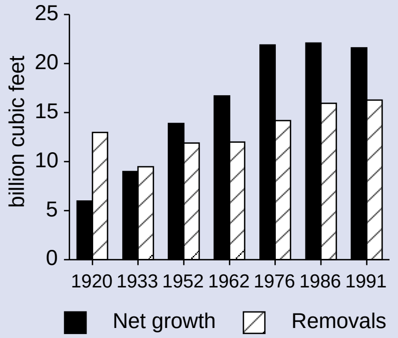
Since 1952, net timber growth of forests has continually exceeded net timber removals. In 1991, for example, net growth was estimated at 21.6 billion cubic feet,

Figure 7.23 U.S. Timberland Area by Ownership, 1952-1992



Source: See Part III, Table 7.13.

Figure 7.24 Net Growth and Removals of U.S. Timber, 1920-1991

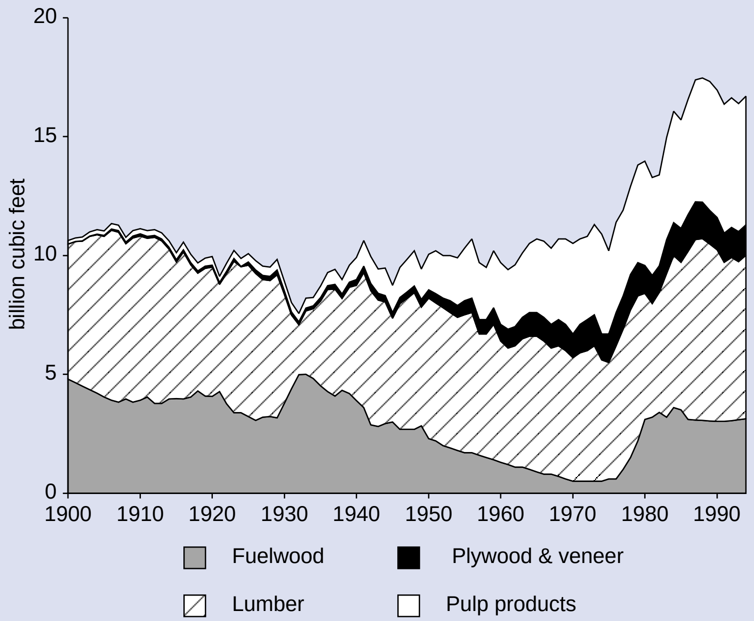


Source: See Part III, Table 7.14.

while net removals were estimated at 16.3 billion cubic feet (Figure 7.24). Almost 55 percent of all timber removals in 1991 came from the forests of the South, which continued to increase its share of U.S. timber harvest—up from 45 percent in 1970. Softwoods accounted for two-thirds of all growing stock removals in 1991. Timber removals continue to be concentrated on private lands, with nonindustrial private forests contributing 49 percent of all timber removals and industrial forests another 33 percent in 1991.

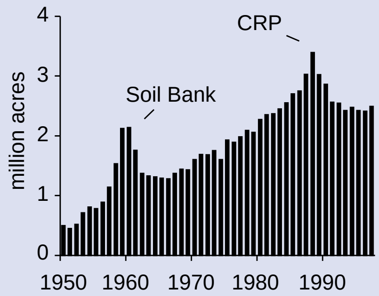
Because growth has exceeded harvest since the 1950s, timber volume of growing stock on timberland has increased since then. All of the increase occurred in hardwoods, which increased from 184 to 335 billion cubic feet over the 1952-92 period. On private lands other than forest industry property, hardwood volume increased from 133 to 242 billion cubic feet. (Part III, Table 7.14)

Figure 7.25 U.S. Production of Forest Products, 1900-1994



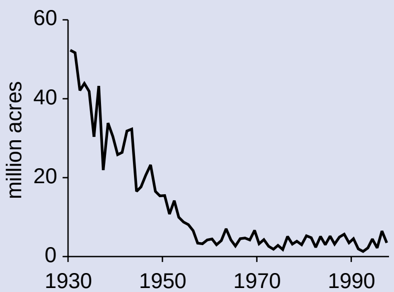
Source: See Part III, Table 7.15.

Figure 7.26 U.S. Tree Planting Trends, 1950-1997



Source: See Part III, Table 7.17.
Note: CRP=Conservation Reserve Program.

Figure 7.27 U.S. Forest Land Burned by Wildfire, 1930-1997



Source: See Part III, Table 7.17.
Note: Data are based on the number of acres reported for each year on federal, state, and private lands.

Since 1950, U.S. production of timber products has risen substantially (Figure 7.25), from 10.8 billion cubic feet in 1950 to about 18 billion cubic feet in the 1990s, including large increases in the production of plywood and veneer and pulp products. Over most of this period, lumber production has remained in the range of 5-7.5 billion cubic feet annually. (Part III, Table 7.15) Logging residues have declined, reflecting increased stumpage prices, improved logging technology, and increased demand for wood products. (Part III, Table 7.16)

Tree planting on all forest ownerships increased dramatically after World War II, peaked in 1988 reflecting increased tree planting on CRP lands, and has remained at about 2-3 million acres annually since then (Figure 7.26). Forest industry, farmers, and other private forest owners account for the largest share of land planted to tree seedlings or direct seeded.

With improved forest fire protection, forest land burned by destructive wildfires has decreased by 90 percent since 1930—from 50 million acres per year to 2 to 7 million acres per year (Figure 7.27). (Part III, Table 7.17)

The Southern pine beetle has caused by far the most insect damage to U.S. forestlands in the 1990s. In 1997, the Southern pine beetle damaged 8.5 million acres of forestland. Damage from the Spruce budworm, Western spruce budworm, Gypsy moth, and Mountain pine beetle has been generally minor since 1993. (Part III, Table 7.18)

ONLINE RESOURCES

The Agriculture Department has four agencies—the Economic Research Service (ERS), National Agricultural Statistical Service (NASS), Natural Resources Conservation Service (NRCS), and Forest Service—that provide valuable online material about terrestrial resources.

ERS (http://www.econ.ag.gov) provides useful material on land use and other subjects. ERS publications (http://www.econ.ag.gov/Prodsrvs/reports.htm) includes a Land, Water, and Conservation category (http://www.econ.ag.gov/Prodsrvs/rept-lwc.htm). Within that category are publications on wetlands and agriculture, soil erosion and conservation, and several studies on the Conservation Reserve Program. ERS also provides the series entitled *Major Uses of Land in the United States*; the latest report summarizes land use in the United States in 1992. Summaries of this and many other reports are available online (http://www.econ.ag.gov/epubs/htmlsum/index.htm#summaries).

ERS also publishes *Agricultural Resources and Environmental Indicators*, which includes data on how natural resources (land and water) and commercial inputs (energy, nutrients, pesticides, and machinery) are used in the agricultural sector (http://www.econ.ag.gov/epubs/pdf/ah712). This report can be downloaded either in parts or in its entirety.

NASS (http://www.usda.gov/nass/) conducts hundreds of surveys and prepares reports covering virtually every facet of U.S. agriculture—production and supplies of food and fiber, prices paid and received by farmers, farm labor and wages, and farm aspects of the industry. NASS publications cover a wide range of subjects, from traditional crops, such as corn and wheat, to specialties, such as mushrooms and flowers; from calves born to hogs slaughtered; from agricultural prices to land in farms (http://www.usda.gov/nass/pubs/pubs.htm). NASS conducted the 1997 Census of Agriculture, which is a complete accounting of United States agricultural production (in prior years, the agricultural census was conducted by the Bureau of the Census). Early reports from the 1997 census are available (http://www.nass.usda.gov/census/).

NRCS information is accessible (http://www.nrcs.usda.gov). The NRCS "Technical Resources" site (http://www.nrcs.usda.gov/TechRes.html) includes links to databases on soil, water, and climate; the National Resources Inventory; the National PLANTS database; and water and climate data. The 1992 National Resources Inventory is a statistically based sample of land use and natural resource conditions on America's 1.5 billion acres of nonfederal land. Information is available for three years—1982, 1987, and 1992.

At the Forest Service homepage (http://www.fs.fed.us), the "Topics" section (http://www.fs.fed.us/links/topics.shtml) includes categories such as fire, forest health, and forest management. The forest management category (http://www.fs.fed.us/land/fm) includes material on reforestation and timber stand improvement, old growth forest vegetation, national forest timber harvest, quarterly harvest reports, and timber sale data by region, forest, and state. The fire category (http://www.fs.fed.us/land/wdfire.htm) includes material on federal wildland fire policy, the role of wildland fire in resource management, and the use of wildland fire.

The Forest Service has a framework for reporting forest health conditions across the United States (http://www.fs.fed.us/foresthealth/). Reports cover forest health on all ownerships and involve collaboration between state and federal agencies. The Forest Service prepares national reports on American forests and also provides regional reports. *America's Forests: 1997 Health Update* (http://www.fs.fed.us/foresthealth//fh_update/update97/index.html) includes a useful summary of forest ecosystem health issues in America's forests.

The Forest Inventory and Analysis section (http://www.srsfia.usfa.msstate.edu/) provides links to regional offices, data retrieval, and information on the 1993 Resource Planning Act (RPA) Assessment. The Timber Production Output (TPO) database retrieval system consists of 11 data variables that describe for each county the roundwood products harvested, the logging residues left behind, the timber otherwise removed, and the wood and bark residues generated by its primary wood-using mills.

The Environmental Protection Agency's Office of Pesticide Programs homepage (http://www.epa.gov/pesticides) provides voluminous information on pesticide health and safety risks. Under Information Resources (http://www.epa.gov/pesticides/info.htm), the office provides access to many other valuable online sites on pesticides. For example, the National Pesticide Information Retrieval System (http://ceris.purdue.edu/npirs/npirs.html) is a set of pesticide-related databases maintained by the Center for Environmental and Regulatory Information Systems at Purdue University. The National Pesticide Telecommunications Network (http://ace.orst.edu/info/nptn), a cooperative effort of EPA and Oregon State University, provides information about a variety of pesticide-related subjects. Information on pesticide industry sales and usage also is available at http://www.epa.gov/oppbead1/95pestsales/index.html.

The American Forest and Paper Association is the national trade association of the forest, paper, and wood products industry (http://www.afandpa.org/index.html). The site includes information on the industry's sustainable forestry initiative and its principles for sustainable forestry. IRIS (http://primusweb.com/forest) is a network providing links and information on forest products generally. Their category on associations and organizations provides a long list of associations in the U.S. and elsewhere with an interest in forest products.

Information on sustainable forest practices is available at many sites. The Forest Stewardship Council of the United States (http://www.fscus.org/fscus1b.html) works on sustainable forestry and forest certification. This site also provides a link to the Forest Stewardship Council International. In Canada, see the Canadian Sustainable Forestry Certification Coaltion (http://www.sfms.com).

Among NGOs, Resources for the Future is active on forest issues (http://www.rff.org/nat_resources/forests.htm). RFF has recently completed studies on timber supply modeling for the 21st Century and on the impacts of climate change on global timber markets.

The Lincoln Institute of Land Policy (http://www.lincolninst.edu) publishes a variety of studies on land use and regulation, property rights, and land taxation. Recent reports include studies on open space conservation and on alternatives to sprawl.

Other NGOs with an interest in forest issues include the American Forest Foundation (http://www.affoundation.org), American Forests (http://www.amfor.org), American Rivers (http://www.amrivers.org), National Association of State Foresters (http://www.stateforesters.org), National Audubon Society (http://www.audubon.org), National Forest Foundation (http://www.nffweb.org), Defenders of Wildlife (http://www.defenders.org), Ducks Unlimited (http://www.ducks.org), Friends of the Earth (http://www.foe.org), Natural Resources Defense Council (http://www.nrdc.org), Public Lands Foundation (http://www.publicland.org), Society of American Foresters (http://www.safnet.org), Trust for Public Land (http://www.igc.org/tpl), The Wilderness Society (http://www.wilderness.org), The Nature Conservancy (http://www.tnc.org), and the Sierra Club (http://www.sierraclub.org).

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CORE DATA

CHAPTER EIGHT

Pollution Prevention, Recycling, Toxics & Waste

Pollution prevention generally refers to preventing or reducing waste where it originates, at the source. It can involve a wide variety of practices, including practices that conserve natural resources by reducing or eliminating pollutants through increased efficiency in the use of raw materials, energy, water, and land.

The goal of source reduction is to prevent the creation of waste, either by reducing the quantity of materials, reusing materials already manufactured, lengthening the life of products to postpone disposal, or managing nonproduct organic wastes through onsite composting or other alternatives to disposal.

Many creative new approaches are under way to promote source reduction and recycling. For example, regulatory measures can be used to mandate or encourage reduced wastes. Many states have adopted bans on the disposal of specific materials, such as vehicle batteries and tires.

Most of the future growth in solid waste generation will be handled through recovery for recycling or composting programs. In 1996, recovery accounted for 57 million tons—over a quarter of all solid waste generated that year.

Many companies are discovering that pollution prevention programs can help lower their operating costs. As part of a legal settlement with EPA, a DuPont plant in New Jersey identified 15 manufacturing processes with pollution prevention potential. The projects focused on reducing solvent waste, tar waste, and other chemical waste. Once all projects are in place, DuPont expects that waste from all 15 processes will be cut roughly in half. DuPont anticipates annual savings of about $15 million, more than twice its up-front investment.

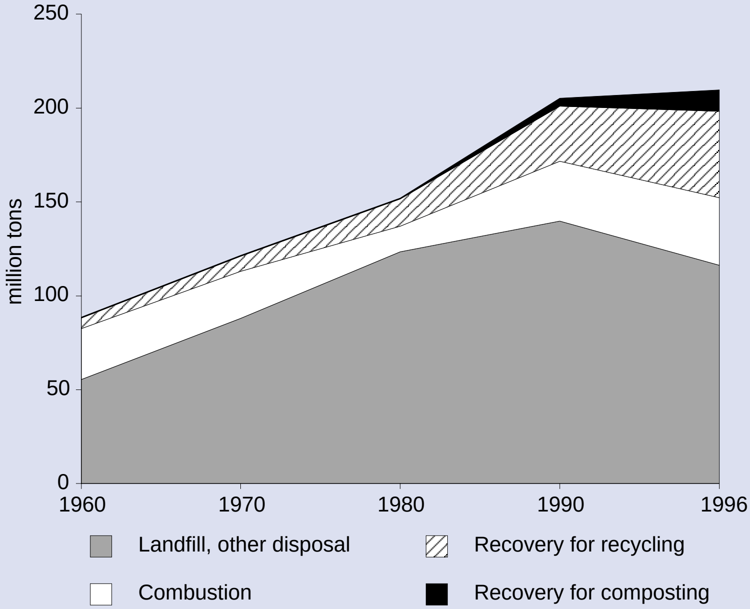
TRENDS

Municipal Solid Waste Trends

Gross solid waste generation continued to grow over the 1990-96 period, but strong growth in recovery for recycling and composting led to a decline in discards to landfills (Figure 8.1). (Part III, Table 8.1)

Over the past 25 years, the American public has increasingly made recycling a societal priority. The United States now diverts about 27 percent of all discarded materials for recycling, up from 17 percent in 1990. About 25 percent of all paper (41

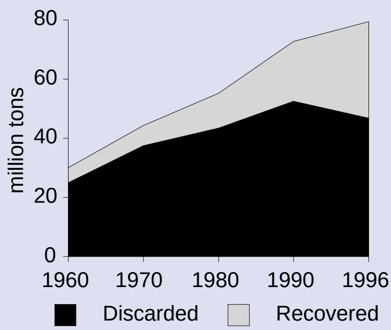
Figure 8.1 U.S. Municipal Solid Waste Management, 1960-1996



Source: See Part III, Table 8.1.

percent including paper and paperboard) is now recycled (Figure 8.2), as are 58 percent of all steel cans, 63 percent of aluminum drink cans, and 62 percent of major appliances. Although the recycling of commercial and industrial secondary materials in the U.S. has occurred in the private sector for well over 100 years, 20 years ago there was just one multimaterial curbside recycling program. Today such service is provided to some 140 million Americans living in 9,000 communities (Figure 8.3).

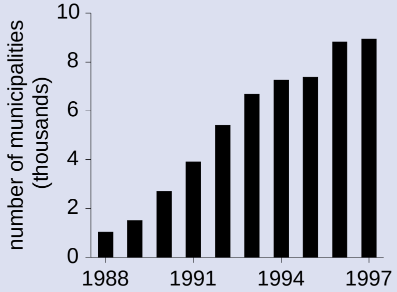
Figure 8.2 Paper and Paperboard Waste, 1960-1996



Source: See Part III, Table 8.2.

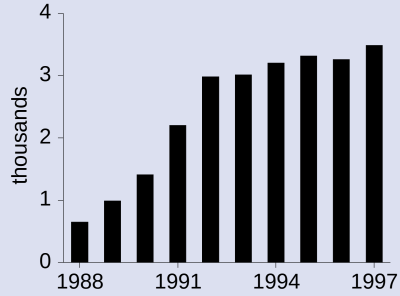
Additional significant gains have been made in composting of yard trimmings (Figure 8.4). Over the 1990-96 period, yard waste generation declined from 35 to 29.75 million tons, while recovery increased from 4.2 to 10.8 million tons. Recovery programs for metals also showed strong growth, climbing from 3.3 to 5.3 million tons over the 1990-96

Figure 8.3 U.S. Participation in Curbside Recycling, 1988-1997



Source: Glenn, J., "The State of Garbage in America, Part I," *BioCycle* (April 1998).

Figure 8.4 U.S. Yard Trimmings Facilities, 1988-1997



Source: Glenn, J., "The State of Garbage in America, Part I," *BioCycle* (April 1998).

period while generation of metals waste remained at about 13 million tons.

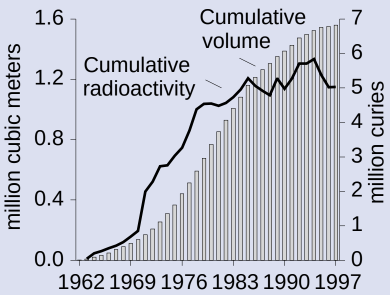
For other waste types, including plastics, rubber, textiles, and wood, recovery programs remain a relatively small percentage of total waste generation. In the case of plastics, for example, total waste generation in 1996 was 19.7 million tons, while only about 1 million tons was recovered. (Part III, Table 8.2)

Nuclear Waste

The annual amount of commercial low-level nuclear waste (LLW) shipped for disposal grew steadily from 1960 to 1980, reaching a peak of 92,400 cubic meters. Since 1980, the annual amount shipped for disposal declined to about 9,000 cubic meters in 1997. Since 1960, a cumulative total of 1.56 million cubic meters of commercial LLW has been shipped for disposal. (Figure 8.5) (Part III, Table 8.3)

Commercial LLW is generally divided into five categories: academic, government, industrial, medical, and utility. The academic category includes university hospitals and university medical and nonmedical research facilities. The government category includes state and non-DOE federal agencies. The industrial category is comprised of private entities such as R&D companies, manufacturers, nondestructive-testing operations, mining

Figure 8.5 U.S. Inventory of Low-Level Nuclear Waste, 1962-1997



Source: See Part III, Table 8.3.
Note: Cumulative radioactivity includes decay.
Data reflect commercial low-level nuclear waste only.

works, fuel fabrication facilities, and radiopharmaceutical manufacturers. The medical category includes hospitals and clinics, research facilities, and private medical offices. The utility category includes commercial nuclear reactors. Disposal of LLW at commercial sites accounted for about 32 percent by volume of all LLW disposed at end of fiscal year 1996.

The majority of LLW is generated by DOE through its defense activities, naval nuclear propulsion program, and various research and development (R&D) activities. To date, DOE has disposed of about 1.3 million cubic meters. The annual trend in waste disposal has paralleled the commercial sector, reaching a peak in 1987 of 154,000 cubic meters and then declining to about 40,000 cubic meters in 1997. While the majority of LLW waste disposal is from DOE, the rate of generation of LLW from routine DOE operations (excluding disposal of contaminated material from environmental restoration activities) has decreased by 60 percent between 1993 and 1997.

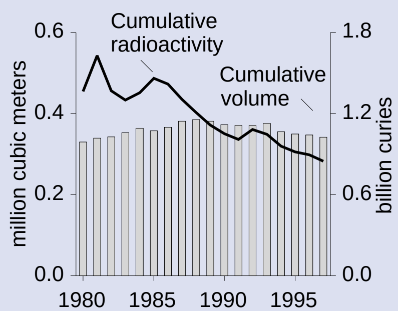
In 1997, the U.S. inventory of high-level nuclear waste (HLW) was estimated to be 341,700 cubic meters (Figure 8.6). (Part III, Table 8.4) HLW is generated by the chemical reprocessing of irradiated targets, naval propulsion fuel, and spent reactor fuel (although chemical reprocessing has been phased out except when needed to reprocess deteriorating spent nuclear fuel). HLW exists in a variety of physical or chemical forms (alkaline or acidic, supernatant liquid, sludge, salt cake, calcine solid, etc.), all of which must be stored to safely protect the environment and the health of workers and of the public. Most of the current U.S. inventory of HLW has resulted from DOE activities and is stored at DOE facilities in South Carolina, Idaho, and Washington.

The cumulative totals of commercial spent nuclear fuel are continuing to grow for all reactor types associated with nuclear electric power generation. The cumulative total of spent fuel for boiling-water and pressurized-water reactors increased from 31,952 metric tons in 1995 to 34,252 metric tons in 1996 (Figure 8.7). (Part III, Table 8.5) In addition, there was an estimated 2,483 metric tons of spent nuclear fuel from government (primarily DOE) and university reactors. Though currently in storage at numerous commercial and DOE sites, this fuel will ultimately require geologic disposal.

Toxic Releases

Onsite releases of toxic substances tracked by EPA's *Toxics Release Inventory*

Figure 8.6 U.S. Inventory of High-Level Nuclear Waste, 1980-1997

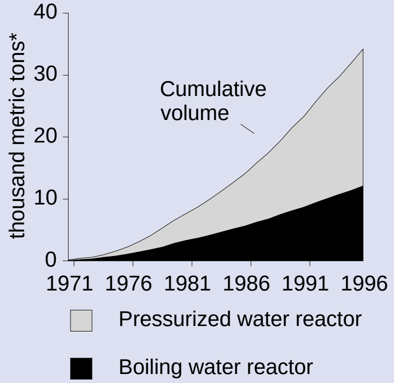


Source: See Part III, Table 8.4.
Note: Cumulative radioactivity includes decay.

(TRI) have declined dramatically since 1988 (Figure 8.8). For example, onsite releases of air toxics have dropped almost 50 percent, from an estimated 2.18 billion pounds in 1988 to 1.095 billion pounds in 1996. Surface water releases have declined by 72 percent and land releases by 34 percent over the same period. All told, onsite releases have dropped by about 48 percent during the 1988-96 period. (Part III, Table 8.6) These reductions are due to both real changes in the amount of TRI chemicals released or otherwise managed and to "paper" changes that reflect changes in estimation or calculation techniques or reporting instructions. Real changes are usually brought about by source reduction, pollution control, and production changes, generally in response to market forces or government programs. One-time events such as accidental releases or clean-up activities can cause real but anomalous increases in the reporting year.

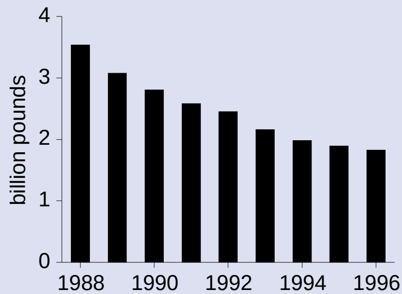
Many industries have cut their onsite and offsite releases of toxics by more than half during the 1988-96 period, including tobacco (-78.5 percent), textiles (-57.3 percent), printing (-53.8 percent), chemicals (-51 percent), leather (-70.7 percent), fabricated metals (-51.6 percent), machinery (-72.5 percent), and electrical equipment (-74.6 percent). (Part III, Table 8.7) Reporting by the chemical industry, which by definition produces chemicals or manufactures products by processing chemicals, dominates most categories of TRI chemicals, followed by primary metals and producers of pulp, paper, and paper products. In 1996, the chemical industry reported the largest totals in air emissions, surface water discharges, and onsite underground injection, while primary metals reported the largest amounts of onsite land releases and offsite transfers (Figure 8.9).

Figure 8.7 U.S. Inventory of Spent Nuclear Fuel by Type of Reactor, 1971-1996



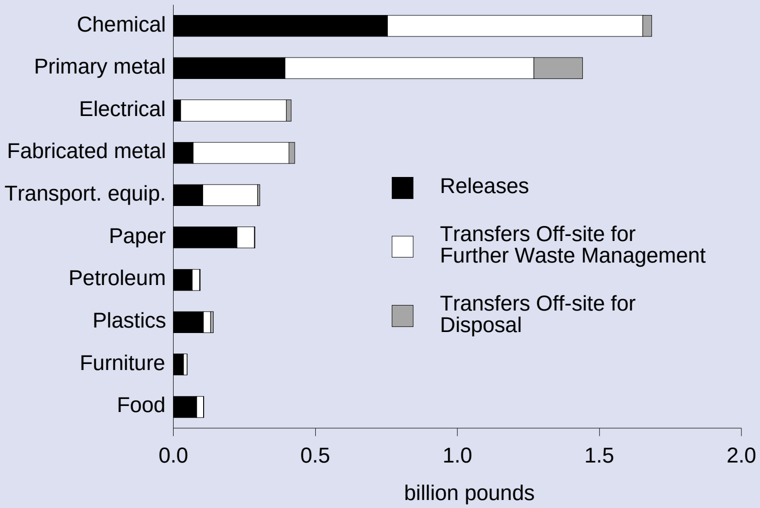
Source: See Part III, Table 8.5.
Note: * Refers to initial heavy metal.

Figure 8.8 U.S. Trends in Toxics Releases, 1988-1996



Source: See Source for Part III, Table 8.6.
Note: Data are standardized to account for changes in reporting requirements.

Figure 8.9 Toxics Releases and Transfers by Selected U.S. Industries, 1996



Source: See Part III, Table 8.7.
Note: Data are from EPA's Toxics Release Inventory. Transfers off-site for further waste management includes transfers to recycling, energy recovery, and various types of treatment.

By state, reductions in onsite and off-site releases averaged 45 percent during the 1988-96 period (Figure 8.10). Many states have cut releases by more than 70 percent in this period, including California, Colorado, Connecticut, Delaware, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Vermont, and Wyoming. (Part III, Table 8.8)

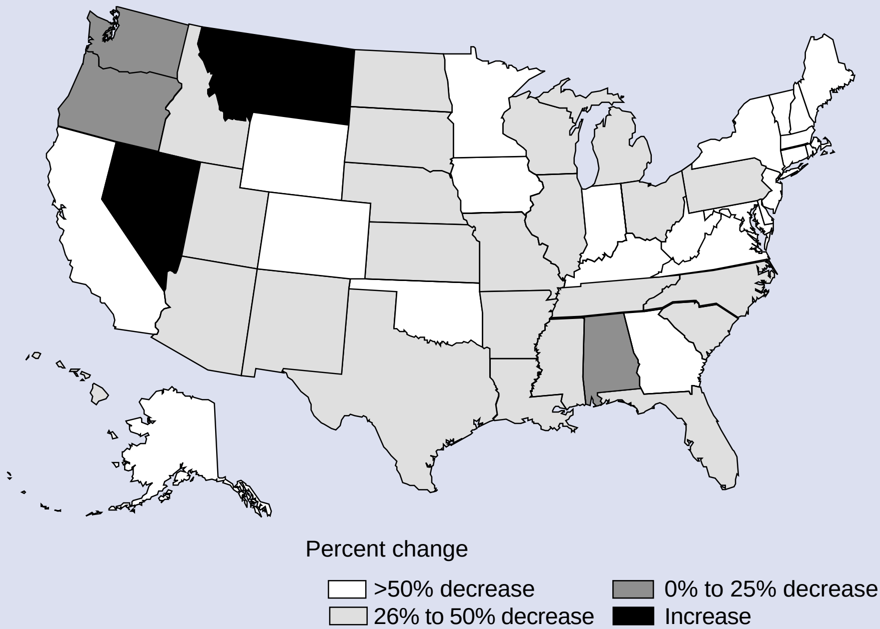
Superfund Inventory and NPL Sites

From its inception in 1980, the number of hazardous waste sites in the Superfund inventory grew steadily, peaking at over 39,000 sites in 1994 and over 1,300 sites on the National Priority List. By the end of 1995, EPA had shortened the list by removing over 24,000 low-priority sites, leaving 15,622 in the inventory. The inventory was reduced further to 12,781 in 1996. Sites on the National Priority List also began to decline, dropping from a high of 1,374 in 1995 to 1,194 in 1997. (Figure 8.11) (Part III, Table 8.9)

Contaminants in Fish and Wildlife

Rachel Carson's *Silent Spring*, published in 1962, focused worldwide attention on the potential for dichlorodiphenyl trichloroethane (DDT) and other contaminants to persist in the environment and harm fish and wildlife. The United States and Canada responded by establishing programs to monitor the concentrations

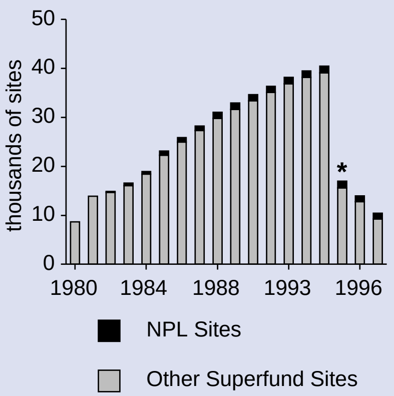
Figure 8.10 Percent Change in Toxic Releases by State, 1988-1996



Source: U.S. Environmental Protection Agency, *1996 Toxics Release Inventory: Public Data Release* (EPA, Washington, DC, 1998).

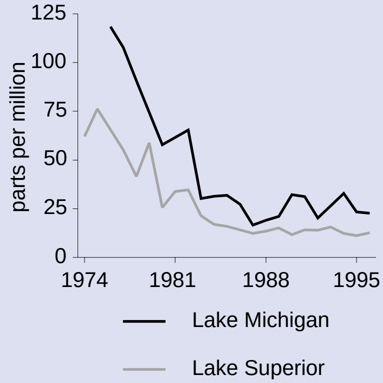
of long-lived toxic contaminants in all segments of the environment, and eventually restricted or banned their manufacture and use. Fish and fish-eating birds were selected for monitoring aquatic ecosystems because of their tendency to accumulate pesticides and other contaminants. The European starling was selected for monitoring contaminant levels in terrestrial habitats because of its varied diet and wide geographic distribution. The wings of ducks killed by hunters were used to monitor contaminants in duck populations of the major flyways and to provide an assessment of contaminant levels in wetlands.

Figure 8.11 U.S. NPL and Other Superfund Sites, 1980-1997



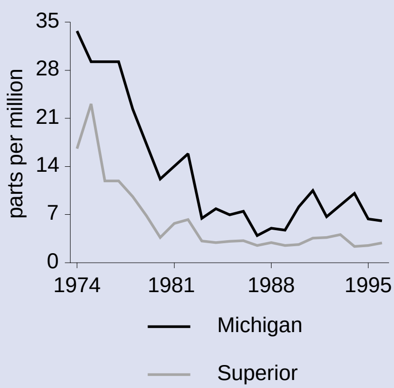
Source: See Part III, Table 8.9.
Note: * >24,000 low-priority sites removed under EPA's Brownfields initiatives. NPL = National Priorities List.

Figure 8.12 PCB Levels in Herring Gull Eggs, 1974-1996



Source: See Part III, Table 8.10.
Note: PCB = Polychlorinated biphenyls.

Figure 8.13 DDE Levels in Herring Gull Eggs, 1974-1996



Source: See Part III, Table 8.10.
Note: DDE = Derivative of Dichlorodiphenyl trichloroethane (DDT).

Over the last several decades, the use of persistent contaminants such as DDT and PCBs was greatly curtailed, and concentrations in fish and wildlife declined. For example, over the 1974-96 period, contaminant levels have generally declined, as measured by contaminant levels in herring gull eggs from colonies on the Great Lakes. In Lake Superior, PCBs in herring gull eggs were measured at 76.24 parts per million (ppm) in 1975; by 1996, the level had dropped to 12.60 ppm (Figure 8.12). Around Lake Michigan, DDE levels were measured at 33.4 ppm in 1976, and have since declined to 6.10 ppm in 1996 (Figure 8.13). Downward trends have been generally similar in other Great Lakes colonies and for other chemicals, including dieldrin, mirex, and HCB. (Part III, Table 8.10)

Although overall concentrations have declined, residues of these contaminants remain widespread, and fish consumption advisories remain in effect for some waters. In the United States, concentrations of DDT (mostly as DDE) remain highest in fish and wildlife from areas in the South, Southwest, and Northwest, where DDT was used to protect cotton and orchards from insects; in the Northeast, where it was used to control mosquitos; and near former centers of DDT production and formulation, such as northern Alabama and the Arkansas, Tombigbee, Alabama, and Tennessee rivers.

Concentrations of other persistent insecticides that are no longer in widespread use, such as heptachlor, endrin, and chlordane, have also declined. PCBs were used historically as lubricants, hydraulic fluids, and fire retardants; as heat transfer agents in electrical equipment, including fluorescent light ballasts; and as a component of carbonless copy papers. Large quantities were discharged directly to waterways, including the Great Lakes and the Hudson, Mississippi, Kanawha, and Ohio rivers before such practice was banned. Today, the greatest concentrations persist in fish and wildlife in the urban-industrial regions of the Midwest and Northeast.

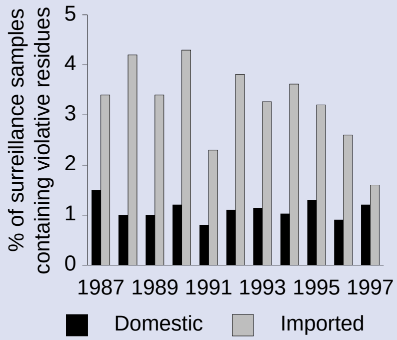
Concentrations of mercury in fish declined significantly from 1969 through 1974 as a result of restrictions on historical sources (e.g., chemical facilities that manufactured caustic soda (sodium hydroxide), paper mills, gold and silver mines, and the production and use of mercury-containing pesticides), but concentrations have not changed appreciably since 1974. Recent findings have highlighted the importance of atmospheric transport and the accumulation of mercury in natural sinks, such as Lake Champlain and the Everglades, in the maintenance of elevated concentrations.

Pesticide Residues in U.S. Domestic Food Samples

Some commodity groups have substantially reduced pesticide residues over the 1978-97 period, while others have showed a more variable pattern.

Milk, dairy products, and eggs have improved steadily during this period, rising from 57 percent of surveillance samples with no residues in 1978 to 97 percent of samples with no residues in 1997. Fish, shellfish, and meats also have improved to 68 percent of samples with no residues in 1997, compared to 20 percent in 1978. For other groups, including grains, fruits, and vegetables, there is no clear trend; residues have been found in about 40 percent of samples as a general rule.

Figure 8.14 Pesticide Violations in Food Samples, 1987-1997



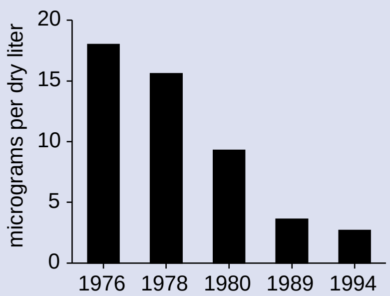
Source: See Part III, Table 8.11.

Taken as a whole, the percentage of surveillance samples without pesticide residues increased from 53 to 66 percent over the 1978-97 period. (Part III, Table 8.11) Of those surveillance food samples containing pesticide residues, only 1.2 percent of domestic foods and 1.6 percent of imported foods exceeded tolerance levels in 1997 (Figure 8.14). The corresponding violation rates in compliance samples were higher than those for surveillance samples: 6.9 percent for domestic and 10.1 percent for imports. (Compliance samples are collected when a pesticide residue problem is known or suspected whereas surveillance samples are random; that is, there is no prior knowledge or evidence that a specific food shipment contains illegal pesticide residues.)

Lead

In the United States, children's mean blood lead levels have decreased more

Figure 8.15 Blood Lead Levels in Children 1-5 Years of Age, 1976-1994



Source: Centers for Disease Control and Prevention, National Health and Nutrition Survey (NHANES). *Update: Blood Lead Levels -- United States, 1991-1994*. MMWR 46(07): 141-146 (GPO, Washington, DC, 1997).
Note: Data shown for 1994 are for the period 1991-1994.

than 75 percent since the 1970s (Figure 8.15). The reduction is primarily the result of the phaseout of lead in gasoline and reductions in other sources and pathways of exposure, such as lead in soldered cans and paint. With the reduction of lead in gasoline and foods, the remaining major sources of lead are lead-based paint, dust and soil, plumbing fixtures and fittings, and occupational exposures.

Lead-based paint is the largest source of high-dose lead exposure for children. About 1.7 million children still have blood lead levels above 10 micrograms per deciliter, the accepted level set by the Centers for Disease Control and Prevention. Although lead was banned from residential paint in 1978, it is estimated that 83 percent of all housing units built before 1980 contain some lead-based paint.

Under the Toxic Substances Control Act and the Residential Lead-Based Paint Hazard Reduction Act of 1992, many new rules have been developed to help reduce lead exposures. These rules include lead hazard identification programs, lead disclosure and consumer education, and renovation and remodeling procedures to help reduce lead exposures.

ONLINE RESOURCES

U.S. EPA's Office of Pollution Prevention and Toxics (http://www.epa.gov/opptintr/) provides abundant material on pollution prevention. The home page has seven broad categories that users can click on to link to sites that provide more in-depth information on topical areas in each category.

The site includes a description of the Pollution Prevention Act of 1990, which made pollution prevention the national environmental policy of the United States. The site also provides additional information on case studies, technical assistance programs, grants, *Federal Register* notices, and the current edition of the *P2 News* newsletter.

EPA also maintains a Pollution Prevention Information Clearinghouse (PPIC) (http://www.epa.gov/opptintr/p2home). PPIC answers questions and distributes selected EPA documents, information packets, and fact sheets on pollution prevention free of charge. A conference list provides details and contact information for many pollution prevention conferences, workshops, and training opportunities for the current quarter. Documents can be ordered by phone (202-260-0178) or e-mail (ppic@epamail.gov)

Many EPA programs include pollution prevention as an important focus and are described at EPA's home page (http://www.epa.gov/epahome/media.htm). The waste prevention program provides examples of how source reduction efforts benefit business and industry. The WasteWi$e program is a voluntary program that targets the reduction of municipal solid waste.

Enviroene, another part of U.S. EPA's website, provides a single repository for pollution prevention, compliance assurance, and enforcement information and databases (http://es.epa.gov). Partners for the Environment (http://es.epa.gov/partners), which is part of the Enviroene site, is a useful guide to the many EPA partnership programs with pollution prevention themes.

The Design for the Environment program (DfE) helps businesses incorporate environmental considerations into the design and redesign of products, processes, and technical and management systems. Initiated by EPA's Office of Pollution Prevention and Toxics in 1992, DfE helps businesses evaluate and compare the performance, cost, pollution prevention benefits, and the human health and environmental risk associated with existing and alternative technologies. The DfE web site (http://www.epa.gov/dfe) provides a broad overview of the DfE program as well as information about publications from the individual projects and programs that operate within DfE.

In partnership with the scientific community and the chemical industry, EPA's Green Chemistry program promotes research, development, and implementation of innovative green chemistry technologies that reduce or eliminate the use or generation of hazardous substances in chemical design, manufacture, and use. Information on the program—including research opportunities, education activities, international initiatives, outreach activities, and tool development—is online (http://www.epa.gov/greenchemistry).

Another EPA site (http://www.epa.gov/opptintr/lead) is devoted to reducing lead poisoning in children. Included in the site are reports on scientific and technical studies on lead, listed by name, and in some cases the executive summary or the full report (or both) are accessible and downloadable from the web page. A list of fact sheets, many with information about lead regulations and standards, is also available (http://www.epa.gov/opptintr/facts.htm), as is a site with materials that can help families find out more about lead in their homes (http://www.epa.gov/opptintr/opptcon.htm). These reports or documents also can be obtained by calling the National Lead Information Center (http://www.epa.gov/lead/nlic.htm) at 1-800-424-LEAD.

EPA's Waste Reduction Resource Center, based in Raleigh, North Carolina, was established in 1988 to provide multimedia waste reduction support for the eight states of EPA Region IV and, since1994, EPA Region III. The site (http://wrre.p2pays.org/) includes a directory of markets for recyclable materials and a vendor database.

Pollution Prevention by Design is an integrated set of tools to help engineers, designers, and planners incorporate pollution prevention strategies into the design stage for new products, processes, and facilities. The project was developed by the Department of Energy's Office of Pollution Prevention and is managed by the Pacific Northwest National Laboratory (http://terrassa.pnl.gov:2080/DFE).

The DOE Pollution Prevention Information Clearinghouse (EPIC) provides up-to-date resources for DOE sites (http://epic.er.doe.gov/epic/). EPIC contains information on pollution prevention policy, successful projects, affirmative procurement, materials exchange and reuse, sustainable design, and awards programs.

State Sites

Many state governments provide valuable online information about pollution prevention. For example, in Michigan the Department of Environmental Quality's Pollution Prevention home page (http://www.deq.state.mi.us/ead/p2sect) offers Michigan businesses, institutions, and environmental groups online access to information on source reduction and recycling. This site includes information on the Great Printers Project, one of the more innovative and comprehensive pollution prevention projects in the nation that attempts to comprehensively reduce pollution in the entire printing process.

In Virginia, the Virginia Department of Environmental Quality's Office of Pollution Prevention (http://www.deq.state.va.us/opp/opp.html) provides technical assistance and materials to industry, governments, academia, non-profits and the general public on how to prevent pollution. The site includes a pollution prevention library with over 2,000 documents.

Global Links

New Ideas in Pollution Prevention, sponsored by the World Bank (http://www.worldbank.org/nipr), is a site for researchers, government officials, and citizens interested in understanding and improving control of industrial pollution, especially in developing countries. It publishes materials produced by the World Bank's Economics of Industrial Pollution Control Research Project. The primary themes of the project include: incentives and behavior, including why polluters behave as they do; the role of the community, including how public information and informal regulation can modify polluting behavior; and the impact of the market, including the implications of market actions on pollution.

The site includes a section on how geographic information systems can be used to explain and improve pollution analysis, a guide to environmental agencies of the world, and a guide to the Internet's best environmental sites, focusing on pollution-related topics.

The United Nations Industrial Development Organization (UNIDO) (http://www.unido.org) includes sections on cleaner production information and an "industrial environment learning kit."

The Canadian Centre for Pollution Prevention (http://c2p2.sarnia.com) is a particularly valuable site. The Centre operates through contracts with Environment Canada's national regional offices as well as with support from provincial governments and businesses.

The Centre's Internet Guide provides links to a long list of businesses, associations, national governments, and NGOs. It also has numerous subject guides, including energy efficiency, accounting, agriculture, chemical management, construction, dry cleaning, electronics, health, metal finishing, and mining.

The Centre also organizes the annual Canadian Pollution Prevention Roundtable, which enables governments, industries, and public and community groups to share experiences.

Other Links

Pollution prevention is not widely taught in colleges. To encourage colleges to add this subject to their curriculum, the National Pollution Prevention Center for Higher Education at the University of Michigan (http://www.umich.edu/~nppcpub/info.html) develops pollution prevention educational materials for university instructional faculty. These materials help faculty incorporate the principles of pollution prevention into existing or new courses.

The National Pollution Prevention Roundtable (http://www.p2.org) is the largest membership organization in the United States devoted solely to pollution prevention. The mission of the Roundtable is to provide a national forum for promoting the development, implementation, and evaluation of efforts to avoid, eliminate, or reduce pollution at the source.

The American Institute for Pollution Prevention (AIPP) (http://es.epa.gov/aipp) is an educational non-profit organization whose members are about 30 large trade associations and professional societies, including the Aerospace Industries Association, American Academy of Environmental Engineers, American Chemical Society, American Institute of Chemical Engineers, Edison Electric Institute, and National Association of Manufacturers.

Through a cooperative agreement with EPA, AIPP constructed and maintains the first and only database containing descriptions of over 75 trade groups and professional societies and their pollution prevention programs. The electronic version of the directory on AIPP's web site contains search capabilities so that visitors can quickly find information about pollution prevention practices. The directory also contains links to many of the organizations as well as staff contacts.

SELECTED RESOURCES

Solid Waste

Council on Environmental Quality and the U.S. Postal Service, *Recycling: Looking Toward the Next Century,* FINAL Workshop Summary (White House Conference Center, Washington, DC, May 19-21, 1998) (http://www.ofee.gov/html/recycle.htm)

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CORE DATA

CHAPTER NINE

Energy

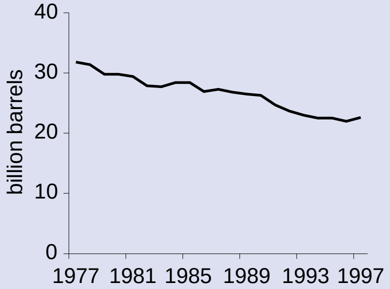
Since the mid-19th century, the American economy has shifted dramatically from an agrarian, rural society towards a largely urban and industrial base powered by fossil fuels—coal, oil, and gas. Electricity, which was unavailable until the 1880s, is now ubiquitous. Within a span of just 100 years, the United States became the world's largest producer and consumer of fossil fuels and roughly tripled its per capita consumption of energy.

The dominance of fossil fuels in the American economy continues today, but not without growing concerns about their environmental implications—particularly their likely role in modifying global climate. Combustion of fossil fuels emits carbon dioxide, the main "greenhouse gas" that scientists think may be contributing to a warming of the planet. The climate issue has increased support for expansion of renewable energy sources such as solar and wind energy, but development of these sources has been slowed by the continuing low cost of fossil fuels. Other methods of generating electricity also pose significant environmental problems. For example, the use of large dams to generate hydroelectric power has had a devastating impact on salmon and other fish, and the flooding of large areas has destroyed important ecosystems. Nuclear power plants, while avoiding the problem of greenhouse gas emissions, nonetheless pose a significant environmental challenge regarding the long-term disposal of nuclear waste.

Energy also is a major source of conventional pollution. The combined effects of the production, distribution, and consumption of fossil fuel energy represent the nation's largest source of pollution. These impacts can be reduced through regulatory-based mechanisms, improved energy efficiency, the introduction of more efficient technologies, and further expansion of market-based incentives to make energy as cost-effective, reliable, and environmentally benign as possible.

Energy production has traditionally been vertically integrated. In the 1990s, however, the U.S. electric power industry is beginning a complex transition to a competitive market. California, New York, and most of the New England states are opening their retail electric power markets to competition. Regulators are experimenting with alternative forms of regulation, including performance-based rates. With

Figure 9.1 U.S. Crude Oil Reserves, 1977-1997



Source: See Part III, Table 9.1.
Note: Data refer to proved reserves.

competition on the horizon, investor-owned utilities are reducing staff and reorganizing their companies to lower costs. These issues are explored in detail in a DOE study on the electric power industry (http://www.eia.doe.gov/cneaf/electricity/chg_str/).

CURRENT TRENDS

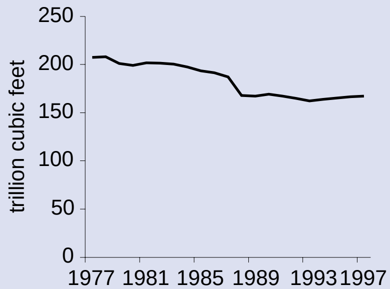
Hydrocarbon Reserves

The United States had large hydrocarbon reserves and was essentially self-sufficient in petroleum until the 1950s and in natural gas until the late 1980s, when consumption began to outpace production. Over the 1977-97 period, proved reserves of crude oil and natural gas in the United States fell substantially and imports rose to make up the difference. Crude oil reserves, estimated at 31.8 billion barrels in 1977, were down to 22.6 billion barrels by 1997 (Figure 9.1). Natural gas reserves, which were estimated at 207.4 trillion cubic feet in 1977, fell to 167.2 trillion cubic feet in 1997 (Figure 9.2). (Part III, Table 9.1)

U.S. Energy Production by Source

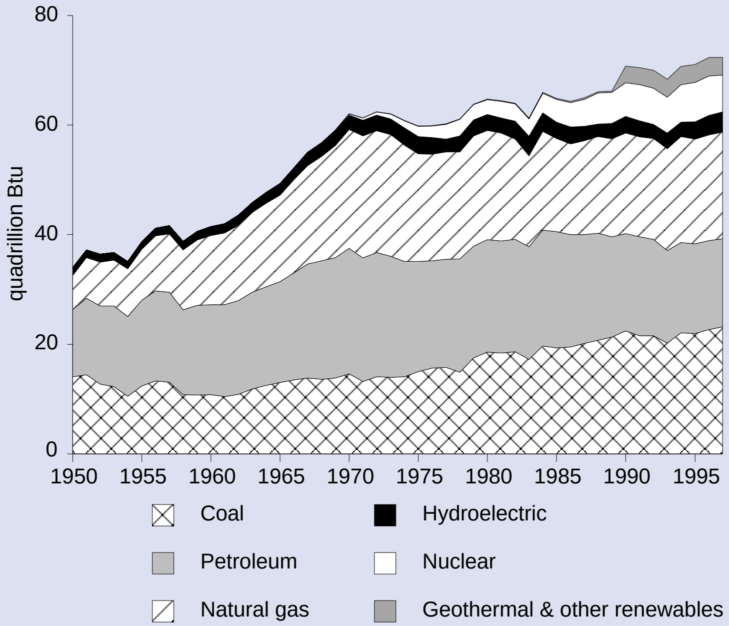
Fossil fuels have dominated U.S. energy production since the early part of this century, but the relative shares have changed (Figure 9.3). Coal relinquished its place as the premier fuel in the years before World War II. However, since the 1950s, coal production has more than doubled, in part because of nationwide use by electric utilities. Petroleum got a major boost with the advent of mass-produced automobiles in the early part of this century. Oil production from domestic reserves rose to the 20-22 quadrillion btu range during the 1970s and 1980s, but declined to about 16 quads in the mid-1990s. Natural gas was used extensively as a lighting fuel until the rapid development of electricity at the turn of the century. The development of steel pipelines, which allowed large volumes of gas to be easily and safely transported over many miles,

Figure 9.2 U.S. Natural Gas Reserves, 1977-1997



Source: See Part III, Table 9.1.
Note: Data refer to proved reserves.

Figure 9.3 U.S. Energy Production by Source, 1950-1997



Source: See Part III, Table 9.2.

Note: Coverage of nonutlity use of renewable energy was expanded in 1990.

launched the modern natural gas industry. Domestic production peaked in the 1970s, then fell steeply through the mid-1980s before stabilizing in a range of 17-19 quads in the 1980s and 1990s. Nuclear energy production has grown from negligible production in 1960 to 6.69 quads in 1997.

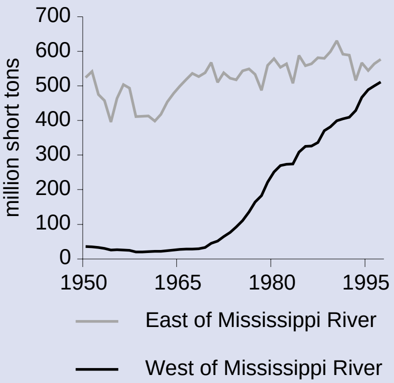
Some renewable energy technologies, such as water- and wind-driven mills, have been in use for centuries. Hydropower production has more than doubled, from 1.42 quads in 1950 to 3.68 quads in 1997, to now represent 5 percent of total U.S. energy production. Most of the rest of U.S. renewable energy production comes from biofuels and geothermal, followed by wind and solar. (Part III, Table 9.2)

U.S. Coal Production

U.S. coal production has undergone substantial changes in this century in both mining methods and mine location.

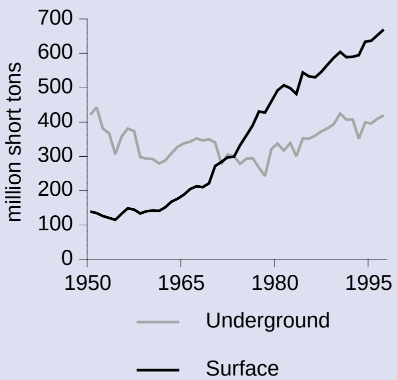
Over the past several decades, coal production shifted from primarily underground mines to surface mines. In addition, the coal reserves of Wyoming and other areas west of the Mississippi River underwent tremendous development (Figure 9.4). Since 1960, coal production in the West has grown dramatically, from 21 million tons in 1960 to 511 million

Figure 9.4 U.S. Coal Production by Location, 1950-1997



Source: See Part III, Table 9.3.

Figure 9.5 U.S. Coal Production by Mining Method, 1950-1997



Source: See Part III, Table 9.3.

tons in 1997, or nearly as much as the 577 million tons produced in the East.

Technological improvements in mining and the shift toward more surface-mined coal have led to great improvements in coal mining productivity. In 1997, U.S. production of coal reached a record-high level of 1.09 billion short tons and was second worldwide after China. Surface mining produced slightly more than one-half of this record quantity (Figure 9.5). (Part III, Table 9.3)

Petroleum Production and Imports

Until the 1950s, the United States produced nearly all the petroleum it needed. But by the end of the decade the gap between production and consumption began to widen and imported petroleum became a major component of the U.S. petroleum supply. After 1992, net imports exceeded production (Figure 9.6). Today the United States produces about 6 million barrels per day while importing nearly 10 million barrels per day. (Part III, Table 9.4)

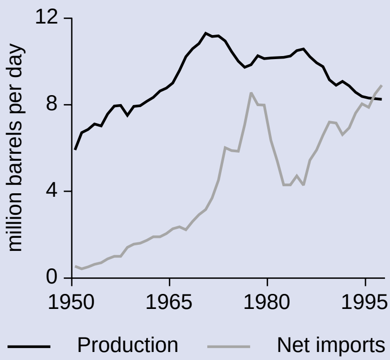
Natural Gas Production

The first all-welded pipeline over 200 miles in length was built in 1925, from Louisiana to Texas. U.S. demand grew rapidly thereafter, especially following World War II. Residential demand grew fifty-fold between 1906 and 1970. U.S. natural gas production peaked at about 22 trillion cubic feet in 1973, and has since drifted downwards in the range of 16-20 trillion cubic feet annually. In 1997, gas production totaled 18.96 trillion cubic feet. (Part III, Table 9.5)

Electricity Net Generation

Electric power arrived barely a hundred years ago, but it radically transformed and expanded energy use. Electricity's broad and increasing usage from 1950 to

Figure 9.6 U.S. Petroleum Production and Net Imports, 1950-1997



Source: See Part III, Table 9.4.
Note: Petroleum = crude oil & natural gas plant liquids.

1997 is evident in many consumption indicators. For example, while the U.S. population grew by 43 percent, total electricity generation grew by more than 920 percent (Figure 9.7). In 1997, the residential sector used the most electricity (1.072 trillion kilowatt-hours), followed closely by the industrial sector (1.036 trillion kilowatt-hours), and then the commercial sector (0.913 trillion kilowatt-hours).

Coal has been and continues to be the source of most electricity, producing over half (1.788 trillion kilowatt-hours) of all electricity generated in 1997 (Figure 9.8). Hydroelectric power was an early source of U.S. electricity (accounting for almost a third of all electricity in 1950) and remains a dependable contributor (about 10 percent of the total in 1997). Natural gas and petroleum grew steadily as sources of electricity in the late 1960s, but have since declined. Nuclear electricity began production in 1957 and increased steadily (except for a downturn following the accident at Three Mile Island) until 1997 when nuclear generation declined seven percent. Nonetheless, nuclear power supplied about 20 percent of U.S. electricity generation in 1997. (See Part III, Table 9.6)

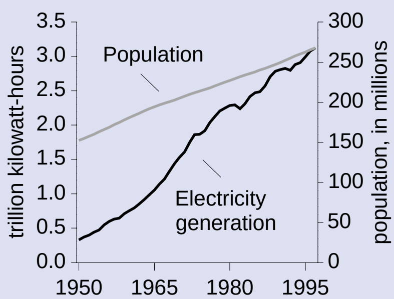
Nuclear Power Plant Operations

The number of operating nuclear power plants rose to a high of 112 in 1990. Since then, the number of operating units has declined to 107. Net generation of electricity reached a high of 674 billion kilowatt-hours in 1996, but declined to 629 billion kilowatt-hours in 1997. (Part III, Table 9.7)

U.S. Net Energy Imports by Source

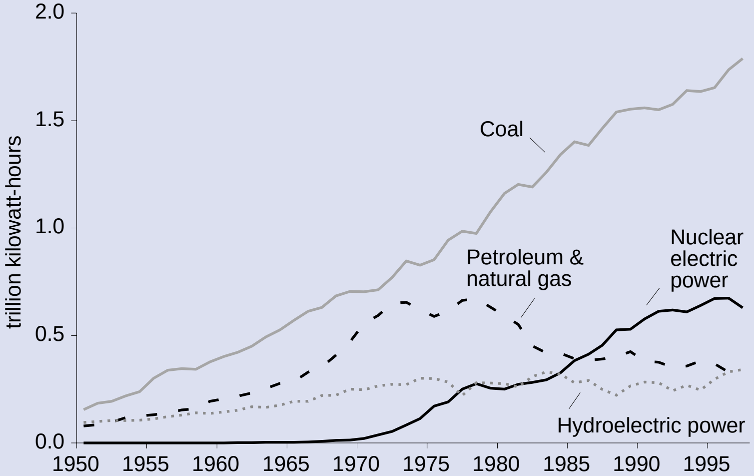
Petroleum is by far the largest source of imported energy in the U.S., accounting for 19.12 quadrillion Btus out of the net total of 20.39 quads of energy imports in 1997 (Figure 9.9). The 1997 energy

Figure 9.7 Growth in U.S. Population and Electricity Generation, 1900-1997



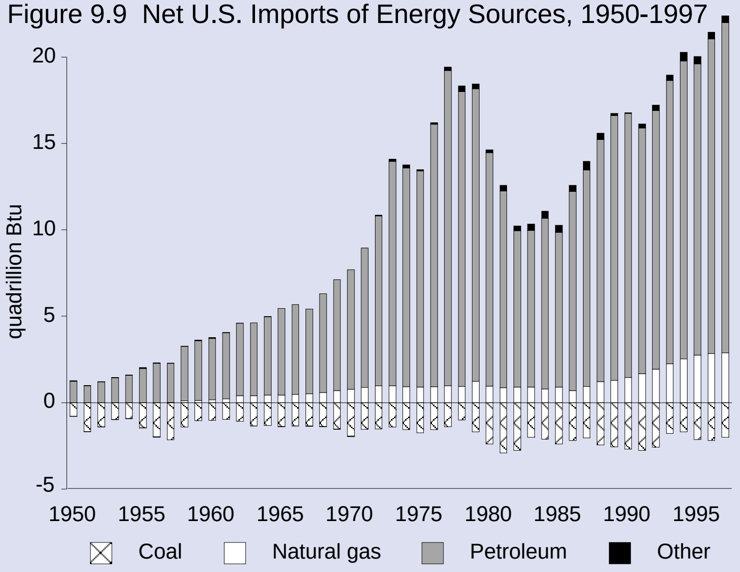
Source: See Part III, Table 1.1 and Table 9.6.

Figure 9.8 U.S. Electricity Generation by Source, 1950-1997



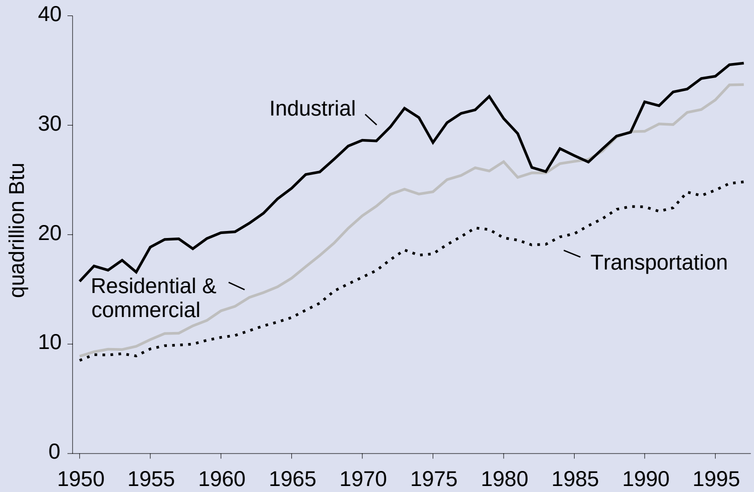
Source: See Part III, Table 9.6.

Figure 9.9 Net U.S. Imports of Energy Sources, 1950-1997



Source: See Part III, Table 9.8.

Figure 9.10 U.S. Energy Consumption by Sector, 1950-1997



Source: See Part III, Table 9.9.

import level represents a 16-fold increase over the 1950 level. (Part III, Table 9.8)

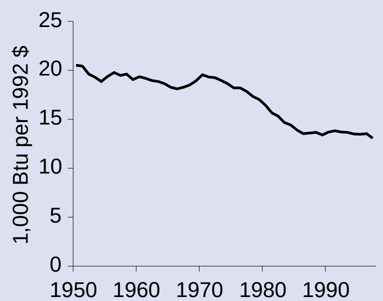
U.S. Total Energy Consumption by Sector

In 1950, U.S. industry accounted for almost half of total energy consumption—15.7 quads out of a national total of 33.1 quads, compared to 8.9 quads for combined residential and commercial and 8.5 quads for the transportation sector. Since then, all sectors have increased their consumption, but residential and commercial consumption has risen to be nearly equal to the industrial sector (Figure 9.10). (Part III, Table 9.9)

Per Capita Total Energy Consumption

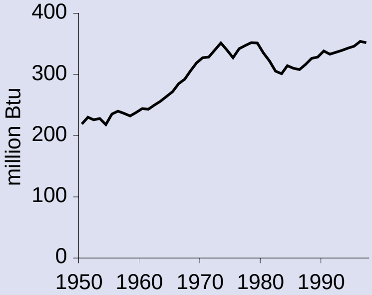
The efficiency with which the U.S. uses energy has improved over the years. One such measure is the amount of energy consumed to produce a (constant) dollar's worth of gross domestic product (GDP). By that measure, efficiency improved by 36 percent between 1950 and 1997, as energy consumption per dollar of GDP fell from 20.5 thousand Btu to 13.1 thousand Btu (Figure 9.11). Nevertheless, a growing population and econo-

Figure 9.11 U.S. Energy Use per Dollar of GDP, 1950-1997



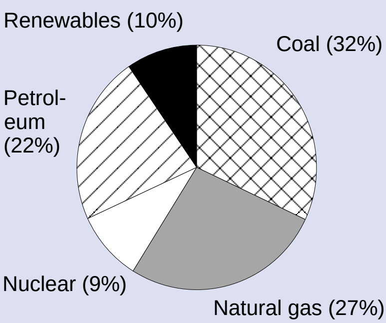
Source: See Part III, Table 9.10.

Figure 9.12 U.S. Energy Use per Capita, 1950-1997



Source: See Part III, Table 9.10.

Figure 9.13 Renewable Energy as Share of Total Energy, 1997



Source: See Part III, Table 9.2.

my drove total energy use up. As the U.S. population expanded from 151 million people in 1950 to 268 million people in 1997 (an increase of nearly 80 percent), total energy consumption grew from 33 quadrillion Btu to 94 quadrillion Btu (up nearly 200 percent) and per capita energy consumption rose from 219 million Btu to 352 million Btu over the period (an increase of 60 percent) (Figure 9.12). (Part III, Table 9.10)

U.S. Renewable Energy Production

U.S. renewable energy production is now almost 10 percent of total U.S. energy production (Figure 9.13).

In 1960, conventional hydroelectric power provided essentially all of the renewable energy in the nation. By 1997, hydropower had more than doubled, growing from 1.6 quads in 1960 to 3.7 quads in 1997 (Figure 9.14). But total renewable energy production grew to 6.9 quads, thanks to rapid growth in biofuels production and modest growth in solar, wind, and geothermal energy. (Part III, Table 9.11)

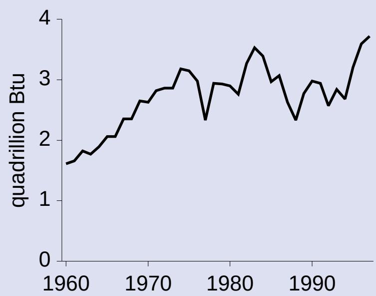
Industrial sources and electric utilities account for about 90 percent of all renewable energy consumption. (Part III, Table 9.12)

U.S. Energy Intensity by Source

Energy intensity is another measure of energy efficiency. In the late 1970s and early 1980s, energy intensity in the residential and commercial sectors fell as a result of energy conservation improvements; since then, estimates of energy intensity in these two sectors have been about the same. Similarly, energy intensity fell during the 1977-84 period in the manufacturing sector, but has apparently stayed about the same since then.

Energy intensity for both passenger cars and trucks has declined steadily over the 1977-95 period, but the decline has been less dramatic in the 1990s. (Part III, Table 9.14)

Figure 9.14 U.S. Conventional Hydroelectric Power Generation, 1960-1997



Source: See Part III, Table 9.11.
Note: Excludes pumped storage facility production.

ONLINE RESOURCES

The web site maintained by the Department of Energy's Energy Information Administration (http://www.eia.doe.gov) provides a wealth of data and information on energy.

Particularly noteworthy is DOE's *Annual Energy Review 1997* (http://www.eia.doe.gov/emeu/aer/contents.html). The review includes numerous tables on end-use energy consumption, financial indicators, energy resources, petroleum, natural gas, coal, electricity, nuclear energy, renewable energy, international energy resources, and environmental indicators.

DOE's Office of Energy Efficiency and Renewable Energy maintains the Energy Efficiency and Renewable Energy Network (EREN), which provides information on alternative fuels, geothermal energy, solar energy, wind energy, and on energy efficiency for industry, utilities, buildings, and transportation. Specialized resources also are available on the environment (http://www.eren.doe.gov).

The Oak Ridge National Laboratory (http://www.ornl.gov) is a multiprogram science and technology laboratory managed for DOE by Lockheed Martin Energy Research Corporation.

In addition to its research on energy, ORNL is one of the world's leading sources of information on greenhouse gas emissions. ORNL's Carbon Dioxide Information Analysis Center—linked to nearly 100 monitoring stations worldwide—is the most comprehensive CO_2 database on earth. The center tracks emissions, estimates the offsetting effects of plants and oceans, and uses sophisticated computer models to project future concentrations (http://cdiac.esd.ornl.gov).

CDIAC's latest estimates of global, regional, and national fossil fuel CO_2 emissions are available (http://cdiac.esd.ornl.gov/trends/emis/tre_glob.htm). The 1996 estimate for global CO_2 emissions, 6,518 million metric tons of carbon, is the highest emission estimate recorded to date.

Based in Paris, the International Energy Agency (IEA) provides a wealth of information about global energy production, consumption and trends. The IEA site (http://www.iea.org/homechoi.htm) includes research on world energy prospects to 2020, on the world energy outlook, and on IEA's world energy model.

IEA's Energy Technology Data Exchange and Energy Database (http://www.etde.org) provides access to more than 3.7 million scientific and technical citations. Updated twice monthly, the database contains bibliographic references and abstracts to journal articles, reports, conference papers, books, and other documents. The database includes information on the environmental aspects of energy production. The data exchange also provides a directory for full-text government reports and conference literature and identifies subject-area experts.

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—, *Renewable Energy Annual 1998* - (with data for 1997) (DOE, EIA, Washington, DC, 1998).(http://www.eia.doe.gov/cneaf/solar.renewables/rea_data/rea_sum.html)

RELATED ENERGY WEB SITES

Energy Information Administration (http://www.eia.doe.gov) within the U.S. Department of Energy maintains web pages on a variety of energy-related subjects. Several are listed below.

Alternative Fuels/Renewables Information at a Glance - links to profiles, reports, and statistics on the following renewable energy resources and related subjects: biomass; municipal solid waste; geothermal; wind; solar; international renewable energy; environment; and electric industry restructuring. (http://www.eia.doe.gov/fuelrenewable.html)

Coal Information at a Glance - links to the following coal related subjects: industry overview; coke; consumption; distribution; employment; imports/exports; prices - end use; prices - mine production; productive capacity; productivity; quality; receipts; recoverable reserves; stocks. (http://www.eia.doe.gov/fuelcoal.html)

Electric Information at a Glance - links to data and reports on the following subjects: capability; capacity; consumers; demand side management; financial: investor-owned; fuel; generation; generating units; ownership; plants; revenue; and sales. (http://www.eia.doe.gov/fuelelectric.html)

Energy and Statistical Information on the Web - links to national, state, local and international governments, associations, energy companies, and other energy information sources. (http://www.eia.doe.gov/links.html)

Index to Energy Consumption Data - links to reports and data on energy consumption by the following sectors: manufacturing; residential; households; residential transportation; and commercial. Also links to alternative fuels, measuring energy efficiency, and contacts. (http://www.eia.doe.gov/emeu/consumption/)

Index to Environmental Publications and Data - links to climate change and greenhouse gas emissions data, utility sector, transportation sector, environmental/energy legislation, and other environmental links See Chapter 11 for other websites on climate change and greenhouse gas emissions. (http://www.eia.doe.gov/environment.html)

Index to Natural Gas Information Publications and Related Data - links to annual, monthly, weekly, and other reports and related data; feature articles and special reports; and EIA's Specialized Natural Gas Information System (GIS). (http://www.eia.doe.gov/oil_gas/natural_gas/nat_frame.html)

Index to Petroleum Information Publications and Related Data - links to Annual, monthly, and weekly reports and related data; feature articles and special reports; presentations; survey forms and instructions; and PEDRO News. (http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html)

International Energy Themes - links to data and reports on the following international energy subject areas: prices; country briefs; forecasts; chronologies; fact sheets; energy security; access database; privatization; restructuring; joint ventures; other finance; environment; data exchange; and reports. (http://www.eia.doe.gov/emeu/international/contents.html)

Nuclear (and Uranium) Information at a Glance - links to reports and data on U.S. nuclear reactors; forecasts; nuclear capacities; uranium requirements; enrichment requirements; spent fuel discharges; nuclear generating units. Also links to information on uranium resources: mining; production; processing; employment; marketing; enrichment; foreign purchases; foreign sales; and inventories. (http://www.eia.doe.gov/fuelnuclear.html)

Alternative Fuels Data Center - links to information on alternative fuels and vehicles operating on alternative fuels. (http://www.afdc.nrel.gov/)

CORE DATA

CHAPTER TEN

Transportation

The U.S. transportation system is a vast enterprise. Transportation-related goods and services account for about one tenth of the nation's gross domestic product, and the economy relies heavily on the low-cost, highly flexible movement of goods and services. Most Americans enjoy a level of personal mobility that offers them a wide range of choices about where to live, work, shop, obtain health care, and vacation.

Yet, not all the costs of mobility are paid directly by the individuals and businesses who are the beneficiaries. Transportation has a significant impact on environmental quality in a wide variety of ways, notably in terms of air quality, land use and development, habitats and open space, and energy use.

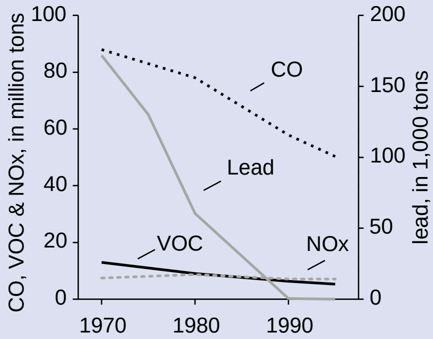
Particularly notable is the high dependence of most American communities on the automobile as the principal means of transportation. Urban growth has often been characterized by new housing developments encroaching farther into agricultural and environmentally sensitive lands, an increasing dependence on automobiles, and the isolation of central cities and older communities.

Many states have been struggling to reverse these trends. One of the most dynamic examples is Maryland's Smart Growth Initiative. The initiative was built on the Maryland Economic Growth, Resource Protection, and Planning Act of 1992, and further strengthened in 1997 with enactment of the Neighborhood Conservation and Smart Growth package of initiatives.

The centerpiece of the 1997 package is the "Smart Growth Areas" legislation. This new law limits most State spending on housing, infrastructure, economic development, and other programs to "Priority Funding Areas," areas that local governments determine are suitable for further growth. This serves to channel state funds to already developed areas and to areas selected by local governments for further growth, while restricting state funding for infrastructure or development in other rural areas. A new "Live Near Your Work" pilot program provides cash contributions to workers buying homes in certain older neighborhoods. To spur more preservation of undeveloped land, a new "Rural Legacy" program provides financial resources for the protection of farm and forest lands and the conservation of these essential rural resources.

Such strategies could have significant long-term environmental benefits. For example, they could help build on the reductions in air pollutants from mobile sources, which to date are attributable almost entirely to technological advances that have reduced pollutant emissions, and to requirements that harmful substances be reduced or removed from fuels, or that substances be added to fuels to make them pollute less.

Figure 10.1 Pollutant Emissions by On-road Sources, 1970-1997



Source: See Part III, Tables 5.1 through 5.7.
Notes: NO_x = Nitrogen oxides. CO = Carbon monoxide. VOC = volatile organic compounds.

TRENDS

Notable reductions in air pollutant emissions and air quality concentrations have occurred since 1970, despite significant increases in population, economic and industrial activity, and vehicle miles traveled.

Over the past decade, for example, national emissions of carbon monoxide have declined from 116.1 million tons in 1988 to 87.5 million tons in 1997. More than half of total emissions are from on-road vehicles. In that category, emissions have declined from 71.1 million tons in 1988 to 50.3 million tons in 1997, despite a 25-percent increase in vehicle miles traveled over the period. NAAQS violations of CO have largely been eliminated, and CO emissions are not expected to increase.

Among other sources, the most significant increase has occurred in the category of non-road engines and vehicles, where CO emissions have increased from 15 to 17 million tons over the 1988-97 period. (Most of the 17 million tons of CO emissions from non-road engines and vehicles is from non-transportation sources, such as lawn and garden equipment and light industrial equipment.) Emissions of volatile organic compounds and lead by on-road vehicles also declined over the period, while emissions of nitrogen oxides increased slightly, continuing the trend since 1970 (Figure 10.1).

Recent data suggest a slowing of the improvements that characterized the last 25 years. Steady growth in travel coupled with increased emissions from previously unregulated off-road sources may overtake the impressive emission reductions achieved under past standards. On the whole, on-road vehicles still accounted for 58 percent of all CO emissions, 30 percent of all nitrogen oxides emissions, 27 percent of all volatile organic compounds, and 5 percent of all lead emissions in 1997.

Transportation is also a significant contributor to the nation's emissions of greenhouse gases, accounting for about one third of CO_2 emissions from anthropogenic sources. In 1996, U.S. transportation-related greenhouse gas emissions grew 3.4 percent over 1995. This rate of increase is faster than the growth of energy consumption from transportation (3.2 percent) and faster than the growth of the economy (2.4 percent).

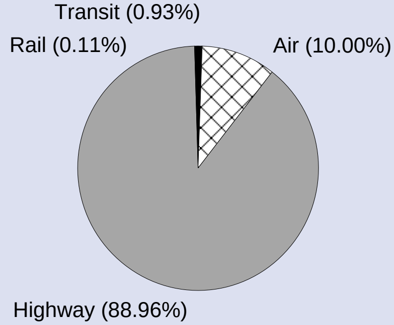
The U.S. transportation system is about 95 percent petroleum dependent, down about two percentage points from a decade ago. In 1997, transportation-driven oil demand together with declining domestic production brought about the highest levels of oil imports ever (48 percent of oil use). Transportation is the only sector of the economy that consumes significantly more petroleum today than it did in 1973, the first year of the oil price shock.

Highway vehicles continue to dominate transportation energy use. Light-duty passenger vehicles alone account for over 60 percent of all energy used in transportation.

Travel by air and on the nation's highways has increased steadily since 1960, though the upward trend for highway travel has slowed in the 1990s.

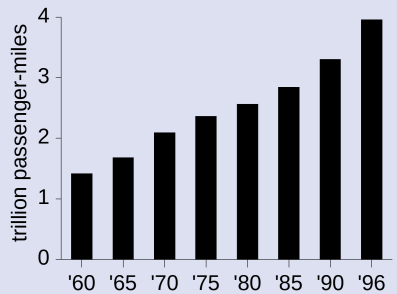
In 1996, U.S. passenger-miles totaled over 4.4 trillion, with nearly 4 trillion of the total attributable to highways and most of the remainder to air travel (Figure 10.2). Highway passenger-miles have nearly doubled since 1970 (Figure 10.3). Over the 1990-96 period, highway passenger-miles increased about 20 percent, while air passenger-miles grew about 24 percent. Travel by transit stayed about the same, while rail travel declined slightly.

Figure 10.2 U.S. Passenger-Miles by Mode, 1996



Source: See Part III, Table 10.1.
Note: Total = 4,412 billion passenger-miles.

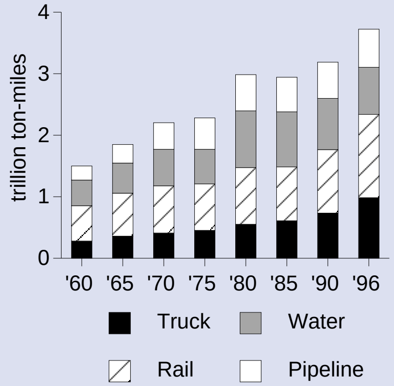
Figure 10.3 U.S. Highway Passenger-Miles, 1960-1996



Source: See Part III, Table 10.1.

Many factors contribute to the overall increase in passenger miles of travel, including increases in the U.S. population, the number of people in the labor force (especially women), and the number of people commuting to work (and the distance they travel). With an increase in disposable income, people also have more money to spend on transportation, particularly automobiles and air travel. (Passenger-miles represents the total dis-

Figure 10.4 U.S. Freight Ton-Miles by Mode, 1960-1996



Source: See Part III, Table 10.2.

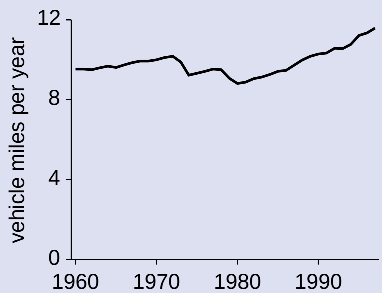
tance traveled by all passengers in passenger cars, airplanes, transit, rail and other modes; one passenger traveling one mile generates one passenger-mile). (Part III, Table 10.1)

The use of the transportation network for the movement of freight continued to grow rapidly in the 1990s (Figure 10.4). Over the 1990-96 period, ton-miles of freight hauled by intercity trucks and by rail both grew by about one third. There are several reasons for these trends other than growth in the general population and economy. These include the increasingly complex logistics of production, more international trade, technological improvements allowing more trading of perishable goods, the implementation of information technologies allowing just-in-time delivery systems, and railroad deregulation. (Ton-miles are defined as the movement of one ton of freight for a distance of one mile. Ton-miles are computed by multiplying the weight in tons of each shipment transported by the distance hauled.) (Part III, Table 10.2)

The Federal Highway Administration, in its survey of nationwide personal travel, collects data on, among other things, the number of licensed drivers per household, vehicles per household, daily vehicle trips and vehicle miles per household, average vehicle occupancy rate, average vehicle trip length, average distance to work, average annual travel per driver, and average annual personal travel.

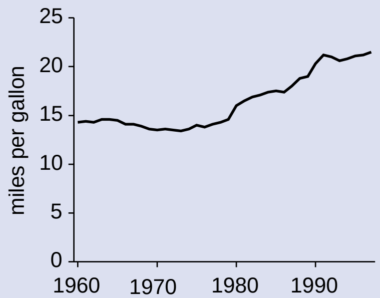
Americans generally are traveling more miles annually in their vehicles. In 1990, the average passenger car traveled 10,280 miles during the course of the year; by 1997, average vehicle-miles for passenger cars had increased to 11,575 miles. This continues a trend that began around 1980 (Figure 10.5) that has been influenced by, among other things, changes in the labor force and income as well as changes in the makeup of households and metropolitan areas. From 1970 to 1996, the number of households increased by 56 percent, partly mirroring a decline in household size. At the same

Figure 10.5 Growth in Travel in Passenger Cars, 1960-1997



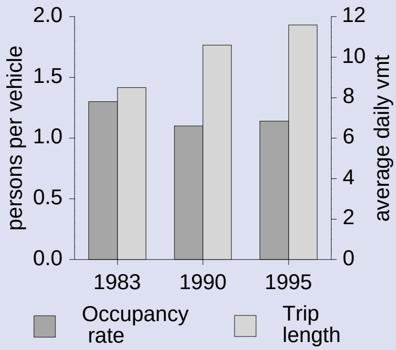
Source: See Part III, Table 10.3

Figure 10.6 U.S. Average Miles Traveled per Gallon of Fuel Consumed for Passenger Cars, 1960-1997



Source: See Part III, Table 10.3.

Figure 10.7 Profile of U.S. Passenger Vehicles Used for Commuting, 1983-1995



Source: See Part III, Table 10.4.
Notes: vmt = vehicle miles of travel.

time, the number of vehicles per household also rose. More households and vehicles translates into more trips for shopping, recreation, and taking care of children (in addition to more commuters). Changes in the locations where people live, work, and shop also increased travel and dependence on private automobiles. As metropolitan areas expanded and low-density suburbs spread into rural areas (see Part III, Table 1.4 and Table 7.2), private vehicle trips soared, as they offered more mobility and direct connections between destinations. (Vehicle-miles are estimated by calculating the number of gallons of gas sold from gasoline tax receipts and multiplying by the average number of miles per gallon for cars, buses, trucks, and other vehicles.) (Part III, Table 10.3)

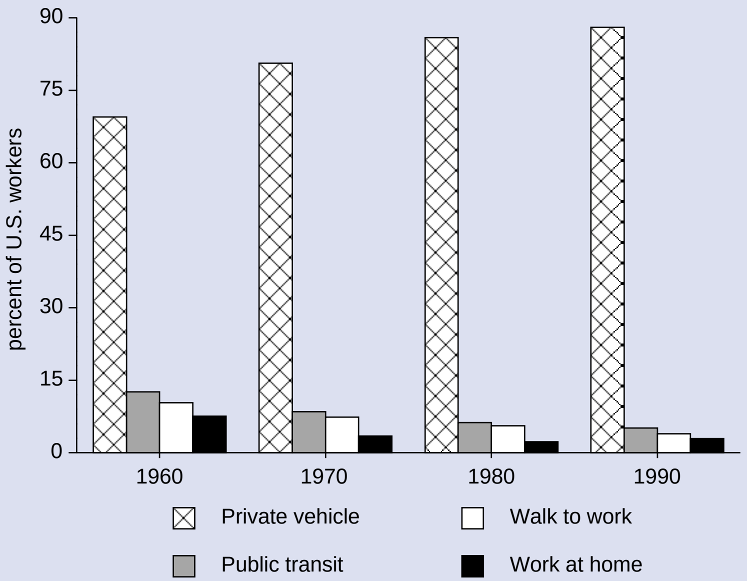
Average gas mileage for passenger cars has stayed about the same in the 1990s — about 20-21 miles per gallon (mpg). Since 1960, gains are impressive. For passenger cars, fuel efficiency per vehicle has increased from 14.3 mpg in 1960 to 21.3 mpg in 1996 (Figure 10.6). From 1973 to 1996, the average fuel efficiency of new passenger cars entering the fleet increased from 14.2 mpg to 28.5 mpg. Some of the gains in car fuel efficiency were offset by a shift in the composition of private vehicle usage towards light-duty trucks and sport-utility vehicles. (Fuel consumption per vehicle is the ratio of vehicle-miles traveled to total gasoline consumption in gallons). (Part III, Table 10.3)

Over the period from 1983 to 1995, the average distance to work increased from 8.5 miles to 11.6 miles, or 36 percent (Figure 10.7). Over the same period, average work travel time increased 14 percent and average work trip duration increased 20 percent. These latter trends appear to contradict the reality of congested roads. The growth in suburbs around large metropolitan areas, the spreading out of peak commuting periods (because of greater flexibility in hours of work), and the switch from carpool to single occupant vehicle trips are often cited among the reasons why people can now have a longer commute in miles with only a modest increase in travel time. (Part III, Table 10.4)

The Commerce Department's Bureau of the Census also collects data on how Americans get to work. Census data shows a dramatic rise in the use of private vehicles (Figure 10.8). In 1960, 69 percent of Americans used private vehicles to get to work, while 12 percent used public transit, 10 percent walked to work, and 7 percent worked at home. In 1990, 88 percent of working Americans were using private vehicles, while 5 percent were using public transit, 4 percent were walking, and 3 percent were working at home. (Part III, Table 10.5)

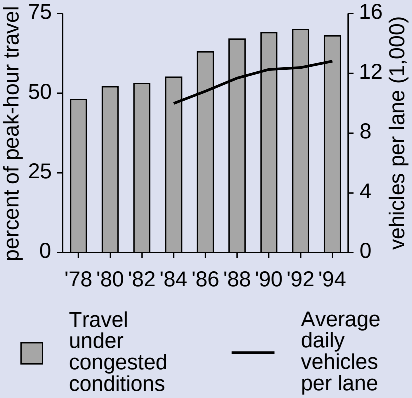
The Federal Highway Administration provides estimates of congestion on U.S. urban interstate highways. Peak hour travel under congested conditions on interstate highways increased from 41 percent of travel time in 1975 to 64 percent of travel time in 1987, and then remained stable at about 69 percent from 1988 to 1994. Meanwhile, the average daily number of vehicles per lane has continued to increase over the period (Figure 10.9). (Part III, Table 10.6) (Beginning in 1995, updated capacity (service flow) calculation procedures were instituted by DOT, making congestion data for 1995 and 1996 not comparable to previous years data.)

Figure 10.8 Journey-to-work by Mode, 1960-1990



Source: See Part III, Table 10.5.

Figure 10.9 U.S. Urban Interstate Congestion, 1978-1994



Source: See Part III, Table 10.6.
Note: See Table 10.6 for definitions of the two measures of congestion shown here.

OTHER TRANSPORTATION-RELATED TRENDS

Aircraft Noise

In the late 1960s, Congress directed the Federal Aviation Administration to begin regulating aircraft noise, establishing the first federal noise standards for new-design turbojet and transport category jet aircraft. These "Stage 2" aircraft noise standards were subsequently applied to all newly produced planes, including those of older designs.

These steps did not fully solve the problem; by 1974, FAA estimated that 7 million people were still severely affected by aircraft noise. In 1976, FAA required that all subsonic aircraft in operation meet Stage 2 requirements by January 1, 1985. In 1977, FAA implemented more stringent Stage 3 noise standards for new aircraft.

In 1990, FAA began a phased elimination of civil, subsonic aircraft over 75,000 pounds flying into or out of airports in the contiguous United States by December 31, 1999. To date, the transition to Stage 3 aircraft has remained on schedule.

In 1995, FAA estimated that 1.7 million people were exposed to day-night noise levels greater than 65 decibels, a decline of over 75 percent since 1975 even while commercial aircraft departures increased by over 75 percent.

Scrap Tire Disposition

Disposal of scrap tires has been an environmental problem for many decades; the nation annually throws away about 250 million scrap tires, many of which go to landfills, scrap tire stockpiles, or illegal dumps.

The scrap tire problem has changed quite dramatically over the past several years, largely as a result of a significant increase in their use as tire-derived fuel. From 1990 to 1996, the number of tires used as fuel increased nearly five-fold, reaching more than 150 million. Demand for scrap tires in other markets also roughly doubled during this period. These markets include ground rubber applications, such as asphalt products, new tires, bound rubber products, and athletic surfaces; civil engineering applications, such as fill material, road bed material, and aggregate; and other applications such as artificial reefs, playground equipment, and crash barriers.

With the growth of these important new markets for scrap tires, EPA and the Scrap Tire Management Council estimate that the number of scrap tires stockpiled, landfilled, and dumped annually may have fallen by as much as two thirds.

ONLINE RESOURCES

The U.S. Department of Transportation's Bureau of Transportation Statistics (http://www.bts.gov/) maintains a vast quantity of data on U.S. transportation. Much of the material is available online through the bureau's National Transportation Library (http://www.bts.gov/ntl).

National Transportation Statistics (http://www.bts.gov/ntda/nts) includes numerous tables on the physical extent of the U.S. transportation system, travel and the movement of goods, energy use in transportation, and transportation-related air emissions. *National Transportation Statistics 1998* is only available online; other BTS materials are available in print form.

Transportation and the Environment

National Transportation Statistics also includes numerous tables on transportation-related energy consumption and air emissions. Air emissions estimates are compiled by Oak Ridge National Laboratory and published in the Environmental Protection Agency's *National Air Pollutant Emission Trends* reports.

Data are available describing transportation-related emissions of carbon monoxide, nitrogen oxides, nonmethane volatile organic compounds, particulate matter, sulfur dioxide, and lead. Transportation-related lead emissions, estimated at 180,000 short tons in 1970, have been nearly eliminated in the 1990s following the phaseout of lead in gasoline.

DOT's Bureau of Transportation Statistics also publishes the *Transportation Statistics Annual Report*, which includes a discussion each year on energy and environment trends pertinent to transportation. Part II of the 1996 report provided in-depth coverage of transportation's environmental impacts and trends, including international comparisons and data needs (http://www.bts.gov/programs/transtu/tsar/tsar.html).

The Federal Highway Administration's Office of Environment and Planning is online (http://www.fhwa.dot.gov/environment/). The site includes a valuable summary of environmental legislation affecting transportation.

The Center for Transportation and the Environment is a DOT-supported university research institute that focuses on research related to mitigating the effects of surface transportation on the environment (http://itre.itre.ncsu.edu/cte/).

The Transportation Action Network, or TransAct, is a joint project of the Environmental Protection Agency's Transportation Partners Program and the Surface Transportation Policy Project. TransAct (http://www.transact.org) provides information and resources about making communities more livable and helping the environment through innovative transportation projects and initiatives.

DOE's Transportation Technologies site (http://www.ott.doe.gov) is a one-stop shop for information on transportation technologies. Among other things, the site provides information about alternative fuels, including the outlook for alternative-fuel vehicles, information sources on alternative fuels, and a glossary of key alternative fuel terms.

The Transportation Research Board is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's research agenda includes studies on the interaction of transportation systems with the environment. One recent report, *Transportation and a Sustainable Environment*, lays out a path toward transportation policies that are commensurate with the need for long-term environmental integrity and sustainability (http://www.nas.edu/trb).

Global Data

The World Bank (http://www.worldbank.org) provides a wealth of information about environmental issues in developing countries. *World Development Indicators*, which is available in published form or on CD-ROM, includes a table on traffic and congestion.

In the transportation area, the Bank is actively encouraging the total phase-out of leaded gasoline. The World Bank-supported Transport Air Quality Management Project for the Mexico City Metropolitan Area includes actions on vehicle emissions control technology, alternative fuels and vapor controls, travel demand management, public transport, and transport investment planning.

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Highway Statistics

U.S. Department of Transportation, Federal Highway Administration, *Our Nation's Highways —Selected Facts and Figures* (FHWA, Washington, DC, 1998). (http://www.fhwa.dot.gov/ohim/onh/onh.pdf)

—, *Highway Statistics 1997* (FHWA, Washington, DC, December 1998), and earlier annual reports. (http://www.fhwa.dot.gov/ohim/1996/ohimstat.htm)

—, *Highway Statistics Summary to 1995* (FHWA, Washington, DC, December 1997). (http://www.fhwa.dot.gov/ohim/Summary95/index.html)

Personal Transportation Trends

—, U.S. Department of Transportation, Federal Highway Administration, *Journey-To-Work Trends in the United States and its Major Metropolitan Areas 1960-1990* (FHWA, no date, based on decennial census data) (http://www.bts.gov/NTL/DOCS/473.html)

—, *Our Nation's Travel: 1995 NPTS Early Results Report* (FHWA, Washington, DC., 1997). (http://www-cta.ornl.gov/npts/1995/Doc/EarlyResults.shtml)

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Davis, S.C., *Transportation Energy Databook,* (DOE, Oak Ridge National Laboratory, Center for Transportation Analysis, annual). (http://www-cta.ornl.gov/data/tedb.htm)

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U.S. Environmental Protection Agency, Office of Policy Planning and Evaluation, *Indicators of the Environmental Impacts of Transportation* (EPA, OPPE, Washington, DC, 1996). (http://www.epa.gov/tp/indicall.pdf)

U.S. Department of Transportation, U.S. Coast Guard, *Pollution Incidents In and Around U.S. Waters, A Spill/Release Compendium: 1969-1997* (DOT, USCG, Washington, DC, 1999). (http://www.uscg.mil/hq/g-m/nmc/response/stats/aa.htm)

CORE DATA

CHAPTER ELEVEN

Global Environment

The global nature of many environment and resource issues is evident in the long list of international conventions and agreements agreed to since World War II. The United Nations' Environment Programme's *Register of International Treaties and Other Agreements in the Field of Environment* lists more than 100 agreements (including protocols and amendments) stretching back over five decades.

Most of these conventions and agreements fall into twelve categories: wildlife and biodiversity, marine pollution and resources, marine mammals, fisheries, wetlands, trade in endangered species, land conservation, transboundary air pollution, conservation and management of migratory species, transboundary movements of hazardous wastes, stratospheric ozone, and global climate change. Summaries of all these conventions and agreements (through 1992) are online (http://sedac.ciesin.org/pidb/register-home.html).

Wetlands

In 1971, at Ramsar, Iran, wetland protection was the focus of one of the first global environmental treaties. The Ramsar Convention is known formally as the Convention on Wetlands of International Importance Especially as Waterfowl Habitat. The Convention originally focused on waterfowl protection, but has since been broadened to cover multiple aspects of wetlands conservation and freshwater issues.

Ramsar recognizes wetlands as ecosystems that are important for biodiversity conservation and for the benefit of human communities. The Convention's definition of wetlands encompasses five major wetland systems: coastal wetlands (including coral reefs), deltas, tidal marshes, mangrove swamps, wetlands associated with lakes, and wetlands associated with rivers, streams, marshes, swamps, and bogs.

The Ramsar Convention entered into force in 1975; there are currently 110 contracting parties. To join, a country must designate at least one wetlands area that meets the criteria for inclusion on the List of Wetlands of International Importance and agree to implement guidelines for wetlands management. Ramsar commitments are voluntary. There are now over 900 sites covering more than 150 million acres worldwide. The United States, which joined the convention in 1986, has 15 designated Ramsar sites, including well-known areas such as the Chesapeake Bay Estuarine Complex, Everglades National Park, and Delaware Bay Estuary.

Biodiversity

The global loss of genetic and species diversity is occurring at unprecedented rates, threatening to impair the natural infrastructure supporting every human society and economic system. Many factors are contributing to the problem, including land and water degradation, forest conversion, overharvesting of commercial species, and the introduction of non-native species.

Although the total number of species is unknown, UNEP's 1995 Global Biodiversity Assessment concluded that a reasonable estimate is about 14 million, of which about 1.7 million have been scientifically described. The report estimates that between 5 and 20 percent of some groups of animal and plant species could be threatened with extinction in the foreseeable future.

The 1992 Convention on Biological Diversity (CBD) is the main international forum for addressing biodiversity issues. Its three objectives are the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of any benefits arising from the commercial development of genetic resources. The Convention requires Parties to develop and implement strategies for the conservation, sustainable use and protection of biodiversity, and provides a forum for continued dialogue through annual meetings of the parties.

The CBD came into force in late 1993. Since it was opened for signature in June 1992, 175 of the 183 countries in the United Nations system have ratified or otherwise acceded to it. The United States declined to sign the CBD in 1992 due to concerns with intellectual property rights, technology transfer, and finance provisions. President Clinton signed the CBD in June 1993. The Senate Foreign Relations Committee favorably reported the Convention to the full Senate in June 1994, but the full Senate curtailed consideration of the treaty over concerns about the potential effect of the CBD on land use and agriculture in the United States.

Endangered Species

Although habitat loss is generally considered to be the major reason for the decline in species, the illegal taking of wild specimens for commercial purposes is also a major threat. Some rare and protected species and their parts and derivatives (e.g., skins, shells, horns, leather goods, etc.) are high-value commodities.

In recognition of these problems, the United States in early 1973 convened a conference at the Department of State with 88 participating countries to negotiate a convention to control international trade in threatened species. The Convention on International Trade in Endangered Species of Wild Fauna and Flora, or CITES, was signed by 21 countries in March 1973. The convention entered into force on July 1, 1975; 143 countries are currently parties to the Convention.

CITES lists species on three appendices. Appendix I includes all species threatened with extinction that are or may be affected by trade. Appendix II includes species that, although not threatened with extinction, may come under threat unless the trade is strictly controlled through a system of permits. Permits for trade are issued only if exporting parties are satisfied that conducting trade does not pose a threat to species survival. Appendix III includes species that any party has placed there because the cooperation of other parties is needed to control or monitor the trade.

International Waters

The degradation of marine, coastal, and river ecosystems is increasingly global in scope and complexity.

For example, many fish stocks are in drastic decline, with three quarters of marine fisheries fully fished, overexploited, depleted, or slowly recovering from collapse. Oversubsidized national fishing fleets are harvesting fish at unsustainable rates, placing both fishery resources and the future of fishing communities at risk.

Many other problems threaten these ecosystems, including a widespread decline in water quality; increasing pressure on water resources for human use; and the loss of watersheds, wetlands, and marine habitats.

The international community has for several decades discussed ways to apply the rule of law to the uses and conservation of the oceans.

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) provides a comprehensive legal framework governing uses of the oceans. It achieved consensus on the nature and extent of jurisdiction that States may exercise off their coasts: a territorial sea of a maximum breadth of 12 nautical miles and coastal State jurisdiction over fisheries and other resources (e.g., oil and gas) in a 200 nautical-mile Exclusive Economic Zone (EEZ) and on the continental shelf where it extends beyond the EEZ.

The Convention provides for the conservation of living marine resources, including coastal fisheries, straddling stocks (fisheries populations whose range includes both areas of the EEZ and the high seas), and highly migratory species and marine mammals. It also addresses vessel-source pollution, pollution from seabed activities, ocean dumping, and land-based sources of marine pollution.

The United States and other industrialized nations had long objected to the Convention's Part XI, which established a system for regulating the mining of mineral resources from the deep seabed beyond national jurisdiction. A 1994 agreement relating to the implementation of Part XI removed those objections by ensuring that the United States and others will have adequate influence over future decisions on possible deep seabed mining and that the administration of the deep seabed mining regime is based on free market principles. The United States signed the 1994 Agreement and has submitted the Law of the Sea Convention and the Agreement to the Senate for advice and consent.

As of May 1998, there were 125 Parties to the Convention, including the United Kingdom, Japan, Germany, Italy, South Korea, Australia, Russia, China, and France.

Marine Pollution

The problem of marine pollution was recognized prior to World War II and became the subject of international negotiations in the early 1950s. The issue grew in importance with the rapid expansion in the amount of oil transported by tankers. Between the mid-1950s and mid-1970s, the amount of oil transported by sea increased seven-fold and the world's tanker fleet expanded to some 7,000 vessels. OILPOL—the 1954 International Convention for the Prevention of Pollution of the Sea by Oil—was aimed primarily at restricting the amount of oily wastewater that could be discharged in certain areas.

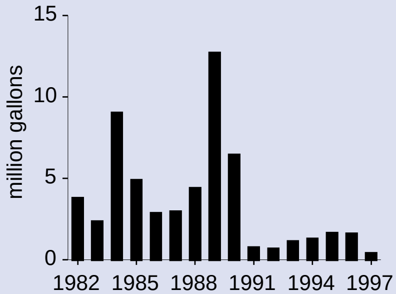
As the demand for maritime oil transportation increased rapidly in the postwar years, the average size of a tanker grew. A single cargo tank on today's large tankers can hold more than twice as much oil as an entire World War II tanker. The large size of tank vessels and major spillage from vessel accidents—such as the grounding and breakup of the *Torrey Canyon* off the Scilly Isles in 1967—stimulated international action to formulate tank vessel design and construction standards aimed at reducing oil outflow following tanker damage.

These standards are now incorporated in international conventions, such as MARPOL—the 1973 International Convention on the Prevention of Pollution from Ships, a subsequent 1978 Protocol, and six Annexes—which promotes ship design and equipment that lessen pollution from marine casualties, and provides a means to monitor discharges from tankers. In addition to preventing pollution by oil, MARPOL was also designed to limit and prohibit other forms of pollution: noxious liquid substances carried in bulk; harmful substances carried in packages, portable tanks, freight containers, or road or rail tank wagons, etc.; sewage from ships; and garbage from ships. It also requires all parties to help reduce pollution by detecting ship violations. The recently negotiated Annex VI deals with air emissions.

The grounding of the *Exxon Valdez* in Prince William Sound in March 1989, and the subsequent spillage of more than 11 million gallons of crude oil into Alaskan waters, resulted in changes in both the character of tank vessel design standards and the manner in which they are formulated. In August 1990, the U.S. Congress promulgated P.L. 101-380, the Oil Pollution Act of 1990 (OPA 90), to minimize oil spills through improved tanker design, operational changes, and greater preparedness. As a result, single-hull tank vessels of 5,000 gross tons or more will be excluded from U.S. waters after 2010 unless they are equipped with a double bottom or double sides, in which case they may be permitted to trade to the United States through 2015, depending on their age. An exemption allows single-hull tankers trading to the United States to unload their cargo offshore at deepwater ports or in designated lightering areas through 2015.

The fact that the United States, as a port state, unilaterally promulgated legislation that applies to all tankers operating in U.S. waters, not just to U.S.-flag vessels, has had a worldwide impact. Following

Figure 11.1 Oil Spills in U.S. Waters by Vessels, 1982-1997



Source: U.S. Department of Transportation, United States Coast Guard. *Pollution Incidents In and Around U.S. Waters -- A Spill/Release Compendium: 1969-1997* (DOT, USCG, Washington, DC, 1999).

the passage of OPA 90, changes in the international regulatory regime in the form of two additions to MARPOL 73/78 mandated a worldwide transition to double-hull vessels or their equivalents.

As a result of these laws and conventions and the development of better methods for controlling the disposal of wastes, the amount of pollution from ships has declined during the last two decades. According to a study by the U.S. National Academy of Sciences, oil pollution from ships fell by about 60 percent during the 1980s, while the number of oil spills has also been greatly reduced. The Academy concludes that the recent reduction in oil spillage in U.S. waters (Figure 11.1) can be attributed to a number of actions: an increased awareness among vessel owners and operators of the financial consequences of oil spills and a resulting increase in attention to policies and procedures aimed at eliminating vessel accidents; actions by port states to ensure the safety of vessels using their ports; increased efforts by ship classification societies to ensure that vessels under their classification meet or exceed existing requirements; improved audit and inspection programs by charterers and terminals; and the increased liability, financial responsibility, and other provisions of OPA 90.

Coral Reefs

Coral colonies thrive in warm water that is free of sediment and pollution. Because reef-building corals require sunlight for photosynthesis, they are generally found in clear, shallow water, usually 75 feet or less.

In many parts of the world, coral colonies are threatened. Diseases and other phenomena are killing 50-80 percent of the elkhorn coral off South Florida and 90 percent of the coral cover in a Venezuelan national park. Many corals are affected by coral bleaching—disturbances such as temperature extremes, hypersalinity, pollutants, or changes in radiation flux can cause coral to expel symbiotic algae that help nourish the coral, and thus the coral turn white and die.

Formed in 1994, the International Coral Reef Initiative (ICRI) is a partnership of local communities, scientists, conservation groups, resource users, private interests, and governments working to protect and manage coral reef resources, including associated ecosystems such as sea grass beds and mangroves.

With strong U.S. support, ICRI has grown rapidly over the past three years from a small group of founding partners to a large consortium in which over 73 countries participate. International activities under the Initiative have included a major diplomatic campaign and a series of global and regional workshops. Among its other achievments, ICRI has established a Global Coral Reef Monitoring System, intended to gather baseline data on coral reefs around the world so that thoughtful and informed conservation and sustainable use strategies can be developed.

In June 1998, President Clinton issued Executive Order 13089, which deals with the protection of coral reefs in U.S. waters, including reef systems in the south Atlantic, Caribbean, Gulf of Mexico, and Pacific Ocean. It orders all federal agencies whose actions may affect U.S. coral reef ecosystems to ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems. The Order also creates a U.S. Coral Reef Task Force, which is charged with overseeing implementation of the policy. The order is available on the White House website (www.whitehouse.gov).

Desertification

In Africa and elsewhere, vast areas of land are threatened by desertification, a process of land degradation in dryland areas where the earth is especially fragile and there is little or no rainfall. The causes of desertification include both climate variations and human activities, including overcultivation, deforestation, and overgrazing of livestock. In many areas, poverty drives people to overuse their land, which triggers the desertification process.

The Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (CCD) was first conceived in 1992 and entered into force in December 1996. President Clinton signed the CCD, which awaits advice and consent in the Senate. The Convention has been ratified by 137 countries.

Recognizing the links between poverty and desertification, the Convention places great emphasis on solving the root causes of desertification by calling for a "bottom-up" approach to desertification prevention efforts that includes active involvement on the part of local communities.

Transboundary Movements of Hazardous Waste

The 1989 Basel Convention on Transboundary Movements of Hazardous Waste controls international trade in hazardous wastes. Under the Convention's provisions, trade in hazardous wastes cannot take place without the importing country's written consent or under conditions in which the wastes cannot be handled in an environmentally sound manner.

U.S. ratification efforts stalled due to concerns over an amendment to the Convention to ban all exports of hazardous waste—whether for disposal or recycling—from OECD to non-OECD countries. Although this amendment has not entered into force, concerns were raised that the ban could affect trade in such things as secondary recyclable materials like scrap metal and scrap paper. Since then, the Basel Parties have clarified that secondary recyclable materials such as scrap metal and paper are not covered by the Convention. U.S. agencies are now examining the possibility of introducing implementing legislation to allow the United States to ratify the Convention.

Stratospheric Ozone

The discovery in the early 1970s of a connection between emissions of a group of chemicals and depletion of the stratospheric ozone layer underscored the realization that some environmental problems are actually global in nature.

Working at the University of California, Sherwood Rowland and Mario Molina discovered that chlorofluorocarbons could drift up to the stratosphere, decay, and, under the influence of intense ultraviolet radiation, release chlorine atoms in the process. In a catalytic chain reaction, the chlorine would aggressively attack ozone molecules, with each chlorine atom triggering the destruction of tens of thousands of ozone compounds.

During the 1980s, the scientific community provided increasing evidence of the linkages between human activities and ozone depletion. International leaders in 1985 agreed to the Vienna Convention on the Protection of the Ozone Layer, and then in 1987 to the Montreal Protocol on Substances that Deplete the Ozone Layer. By 1989, the scientific community had confirmed conclusively that ozone depletion was linked to human activities and posed an immediate threat to human health and the global environment.

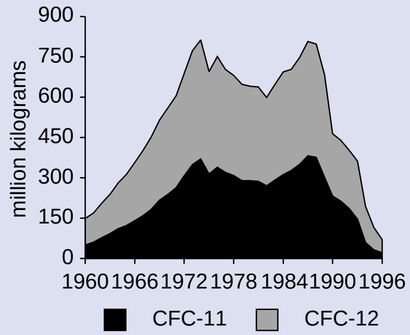
The Montreal Protocol on Substances that Deplete the Ozone Layer has been remarkably successful in reducing global production of chlorofluorocarbons (CFCs) (Figure 11.2). Since the treaty was adopted in 1987, global consumption of CFCs has declined more than 70 percent. But long-term success is still not assured. In some developing nations, production of CFCs and other ozone-depleting chemicals is increasing. Production of halons, typically used as fire retardants and 3 to 10 times more destructive to the ozone layer than CFCs, is also rising in some developing nations. (Part III, Table 11.3)

Climate Change

Since the 1950s, scientists have been considering the possibility that human activities could be fundamentally altering the global climate. The theory was that emissions of certain "greenhouse" gases —mainly carbon dioxide, but also methane, nitrous oxide, CFCs, sulfur hexafluoride, hydrofluorocarbons, and perfluorocarbons—were increasing in the atmosphere and working like a blanket by trapping heat.

Several global climate models were run in the 1960s, and DOE began a substan-

Figure 11.2 Annual Global Production of CFCs,1960-1996



Source: See Part III, Table 11.3.

tial research program on carbon dioxide and climate in 1978. International discussions on climate change began with the first World Climate Conference, sponsored by the United Nations in 1979. Policymakers became seriously interested in the issue in the late 1980s. In 1988, governments agreed to support an international scientific evaluation of climate change and created the Intergovernmental Panel on Climate Change (IPCC) under the supervision of the United Nations Environment Programme and World Meterological Organization. The IPCC published its first assessment in 1990, which concluded that if current emissions trends continued mean global temperatures would rise at the 0.3 degrees Centigrade per decade.

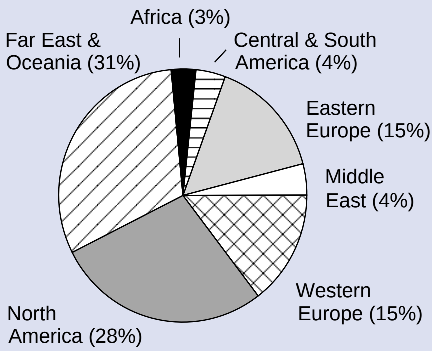
At the Earth Summit in Rio de Janeiro in 1992, more than 150 governments signed the Framework Convention on Climate Change. Developed countries agreed to the "aim" of returning their greenhouse emissions to 1990 levels by the year 2000. Developing countries agreed to prepare inventories of emissions and strategies to mitigate climate change with financial support from the industrialized nations.

At the end of 1995, the IPCC released its Second Assessment Report. The report concludes that "the balance of evidence suggests that human activities are having a discernible influence on global climate."

The largely voluntary targets created by the 1992 Framework Convention proved insufficient. By the end of 1997, emissions had increased in all but a few developed nations and prospects for meeting the year 2000 target were poor. In July 1996, the United States announced its support for a framework based on "realistic, verifiable, and binding" medium-term targets. In December 1997, at the third Conference of the Parties to the Framework Convention in Kyoto, Japan, more than 160 nations produced a Protocol to the convention. Under the Protocol, industrialized nations agreed to reduce their aggregate emissions of a "basket" of six greenhouse gases by at least 5 percent below 1990 levels in the period 2008-2012. Further elaboration of other issues, e.g., flexibility mechanisms, were left for the next meeting at Buenos Aires in 1998 and subsequent meetings.

Over the 1986-95 period, world emissions of carbon dioxide from fossil fuel burning and gas flaring (excluding emissions from cement manufacturing) rose from an estimated 5.27 to 6.06 billion metric tons of carbon, or about 15 percent. But trends are quite uneven among regions (Figure 11.3). In the Far East, the

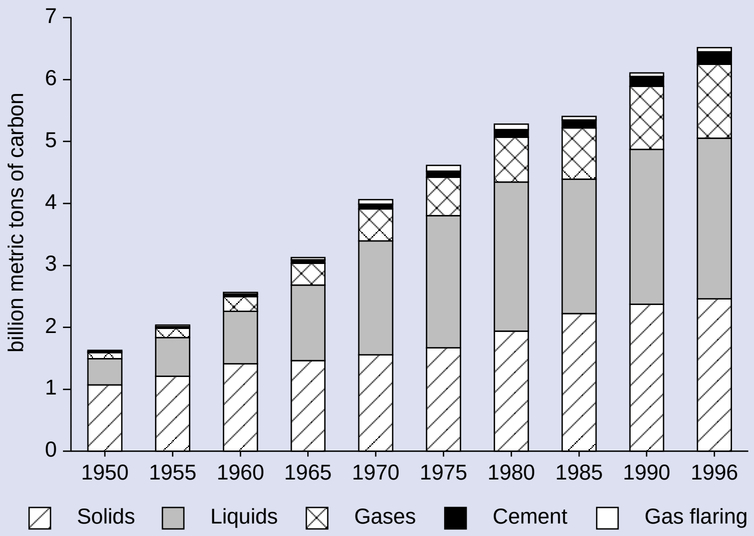
Figure 11.3 Global Carbon Dioxide Emissions by Region, 1995



Source: See Part III, Table 11.1

Notes: Far East & Oceana includes China. North America includes United States, Canada, and Mexico.

Figure 11.4 Global Emissions of Carbon Dioxide from Fossil Fuel Burning, Cement Manufacture, and Gas Flaring, 1950-1996



Source: See Part III, Table 11.2.

Note: Fossil fuels include solids (such as coal), liquids (such as oil), and gases (such as natural gas).

combination of population growth, rapid industrialization, and dependence on coal (which produces the highest CO_2 emissions of any fuel) as the primary source of fuel is leading to a rapid increase in CO_2 emissions. Over the 1986-95 period, emissions rose by more than 50 percent. In Africa, population is growing rapidly, but industrialization is occurring slowly, so energy consumption is stable and CO_2 emissions are rising only slightly. In Eastern Europe and the nations of the former Soviet Union, the transition from central planning to market economies resulted in a significant fall in economic output, slowed economic growth, and the shutdown of many inefficient industries. As a result, both energy consumption and CO_2 emissions declined over the 1986-1995 period in these countries. (Part III, Table 11.1)

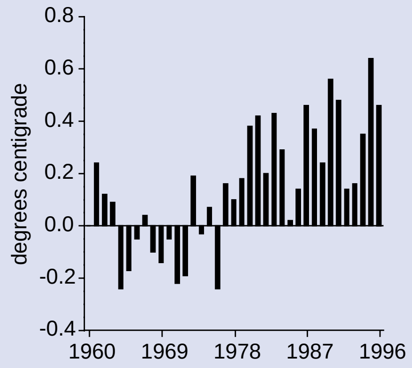
Developed nations account for only about 20 percent of world population but consume about two thirds of the world's energy. But energy use is expected to grow quickly in many parts of the developing world. The developing nations' share of commercial energy consumption could rise to about 40 percent by the year 2010, and their share of CO_2 emissions (excluding emissions from land-use change) to 45 percent of the global total.

The relative carbon dioxide emissions of three major fossil fuels—natural gas, oil, and coal—differ substantially (Figure 11.4). Compared to natural gas, oil emits about 50 percent and coal about 80 per cent more CO_2. At present, however, the energy market is dominated by coal and oil, which together account for about two thirds of global commercial energy production. Gas production has grown by about 46 percent over the 1985-96 period, but provides about 25 percent of global commercial energy production. Coal and oil production are growing at much slower rates, but they have a disproportionate impact on CO_2 emissions. (Part III, Table 11.2)

Since 1860, it is estimated that global CO_2 concentrations have increased from about 280 parts per million to about 360 parts per million today, or about 30 percent. Roughly half of that increase has occurred since 1970 (Figure 11.5). Atmospheric methane concentrations have been increasing in the atmosphere by about 0.6 percent annually and have more than doubled since 1860. Methane has both natural sources (peat bogs, termites, swamps, and other wetlands) and human sources (rice paddies, domestic livestock, landfills, biomass burning, and the production and burning of fossil fuels). About 60 to 80 percent of all methane emissions are of human origin, with fossil fuels accounting for about 20 percent of the total. Methane accounts for about 20 percent of greenhouse warming from human sources. Nitrous oxide, which accounts for about five per cent of the human sources of greenhouse warming, comes from the application of nitrogen fertilizers to agricultural lands, the burning of biomass and fuels, and industrial chemical production. Halogenated compounds such as CFCs, which contain fluorine, chlorine, bromine, or iodine, account for about 10 percent of warming from human sources. (Part III, Table 11.4)

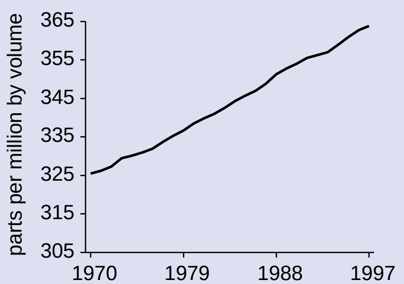
Using a global network of 63 radiosonde stations, the NOAA Air Resources Laboratory has calculated surface temperatures and thickness-derived temperature anomalies over the globe (Figure 11.6) and several global regions during the 1958-96 period. These estimates have been calculated relative to a 1958-77 reference period mean. For the

Figure 11.6 Global Temperature Anomalies, 1960-1996



Source: See Part III, Table 11.5.
Note: Estimates are calculated relative to a 1958-1977 reference period mean.

Figure 11.5 Global CO_2 Concentrations, 1970-1997



Source: See Part III, Table 11.4.
Note: CO_2 = Carbon dioxide. Data are from the Mauna Loa Observatory, Hawaii.

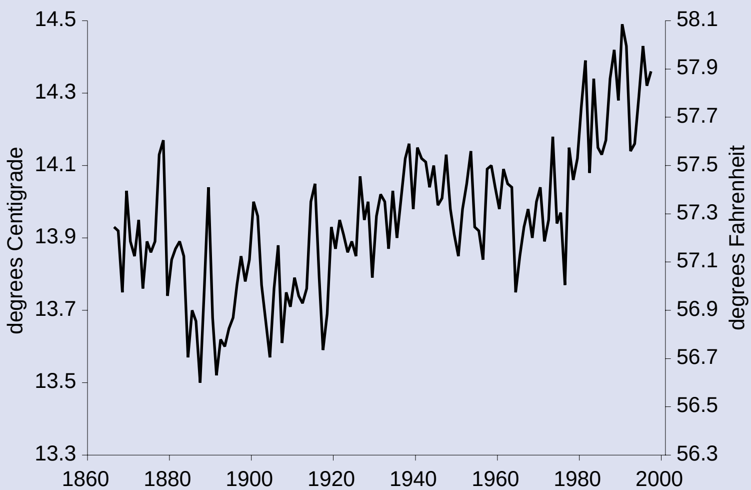
globe as a whole, the data show that temperatures have been consistently and substantially above the reference period in the 1980s and 1990s. (Part III, Table 11.5)

Another source of global surface air temperature data is the Global Historical Climatology Network which consists of rural and small town meteorological stations, and urban meteorological stations adjusted such that their long-term trend matches that of rural neighbors. The data are analyzed by NASA Goddard Institute for Space Studies (GISS) to provide a measure of the changing global surface temperature with monthly resolution for the period since the mid-1800s, when a reasonably global distribution of meteorological stations was established. On an absolute scale, these data show that the average surface temperature of the Earth has increased by about 1.0 degrees Fahrenheit over the last century (Figure 11.7). The thirteen warmest years this century have all occurred since 1980, with 1997 the warmest on record. The higher latitudes have warmed more than the equatorial regions. (See Part III, Table 11.6)

ONLINE RESOURCES

Many institutions offer information related to global environmental issues. One good general source is the United Nations Environment Programme (http://www.unep.org). This site offers information on the state of the global environment, on countries and regions, and on environmental legal instruments. UNEP's environmental links page (http://www.unep.org/unep/newlink.htm) provides links to the UN Common

Figure 11.7 Global Average Annual Temperature, 1866-1997



Source: See Part III, Table 11.6.

Notes: Data are derived from global temperature anomalies in 0.01 degrees C based on a 1951-1980 reference period mean. Data were checked and adjusted for urban warming.

System, to ministries of environment, to networks such as INFOTERRA, and elsewhere.

At the U.S. Department of State, the Bureau of Oceans and International Environmental and Scientific Affairs maintains a valuable website (http://www.state.gov/www/global/oes/index.html). This sites includes fact sheets on numerous global environmental conventions, including MARPOL, RAMSAR, CITES, the Law of the Sea, the Basel Convention, and the Convention on Desertification. The site also can steer users to related websites of interest.

The Center for International Earth Science Information Network (CIESIN) site at Columbia University, which is federally supported, provides both data and textual information resources on a variety of global environmental issues (http://www.ciesin.org).

Another important site is the Global Environment Facility (GEF), which is the financing arm for the climate change and biodiversity conventions. GEF (http://www.gefweb.org) provides information about financing, GEF reports, and links to other sites.

The International Institute for Sustainable Development (http://www.iisd.ca) has a links page (http://www.iisd.ca/linkages) that leads to the Earth Negotiations Bulletin, IISD's reporting service on ongoing international negotiations on climate change, ozone, biodiversity, desertification, global forests, etc. The World Resources Institute (http://www.wri.org) also provides news and data on global environmental issues. WRI recently released a *Guide to Global Environmental Statistics* which is an electronic directory to statistical programs of environmental relevance aimed at helping people quickly find the environmental statistics and knowledgeable contacts they seek (http://www.wri.org/sdis/global-g/index.html).

Climate Change

The Framework Convention on Climate Change (http://www.unfccc.de) provides voluminous information on the convention. The site provides a series of tables on anthropogenic emissions of CO_2, CH_4, and N_2O, plus data on per capita emissions, total primary energy supply by energy type, and projected anthropogenic emissions (http://www.unfccc.de/resource/iuckit/fact30.html)

The Intergovernmental Panel on Climate Change (IPCC) (http://www.ipcc.ch) is another significant source of information. The IPCC is organized into three working groups: Working Group I concentrates on the climate system; Working Group II on impacts and response options; and Working Group III on economic and social dimensions. The IPCC released its *Second Assessment Report* in 1995 and continues to produce Technical Papers and develop methodologies for use by Parties to the Climate Change Convention. Many of these reports are listed online (http://www.ipcc.ch/pub/reports.htm), including a special report on the regional impacts of climate change (http://www.ipcc.ch/pub/sr97.pdf).

The IPCC has begun a Data Distribution Centre (http://ipccddc.cru.uea.ac.uk/ipcc_ddc.html) that provides a consistent set of up-to-date scenarios of changes in climate and related socioeconomic and environmental factors for use in climate-impact assessments. Researchers who wish to download the scenario data, which cannot be used for commercial purposes, are required to register with the IPCC.

In the United States, the Department of Energy's Energy Information Administration provides reports on national emissions of greenhouse gases. *Emissions of Greenhouse Gases in the U.S. 1997* (http://www.eia.doe.gov/oiaf/1605/gg98rpt/preface.html) is EIA's 6th annual edition of the U.S. greenhouse gas emissions inventory report. This report presents estimates of U.S. anthropogenic (human-caused) emissions of carbon dioxide, methane, nitrous oxide, halocarbons, and criteria pollutants for 1997. A detailed discussion of the emission coefficients for fossil fuels used in the 1997 report can be found in Appendix A of the 1987-92 report.

Other U.S. government sites include DOE/ORNL's Carbon Dioxide Information Analysis Center (CDIAC) (http://cdiac.esd.ornl.gov); NASA Goddard Institute for Space Studies (GISS) (http://www.giss.nasa.gov/data/update/); the U.S. Global Change Research Information Office (http://www.gcrio.org); and the Global Change Data and Information System (http://www.gcdis.usgcrp.gov).

EPA and NOAA also maintain valuable sites on climate change issues. EPA's global warming site (http://www.epa.gov/oppeoee1/globalwarming) includes material that describes the problem and what we know about it, the potential seriousness of the problem now and in the future, and some of the actions currently underway to ameliorate the problem. NOAA provides information about climate variability, climate models, climate and weather extremes, and other issues (http://www.ncdc.noaa.gov/pw/cg/decadal.html).

EPA has done extensive work on cost-effective opportunities to mitigate the negative effects of climate change. In cooperation with the Lawrence Berkeley National Laboratory (LBNL), EPA's Office of Atmospheric Research has recently completed a study on opportunities for domestic investments in technology that can both save money and reduce greenhouse gas emissions (http://enduse.lbl.gov/Projects/GHGcosts.html). In addition, EPA's Energy Star programs (http://www.epa.gov/energystar) are specifically designed to reduce greenhouse gas emissions through voluntary initiatives that also save money for both consumers and businesses.

Biodiversity

The Convention on Biological Diversity website (http://www.biodiv.org) provides information about the history of the convention, key thematic areas, scientific and technical advice, and upcoming meetings and events. The site includes the articles of the convention and the ratification list.

Another important site is the World Conservation Union (IUCN) (http://www.iucn.org). IUCN publishes numerous reports on threatened and endangered species. *The 1996 IUCN Red List of Threatened Animals* includes for the first time an assessment of the conservation status of all known mammal and bird species. It includes articles about new categories of threat, information on the sources and quality of data, and two guest essays. The actual list of threatened animals is in a searchable database maintained by the World Conservation Monitoring Centre. IUCN also has issued *The Red List of Threatened Plants* and *The World List of Threatened Trees*.

At the World Bank (http://www.worldbank.org), under themes/biodiversity, information is available about bank projects, partnerships, and publications. As of October 1998, biodiversity lending totaled $956 million for 101 projects or components in 56 countries. Of the total, $619 million represents borrowing and another $337 represents grants from the Global Environment Facility or the Brazil Rain Forest Trust Fund.

Ozone Depletion

Information about the science of ozone depletion, regulations in the U.S. designed to protect the ozone layer, and other topics are listed at a site maintained by EPA's Stratospheric Protection Division (http://www.epa.gov/ozone/index.html).

Information about the Montreal Protocol can be found at the Ozone Secretariat (http://www.unep.org/unep/secretar/ozone/home.htm). The site includes information about the status of ratification of the Montreal Protocol, the protocol's financial mechanism, current and upcoming activities, common questions about ozone, and useful links. Information about the protocol's control measures and noncompliance procedures is available as well (http://www.unep.org/unep/secretar/ozone/issues.htm).

The executive summary of *Scientific Assessment of Ozone Depletion: 1994* (http://www.al.noaa.gov/WWWHD/pubdocs/WMOUNE94.html) was prepared by 295 international scientific experts and provides an up-to-date assessment of ozone depletion science.

As part of its information clearinghouse services for developing countries, UNEP's OzonAction Programme has recently released its fifth version of the OzonAction Diskette, a self-contained, Windows-based database system that enables target users in developing countries to research and solve technical and policy problems related to ODS phase-out (http://www.unepie.org/ozat/aboutus/oaicdv5.html).

The Technology and Economic Assessment Panel (TEAP) of the Montreal Protocol maintains a website (http://www.teap.org). The site has several categories, including aerosols, economics, foams, halons, methyl bromide, process agents, refrigeration, and solvents. The site provides technical information about the alternative technologies that have been investigated and employed to eliminate use of CFCs and halons. All reports, notes, and other materials are available for downloading in PDF format.

Water

The World Bank website on water (http://www.worldbank.org, under development themes/water) is organized along four main themes: hydropower; water supply and sanitation; water resources management in rural development (including agricultural irrigation and drainage) and environmental dimensions of water resources management (freshwater, coastal and marine, inter-basin water transfers, and regional programs).

Under water supply and sanitation, a section on publications includes a long list of studies and reports on water demand and financing, handpumps, utilities and public/private participation, participation and gender, wastewater management and reuse, water resources management and conservation, and industrialized country experience. Many publications can be ordered free of charge. Under the environmental dimensions of water theme, there is a useful links page that can take researchers to other sites dealing with issues such as integrated coastal management and coral reefs.

Another valuable site is maintained by the Stockholm Environment Institute (http://www.sei.we/seihq.html). The UN and SEI recently produced the *Comprehensive Assessment of the Freshwater Resources of the World*. Information about this report is available at the SEI website. SEI also maintains an interactive “Water Forum” on global water issues.

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CORE DATA

Part III

Environmental Data and Trends

List of Tables

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Ecosystems and Biodiversity

Air Quality

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Pollution Prevention, Recycling, Toxics and Waste

Energy

Transportation

Global Environment

Population

Table 1.1 U.S. Population and Population Growth Rate, 1900-1997

Year	Population	Growth rate	Year	Population	Growth rate	Year	Population	Growth rate
	millions	*%*		*millions*	*%*		*millions*	*%*
1900	76.09	na	1933	125.58	0.59	1966	196.56	1.16
1901	77.58	1.94	1934	126.37	0.63	1967	198.71	1.09
1902	79.16	2.01	1935	127.25	0.69	1968	200.71	1.00
1903	80.63	1.84	1936	128.05	0.63	1969	202.68	0.98
1904	82.17	1.88	1937	128.82	0.60	1970	205.05	1.17
1905	83.82	2.00	1938	129.82	0.77	1971	207.66	1.26
1906	85.45	1.92	1939	130.88	0.81	1972	209.90	1.07
1907	87.01	1.81	1940	132.12	0.95	1973	211.91	0.95
1908	88.71	1.94	1941	133.40	0.96	1974	213.85	0.91
1909	90.49	1.99	1942	134.86	1.09	1975	215.97	0.99
1910	92.41	2.10	1943	136.74	1.38	1976	218.04	0.95
1911	93.86	1.56	1944	138.40	1.21	1977	220.24	1.01
1912	95.34	1.56	1945	139.93	1.10	1978	222.58	1.06
1913	97.23	1.96	1946	141.39	1.04	1979	225.06	1.10
1914	99.11	1.92	1947	144.13	1.92	1980	227.22	0.96
1915	100.55	1.44	1948	146.63	1.72	1981	229.47	0.98
1916	101.96	1.40	1949	149.19	1.73	1982	231.66	0.95
1917	103.27	1.27	1950	152.27	2.05	1983	233.79	0.91
1918	103.21	-0.06	1951	154.88	1.70	1984	235.82	0.87
1919	104.51	1.26	1952	157.55	1.71	1985	237.92	0.89
1920	106.46	1.85	1953	160.18	1.66	1986	240.13	0.92
1921	108.54	1.93	1954	163.03	1.76	1987	242.29	0.89
1922	110.05	1.38	1955	165.93	1.77	1988	244.50	0.91
1923	111.95	1.71	1956	168.90	1.78	1989	246.82	0.94
1924	114.11	1.91	1957	171.98	1.81	1990	249.44	1.06
1925	115.83	1.50	1958	174.88	1.67	1991	252.12	1.07
1926	117.40	1.34	1959	177.83	1.67	1992	255.00	1.13
1927	119.04	1.39	1960	180.67	1.59	1993	257.75	1.07
1928	120.51	1.23	1961	183.69	1.66	1994	260.29	0.98
1929	121.77	1.04	1962	186.54	1.54	1995	262.76	0.94
1930	123.08	1.07	1963	189.24	1.44	1996	265.18	0.92
1931	124.04	0.78	1964	191.89	1.39	1997	267.64	0.92
1932	124.84	0.64	1965	194.30	1.25			

Source: U.S. Department of Commerce, Bureau of the Census, *Historical National Population Estimates: July 1, 1900 to July 1, 1997* (an Internet accessible data file, release date: April 2, 1998) based on Current Population Reports, Series P-25, Nos. 311, 917, and 1095, and Population Paper Listing PPL-91 R (DOC, Census, Washington, DC, 1998).

Notes: Annual population estimates are for July 1 of each year. National population estimates for the years 1940-1979 cover the resident population plus armed forces overseas. National population estimates for all other years only cover the resident population. All years 1900-1949 exclude the population residing in Alaska and Hawaii. Growth rate refers to average annual change in population, in percent.

Table 1.2 Components of U.S. Population Change, 1940-1997

Year	Births	Deaths	Net civilian immigration	Net change
		millions		
1940	2.570	1.432	0.077	1.221
1945	2.873	1.549	0.162	1.462
1950	3.645	1.468	0.299	2.486
1955	4.128	1.537	0.337	2.925
1960	4.307	1.708	0.328	2.901
1965	3.801	1.830	0.373	2.315
1970	3.739	1.927	0.438	2.617
1975	3.144	1.894	0.449	2.165
1980	3.612	1.990	0.845	2.510
1985	3.761	2.086	0.649	2.171
1990	4.148	2.155	0.539	2.532
1997	3.899	2.333	0.868	2.435

Sources: U.S. Department of Commerce, Bureau of the Census, *U.S. Population Estimates, by Age, Sex, Race, and Hispanic Origin*, Current Population Reports, Series P-25, No. 1045 (1990) and No. 1095 (1993) (GPO, Washington, DC), and Population Paper Listings, PPL-91 R (DOC, Census, Washington, DC, 1998), and earlier census reports.

Note: Annual population estimates are for July 1 of each year.

Table 1.3 Age Structure of the U.S. Population, including Armed Forces Overseas, 1940-1997

	Age classes, in years							
Year	< 5	5-14	15-24	25-34	35-44	45-54	55-64	> 64
				millions				
1940	10.6	22.4	24.0	21.5	18.4	15.6	10.7	9.0
1950	16.2	24.3	22.1	23.8	21.5	17.3	13.3	12.3
1960	20.3	35.7	24.6	22.9	24.2	20.6	15.6	16.7
1970	17.2	40.7	36.5	25.3	23.1	23.3	18.7	20.0
1980	16.4	34.9	42.8	37.3	25.7	22.8	21.7	25.6
1985	18.0	33.9	39.8	41.6	31.8	22.6	22.3	28.5
1990	18.9	35.2	37.1	43.4	37.9	25.2	21.1	31.2
1997	19.2	38.8	36.7	39.7	44.1	33.6	21.8	34.1

Sources: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States: Colonial Times to 1970*, Part I, Series A 30-37 (GPO, Washington, DC, 1975).

--, *U.S. Population Estimates, by Age, Sex, Race, and Hispanic Origin*, Current Population Reports, Series P-25, No. 1045 (1990) and No. 1095 (1993) (GPO, Washington, DC), and Population Paper Listing PPL-91 R (DOC, Census, Washington, DC, 1998).

Note: Annual population estimates are for July 1 of each year.

Table 1.4 U.S. Population in Urban, Suburban, and Rural Areas, 1950-1996

Year	Urban population		Suburban population		Rural population	
	millions	*%*	*millions*	*%*	*millions*	*%*
1950	49.412	32.8	35.087	23.3	66.197	43.9
1960	58.004	32.3	54.881	30.6	66.438	37.0
1970	63.797	31.4	75.622	37.2	63.793	31.4
1980	67.949	30.0	101.481	44.8	57.115	25.2
1990	77.243	31.1	115.483	46.4	55.984	22.5
1996	80.445	30.3	131.340	49.5	53.498	20.2

Source: U.S. Department of Commerce, Bureau of the Census, Census of Population and Housing, 1950, 1960, 1970, 1980, and 1990, Number of Inhabitants, U.S. Summary (GPO, Washington, DC) and updates by agency.

Notes: Urban refers to population inside central cities of metropolitan areas (MAs). Suburban refers to MA population in suburbs outside central cities. Rural refers to nonmetropolitan population. MAs are defined for each population census.

Table 1.5 U.S. Population by Region, 1900-1997

Year	Northeast	Midwest	South	West
	regional population, in millions			
1900	21.047	26.333	24.524	4.309
1910	25.869	29.889	29.389	7.082
1920	29.662	34.020	33.126	9.214
1930	34.427	38.594	37.858	12.324
1940	35.977	40.143	41.666	4.379
1950	39.478	44.461	47.197	20.190
1960	44.678	51.619	54.973	28.053
1970	49.061	56.590	62.813	34.838
1980	49.137	58.867	75.367	43.171
1990	50.809	59.669	85.446	52.786
1997	51.588	62.461	94.187	59.400

Sources: U.S. Department of Commerce, Bureau of the Census, *1990 Census of Population and Housing,* CPH-2-1 (GPO, Washington, DC, 1993).

--, *Estimates of the Population of States: Annual Time Series July 1, 1990 to July 1, 1997* (an Internet accessible data file; release date: January 8, 1998). Data are consistent with data in Press Release CB97-213, December 31, 1997.

Table 1.6 U.S. Population Density, 1960-1997

Year	Total United States	Counties in coastal regions: Pacific	Gulf of Mexico	Atlantic	Great Lakes	Interior of U.S.
	Land area, in thousands of square miles					
1994	3,536.3	509.9	114.5	147.8	115.4	2,648.7
	Population, in millions					
1960	179.3	17.9	8.4	44.5	23.7	84.8
1970	203.3	22.8	10.0	51.1	26.0	93.3
1980	226.5	27.0	13.1	53.7	26.0	106.7
1990	248.7	33.2	15.2	59.0	25.9	115.3
1995	262.8	35.2	16.5	61.0	26.5	123.5
1997	267.6	36.0	16.9	61.7	26.6	126.3
	Population per square mile					
1960	50.7	35.1	73.4	301.1	205.4	32.0
1970	57.5	44.7	87.3	345.7	225.3	35.2
1980	64.0	53.0	114.4	363.3	225.3	40.3
1990	70.3	65.1	132.8	399.2	224.4	43.5
1995	74.3	69.0	144.1	412.7	229.6	46.6
1997	76.7	70.6	147.6	417.5	230.5	47.7

Source: U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States, 1996* (GPO, Washington, DC, 1996).

--. *Statistical Abstract of the United States, 1998* (GPO, Washington, DC, 1998).

Notes: Coastal area includes 672 counties and independent cities with at least 15 percent of their land area either in a coastal watershed or in a coastal cataloging unit defined in 1992 by the National Oceanic and Atmospheric Administration.

Table 1.7 U.S. Population Below Poverty Level by Race, Residence, and Region, 1969-1997

	Total		Race			Residence			Region			
Year	Number	Rate	White	African American	Hispanic origin	MA urban	MA suburb	Rural	Northeast	Midwest	South	West
	millions	%				*millions*						
1969	24.15	12.1	16.66	7.10	na	7.99	5.09	11.06	4.11	5.42	11.09	3.53
1970	25.42	12.6	17.48	7.55	na	8.12	5.20	12.10	na	na	11.48	na
1971	25.56	12.5	17.78	7.40	na	8.91	5.65	11.00	4.51	5.76	11.18	4.10
1972	24.46	11.9	16.20	7.71	na	9.18	5.33	9.95	4.27	5.26	10.93	4.01
1973	22.97	11.1	15.14	7.39	2.37	8.59	5.17	9.21	4.21	4.86	10.06	3.84
1974	23.37	11.2	15.74	7.18	2.58	8.37	5.48	9.52	4.47	4.99	10.76	4.04
1975	35.88	12.3	17.77	7.55	2.99	9.09	6.26	10.53	4.90	5.46	11.06	4.45
1976	24.98	11.8	16.71	7.60	2.78	9.48	5.75	9.75	4.95	5.66	10.35	4.02
1977	24.72	11.6	16.42	7.73	2.70	9.20	5.66	9.86	4.96	5.59	10.25	3.93
1978	24.50	11.4	16.26	7.63	2.61	9.29	5.81	9.41	5.05	5.19	10.26	4.00
1979	26.07	11.7	17.21	8.05	2.92	9.72	6.42	9.94	5.03	5.59	10.63	4.10
1980	29.27	13.0	19.70	8.58	3.49	10.64	7.38	11.25	5.37	6.59	12.36	4.96
1981	31.82	14.0	21.55	9.17	3.71	11.23	8.12	12.48	5.82	7.14	13.26	5.61
1982	34.40	15.0	23.52	9.70	4.30	12.70	8.55	13.15	6.36	7.77	13.97	6.30
1983	35.30	15.2	23.98	9.88	4.63	12.87	8.88	13.52	6.56	8.54	13.48	6.68
1984	33.70	14.4	22.96	9.49	4.81	na	na	na	6.53	8.30	12.79	6.07
1985	33.06	14.0	22.86	8.93	5.24	14.18	9.10	9.79	5.75	8.19	12.92	6.20
1986	32.37	13.6	22.18	8.98	5.12	13.30	9.36	9.71	5.21	7.64	13.11	6.41
1987	32.22	13.4	21.20	9.52	5.42	13.70	9.36	9.17	5.48	7.50	13.29	6.29
1988	31.75	13.0	20.72	9.36	5.36	13.62	9.44	8.69	5.09	6.80	13.53	6.32
1989	31.53	12.8	20.79	9.30	5.43	13.59	9.33	8.61	5.06	7.04	12.94	6.48
1990	33.59	13.5	22.33	9.84	6.01	14.25	10.26	9.08	5.79	7.46	13.46	6.88
1991	35.71	14.2	23.75	10.24	6.34	15.31	11.51	8.88	6.18	7.99	13.78	7.76
1992	38.01	14.8	25.26	10.83	7.59	16.35	12.03	9.63	6.41	8.06	15.20	8.34
1993	39.27	15.1	26.23	10.88	8.13	16.81	12.81	9.65	6.84	8.17	15.38	8.88
1994	38.06	14.5	25.38	10.20	8.42	16.10	13.51	8.45	6.60	7.97	14.73	8.77
1995	36.43	13.8	24.42	9.87	8.57	16.27	12.07	8.08	6.45	6.79	14.46	8.74
1996	36.53	13.7	24.65	9.69	8.70	15.65	12.57	8.32	6.56	6.65	14.10	9.22
1997	35.57	13.3	24.40	9.12	8.31	15.02	12.26	8.30	6.47	6.49	13.75	8.86

Source: U.S. Department of Commerce, Bureau of the Census, *March Current Population Survey* (DOC, Census, Washington, DC, 1998).

Notes: na = not available. Poverty rate = percent of persons below poverty level. MA = Metropolitan Area. Total includes other races not shown separately. Persons of Hispanic origin may be of any race. Poverty rate for all races for years not shown are: 1959, 22.4; 1960, 22.2; 1961, 21.9; 1962, 21.0; 1963, 19.5; 1964, 19.0; 1965, 17.3; 1966, 14.7; 1967, 14.2; and 1968, 12.8. Poverty thresholds are updated annually to reflect changes in the consumer price index.

Economy and Environment

Table 2.1 U.S. Gross Domestic Product, 1959-1997

Year	Gross domestic product: Current dollars	Gross domestic product: Constant (1992) dollars	Implicit price deflator
	billions	*billions*	*(1992=100)*
1959	507.2	2,210.2	22.95
1960	526.6	2,262.9	23.27
1961	544.8	2,314.3	23.54
1962	585.2	2,454.8	23.84
1963	617.4	2,559.4	24.12
1964	663.0	2,708.4	24.48
1965	719.1	2,881.1	24.96
1966	787.8	3,069.2	25.67
1967	833.6	3,147.2	26.49
1968	910.6	3,293.9	27.64
1969	982.2	3,393.6	28.94
1970	1,035.6	3,397.6	30.48
1971	1,125.4	3,510.0	32.06
1972	1,237.3	3,702.3	33.42
1973	1,382.6	3,916.3	35.30
1974	1,496.9	3,891.2	38.47
1975	1,630.6	3,873.9	42.09
1976	1,819.0	4,082.9	44.55
1977	2,026.9	4,273.6	47.43
1978	2,291.4	4,503.0	50.89
1979	2,557.5	4,630.6	55.23
1980	2,784.2	4,615.0	60.33
1981	3,115.9	4,720.7	66.01
1982	3,242.1	4,620.3	70.17
1983	3,514.5	4,803.7	73.16
1984	3,902.4	5,140.1	75.92
1985	4,180.7	5,323.5	78.53
1986	4,422.2	5,487.7	80.58
1987	4,692.3	5,649.5	83.06
1988	5,049.6	5,865.2	86.09
1989	5,438.7	6,062.0	89.72
1990	5,743.8	6,136.3	93.60
1991	5,916.7	6,079.4	97.32
1992	6,244.4	6,244.4	100.00
1993	6,558.1	6,389.6	102.64
1994	6,947.0	6,610.7	105.09
1995	7,269.6	6,761.7	107.51
1996	7,661.6	6,994.8	109.53
1997	8,110.9	7,269.8	111.57

Source: U.S. Department of Commerce, Bureau of Economic Analysis, “Summary National Income and Product Series, 1929-97,” *Survey of Current Business* (GPO, Washington, DC, August 1998).

Table 2.2 U.S. Federal Government Expenditures on Natural Resources and Environment, 1965-1997

Year	Water resources	Conservation & land man-agement	Recrea-tional resources	Pollution control & abatement	Other natural resources	Total
			billions of constant (1992) dollars			
1965	6.21	1.36	0.88	0.52	1.16	10.14
1966	6.62	1.21	0.93	0.62	1.25	10.60
1967	6.38	1.40	1.02	0.72	1.32	10.83
1968	5.93	1.45	1.16	0.90	1.34	10.82
1969	5.49	1.28	1.28	1.04	1.28	10.37
1970	4.95	1.25	1.18	1.25	1.41	10.07
1971	5.52	1.53	1.43	2.18	1.56	12.23
1972	5.83	1.35	1.56	2.27	1.71	12.69
1973	6.29	0.91	1.56	3.17	1.61	13.54
1974	5.72	0.39	1.69	5.30	1.74	14.82
1975	6.20	1.57	1.90	5.99	1.81	17.46
1976	6.15	1.39	1.95	6.89	2.00	18.36
1977	6.77	1.24	2.09	9.02	2.05	21.15
1978	6.74	2.02	2.77	7.80	2.26	21.58
1979	6.97	1.48	2.70	8.53	2.30	21.96
1980	6.99	1.72	2.78	9.13	2.34	22.97
1981	6.26	1.80	2.42	7.83	2.24	20.56
1982	5.63	1.54	2.05	7.14	2.17	18.53
1983	5.33	2.05	1.98	5.82	2.12	17.32
1984	5.36	1.71	2.08	5.32	2.11	16.58
1985	5.25	1.88	2.06	5.69	2.13	17.01
1986	5.01	1.72	1.87	5.99	2.32	16.93
1987	4.55	1.77	1.88	5.86	2.02	16.08
1988	4.68	2.54	1.94	5.61	2.18	16.97
1989	4.76	3.70	2.03	5.44	2.11	18.03
1990	4.70	3.79	2.01	5.52	2.22	18.25
1991	4.49	4.16	2.20	6.02	2.21	19.07
1992	4.56	4.58	2.38	6.08	2.43	20.03
1993	4.15	4.66	2.55	5.90	2.46	19.72
1994	4.31	4.91	2.49	5.76	2.58	20.04
1995	4.46	4.95	2.60	6.06	2.47	20.54
1996	4.22	4.93	2.44	5.64	2.51	19.73
1997	4.07	4.54	2.50	5.64	2.41	19.15

Source: U.S. Office of Management and Budget. *The Budget of the United States, Fiscal Year 1999, Historical Tables, Table 3.2* (OMB, Washington, DC, 1998).

Notes: Implicit price deflators from Table 2.1 were used to calculate constant dollars. This table provides a tabulation of outlays which comprise the U.S. budget subfunction '300 Natural Resources and Environment.'

Table 2.3 State and Local Government Expenditures on Natural Resources and Environment, 1965-1995

Year	Natural resources	Parks & recreation	Sewerage	Solid waste management	Total
			billions of constant (1992) dollars		
1965	7.45	4.41	6.29	3.17	21.35
1966	7.95	4.64	6.66	3.35	22.59
1967	8.83	4.87	6.19	3.36	23.25
1968	8.94	5.10	6.26	3.55	23.84
1969	8.81	5.70	6.57	3.70	24.78
1970	8.96	6.20	7.12	4.10	26.35
1971	9.61	6.58	8.27	4.49	28.95
1972	9.34	6.94	9.75	4.76	30.79
1973	9.29	7.25	10.20	4.87	31.61
1974	9.51	7.67	10.61	4.99	32.78
1975	10.03	8.22	12.50	5.18	35.92
1976	10.46	8.66	13.33	5.16	37.64
1977	8.54	10.37	14.86	5.00	38.77
1978	8.31	10.36	14.03	5.36	38.04
1979	8.53	10.68	15.93	5.41	40.54
1980	9.13	10.81	16.39	5.50	41.84
1981	9.36	10.70	16.85	5.73	42.63
1982	9.36	10.69	15.41	5.89	41.34
1983	9.68	11.00	15.36	5.96	42.02
1984	9.77	10.99	15.17	6.20	42.14
1985	10.65	11.66	15.52	6.63	44.47
1986	11.26	12.61	16.52	7.25	47.63
1987	11.97	13.27	18.24	7.83	51.30
1988	11.89	14.02	18.97	8.54	53.42
1989	12.36	14.41	18.99	9.73	55.49
1990	13.17	15.31	19.56	10.83	58.88
1991	12.93	16.37	20.22	11.65	61.17
1992	13.05	15.73	20.34	12.05	61.17
1993	12.83	15.58	22.11	12.39	62.91
1994	13.31	15.87	20.57	13.36	63.12
1995	14.18	16.64	21.93	13.94	66.70

Sources: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics on Government Finances and Employment* (data for years 1965 to 1981), *Government Finances* (data for years 1982 to 1987), and *United States State and Local Government Finances by Level of Government* (Internet accessible data for years 1988 to 1995).

Notes: Implicit price deflators from Table 2.1 were used to calculate constant dollars. This table provides a tabulation of expenditures for all but one of the subfunctions listed under the Census Bureau function 'Environment and Housing.' The subfunction 'Housing and Community Development' is not included in this table. It should also be noted that Table 2.2 and Table 2.3 are not directly comparable because of definitional differences between categories. For example, federal expenditures for natural resources include, among other categories, multi-purpose power and reclamation projects (including the Tennessee Valley Authority) whereas state and local government expenditures for natural resources do not include such expenditures.

Table 2.4 U.S. Pollution Abatement and Control Expenditures by Function, 1972-1994

Year	Pollution abatement		Regulation & monitoring		Research & development		Total	
	billion current dollars	*billion constant dollars*	*billion current dollars*	*billion constant dollars*	*billion current dollars*	*billion constant dollars*	*billion current dollars*	*billion constant dollars*
1972	15.45	46.23	0.37	1.11	0.82	2.45	16.64	49.79
1973	17.93	50.79	0.49	1.39	0.90	2.55	19.33	54.76
1974	21.85	56.80	0.60	1.56	0.99	2.57	23.43	60.90
1975	26.55	63.08	0.65	1.54	1.10	2.61	28.30	67.24
1976	29.80	66.89	0.73	1.64	1.28	2.87	31.80	71.38
1977	32.79	69.13	0.83	1.75	1.48	3.12	35.10	74.00
1978	36.90	72.51	0.95	1.87	1.65	3.24	39.50	77.62
1979	42.43	76.82	1.07	1.94	1.78	3.22	45.27	81.97
1980	47.75	79.15	1.26	2.09	1.75	2.90	50.76	84.14
1981	51.39	77.85	1.31	1.98	1.71	2.59	54.41	82.43
1982	52.99	75.52	1.32	1.88	1.64	2.34	55.95	79.73
1983	56.23	76.86	1.30	1.78	1.60	2.19	59.12	80.81
1984	63.26	83.32	1.29	1.70	1.51	1.99	66.06	87.01
1985	68.73	87.52	1.25	1.59	1.38	1.76	71.36	90.87
1986	72.91	90.48	1.46	1.81	1.67	2.07	76.04	94.37
1987	75.61	91.03	1.65	1.99	1.69	2.03	78.95	95.05
1988	80.55	93.56	1.66	1.93	1.54	1.79	83.75	97.28
1989	85.10	94.85	1.73	1.93	1.68	1.87	88.51	98.65
1990	91.61	97.87	1.79	1.91	1.42	1.52	94.82	101.30
1991	93.75	96.33	2.29	2.35	1.87	1.92	97.90	100.60
1992	100.46	100.46	2.60	2.60	1.56	1.56	104.83	104.83
1993	105.84	103.12	2.34	2.28	1.87	1.82	110.05	107.22
1994	117.62	111.92	2.20	2.09	1.99	1.89	121.81	115.91

Source: Vogan, C.R., "Pollution Abatement and Control Expenditures, 1972-94," *Survey of Current Business* (GPO, Washington, DC, September 1996).

Notes: Implicit price deflators from Table 2.1 were used to calculate constant (1992) dollars. Expenditures are for goods and services that U.S. residents use to produce cleaner air and water and to manage solid waste. Pollution abatement directly reduces emissions by preventing the generation of pollutants, by recycling the pollutants, or by treating the pollutants prior to discharge. Regulation and monitoring are government activities that stimulate and guide action to reduce pollutant emissions. Research and development by business and government not only support abatement but also help increase the efficiency of regulation and monitoring. Totals may not agree with sum of components due to independent rounding. This series was discontinued after 1994.

Table 2.5 U.S. Pollution Abatement and Control Expenditures by Type, 1972-1994

Year	Air		Water		Solid waste		Other	
	billion current dollars	*billion constant dollars*	*billion current dollars*	*billion constant dollars*	*billion current dollars*	*billion constant dollars*	*billion current dollars*	*billion constant dollars*
1972	6.43	19.24	7.21	21.57	3.18	9.52	-0.19	-0.57
1973	7.68	21.76	8.21	23.26	3.59	10.17	-0.15	-0.42
1974	9.68	25.16	9.77	25.40	4.18	10.87	-0.19	-0.49
1975	11.92	28.32	12.07	28.68	4.52	10.74	-0.22	-0.52
1976	13.03	29.25	14.06	31.56	5.00	11.22	-0.28	-0.63
1977	14.72	31.04	14.96	31.54	5.72	12.06	-0.29	-0.61
1978	16.38	32.19	17.00	33.41	6.51	12.79	-0.39	-0.77
1979	19.40	35.13	19.19	34.75	7.28	13.18	-0.59	-1.07
1980	22.35	37.05	20.64	34.21	8.52	14.12	-0.75	-1.24
1981	25.42	38.51	20.15	30.53	9.69	14.68	-0.86	-1.30
1982	25.96	37.00	20.70	29.50	9.80	13.97	-0.52	-0.74
1983	26.68	36.47	21.71	29.67	11.12	15.20	-0.39	-0.53
1984	29.42	38.75	24.18	31.85	13.03	17.16	-0.56	-0.74
1985	30.68	39.07	26.17	33.32	15.18	19.33	-0.66	-0.84
1986	31.43	39.00	28.23	35.03	17.06	21.17	-0.69	-0.86
1987	29.36	35.35	30.76	37.03	19.43	23.39	-0.61	-0.73
1988	31.33	36.39	31.29	36.35	22.43	26.05	-1.30	-1.51
1989	29.34	32.70	33.68	37.54	26.66	29.71	-1.17	-1.30
1990	28.33	30.27	37.13	39.67	30.64	32.74	-1.28	-1.37
1991	27.79	28.56	37.92	38.96	32.83	33.73	-0.63	-0.65
1992	29.79	29.79	39.07	39.07	36.58	36.58	-0.81	-0.81
1993	32.48	31.64	39.38	38.37	38.37	37.38	-0.18	-0.18
1994	37.60	35.78	42.38	40.33	41.74	39.72	0.09	0.09

Source: Vogan, C.R., "Pollution Abatement and Control Expenditures, 1972-94," *Survey of Current Business* (GPO, Washington, DC, September 1996).

Notes: Implicit price deflators from Table 2.1 were used to calculate constant (1992) dollars. Expenditures cover most, but not all, pollution abatement and control activities, which are defined as those resulting from rules, policies and conventions, and formal regulations restricting the release of pollutants into common-property media such as the air and water. Solid waste management includes the collection and disposal of solid waste and the alteration of production processes that generate less solid waste. Other covers expenditures for abatement and control of noise, radiation, and pesticide pollution, plus any expenditure not assigned to media (including recovered cost which consists of the value of reclaimed materials and energy). This series was discontinued after 1994.

Table 2.6 U.S. Pollution Abatement Expenditures by Sector, 1972-1994

Year	Personal consumption		Business		Government	
	billion current dollars	*billion constant dollars*	*billion current dollars*	*billion constant dollars*	*billion current dollars*	*billion constant dollars*
1972	1.35	4.04	10.69	31.99	3.41	10.20
1973	1.86	5.27	12.20	34.56	3.86	10.93
1974	2.33	6.06	14.59	37.93	4.93	12.82
1975	3.25	7.72	16.41	38.99	6.89	16.37
1976	3.81	8.55	18.38	41.26	7.62	17.10
1977	4.34	9.15	21.04	44.36	7.41	15.62
1978	4.85	9.53	23.40	45.98	8.65	17.00
1979	5.52	9.99	26.97	48.83	9.94	18.00
1980	6.65	11.02	29.99	49.71	11.11	18.42
1981	8.20	12.42	32.51	49.25	10.68	16.18
1982	8.36	11.91	33.54	47.80	11.09	15.80
1983	9.76	13.34	35.02	47.87	11.45	15.65
1984	11.04	14.54	39.36	51.84	12.86	16.94
1985	12.16	15.48	42.04	53.53	14.54	18.52
1986	12.68	15.74	44.11	54.74	16.11	19.99
1987	11.34	13.65	46.73	56.26	18.54	22.32
1988	12.48	14.50	48.40	56.22	19.67	22.85
1989	11.09	12.36	52.23	58.21	21.77	24.26
1990	9.33	9.97	58.30	62.29	23.99	25.63
1991	7.43	7.63	61.09	62.77	25.23	25.92
1992	7.90	7.90	65.93	65.93	26.64	26.64
1993	8.44	8.22	69.01	67.23	28.39	27.66
1994	9.76	9.29	76.63	72.92	31.23	29.72

Source: Vogan, C.R., "Pollution Abatement and Control Expenditures, 1972-94," *Survey of Current Business* (GPO, Washington, DC, September 1996).

Notes: Implicit price deflators from Table 2.1 were used to calculate constant (1992) dollars. Expenditures are attributed to the sector that performs the air or water pollution abatement or solid waste collection and disposal. Personal consumption refers to expenditures to purchase and operate motor vehicle emission abatement devices. Government refers to pollution abatement expenditures by federal, state, and local governments and government enterprise fixed capital expenditures for publicly-owned electric utilities and public sewer systems. This series was discontinued after 1994.

Table 2.7 U.S. Pollution Abatement Expenditures by Industry, 1973-1994

Year	Capital expenditures: Air	Capital expenditures: Water	Capital expenditures: Solid waste	Capital expenditures: Total	Operating costs: Air	Operating costs: Water	Operating costs: Solid waste	Operating costs: Total	Cost offsets
	billions of constant (1992) dollars								
Chemicals and allied products									
1973	0.47	0.61	0.05	1.12	0.49	0.70	0.23	1.42	0.24
1974	0.65	0.69	0.06	1.40	0.53	0.87	0.27	1.67	0.27
1975	0.85	0.92	0.08	1.85	0.59	1.02	0.30	1.92	0.33
1976	0.72	1.30	0.10	2.11	0.66	1.16	0.39	2.21	0.42
1977	0.72	1.25	0.10	2.07	0.71	1.44	0.46	2.61	0.44
1978	0.74	0.76	0.13	1.63	0.78	1.56	0.55	2.89	0.45
1979	0.57	0.65	0.17	1.40	0.88	1.62	0.52	3.02	0.42
1980	0.54	0.58	0.17	1.29	0.89	1.56	0.61	3.07	0.51
1981	0.51	0.49	0.14	1.14	0.87	1.62	0.62	3.10	0.52
1982	0.39	0.37	0.14	0.89	0.79	1.59	0.62	3.00	0.49
1983	0.22	0.26	0.07	0.54	0.85	1.51	0.64	3.00	0.41
1984	0.19	0.28	0.04	0.55	0.82	1.59	0.68	3.09	0.47
1985	0.25	0.35	0.35	0.94	0.86	1.61	0.76	3.23	0.34
1986	0.25	0.40	0.13	0.77	0.80	1.62	0.88	3.29	0.42
1987	nd	nd	nd	nd	nd	nd	nd	nd	nd
1988	0.43	0.57	0.27	1.27	0.82	1.66	1.09	3.57	0.52
1989	0.42	0.67	0.24	1.33	0.88	1.80	1.23	3.91	0.44
1990	0.64	1.06	0.28	1.98	0.90	1.92	1.39	4.21	0.43
1991	0.84	0.97	0.32	2.12	0.90	1.84	1.42	4.16	0.36
1992	0.77	1.02	0.33	2.12	1.03	1.95	1.45	4.43	0.51
1993	0.75	0.91	0.25	1.91	0.99	1.91	1.34	4.24	0.35
1994	0.64	0.96	0.24	1.84	1.08	1.90	1.36	4.35	0.31
Petroleum and coal products									
1973	0.63	0.27	0.01	0.91	0.55	0.36	0.06	0.96	0.13
1974	0.89	0.31	0.00	1.20	0.62	0.40	0.07	1.09	0.22
1975	0.95	0.37	0.00	1.32	0.81	0.46	0.08	1.34	0.33
1976	0.53	0.45	0.01	0.99	1.05	0.59	0.10	1.74	0.41
1977	0.35	0.41	0.01	0.78	1.27	0.61	0.12	2.00	0.50
1978	0.61	0.20	0.01	0.82	1.25	0.60	0.11	1.96	0.51
1979	0.72	0.22	0.03	0.97	1.36	0.67	0.05	2.13	0.59
1980	0.67	0.19	0.03	0.88	1.51	0.67	0.17	2.35	0.84
1981	0.67	0.20	0.03	0.89	1.69	0.66	0.20	2.55	0.86
1982	0.76	0.24	0.02	1.01	1.70	0.67	0.19	2.57	0.48
1983	0.42	0.23	0.02	0.66	1.65	0.75	0.19	2.59	0.72
1984	0.26	0.13	0.03	0.41	1.75	0.77	0.23	2.74	0.73
1985	0.22	0.11	0.03	0.37	1.63	0.75	0.25	2.63	0.64
1986	0.34	0.15	0.04	0.53	1.53	0.72	0.24	2.49	0.62
1987	nd	nd	nd	nd	nd	nd	nd	nd	nd
1988	0.24	0.24	0.08	0.56	1.37	0.65	0.31	2.33	0.56
1989	0.16	0.26	0.05	0.47	1.40	0.65	0.37	2.42	0.58
1990	0.45	0.43	0.10	0.98	1.57	0.75	0.57	2.89	0.60
1991	1.02	0.38	0.10	1.50	1.51	0.82	0.61	2.93	0.49
1992	2.08	0.49	0.11	2.69	1.43	0.74	0.41	2.59	0.48
1993	1.92	0.55	0.10	2.58	1.54	0.67	0.37	2.58	0.41
1994	1.89	0.44	0.12	2.45	1.66	0.72	0.40	2.77	0.32

See next page for continuation of table.

Table 2.7 U.S. Pollution Abatement Expenditures by Industry, 1973-1994 (continued)

Year	Air	Water	Solid waste	Total	Air	Water	Solid waste	Total	Cost offsets
	Primary metal industries								
	Capital expenditures				Operating costs				
	billions of constant (1992) dollars								
1973	1.13	0.24	0.05	1.41	0.75	0.42	0.15	1.32	0.15
1974	1.33	0.34	0.03	1.68	0.88	0.47	0.18	1.53	0.20
1975	1.52	0.45	0.01	1.98	1.02	0.50	0.18	1.70	0.23
1976	1.42	0.44	0.01	1.87	1.29	0.52	0.20	2.01	0.23
1977	1.30	0.53	0.02	1.84	1.52	0.57	0.28	2.37	0.27
1978	1.11	0.43	0.02	1.56	1.59	0.65	0.35	2.60	0.28
1979	1.07	0.41	0.01	1.49	1.78	0.80	0.30	2.87	0.44
1980	0.89	0.30	0.03	1.23	1.65	0.77	0.36	2.78	0.28
1981	0.86	0.22	0.03	1.10	1.68	0.83	0.38	2.90	0.29
1982	0.60	0.19	0.02	0.81	1.28	0.64	0.24	2.16	0.21
1983	0.20	0.14	0.01	0.31	1.24	0.62	0.35	2.21	0.13
1984	0.23	0.10	0.03	0.36	1.34	0.59	0.40	2.33	0.23
1985	0.18	0.11	0.03	0.32	1.36	0.66	0.35	2.37	0.17
1986	0.13	0.09	0.06	0.28	1.20	0.63	0.33	2.14	0.23
1987	nd	nd	nd	nd	nd	nd	nd	nd	nd
1988	0.19	0.12	0.05	0.36	1.12	0.60	0.38	2.10	0.22
1989	0.24	0.15	0.06	0.45	0.98	0.64	0.53	2.15	0.21
1990	0.30	0.18	0.06	0.53	1.01	0.60	0.55	2.16	0.22
1991	0.51	0.14	0.04	0.69	0.94	0.58	0.54	2.06	0.19
1992	0.34	0.12	0.06	0.53	0.93	0.58	0.49	1.99	0.16
1993	0.27	0.09	0.07	0.43	0.92	0.58	0.46	1.97	0.13
1994	0.28	0.09	0.04	0.41	0.93	0.66	0.51	2.10	0.13
	Transportation equipment								
1973	0.15	0.12	0.02	0.29	0.10	0.14	0.12	0.37	0.06
1974	0.14	0.11	0.02	0.27	0.12	0.15	0.13	0.40	0.04
1975	0.08	0.09	0.02	0.18	0.12	0.16	0.12	0.40	0.03
1976	0.05	0.12	0.01	0.18	0.13	0.19	0.13	0.44	0.03
1977	0.08	0.08	0.01	0.17	0.13	0.21	0.16	0.49	0.03
1978	0.14	0.11	0.02	0.27	0.15	0.22	0.18	0.55	0.03
1979	0.22	0.11	0.02	0.34	0.17	0.23	0.20	0.60	0.07
1980	0.33	0.10	0.02	0.46	0.18	0.23	0.25	0.67	0.04
1981	0.32	0.09	0.02	0.43	0.18	0.23	0.24	0.65	0.03
1982	0.09	0.05	0.02	0.15	0.15	0.22	0.20	0.57	0.03
1983	0.05	0.08	0.01	0.13	0.22	0.31	0.24	0.77	0.03
1984	0.09	0.15	0.03	0.27	0.25	0.37	0.28	0.90	0.03
1985	0.32	0.21	0.05	0.58	0.25	0.36	0.33	0.94	0.03
1986	0.54	0.10	0.03	0.67	0.24	0.42	0.38	1.04	0.03
1987	nd	nd	nd	nd	nd	nd	nd	nd	nd
1988	0.10	0.09	0.05	0.24	0.25	0.35	0.53	1.13	0.04
1989	0.17	0.09	0.05	0.32	0.24	0.35	0.52	1.11	0.05
1990	0.22	0.15	0.05	0.42	0.26	0.40	0.65	1.32	0.04
1991	0.18	0.10	0.03	0.31	0.26	0.33	0.56	1.15	0.05
1992	0.18	0.07	0.03	0.28	0.30	0.35	0.53	1.17	0.07
1993	0.17	0.07	0.03	0.27	0.29	0.34	0.53	1.16	0.06
1994	0.23	0.06	0.03	0.32	0.28	0.33	0.46	1.06	0.07

See next page for continuation of table.

Table 2.7. U.S. Pollution Abatement Expenditures by Industry, 1973-1994 (continued)

	Food and kindred products								
	Capital expenditures				Operating costs				
Year	Air	Water	Solid waste	Total	Air	Water	Solid waste	Total	Cost offsets
	billions of constant (1992) dollars								
1973	0.22	0.30	0.04	0.56	0.11	0.31	0.15	0.58	0.09
1974	0.19	0.29	0.04	0.52	0.13	0.37	0.20	0.70	0.14
1975	0.18	0.22	0.03	0.43	0.13	0.37	0.21	0.70	0.15
1976	0.23	0.22	0.02	0.47	0.13	0.42	0.23	0.78	0.14
1977	0.14	0.22	0.03	0.39	0.12	0.45	0.19	0.75	0.11
1978	0.13	0.19	0.03	0.34	0.14	0.48	0.20	0.81	0.11
1979	0.10	0.20	0.02	0.33	0.16	0.54	0.21	0.91	0.15
1980	0.10	0.22	0.02	0.35	0.14	0.52	0.20	0.86	0.13
1981	0.08	0.16	0.02	0.26	0.12	0.52	0.24	0.88	0.14
1982	0.07	0.16	0.02	0.24	0.11	0.47	0.17	0.74	0.07
1983	0.05	0.14	0.01	0.21	0.13	0.55	0.21	0.89	0.04
1984	0.07	0.12	0.02	0.20	0.13	0.60	0.20	0.94	0.06
1985	0.08	0.10	0.01	0.20	0.14	0.67	0.26	1.06	0.04
1986	0.08	0.13	0.02	0.23	0.16	0.69	0.31	1.16	w/h
1987	nd	nd	nd	nd	nd	nd	nd	nd	nd
1988	0.12	0.11	0.02	0.25	0.18	0.78	0.38	1.35	0.13
1989	0.06	0.20	0.03	0.29	0.15	0.74	0.28	1.18	0.09
1990	0.07	0.17	0.02	0.27	0.16	0.74	0.29	1.18	0.09
1991	0.10	0.37	0.03	0.50	0.15	0.81	0.32	1.29	0.07
1992	0.09	0.20	0.03	0.32	0.16	0.84	0.31	1.31	0.08
1993	0.07	0.11	0.03	0.21	0.15	0.84	0.32	1.30	0.06
1994	0.10	0.15	0.01	0.26	0.16	0.89	0.32	1.38	0.09
	Paper and allied products								
1973	0.47	0.46	0.03	0.96	0.17	0.33	0.12	0.62	0.15
1974	0.70	0.50	0.03	1.24	0.21	0.40	0.14	0.75	0.22
1975	0.77	0.63	0.04	1.44	0.24	0.44	0.14	0.82	0.27
1976	0.41	0.63	0.06	1.09	0.28	0.54	0.15	0.97	0.31
1977	0.28	0.55	0.07	0.90	0.28	0.65	0.18	1.12	0.32
1978	0.24	0.37	0.06	0.67	0.31	0.70	0.21	1.22	0.35
1979	0.37	0.33	0.07	0.77	0.32	0.73	0.22	1.26	0.29
1980	0.33	0.18	0.05	0.56	0.33	0.72	0.21	1.26	0.41
1981	0.25	0.13	0.05	0.43	0.32	0.71	0.22	1.26	0.45
1982	0.27	0.13	0.04	0.45	0.29	0.65	0.19	1.13	0.30
1983	0.17	0.09	0.04	0.30	0.31	0.70	0.25	1.26	0.35
1984	0.20	0.09	0.06	0.35	0.37	0.75	0.28	1.40	0.16
1985	0.24	0.13	0.05	0.42	0.40	0.73	0.30	1.43	0.14
1986	0.17	0.12	0.05	0.34	0.40	0.70	0.33	1.43	0.17
1987	nd	nd	nd	nd	nd	nd	nd	nd	nd
1988	0.27	0.11	0.10	0.49	0.43	0.73	0.40	1.56	0.29
1989	0.44	0.29	0.17	0.90	0.43	0.77	0.42	1.62	0.30
1990	0.44	0.54	0.16	1.15	0.42	0.84	0.45	1.72	0.28
1991	0.49	0.57	0.20	1.27	0.41	0.81	0.46	1.68	0.18
1992	0.40	0.37	0.23	1.00	0.54	0.82	0.50	1.86	0.25
1993	0.30	0.28	0.12	0.70	0.50	0.83	0.52	1.85	0.23
1994	0.23	0.19	0.19	0.61	0.51	0.79	0.49	1.79	0.27

See next page for continuation of table.

Table 2.7 U.S. Pollution Abatement Expenditures by Industry, 1973-1994 (continued)

	Rubber and miscellaneous plastic products								
	Capital expenditures				Operating costs				
Year	Air	Water	Solid waste	Total	Air	Water	Solid waste	Total	Cost offsets
	billions of constant (1992) dollars								
1973	0.04	0.02	0.01	0.07	0.03	0.03	0.06	0.12	0.01
1974	0.06	0.04	0.01	0.10	0.04	0.04	0.07	0.15	0.05
1975	0.05	0.02	0.01	0.08	0.05	0.04	0.06	0.15	0.03
1976	0.05	0.02	0.01	0.08	0.05	0.05	0.08	0.18	0.04
1977	0.04	0.03	0.01	0.08	0.04	0.04	0.07	0.16	0.02
1978	0.04	0.01	0.01	0.05	0.03	0.05	0.09	0.17	0.02
1979	0.02	0.02	0.01	0.05	0.06	0.05	0.09	0.20	0.02
1980	0.02	0.01	0.00	0.04	0.05	0.05	0.08	0.18	0.03
1981	0.02	0.01	0.01	0.03	0.05	0.04	0.09	0.18	0.02
1982	0.02	0.01	0.00	0.04	0.03	0.04	0.06	0.13	0.01
1983	0.02	0.01	0.01	0.03	0.07	0.07	0.08	0.23	0.01
1984	0.03	0.01	0.01	0.04	0.07	0.06	0.09	0.22	0.01
1985	0.03	0.00	0.01	0.04	0.06	0.07	0.12	0.25	0.01
1986	0.02	0.01	0.01	0.04	0.06	0.06	0.15	0.28	0.02
1987	nd	nd	nd	nd	nd	nd	nd	nd	nd
1988	0.03	0.01	0.01	0.05	0.07	0.07	0.18	0.32	0.02
1989	0.06	0.02	0.01	0.09	0.10	0.11	0.24	0.45	0.03
1990	0.07	0.01	0.01	0.10	0.10	0.12	0.23	0.46	0.03
1991	0.05	0.02	0.01	0.08	0.12	0.08	0.25	0.45	0.03
1992	0.07	0.02	0.01	0.10	0.11	0.07	0.20	0.38	0.03
1993	0.04	0.01	0.01	0.06	0.10	0.08	0.19	0.38	0.02
1994	0.05	0.02	0.01	0.07	0.11	0.09	0.22	0.42	0.03

Source: U.S. Department of Commerce, Bureau of the Census, *Pollution Abatement Costs and Expenditures*, Current Industrial Reports (GPO, Washington, DC, annual).

Notes: nd = no data. Data for 1987 were not collected. w/h = withheld by industry. Data are for selected industries. Does not include all industries covered in the survey. This series was discontinued after 1994.

Table 2.8 Employment and Revenues in U.S. Environmental Industries, 1980 to 1996

Industry	Employment			Revenues		
	1980	1990	1996	1980	1990	1996
	thousands			*billions of constant dollars*		
Analytical services [1]	6.0	20.2	16.5	0.7	1.6	1.4
Water treatment works [2]	53.9	95.0	120.9	15.2	21.2	24.3
Solid waste management [3]	83.2	209.5	234.6	14.1	27.9	30.9
Hazardous waste management [4]	6.8	56.9	51.2	1.0	6.7	5.5
Remediation/industrial services	6.9	107.2	95.3	0.7	9.1	7.9
Consulting & engineering	20.5	144.2	159.7	2.5	13.4	14.2
Water equipment & chemicals	62.4	97.9	123.3	10.4	14.4	15.9
Instrument manufacturing	0.5	18.8	26.6	0.3	2.1	2.9
Air pollution control equipment [5]	28.3	82.7	82.6	5.0	11.4	10.8
Waste management equipment [6]	41.9	88.8	94.9	6.6	11.1	11.0
Process & prevention technology	2.1	8.9	20.3	0.2	0.4	0.8
Water utilities [7]	76.9	104.7	122.2	19.7	21.2	24.0
Resource recovery [8]	48.7	118.4	131.3	7.3	14.0	14.9
Environmental energy sources [9]	22.4	21.1	26.7	2.5	1.9	2.2
Total [10]	462.5	1,174.3	1,306.1	86.2	156.4	168.3

Source: Environmental Business International, Inc., *Environmental Business Journal*, (Environmental Business International, Inc., San Diego, CA, monthly).

Notes: Implicit price deflators from Table 2.1 were used to calculate constant (1992) dollars. [1]Covers environmental laboratory testing and services. [2]Mostly revenues collected by municipal entities. [3]Covers activities such as collection, transportation, transfer stations, disposal, landfill ownership, and management for solid waste. [4]Transportation and disposal of hazardous, medical, and nuclear waste. [5]Includes stationary and mobile sources. [6]Includes vehicles, containers, liners, processing, and remedial equipment. [7]Revenues generated from the sale year. [8]Revenues generated from the sale of recovered metals, paper, plastic, etc. [9]Includes solar, geothermal, and conservation devices. [10]Covers approximately 59,000 private and public companies engaged in environmental activities.

Table 2.9 Summary of Value of Selected Product Shipments and Receipts for Selected Services and Types of Construction Projects for Environmental or Potential Environmental Purposes by Media, 1995

Selected products, services, and types of construction projects	Value of product shipments and receipts for services and types of construction projects: All	For environmental purposes	Not for environmental purposes	Purpose unknown	Relative standard error: All	For environmental purposes
	billions of constant (1992) dollars				*percent*	
Air treatment	5.57	5.47	0.08	0.03	15	15
Water & wastewater treatment	33.86	28.92	4.02	0.93	8	8
Solid waste	35.37	33.38	1.43	0.56	11	12
Energy conservation	7.10	2.28	4.54	0.28	14	11
Noise pollution control	1.36	0.16	1.16	0.04	41	43
Monitoring, assessm't & analysis	15.85	4.99	5.67	5.19	26	19
Admin., management, engineering	55.51	5.84	48.90	0.78	27	18
Other	14.58	14.58	-	-	25	25
Total	169.21	95.61	65.79	7.81	15	6

Source: U.S. Department of Commerce, Bureau of the Census, *Survey of Environmental Products and Services* (sponsored by the Environmental Protection Agency, the International Trade Administration, and the Bureau of the Census) (DOC, Census, Washington, DC, 1998).

Table 2.10 Expenditures for Air Pollution Control, 1972-1990

Year	Stationary K	Stationary O& M	Rec. costs	Mobile source K	Mobile source O& M	Other	Total
	billions of constant (1992) dollars						
1972	6.69	na	na	na	na	na	na
1973	8.64	4.07	0.56	0.78	5.00	2.37	20.29
1974	8.92	4.93	0.77	0.63	6.11	2.25	22.07
1975	9.54	5.32	0.92	3.73	5.42	2.13	25.22
1976	8.88	5.98	1.11	4.40	4.62	2.26	25.03
1977	8.45	6.80	1.17	4.74	3.77	2.48	25.05
1978	8.22	7.32	1.21	4.94	1.78	2.60	23.65
1979	8.87	8.34	1.36	5.33	2.23	2.62	26.02
1980	9.03	9.23	1.43	4.89	2.97	2.34	27.02
1981	8.46	9.28	1.51	5.35	2.10	2.04	25.73
1982	7.97	8.29	1.22	5.06	0.79	1.85	22.74
1983	6.26	8.60	1.12	5.92	-0.21	1.77	21.21
1984	6.19	9.01	1.15	7.48	-0.43	1.73	22.83
1985	5.69	9.15	0.98	8.13	0.43	1.89	24.32
1986	5.46	9.00	1.08	8.55	-1.73	1.92	22.13
1987	5.36	9.15	1.19	8.25	-1.57	1.92	21.93
1988	5.24	8.68	1.29	8.37	-1.83	1.94	21.12
1989	5.57	8.82	1.25	7.86	-1.82	1.99	21.17
1990	4.70	9.45	1.34	7.81	-1.94	1.65	20.32

Source: U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation and Office of Air and Radiation, *The Benefits and Costs of the Clean Air Act, 1970 to 1990* (EPA, OPPE and OAR, Washington, DC, 1997).

Notes: K = Capital expenditures. O&M = Operations and Maintenance. Rec. costs = recovered costs. Implicit price deflators from Table 2.1 were used to calculate constant dollars. Total expenditures are the sum of stationary source, mobile source, and "other" expenditures, less recovered costs. Capital expenditures for stationary air pollution control are made by factories and electric utilities for plant and equipment that abate pollutants through end-of-line techniques or that reduce or eliminate the generation of pollutants through changes-in-production process. Stationary source O&M expenditures are made by manufacturing establishments and electric utilities to operate air pollution abatement equipment. Recovered costs consist of the value of materials or energy reclaimed through abatement activities that are reused in production and revenue that was obtained from the sale of materials or energy reclaimed through abatement activities. Capital expenditures for mobile source emission control are associated with pollution abatement equipment on passenger cars. O&M costs for emission control devices include the costs of maintaining pollution control equipment plus the cost of vehicle inspection maintenance programs. Other includes air pollution control costs by federal and state governments, government costs to develop and enforce Clean Air Act regulations, and public and private air pollution control research and development expenditures.

Public Lands and Recreation

Table 3.1 Lands Under the Control of Selected Federal Agencies, 1970-1997

Year	National Park System	National Wildlife Refuge System	National Forest System	Bureau of Reclamation	Bureau of Land Management
			million acres		
1970	29.6	30.7	182.6	9.4	451.1
1971	29.9	30.9	182.6	8.2	451.0
1972	30.4	31.1	182.8	8.3	450.9
1973	30.5	31.1	183.0	8.2	450.8
1974	31.1	33.9	182.1	8.2	447.3
1975	31.0	34.1	183.3	8.0	447.3
1976	31.3	34.4	183.4	7.3	446.8
1977	31.3	34.5	183.5	7.3	427.2
1978	76.7	34.6	183.6	7.1	457.4
1979	76.7	46.8	183.2	7.1	397.5
1980	77.0	71.9	183.1	7.2	343.0
1981	79.1	88.8	186.4	7.1	343.4
1982	79.4	88.8	186.6	7.1	341.1
1983	79.4	88.9	186.5	7.0	342.3
1984	79.4	90.2	186.4	7.9	341.9
1985	79.5	90.4	186.3	7.8	337.1
1986	79.5	90.5	186.5	9.0	334.1
1987	79.6	90.6	186.5	8.5	333.6
1988	80.0	90.8	186.3	8.8	270.4
1989	80.1	91.3	186.9	8.6	269.6
1990	80.2	90.6	187.1	9.0	272.0
1991	80.3	90.8	187.0	8.6	269.0
1992	80.7	91.0	187.1	8.6	268.5
1993	80.3	91.5	187.2	8.6	267.6
1994	83.3	91.8	187.3	8.6	267.1
1995	83.2	92.3	187.2	8.6	264.3
1996	83.2	92.6	187.3	8.6	264.3
1997	83.4	93.1	187.4	8.6	263.9

Sources: U.S. Department of Agriculture, Forest Service, *Land Areas of the National Forest System* (USDA, FS, Washington, DC, annual).

U.S. Department of the Interior, Fish and Wildlife Service, *Lands Under the Control of the U.S. Fish and Wildlife Service* (DOI, FWS, Washington, DC, annual).

U.S. Department of the Interior, National Park Service, *Areas Administered by the National Park Service: Information Tables* (DOI, NPS, Washington, DC, annual).

U.S. Department of the Interior, Bureau of Land Management, *Public Land Statistics* (DOI, BLM, Washington, DC, annual).

U.S. Department of the Interior, Bureau of Reclamation, unpublished, Denver, CO, 1998.

Notes: Data reflect year-end cumulative totals. National Park Service data for 1978-1997 are not directly comparable with data for earlier years due to reclassification of several sites within the system.

Table 3.2 National Wilderness Preservation System and National Wild and Scenic River System, 1968-1997

Year	National Wilderness Preservation System	National Wild and Scenic River System
	million acres	*river miles*
1968	10.03	773
1969	10.19	773
1970	10.40	868
1971	10.40	868
1972	11.03	895
1973	11.03	961
1974	11.38	1,018
1975	12.72	1,145
1976	14.45	1,610
1977	14.49	1,610
1978	19.00	2,299
1979	19.00	2,299
1980	79.71	5,662
1981	79.84	6,908
1982	79.88	6,908
1983	80.21	6,908
1984	88.55	7,217
1985	88.70	7,224
1986	88.80	7,363
1987	88.99	7,709
1988	90.81	9,264
1989	91.46	9,281
1990	94.97	9,318
1991	95.03	9,463
1992	95.39	10,295
1993	95.44	10,516
1994	103.72	10,734
1995	103.60	10,734
1996	103.60	10,815
1997	103.60	10,815

Sources: U.S. Department of Agriculture, Forest Service, National Wilderness Preservation System Fact Sheet, unpublished, Washington, DC, annual.

U.S. Department of the Interior, National Park Service, River Mileage Classifications for Components of the National Wild and Scenic River System, unpublished, Washington, DC, annual.

Note: Data reflect year-end cumulative totals.

Table 3.3 National Estuarine Research Reserves and National Marine Sanctuaries, 1975-1997

Year	Estuarine Research Reserves		Marine Sanctuaries	
	number	*acres*	*number*	*sq. nmi.*
1975	1	4,700	2	101.0
1976	3	14,205	2	101.0
1977	3	14,205	2	101.0
1978	4	22,605	2	101.0
1979	5	216,363	2	101.0
1980	9	223,426	3	1,353.0
1981	11	229,652	6	2,323.3
1982	14	240,571	6	2,323.3
1984	15	242,121	6	2,323.3
1986	16	245,149	7	2,323.6
1987	16	245,149	7	2,323.6
1988	17	247,348	7	2,323.6
1989	18	253,477	8	2,720.7
1990	18	259,945	9	5,415.3
1991	19	399,302	9	5,415.3
1992	21	400,559	13	11,419.3
1993	22	401,570	13	11,419.3
1994	22	433,864	14	11,419.3
1995	22	433,865	14	11,419.3
1996	21[1]	427,528	14	11,419.3
1997	21	427,528	12[2]	13,837.3

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Ocean and Coastal Resources Management, Sanctuaries and Reserves Division, unpublished, Washington, DC, 1997.

Notes: sq. nmi. = square nautical miles. [1]The Waimanu, Hawaii National Estuarine Research Reserve (NERR) site was withdrawn from the NERR System on May 1, 1996. [2]The Florida Keys National Marine Sanctuary incorporated the pre-existing sanctuaries at Looe Key and Key Largo, effective July 1, 1997.

Table 3.4 National Register of Historic Places, 1967-1997

Year	Properties listed	Properties removed	Year	Properties listed	Properties removed
	number			*number*	
1967	873	2	1983	35,112	434
1968	903	3	1984	39,121	440
1969	1,106	4	1985	42,538	445
1970	1,888	19	1986	45,936	452
1971	3,026	51	1987	48,254	525
1972	4,376	93	1988	51,286	574
1973	6,646	144	1989	53,838	635
1974	8,247	188	1990	56,688	651
1975	10,805	231	1991	58,209	683
1976	12,561	265	1992	60,500	716
1977	14,203	290	1993	62,095	749
1978	16,575	338	1994	63,710	792
1979	20,589	366	1995	65,255	810
1980	24,680	403	1996	66,805	833
1981	26,499	406	1997	68,394	816
1982	29,999	420			

Source: U.S. Department of the Interior, National Park Service, The National Register of Historic Places, National Register Information System (an Internet accessible database).

Note: Data are year-end cumulative totals.

Table 3.5 Recreational Fishing and Hunting in the United States, 1955-1996

Year	Fishermen			Hunters				Total
	Fresh-water	Salt-water	Total	Small game	Big game	Water-fowl	Total	sports-men
	millions							
1955	18.42	4.56	20.81	9.82	4.41	1.99	11.78	24.92
1960	21.68	6.29	25.32	12.11	6.28	1.96	14.64	30.44
1965	23.96	8.31	28.34	10.58	6.57	1.65	13.58	32.88
1970	29.36	9.46	33.15	11.67	7.77	2.89	14.34	36.28
1975	36.60	13.74	41.29	14.18	11.04	4.28	17.09	45.77
1980	35.78	11.97	41.87	12.50	11.05	3.18	16.76	46.97
1985	39.12	12.89	45.35	11.13	12.58	3.20	16.34	49.83
1991	31.04	8.89	39.98	7.64	10.75	3.01	14.06	39.98
1996	29.73	9.44	39.69	6.93	11.27	3.04	13.98	39.69

Year	Fishing days			Hunting days				Total
	Fresh-water	Salt-water	Total	Small game	Big game	Water-fowl	Total	sporting days
	millions							
1955	338.83	58.62	397.45	118.63	30.83	19.96	169.42	566.87
1960	385.17	80.60	465.77	138.19	39.19	15.16	192.54	658.31
1965	426.92	95.84	522.76	128.45	43.85	13.53	185.82	708.58
1970	592.49	113.69	706.19	124.04	54.54	25.11	203.69	909.88
1975	890.58	167.50	1,050.08	269.65	100.60	31.22	401.48	1,459.55
1980	788.39	164.04	952.42	225.79	117.41	26.18	348.54	1,300.98
1985	895.03	171.06	1,064.99	214.54	135.45	25.93	350.39	1,415.38
1991	439.54	74.70	511.24	77.13	128.41	22.24	227.78	761.33
1996	513.74	103.03	623.54	75.02	153.72	26.50	255.56	879.10

Sources: U.S. Department of the Interior, Fish and Wildlife Service, *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (DOI, FWS, Washington, DC, 1993).

--, *1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: National Overview* (DOI, FWS, Washington, DC, 1997).

Notes: Number of fishermen and hunters includes persons 16 years and older. Total number of hunters includes 1,411 hunters of other animals in 1991 and 1,472 in 1996. Totals may not agree with sum of components due to independent rounding and because of multiple responses (e.g., where sportsmen participate in more than one activity per outing). Estimates for 1991 and 1996 are comparable because of similar survey methodologies. However, these estimates are not strictly comparable with estimates from previous surveys because of differences in survey methodologies.

Table 3.6 U.S. Marine Recreational Fisheries by Region, 1981-1997

	North Atlantic			Mid-Atlantic			South Atlantic		
Year	Fishing trips	Fish caught	Fish weight	Fishing trips	Fish caught	Fish weight	Fishing trips	Fish caught	Fish weight
	number in millions		*million pounds*	*number in millions*		*million pounds*	*number in millions*		*million pounds*
1981	5.76	36.98	68.79	14.01	100.82	118.56	8.55	44.48	37.87
1982	7.04	46.75	85.71	15.50	81.15	105.42	13.63	64.15	48.53
1983	7.10	35.20	68.38	18.57	125.02	124.65	14.46	62.99	65.20
1984	5.32	24.58	39.63	15.76	101.11	100.53	15.09	59.77	50.05
1985	7.07	41.08	59.43	14.74	90.85	79.40	15.32	67.18	59.96
1986	7.48	49.89	81.97	18.84	153.94	135.53	14.90	59.42	53.56
1987	5.78	34.29	55.17	14.72	99.92	116.72	16.95	50.30	51.56
1988	5.74	25.72	39.73	14.90	77.90	85.89	18.82	56.08	54.85
1989	5.23	24.58	33.10	12.17	64.58	76.97	16.36	46.05	46.35
1990	5.54	18.65	28.89	13.35	84.59	56.80	13.57	40.78	35.77
1991	6.80	26.69	35.63	15.98	126.00	65.19	17.39	54.95	47.66
1992	5.70	17.74	21.17	12.22	75.03	47.33	16.74	54.09	45.00
1993	6.23	20.99	24.30	15.29	97.57	55.08	16.80	50.89	37.35
1994	6.28	25.88	23.92	16.24	94.95	45.86	19.93	72.17	50.09
1995	6.51	21.98	19.79	15.58	88.52	58.87	18.75	65.24	50.44
1996	6.76	23.43	21.29	16.50	86.42	55.74	16.82	51.26	43.76
1997	7.63	23.78	19.32	17.23	96.55	60.24	18.00	58.30	49.32

	Gulf of Mexico[1]			Total Atlantic & Gulf			Pacific[2]		
Year	Fishing trips	Fish caught	Fish weight	Fishing trips	Fish caught	Fish weight	Fishing trips	Fish caught	Fish weight
	number in millions		*million pounds*	*number in millions*		*million pounds*	*number in millions*		*million pounds*
1981	12.06	87.39	53.00	40.38	269.67	278.22	11.00	51.00	na
1982	13.42	113.33	75.70	49.59	305.38	315.36	11.00	53.00	na
1983	19.98	146.17	80.92	60.11	369.38	339.15	11.00	44.52	na
1984	19.64	133.87	71.75	55.81	319.33	261.97	10.00	46.84	na
1985	15.42	101.20	65.45	52.55	300.30	264.23	9.90	43.18	na
1986	19.04	144.08	96.56	60.26	407.32	367.62	11.03	55.31	na
1987	16.09	101.56	66.54	53.54	286.08	289.98	9.97	47.54	na
1988	19.74	130.95	70.85	59.20	290.65	251.31	12.42	51.22	na
1989	15.62	113.91	66.90	48.38	249.11	223.32	9.45	41.29	na
1990	13.31	106.38	51.55	45.77	250.40	173.00	na	na	na
1991	18.17	177.34	79.77	58.34	284.98	228.24	na	na	na
1992	18.08	145.03	68.93	52.74	291.88	182.40	na	na	na
1993	17.43	147.33	68.52	54.75	316.78	185.24	6.89	30.92	20.94
1994	17.50	148.86	63.57	59.95	341.85	183.44	7.19	27.17	17.92
1995	17.12	135.78	73.06	57.96	311.53	202.16	7.22	27.61	24.31
1996	16.32	118.63	64.57	56.40	279.73	185.35	7.77	34.05	23.19
1997	18.10	139.82	79.31	60.95	318.44	208.19	7.19	29.00	26.01

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States 1997* (GPO, Washington, DC, 1998).

Notes: na = not available. [1]Does not include Texas. [2]Does not include Washington for 1993-1996.

Table 3.7 Visits to Selected U.S. Federal Recreation Areas, 1977-1997

Year	National Parks	National Wildlife Refuges	Bureau of Reclamation Recreation Areas	National Forests	Army Corps of Engineers Reservoirs	Bureau of Land Management Lands
	million visits	.... *million visitors*		.... *million visitor days*		
1977	211	27	55	205	424	na
1978	222	26	63	219	439	na
1979	205	25	59	220	449	na
1980	198	23	60	234	457	na
1981	210	26	69	236	469	64
1982	214	24	63	233	480	40
1983	217	22	66	228	480	42
1984	218	23	76	228	482	34
1985	216	24	76	225	502	31
1986	237	25	80	237	506	36
1987	246	25	80	239	181	64
1988	250	26	82	242	191	57
1989	256	26	84	253	191	50
1990	263	27	80	263	190	70
1991	268	28	80	279	192	68
1992	275	28	83	287	203	65
1993	273	28	84	296	200	39
1994	269	27	na	330	205	40
1995	270	28	na	345	206	73
1996	266	30	na	341	212	73
1997	275	31	90	na	213	72

Sources: U.S. Army Corps of Engineers, Directorate of Civil Works, Operations, Construction and Readiness Division, Natural Resources Management Branch, Visitation to Corps Recreation Areas, unpublished, Washington, DC, 1997.

U.S Department of Agriculture, Forest Service, *Report of the Forest Service* (USDA, FS, Washington, DC, annual).

U.S. Department of the Interior, Bureau of Land Management, *Public Land Statistics* (DOI, BLM, Washington, DC, annual).

U.S. Department of the Interior, Bureau of Reclamation, Utilization of Recreation Areas on Reclamation Projects, unpublished, Denver, CO, 1994.

U.S. Department of the Interior, Fish and Wildlife Service, Refuge Division, Refuge Management Information System, unpublished, Washington, DC, 1997.

U.S. Department of the Interior, National Park Service, Statistical Office, *National Park Statistical Abstract* (DOI, NPS, Denver, CO, annual).

Notes: na = not available. Visitor day = visitor hours divided by 12. Data for Army Corps of Engineers refer to recreation days of use for years 1977 through 1986 and 12-hour visitor days thereafter.

Ecosystems and Biodiversity

Table 4.1 Trends in Selected U.S. Resident and Neotropical Migrant Bird Species, 1966-1996, 1966-1979, and 1980-1996

	Resident/short distance migrant bird species		
Common name	Long-term trend (1966-1996)	Mid-term trend (1966-1979)	Short-term trend (1980-1996)
	% change per year		
Northern bobwhite	- 2.5	- 1.0	- 3.3
Mourning dove	- 0.3	1.2	- 0.8
Great horned owl	1.1	3.0	- 0.8
Red-headed woodpecker	- 2.2	0.7	- 4.7
Downy woodpecker	- 0.5	0.1	- 1.3
Hairy woodpecker	0.1	1.7	- 0.1
Pileated woodpecker	1.1	1.1	0.8
Red-cockaded woodpecker	- 2.0	8.8	- 8.8
Horned lark	- 1.2	- 0.4	- 1.8
Blue jay	- 1.6	- 1.1	- 1.3
Black-capped chickadee	1.5	1.6	0.1
Carolina chickadee	- 0.9	- 0.8	- 1.7
Tufted titmouse	1.0	- 1.9	2.4
Brown-headed nuthatch	- 2.2	- 2.0	- 2.4
Brown creeper	- 1.5	- 2.6	- 0.9
Carolina wren	0.8	0.0	2.1
Marsh wren	3.9	- 3.1	6.7
Brown thrasher	- 1.1	- 0.9	- 1.1
American robin	0.9	0.7	0.8
Eastern bluebird	2.4	- 4.9	3.9
Northern mockingbird	- 0.9	- 2.0	0.3
Northern cardinal	0.0	- 0.8	0.9
Song sparrow	- 0.1	- 1.9	1.0
Field sparrow	- 3.3	- 5.6	- 2.2
White-throated sparrow	- 1.0	- 2.2	- 0.4
Slate-colored junco	0.0	- 0.5	0.3

	Neotropical migrant bird species		
Common name	Long-term trend (1966-1996)	Mid-term trend (1966-1979)	Short-term trend (1980-1996)
	% change per year		
Yellow-billed cuckoo	- 1.6	3.2	- 3.1
Chuck-will's-widow	- 1.5	- 1.0	- 0.8
Whip-poor-will	- 1.1	- 1.9	- 0.9
Ruby-throated hummingbird	1.5	1.3	2.1
Eastern wood pewee	- 1.6	- 2.1	- 1.2
Least flycatcher	- 1.5	- 2.3	- 0.6
Olive-sided flycatcher	- 4.1	- 2.3	- 3.9
Yellow-bellied flycatcher	0.8	2.7	4.9
Great-crested flycatcher	- 0.1	0.6	0.3

See next page for continuation of table.

Table 4.1 Trends in Selected U.S. Resident and Neotropical Migrant Bird Species, 1966-1996, 1966-1979, and 1980-1996 (continued)

	Neotropical migrant bird species		
Common name	Long-term trend (1966-1996)	Mid-term trend (1966-1979)	Short-term trend (1980-1996)
	% change per year		
Purple martin	- 0.1	3.1	- 2.0
Barn swallow	1.0	4.2	- 1.6
Blue-gray gnatcatcher	1.0	0.8	2.2
Veery	- 1.1	0.8	- 1.6
Wood thrush	- 1.7	0.5	- 1.2
Gray catbird	- 0.2	0.5	0.2
White-eyed vireo	- 0.1	0.2	0.2
Red-eyed vireo	1.1	2.2	1.6
Solitary vireo	3.0	3.4	3.6
Golden-winged warbler	- 2.5	- 3.2	2.1
Tennessee warbler	6.5	8.5	6.5
Northern parula	0.2	0.2	0.2
Cape May warbler	0.9	14.8	- 10.4
Blue-winged warbler	0.5	1.3	0.7
Prairie warbler	- 2.6	- 5.2	- 0.9
Cerulean warbler	- 3.8	- 5.7	- 0.4
Blackpoll warbler	- 3.1	9.6	- 1.8
Chestnut-sided warbler	- 0.3	0.2	0.6
Wilson's warbler	- 0.3	- 1.9	- 2.0
Nashville warbler	0.6	- 2.8	0.7
Kentucky warbler	- 1.0	0.2	- 1.4
American redstart	- 0.5	- 1.2	0.4
Prothonotary warbler	- 1.6	1.0	- 2.2
Ovenbird	1.4	0.7	2.0
Northern waterthrush	0.8	4.7	- 0.5
Louisiana waterthrush	0.3	0.5	- 1.2
Common yellowthroat	- 0.2	0.7	- 0.6
Yellow-breasted chat	- 0.3	- 3.5	1.0
Scarlet tanager	0.1	3.3	- 0.4
Summer tanager	- 0.2	0.2	- 0.5
Baltimore oriole	- 0.4	2.0	- 1.4
Orchard oriole	- 1.8	- 2.6	- 1.0
Rose-breasted grosbeak	0.1	3.3	- 1.3
Indigo bunting	- 0.7	0.1	- 1.0
Grasshopper sparrow	- 3.5	- 4.6	- 1.8
Chipping sparrow	0.0	- 2.1	0.5

Source: Sauer, J.R., J.E. Hines, G. Gough, I. Thomas and B.G. Peterjohn, *The North American Breeding Bird Survey Results and Analysis*, *Version 96.4* (U.S. Department of the Interior, Patuxent Wildlife Research Center, Laurel, MD, 1997).

Table 4.2 North American Duck Population Estimates, 1955-1997

Year	Mallard	Gadwall	Am. widgeon	Green wing teal	Blue wing teal	No. shoveler	No. pintail	Redhead	Canvasback	Scaup	Black duck (Atlan)	Black duck (Miss)
						millions						
1955	8.78	0.65	3.22	1.81	5.31	1.64	9.78	0.54	0.59	5.62	0.58	0.18
1956	10.45	0.77	3.15	1.53	5.00	1.78	10.37	0.76	0.70	5.99	0.42	0.21
1957	9.30	0.67	2.92	1.10	4.30	1.48	6.61	0.51	0.63	5.77	0.42	0.23
1958	11.23	0.50	2.55	1.35	5.46	1.38	6.04	0.46	0.75	5.35	0.28	0.26
1959	9.02	0.59	3.79	2.65	5.10	1.58	5.87	0.50	0.49	7.04	0.31	0.18
1960	7.37	0.78	2.99	1.43	4.29	1.82	5.72	0.50	0.61	4.87	0.34	0.17
1961	7.33	0.65	3.05	1.73	3.66	1.38	4.22	0.32	0.44	5.38	0.32	0.16
1962	5.54	0.91	1.96	0.72	3.01	1.27	3.62	0.51	0.36	5.29	0.34	0.11
1963	6.75	1.06	1.83	1.24	3.72	1.40	3.85	0.41	0.51	5.44	0.33	0.14
1964	6.06	0.87	2.59	1.56	4.02	1.72	3.29	0.53	0.64	5.13	0.37	0.22
1965	5.13	1.26	2.30	1.28	3.59	1.42	3.59	0.60	0.52	4.64	0.33	0.16
1966	6.73	1.68	2.32	1.62	3.73	2.15	4.81	0.71	0.66	4.44	0.30	0.15
1967	7.51	1.38	2.33	1.59	4.49	2.31	5.28	0.74	0.50	4.93	0.29	0.21
1968	7.09	1.95	2.30	1.43	3.46	1.68	3.49	0.50	0.56	4.41	0.34	0.14
1969	7.53	1.57	2.94	1.49	4.14	2.16	5.90	0.63	0.50	5.14	0.33	0.15
1970	9.99	1.61	3.47	2.18	4.86	2.23	6.39	0.62	0.58	5.66	0.28	0.14
1971	9.42	1.61	3.27	1.89	4.61	2.01	5.85	0.53	0.45	5.14	0.26	0.13
1972	9.27	1.62	3.20	1.95	4.28	2.47	6.98	0.55	0.43	8.00	0.27	0.14
1973	8.08	1.25	2.88	1.95	3.33	1.62	4.36	0.50	0.62	6.26	0.27	0.15
1974	6.88	1.59	2.67	1.86	4.98	2.01	6.60	0.63	0.51	5.78	0.25	0.08
1975	7.73	1.64	2.78	1.66	5.89	1.98	5.90	0.83	0.60	6.46	0.24	0.12
1976	7.93	1.24	2.51	1.55	4.74	1.75	5.48	0.67	0.61	5.82	0.28	0.15
1977	7.40	1.30	2.58	1.29	4.46	1.45	3.93	0.63	0.66	6.26	0.26	0.10
1978	7.43	1.56	3.28	2.17	4.50	1.98	5.11	0.72	0.37	5.98	0.27	0.09
1979	7.88	1.76	3.11	2.07	4.88	2.41	5.38	0.70	0.58	7.66	0.24	0.08
1980	7.71	1.39	3.60	2.05	4.90	1.91	4.51	0.73	0.73	6.38	0.20	0.08
1981	6.41	1.40	2.95	1.91	3.72	2.33	3.48	0.59	0.62	5.99	0.24	0.08
1982	6.41	1.63	2.46	1.54	3.66	2.15	3.71	0.62	0.51	5.53	0.24	0.07
1983	6.46	1.52	2.64	1.88	3.37	1.88	3.51	0.71	0.53	7.17	0.20	0.09
1984	5.42	1.52	3.00	1.41	3.98	1.62	2.96	0.67	0.53	7.02	0.23	0.06
1985	4.96	1.30	2.05	1.48	3.50	1.70	2.52	0.58	0.38	5.10	0.22	0.06
1986	6.12	1.55	1.74	1.67	4.48	2.13	2.74	0.56	0.44	5.24	0.23	0.10
1987	5.79	1.31	2.01	2.01	3.53	1.95	2.63	0.50	0.45	4.86	0.20	0.07
1988	6.37	1.35	2.21	2.06	4.01	1.68	2.01	0.44	0.44	4.67	0.23	0.11
1989	5.65	1.41	1.97	1.84	3.13	1.54	2.11	0.51	0.48	4.34	0.24	0.07
1990	5.45	1.67	1.86	1.79	2.78	1.76	2.26	0.48	0.54	4.29	0.23	0.01
1991	5.44	1.58	2.25	1.56	3.76	1.72	1.80	0.45	0.49	5.25	0.23	0.05
1992	5.98	2.03	2.21	1.77	4.33	1.95	2.10	0.60	0.48	4.64	0.20	0.08
1993	5.71	1.76	2.05	1.69	3.19	2.05	2.05	0.49	0.47	4.08	0.21	0.08
1994	6.98	2.32	2.38	2.11	4.62	2.91	2.97	0.65	0.53	4.53	0.22	0.08
1995	8.27	2.84	2.61	2.30	5.14	2.85	2.76	0.89	0.77	4.45	0.21	0.09
1996	7.94	2.98	2.27	2.50	6.41	3.45	2.74	0.83	0.85	4.22	0.20	0.04
1997	9.94	3.90	3.12	2.51	6.12	4.12	3.56	0.92	0.69	4.11	0.20	0.04

Source: U.S. Department of the Interior, Fish and Wildlife Service, Office of Migratory Bird Management in Conjunction with the Canadian Wildlife Service, *Status of Waterfowl and Fall Flight Forecast* (DOI, FWS, Washington, DC, annual).

Table 4.3 North American Goose and Swan Population Estimates, 1969-1997

Year	Canada goose	Snow goose	Greater white-fronted goose	Brant	Emperor goose	Tundra swan Eastern	Tundra swan Western
	.... *millions*	....	....		*thousands*	....	
1969/70	0.244	0.908	na	141.7	na	31.0	55.0
1970/71	0.367	1.191	na	300.2	na	98.8	58.2
1971/72	0.550	1.467	na	197.8	na	82.8	63.4
1972/73	0.648	1.180	na	166.0	na	33.9	57.2
1973/74	0.536	1.371	na	218.7	na	69.7	64.2
1974/75	0.535	1.277	na	211.4	na	54.3	66.6
1975/76	0.810	1.751	na	249.0	na	51.4	78.6
1976/77	0.727	1.344	na	221.0	na	47.3	76.2
1977/78	0.724	2.191	na	208.9	na	45.6	70.3
1978/79	0.604	1.485	na	173.4	na	53.5	78.6
1979/80	0.610	1.598	73.1	215.4	na	65.2	63.7
1980/81	0.923	1.615	93.5	291.2	93.3	83.6	93.0
1981/82	1.027	2.007	116.5	227.0	100.6	91.3	73.1
1982/83	1.024	1.974	91.7	233.3	79.2	67.3	87.0
1983/84	0.859	1.763	112.9	260.4	71.2	61.9	81.1
1984/85	1.012	2.275	100.2	290.8	58.8	48.8	94.3
1985/86	0.925	1.808	93.8	246.2	42.0	66.2	90.9
1986/87	1.148	2.232	107.1	219.9	51.7	52.8	94.5
1987/88	1.307	1.797	130.6	278.0	53.8	59.2	77.4
1988/89	2.482	2.387	161.5	273.2	45.8	78.7	90.6
1989/90	2.615	2.131	218.8	287.0	67.6	40.1	89.7
1990/91	2.238	2.589	240.8	279.4	70.9	47.6	97.4
1991/92	3.280	2.550	236.5	302.5	71.3	63.7	110.1
1992/93	2.885	2.288	853.8	225.0	52.5	62.6	76.6
1993/94	3.314	2.877	971.4	287.2	57.3	79.4	84.5
1994/95	3.829	3.488	1,052.1	281.9	51.2	52.9	81.3
1995/96	3.721	3.160	1,406.9	232.8	80.3	98.1	79.0
1996/97	4.577	3.636	1,086.6	279.4	57.1	122.5	86.1

Source: U.S. Department of the Interior, Fish and Wildlife Service, Office of Migratory Bird Management in Conjunction with the Canadian Wildlife Service, *Status of Waterfowl and Fall Flight Forecast* (DOI, FWS, Washington, DC, annual).

Notes: na = not available. Data for Canada goose are aggregate population totals for 13 separate populations that nest in North America. Data for snow goose are aggregate population totals for the greater snow goose, lesser snow goose, and Ross' goose populations. The 1994/95 survey of the western tundra swan population was incomplete.

Table 4.4 Status of Marine Mammal Stocks in U.S. Waters, 1995

Marine Mammals of the Pacific					
Species	Stock area	Nmin	PBR	Total annual mortality	Trend
Sperm whale	CA/OR/WA	511	1.0	15	S
Humpback whale	CA/Mexico	563	0.5	1	I
Blue whale	CA/Mexico	1,708	1.7	1	I
Fin whale	CA/WA	575	1.1	1	I
Brydes whale	E. Trop. Pacific	11,145	0.5	na	U
Sei whale	E. North Pacific	na	na	na	U
Minke whale	CA/WA	265	2.6	0.5	U
Harbor porpoise	Central CA	3,430	34	31	D
Harbor porpoise	N. California	7,649	76	0	S
Harbor porpoise	OR/WA	22,049	220	14.2	U
Harbor porpoise	Inland WA	2,680	27	15	D
Dall's porpoise	CA/WA	58,902	589	36	U
Pacific white-sided dolphin	CA/WA	82,939	829	28	S
Risso's dolphin	CA/WA	22,388	224	39	U
Bottlenose dolphin	CA coastal	245	2.5	0	S
Bottlenose dolphin	CA/WA offshore	1,775	18	8	U
Striped dolphin	California	13,639	136	0	U
Common dolphin (short-beaked)	CA/WA	1,798,185	1,792	316	I
Common dolphin (long-beaked)	California	5,636	56	23	U
No. right whale dolphin	CA/WA	15,080	151.0	46	U
Killer whale	CA/WA	139	1.4	0	U
Pilot whale (short-finned)	CA/WA	na	na	36	U
Baird's beaked whale	CA/WA	19	0.2	2	U
Mesoplodont beaked whale	CA/WA	136	1.4	8	U
Cuvier's beaked whale	CA/WA	886	9.0	24	U
Pygmy sperm whale	CA/WA	481	4.8	6	U
Dwarf sperm whale	CA/WA	na	na	0	U
Brydes whale	Hawaii	na	na	0	U
Blue whale	Hawaii	na	na	0	U
Fin whale	Hawaii	na	na	0	U

See next page for continuation of table.

Table 4.4 Status of Marine Mammal Stocks in U.S. Waters, 1995 (continued)

Marine Mammals of the Pacific					
Species	Stock area	Nmin	PBR	Total annual mortality	Trend
Pygmy killer whale	Hawaii	na	na	na	U
Pilot whale (short finned)	Hawaii	na	na	na	U
Risso's dolphin	Hawaii	na	na	na	U
Killer whale	Hawaii	na	na	0.0	U
Melon-headed whale	Hawaii	na	na	0.0	U
False killer whale	Hawaii	na	na	na	U
Pantropical spotted dolphin	Hawaii	na	na	na	U
Stripped dolphin	Hawaii	na	na	na	U
Spinner dolphin	Hawaii	677	6.8	1.0	U
Rough-toothed dolphin	Hawaii	na	na	na	U
Bottlenose dolphin	Hawaii	na	na	0.0	U
Pygmy sperm whale	Hawaii	na	na	na	U
Dwarf sperm whale	Hawaii	na	na	0.0	U
Sperm whale	Hawaii	na	na	na	U
Cuvier's beaked whale	Hawaii	na	na	0.0	U
Blainville's beaked whale	Hawaii	na	na	0.0	U
California sea lion	U.S.	84,195	5,052	2,434	I
Harbor seal	California	32,800	1,968	729	I
Harbor seal	WA inland	13,053	783	14	I
Harbor seal	OR/WA	28,322	850	233	I
Northern elephant seal	CA breeding	42,000	1,743	166	I
Northern fur seal	San Miguel Is.	10,536	227	0	I
Guadalupe fur seal	Mexico to CA	3,028	104	0	I
Hawaiian monk seal	Hawaii	1,300	4.6	1	D
NE spotted dolphin	E. Trop. Pacific	648,900	6,489	934	D
W/S offshore spotted dolphin	E. Trop. Pacific	1,145,100	11,451	1,226	S
Eastern spinner dolphin	E. Trop. Pacific	518,500	5,185	743	S
Whitebelly spinner dolphin	E. Trop. Pacific	872,000	8,720	619	S
Common dolphin (northern)	E. Trop. Pacific	3,531,000	3,531	101	S
Common dolphin (central)	E. Trop. Pacific	297,400	2,974	151	S
Common dolphin (southern)	E. Trop. Pacific	1,845,600	18,456	0	S
Stripped dolphin	E. Trop. Pacific	1,745,900	17,459	11	S
Coastal spotted dolphin	E. Trop. Pacific	22,500	225	na	S
Central Am. spinner dolphin	E. Trop. Pacific	na	na	11	S
Sea otter	Central CA	na	na	na	I
Sea otter	WA	na	na	na	I

See next page for continuation of table.

Table 4.4 Status of Marine Mammal Stocks in U.S. Waters, 1995 (continued)

Marine Mammals of the Atlantic and Gulf of Mexico					
Species	Stock area	Nmin	PBR	Total annual mortality	Trend
No. Atlantic right whale	W. No. Atlantic	395	0.4	2.5	I
Humpback whale	W. No. Atlantic	4,848	9.7	1	U
Fin whale	W. No. Atlantic	1,704	3.4	na	U
Sei whale	W. No. Atlantic	155	0.3	0.3	U
Minke whale	E. Coast Canada	2,053	21.0	2.5	U
Blue whale	W. No. Atlantic	na	na	0.0	U
Sperm whale	W. No. Atlantic	226	0.5	1.6	U
Dwarf sperm whale	W. No. Atlantic	na	na	na	U
Pygmy sperm whale	W. No. Atlantic	na	na	na	U
Killer whale	W. No. Atlantic	na	na	0	U
Pygmy killer whale	W. No. Atlantic	6	0.1	0	U
Northern bottlenose whale	W. No. Atlantic	na	na	0	U
Cuvier's beaked whale	W. No. Atlantic	na	na	34	U
True's beaked whale	W. No. Atlantic	na	na	34	U
Gervais beaked whale	W. No. Atlantic	na	na	34	U
Blainville's beaked whale	W. No. Atlantic	na	na	34	U
Sowerby's beaked whale	W. No. Atlantic	na	na	34	U
Risso's dolphin	W. No. Atlantic	11,140	111	68	U
Pilot whale (long-finned)	W. No. Atlantic	3,537	28	109	U
Pilot whale (short-finned)	W. No. Atlantic	457	3.7	109	U
Atlantic white-sided dolphin	W. No. Atlantic	12,538	125	127	U
White-beaked dolphin	W. No. Atlantic	na	na	0.0	U
Common dolphin	W. No. Atlantic	3,233	32	449	U
Atlantic spotted dolphin	W. No. Atlantic	4,885	9.8	31	U
Pantropical spotted dolphin	W. No. Atlantic	na	na	31	U
Stripped dolphin	W. No. Atlantic	9,165	73	63	U
Spinner dolphin	W. No. Atlantic	na	na	1.0	U
Bottlenose dolphin	Mid-Atl. offshore	9,195	92	128	U
Bottlenose dolphin	Mid-Atl. coastal	2,482	25	29	S
Harbor porpoise	Gulf of Maine*	40,279	403	1,876	U
Harbor seal	W. No. Atlantic	28,810	1,729	476	I
Gray seal	N. W. No. Atlantic	2.035	122	4.5	I
Harp seal	N. W. No. Atlantic	na	na	0	I
Hooded seal	N. W. No. Atlantic	na	na	0	I
Sperm whale	N. Gulf of Mexico	411	0.8	0	U
Bryde's whale	N. Gulf of Mexico	17	0.2	0	U
Cuvier's beaked whale	N. Gulf of Mexico	20	0.2	0	U
Blainsville's beaked whale	N. Gulf of Mexico	na	na	0	U
Gervais' beaked whale	N. Gulf of Mexico	na	na	0	U
Bottlenose dolphin	G. of Mexico OCS	43,233	432	5	U
Bottlenose dolphin	G. of Mexico S&S	4,530	45	5	U
Bottlenose dolphin	W. G. of Mexico coast	2,938	29	13	U
Bottlenose dolphin	E. G. of Mexico coast	8,963	90	8	U
Bottlenose dolphin	G. of Mexico inland**	na	39.7	30	U

See next page for continuation of table.

Table 4.4 Status of Marine Mammal Stocks in U.S. Waters, 1995 (continued)

Marine Mammals of the Atlantic and Gulf of Mexico					
Species	Stock area	Nmin	PBR	Total annual mortality	Trend
Atlantic spotted dolphin	N. Gulf of Mexico	2,555	23	1.5	U
Pantropical spotted dolphin	N. Gulf of Mexico	26,510	265	1.5	U
Stripped dolphin	N. Gulf of Mexico	3,409	34	0	U
Spinner dolphin	N. Gulf of Mexico	4,465	45	0	U
Rough-toothed dolphin	N. Gulf of Mexico	660	6.6	0	U
Clymene dolphin	N. Gulf of Mexico	4,120	41	0	U
Fraser’s dolphin	N. Gulf of Mexico	66	0.7	0	U
Killer whale	N. Gulf of Mexico	197	2	0	U
False killer whale	N. Gulf of Mexico	236	2.4	0	U
Pygmy killer whale	N. Gulf of Mexico	285	2.8	0	U
Dwarf sperm whale	N. Gulf of Mexico	na	na	0	U
Pygmy sperm whale	N. Gulf of Mexico	na	na	0	U
Melon-headed whale	N. Gulf of Mexico	2,888	29	0	U
Risso’s dolphin	N. Gulf of Mexico	2,199	22	19	U
Pilot whale (short-finned)	N. Gulf of Mexico	186	1.9	0.3	U
West Indian manatee	Florida	na	na	na	D
West Indian manatee	Antillean	na	na	na	D

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Our Living Oceans, Report on the Status of U.S. Living Marine Resources, 1995*, NOAA Technical Memorandum NMFS-F/SPO-19 (DOC, NOAA, NMFS, Washington, DC, 1996).

Notes: N_{min} = minimum population. PBR = potential biological removal. Trend is increasing (I), decreasing (D), stable (S), and unknown (U). na = not available. *Also includes the Bay of Fundy. **Represents at least 33 individually recognized stocks of bottlenose dolphin in U.S. Gulf of Mexico bays, sounds, and other estuaries. OCS = Outer Continental Shelf. S&S = Shelf and Slope. The following marine mammals in the Pacific have Endangered Species Act status: sperm whale (endangered); humpback whale (endangered), blue whale (both CA/Mexico and Hawaii stocks) (endangered), fin whale (both CA/WA and Hawaii stocks) (endangered), sei whale (endangered), Guadalupe fur seal (threatened); and Hawaiian monk seal (endangered). Two species of marine mammals in the Pacific have Marine Mammal Protection Act status: northeastern spotted dolphin (depleted) and eastern spinner dolphin (depleted). Nine species of marine mammals in the Atlantic and Gulf of Mexico have Endangered Species Act status: North Atlantic right whale (endangered); humpback whale (endangered); fin whale (endangered); sei whale (endangered); blue whale (endangered); W. North Atlantic sperm whale (endangered); Gulf of Mexico sperm whale (endangered); Florida West Indian manatee (endangered); and Antillean West Indian manatee (endangered). One marine mammal species in the Atlantic and Gulf of Mexico has Marine Mammal Protection Act status: Mid-Atlantic coastal bottlenose dolphin (depleted).

Table 4.5 Status of Sea Turtle Stocks in U.S. Waters, 1998

Region/ Species	Location of principal nesting population	Historic number of females nesting nanually	Current number of nesting females	Trend in U.S. nesting population[1]	Status in the United States	Foot-notes
Atlantic						
Loggerhead	SE U.S.	Unknown	10,502	Stable	T	2
Green	Florida	Unknown	675	Increasing	T,E	3
Kemp's ridley	Mexico	>40,000	954	Increasing	E	4
Leatherback	Florida, USVI, PR	Unknown	160	Stable	E	5
Hawksbill	USVI, PR	Unknown	367	Unknown	E	6
Pacific						
Loggerhead	Japan	Unknown	1,000	Stable	T	7
Green	Hawaii	Unknown	1,000	Increasing	T	8
Olive ridley	Mexico, Costa Rica	Unknown	350,000	Increasing	T	9
Leatherback	Mexico, Costa Rica	Unknown	985	Decreasing	E	10
Hawksbill	Hawaii	Unknown	30-40	Stable	E	11

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Our Living Oceans, Report on the Status of U.S. Living Marine Resources, 1995*, NOAA Technical Memorandum NMFS-F/SPO-19 (DOC, NOAA, NMFS, Washington, DC, 1996), with updates by agency.

Notes: E = Listed as Endangered under the Endangered Species Act. T = Listed as Threatened under the Endangered Species Act. [1]Unless principal population is outside U.S. jurisdiction. [2]Average number of females nesting annually based on 4.1 nests per female per year for 1989-1995. [3]Average number of females nesting annually based on 3.5 nests per female per year for 1993-1997. [4]Number of females nesting in 1997 based on 2.5 nests per female per year. [5]Average number of females nesting annually based on 5.3 nests per female per year for 1993-1997 for Florida, Sandy Point (USVI), and Culebra Island (PR). [6]Average number of females nesting annually based on 4.5 nests per female per year for 1994-1998 for Mona Island (PR). Nesting also occurs at other PR and USVI beaches. [7]Estimated aggregate 1995 nesting population based on surveys of principal nesting beaches. [8]Estimated total Hawaiian nesting population based on doubling results of 1997 East Island survey. Despite growth in nesting population, concern remains over increasing incidence of fibropapillomatosis. [9]Estimated number of nesters at La Escobilla beach, Oaxaca, in 1996. Nesting also occurs at other Mexican beaches. [10]Based on estimated 5,222 nests in 1996 on principal nesting beaches. [11]Based on recent nesting beach surveys through 1997 by USFWS.

Table 4.6 U.S. Threatened and Endangered Species, 1980-1997

Year	Threatened animal species by taxonomic group										Threatened plant species	Total
	Mammals	Birds	Reptiles	Amphibians	Fish	Crustaceans	Snails	Insects	Arachnids	Clams		
	number of species											
1980	4	3	12	3	14	0	5	7	0	0	9	57
1981	4	3	12	3	14	0	5	6	0	0	10	57
1982	4	3	12	3	14	1	5	6	0	0	10	58
1983	4	3	12	3	15	1	5	6	0	0	11	60
1984	5	3	12	3	18	1	5	5	0	0	11	63
1985	5	4	12	3	24	1	5	5	0	0	25	84
1986	6	4	14	3	28	1	5	7	0	0	27	95
1987	6	9	17	4	32	1	5	7	0	0	35	116
1988	6	9	17	4	31	1	5	7	0	0	48	128
1989	7	9	17	5	32	1	6	7	0	0	51	135
1990	8	11	17	5	33	2	6	9	0	2	61	154
1991	8	11	17	5	34	2	6	9	0	2	64	159
1992	9	12	18	5	36	2	7	9	0	2	74	174
1993	9	16	19	5	37	2	7	9	0	3	80	187
1994	9	16	19	5	39	3	7	9	0	3	90	200
1995	9	16	19	5	39	3	7	9	0	6	93	206
1996	9	16	19	6	40	3	7	9	0	6	101	216
1997	7	15	20	7	41	3	7	9	0	6	115	230

Year	Endangered animal species by taxonomic group										Endangered plant species	Total
	Mammals	Birds	Reptiles	Amphibians	Fish	Crustaceans	Snails	Insects	Arachnids	Clams		
	number of species											
1980	32	58	13	5	33	1	2	7	0	23	50	223
1981	32	58	13	5	33	1	3	7	0	23	51	225
1982	32	58	14	5	35	2	3	7	0	23	57	235
1983	35	53	14	5	34	3	3	7	0	23	58	234
1984	37	66	14	5	33	3	3	8	0	22	71	261
1985	43	68	14	5	40	3	3	8	0	23	93	299
1986	43	71	14	5	42	4	3	8	0	23	114	326
1987	46	73	15	5	42	5	3	8	0	28	139	362
1988	50	72	15	5	46	8	3	11	4	31	153	397
1989	51	72	15	6	50	8	3	12	4	34	166	420
1990	53	72	15	6	53	8	3	12	4	37	179	441
1991	56	72	15	6	54	8	7	14	4	40	238	513
1992	56	72	15	6	55	9	11	16	4	40	295	578
1993	56	72	14	6	61	11	12	17	4	50	323	626
1994	57	74	14	7	66	14	15	19	4	51	420	741
1995	57	75	14	7	66	14	15	20	5	51	432	756
1996	57	74	14	7	67	14	15	20	5	51	513	837
1997	58	75	14	9	67	16	15	28	5	56	553	896

Source: U.S. Department of the Interior, Fish and Wildlife Service, *Endangered Species Bulletin* (DOI, FWS, Washington, DC, bimonthly).

Note: Data are year-end cumulative totals.

Air Quality

Table 5.1 U.S. Emissions of Carbon Monoxide by Source, Ten-Year Intervals, 1940-1980, and Annually, 1988-1997

Year	Industrial processes: Chemical industries	Metals processing	Petroleum industries	Other industries	Solvent utilization	Storage and transport	Waste disposal and recycling	Total industrial
	million tons							
1940	4.190	2.750	0.221	0.114	na	na	3.630	10.905
1950	5.844	2.910	2.651	0.231	na	na	4.717	16.353
1960	3.982	2.866	3.086	0.342	na	na	5.597	15.873
1970	3.397	3.644	2.179	0.620	na	na	7.059	16.899
1980	2.151	2.246	1.723	0.830	na	na	2.300	9.250
1988	1.917	2.101	0.441	0.711	0.002	0.056	1.806	7.034
1989	1.925	2.132	0.436	0.716	0.002	0.055	1.747	7.013
1990	1.183	2.640	0.333	0.537	0.005	0.076	1.079	5.853
1991	1.127	2.571	0.345	0.548	0.005	0.028	1.116	5.740
1992	1.112	2.496	0.371	0.544	0.005	0.017	1.138	5.683
1993	1.093	2.536	0.371	0.594	0.005	0.051	1.248	5.898
1994	1.171	2.475	0.338	0.600	0.005	0.024	1.225	5.839
1995	1.223	2.380	0.348	0.624	0.006	0.025	1.185	5.791
1996	1.223	2.378	0.348	0.635	0.006	0.025	1.203	5.818
1997	1.287	2.465	0.364	0.663	0.006	0.026	1.242	6.052

Year	Fuel combustion: Electric utilities	Industrial	Other	Total	On-road vehicles	Non-road sources	Miscellaneous	Total all sources
	million tons							
1940	0.004	0.435	14.890	15.329	30.121	8.051	29.210	93.615
1950	0.110	0.549	10.656	11.315	45.196	11.610	18.135	102.609
1960	0.110	0.661	6.250	7.021	64.266	11.575	11.010	109.745
1970	0.237	0.770	3.625	4.632	88.034	11.287	7.909	128.761
1980	0.322	0.750	6.230	7.302	78.049	13.758	8.344	116.702
1988	0.314	0.669	6.390	7.373	71.081	14.698	15.895	116.081
1989	0.321	0.672	6.450	7.443	66.050	14.820	8.154	103.480
1990	0.363	0.879	4.268	5.510	57.848	15.376	11.208	95.794
1991	0.349	0.920	4.587	5.856	62.074	15.368	8.751	97.790
1992	0.350	0.955	4.849	6.154	59.859	15.652	7.052	94.400
1993	0.362	1.043	4.180	5.585	60.202	15.828	7.013	94.526
1994	0.370	1.041	4.108	5.519	61.833	16.050	9.613	98.854
1995	0.372	1.056	4.506	5.934	54.106	16.271	7.049	89.151
1996	0.394	1.072	4.513	5.980	52.944	16.409	9.462	90.611
1997	0.406	1.110	3.301	4.817	50.257	16.755	9.680	87.451

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Pollutant Emissions Trends Report, 1970-1997,* Table A-1 (EPA, OAQPS, Research Triangle Park, NC, 1998), and earlier reports in this series.

Notes: na = not available. Non-road sources include non-road gasoline engines (e.g., industrial, lawn and garden, light commercial, and recreational marine vessels), non-road diesel (e.g., construction and farm), aircraft, and railroads. Miscellaneous includes agricultural fires, slash/prescribed burning, and forest wildfires.

Table 5.2 U.S. Emissions of Nitrogen Oxides by Source, Ten-Year Intervals, 1940-1980, and Annually, 1988-1997

Year	Industrial processes: Chemical industries	Metals processing	Petroleum industries	Other industries	Solvent utilization	Storage and transport	Waste disposal and recycling	Total industrial
	million tons							
1940	0.006	0.004	0.105	0.107	na	na	0.110	0.332
1950	0.063	0.110	0.110	0.093	na	na	0.215	0.591
1960	0.110	0.110	0.220	0.131	na	na	0.331	0.902
1970	0.271	0.077	0.240	0.187	na	na	0.440	1.215
1980	0.213	0.065	0.072	0.205	na	na	0.111	0.669
1988	0.274	0.087	0.100	0.315	0.003	0.002	0.085	0.860
1989	0.273	0.083	0.097	0.311	0.003	0.002	0.084	0.852
1990	0.168	0.097	0.153	0.378	0.001	0.003	0.091	0.892
1991	0.165	0.076	0.121	0.352	0.002	0.006	0.095	0.816
1992	0.163	0.081	0.148	0.361	0.003	0.005	0.096	0.857
1993	0.155	0.083	0.123	0.370	0.003	0.005	0.123	0.861
1994	0.160	0.091	0.117	0.389	0.003	0.005	0.114	0.878
1995	0.158	0.098	0.110	0.399	0.003	0.006	0.099	0.873
1996	0.159	0.098	0.110	0.403	0.003	0.006	0.100	0.879
1997	0.167	0.102	0.115	0.421	0.003	0.006	0.103	0.917

Year	Fuel combustion: Electric utilities	Industrial	Other	Total	On-road vehicles	Non-road sources	Miscellaneous	Total all sources
	million tons							
1940	0.660	2.543	0.529	3.732	1.330	0.991	0.990	7.374
1950	1.316	3.192	0.647	5.155	2.143	1.538	0.665	10.093
1960	2.536	4.075	0.760	7.371	3.982	1.443	0.441	14.140
1970	4.900	4.325	0.836	10.061	7.390	2.182	0.330	21.179
1980	7.024	3.555	0.741	11.318	8.621	4.011	0.248	24.866
1988	6.545	3.187	0.740	10.472	7.661	3.998	0.727	23.718
1989	6.593	3.209	0.736	10.538	7.682	4.049	0.293	23.414
1990	6.663	3.035	1.196	10.895	7.040	4.237	0.371	23.436
1991	6.519	2.979	1.281	10.779	7.373	4.265	0.286	23.520
1992	6.504	3.071	1.353	10.928	7.440	4.310	0.254	23.789
1993	6.651	3.151	1.308	11.111	7.510	4.339	0.225	24.046
1994	6.565	3.147	1.303	11.015	7.672	4.397	0.383	24.345
1995	6.384	3.144	1.298	10.828	7.323	4.507	0.237	23.768
1996	6.060	3.170	1.289	10.519	7.245	4.478	0.343	23.465
1997	6.178	3.270	1.276	10.724	7.035	4.560	0.346	23.582

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Pollutant Emissions Trends Report, 1970-1997,* Table A-2 (EPA, OAQPS, Research Triangle Park, NC, 1998), and earlier reports in this series.

Notes: na = not available. Non-road sources include non-road gasoline engines, non-road diesel (e.g., construction and farm), aircraft, marine vessels, and railroads. Miscellaneous is not defined by the Source.

Table 5.3 U.S. Emissions of Volatile Organic Compounds by Source, Ten-Year Intervals, 1940-1980, and Annually, 1988-1997

	Industrial processes							
Year	Chemical industries	Metals processing	Petroleum industries	Other industries	Solvent utilization	Storage and transport	Waste disposal and recycling	Total industrial
	million tons							
1940	0.884	0.325	0.571	0.130	1.971	0.639	0.990	5.510
1950	1.324	0.442	0.548	0.184	3.679	1.218	1.104	8.499
1960	0.991	0.342	1.034	0.202	4.403	1.762	1.546	10.280
1970	1.341	0.394	1.194	0.270	7.174	1.954	1.984	14.311
1980	1.595	0.273	1.440	0.237	6.584	1.975	0.758	12.861
1988	0.982	0.074	0.645	0.408	5.945	1.842	0.959	10.853
1989	0.980	0.074	0.639	0.403	5.964	1.753	0.941	10.755
1990	0.634	0.122	0.612	0.401	5.750	1.495	0.986	10.000
1991	0.710	0.123	0.640	0.391	5.782	1.532	0.999	10.178
1992	0.715	0.124	0.632	0.414	5.901	1.583	1.010	10.380
1993	0.701	0.124	0.649	0.442	6.016	1.600	1.046	10.578
1994	0.691	0.126	0.647	0.438	6.162	1.629	1.046	10.738
1995	0.660	0.125	0.642	0.450	6.183	1.652	1.067	10.780
1996	0.436	0.070	0.517	0.439	6.273	1.312	0.433	9.482
1997	0.458	0.073	0.538	0.458	6.483	1.377	0.449	9.836

	Fuel combustion							
Year	Electric utilities	Industrial	Other	Total	On-road vehicles	Non-road sources	Miscellaneous	Total all sources
	million tons							
1940	0.002	0.108	1.867	1.977	4.817	0.778	4.079	17.161
1950	0.009	0.098	1.336	1.443	7.251	1.213	2.530	20.936
1960	0.009	0.106	0.768	0.883	10.506	1.215	1.573	24.459
1970	0.030	0.150	0.541	0.694	12.972	1.644	1.101	30.748
1980	0.045	0.157	0.848	1.050	8.979	2.141	1.134	26.166
1988	0.037	0.136	1.188	1.360	8.290	2.293	1.230	24.027
1989	0.037	0.134	1.200	1.372	7.192	2.314	0.642	22.274
1990	0.047	0.182	0.776	1.005	6.313	2.452	1.164	20.935
1991	0.044	0.196	0.835	1.075	6.499	2.466	0.845	21.063
1992	0.044	0.187	0.884	1.114	6.072	2.498	0.579	20.642
1993	0.045	0.186	0.762	0.993	6.103	2.516	0.641	20.830
1994	0.045	0.196	0.748	0.989	6.401	2.538	0.798	21.465
1995	0.044	0.206	0.823	1.073	5.701	2.405	0.600	20.558
1996	0.049	0.208	0.822	1.079	5.490	2.397	0.846	19.293
1997	0.051	0.217	0.593	0.861	5.230	2.430	0.858	19.214

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Pollutant Emissions Trends Report, 1970-1997,* Table A-3 (EPA, OAQPS, Research Triangle Park, NC, 1998), and earlier reports in this series.

Notes: Non-road sources include non-road gasoline engines (e.g., lawn and garden and recreational marine vessels), non-road diesel (e.g., construction and farm), and aircraft. Miscellaneous includes fires, other combustion and natural geogenic sources. The latter accounted for 0.014 million tons each year 1990-1997 (data not available for other years).

Table 5.4 U.S. Emissions of Sulfur Dioxide by Source, Ten-Year Intervals, 1940-1980, and Annually, 1988-1997

Year	Industrial processes: Chemical industries	Metals processing	Petroleum industries	Other industries	Solvent utilization	Storage and transport	Waste disposal and recycling	Total industrial
	million tons							
1940	0.215	3.309	0.224	0.334	na	na	0.003	4.085
1950	0.427	3.747	0.340	0.596	na	na	0.003	5.113
1960	0.447	3.986	0.676	0.671	na	na	0.010	5.790
1970	0.591	4.775	0.881	0.846	na	na	0.008	7.100
1980	0.280	1.842	0.734	0.918	na	na	0.033	3.773
1988	0.449	0.707	0.443	0.411	0.001	0.005	0.036	2.052
1989	0.440	0.695	0.429	0.405	0.001	0.005	0.036	2.010
1990	0.297	0.726	0.430	0.399	0.000	0.007	0.042	1.900
1991	0.280	0.612	0.378	0.396	0.000	0.010	0.044	1.721
1992	0.278	0.615	0.416	0.396	0.001	0.009	0.044	1.758
1993	0.269	0.603	0.383	0.392	0.001	0.005	0.071	1.723
1994	0.275	0.562	0.379	0.398	0.001	0.002	0.060	1.676
1995	0.286	0.530	0.369	0.403	0.001	0.002	0.047	1.637
1996	0.287	0.530	0.368	0.409	0.001	0.002	0.048	1.644
1997	0.301	0.552	0.385	0.427	0.001	0.002	0.050	1.718

Year	Fuel combustion: Electric utilities	Industrial	Other	Total	On-road vehicles	Non-road sources	Miscellaneous	Total all sources
	million tons							
1940	2.427	6.060	3.642	12.129	0.003	3.190	0.545	19.953
1950	4.515	5.725	3.964	14.204	0.103	2.392	0.545	22.358
1960	9.264	3.864	2.319	15.447	0.114	0.321	0.554	22.227
1970	17.398	4.568	1.490	23.456	0.411	0.083	0.110	31.161
1980	17.469	2.951	0.971	21.391	0.521	0.175	0.011	25.905
1988	15.987	3.111	0.660	19.758	0.553	0.764	0.027	23.154
1989	16.215	3.086	0.624	19.923	0.570	0.794	0.011	23.308
1990	15.909	3.550	0.831	20.290	0.542	0.934	0.012	23.678
1991	15.784	3.256	0.755	19.795	0.570	0.958	0.011	23.056
1992	15.416	3.292	0.784	19.492	0.578	0.980	0.010	22.818
1993	15.189	3.284	0.772	19.244	0.517	0.982	0.009	22.476
1994	14.889	3.218	0.780	18.886	0.301	1.000	0.015	21.879
1995	12.080	3.357	0.793	16.229	0.304	1.008	0.009	19.189
1996	12.632	3.399	0.782	16.814	0.316	1.026	0.013	19.812
1997	13.082	3.365	0.813	17.260	0.320	1.060	0.013	20.369

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Pollutant Emissions Trends Report, 1970-1997,* Table A-4 (EPA, OAQPS, Research Triangle Park, NC, 1998), and earlier reports in this series.

Notes: na = not available. Non-road sources include marine vessels and railroads. Miscellaneous include fugitive dust and other combustion.

Table 5.5 U.S. Emissions of Particulate Matter (PM-10) by Source, Ten-Year Intervals, 1940-1980, and Annually, 1988-1997

	Industrial processes							
Year	Chemical industries	Metals processing	Petroleum industries	Other industries	Solvent utilization	Storage and transport	Waste disposal and recycling	Total industrial
	million tons							
1940	0.330	1.208	0.366	3.996	na	na	0.392	6.292
1950	0.455	1.027	0.412	6.954	na	na	0.505	9.353
1960	0.309	1.026	0.689	7.211	na	na	0.764	9.999
1970	0.235	1.316	0.286	5.832	na	na	0.999	8.668
1980	0.148	0.622	0.138	1.846	na	na	0.273	3.027
1988	0.062	0.208	0.060	0.601	0.002	0.101	0.259	1.000
1989	0.063	0.211	0.058	0.591	0.002	0.101	0.251	1.276
1990	0.077	0.214	0.055	0.583	0.004	0.102	0.271	1.306
1991	0.068	0.251	0.043	0.520	0.005	0.101	0.276	1.264
1992	0.071	0.250	0.043	0.506	0.005	0.117	0.278	1.269
1993	0.066	0.181	0.038	0.501	0.006	0.114	0.334	1.240
1994	0.076	0.184	0.038	0.495	0.006	0.106	0.313	1.219
1995	0.067	0.212	0.040	0.511	0.006	0.109	0.287	1.231
1996	0.067	0.211	0.040	0.510	0.006	0.109	0.290	1.232
1997	0.070	0.220	0.041	0.530	0.006	0.114	0.296	1.277

	Fuel combustion							
Year	Electric utilities	Industrial	Other	Total	On-road vehicles	Non-road sources	Miscellaneous	Total all sources
	million tons							
1940	0.962	0.708	2.338	4.008	0.210	2.480	(1)	15.956
1950	1.467	0.604	1.674	3.745	0.314	1.788	(1)	17.133
1960	2.117	0.331	1.113	3.561	0.554	0.201	(1)	15.558
1970	1.775	0.641	0.455	2.871	0.443	0.255	(1)	13.190
1980	0.879	0.679	0.887	2.445	0.397	0.566	(1)	7.287
1988	0.276	0.244	0.862	1.381	0.369	0.483	(1)	4.000
1989	0.271	0.243	0.869	1.382	0.367	0.482	(1)	3.507
1990	0.295	0.270	0.631	1.196	0.336	0.495	(1)	3.333
1991	0.257	0.233	0.657	1.147	0.349	0.491	(1)	3.252
1992	0.257	0.243	0.683	1.184	0.343	0.492	(1)	3.288
1993	0.279	0.257	0.588	1.124	0.321	0.485	(1)	3.170
1994	0.273	0.270	0.570	1.113	0.320	0.481	(1)	3.134
1995	0.268	0.302	0.610	1.179	0.293	0.457	(1)	3.161
1996	0.288	0.306	0.598	1.192	0.282	0.459	(1)	3.157
1997	0.290	0.314	0.497	1.101	0.268	0.466	(1)	3.112

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Pollutant Emissions Trends Report, 1970-1997,* Table A-5 (EPA, OAQPS, Research Triangle Park, NC, 1998), and earlier reports in this series.

Notes: PM-10 refers to particulate matter with a diameter 10 micrometers or less. na = not available. (1) Emissions from miscellaneous and natural sources are reported in Table 5.6. Non-road sources include non-road diesel (e.g., construction and farm) and railroads.

Table 5.6 U.S. Emissions of Miscellaneous and Natural Particulate Matter (PM-10) by Source, 1988-1997

Year	Agricul-ture and forestry	Fire & other com-bustion	Fugitive dust: Un-paved roads	Fugitive dust: Paved roads	Fugitive dust: Con-struc-tion	Fugitive dust: Other	Total fugitive dust	Natural sources (wind erosion)	Total all sources
	million tons								
1988	7.453	1.704	12.379	5.900	11.662	0.346	30.287	18.110	57.555
1989	7.320	0.912	11.798	5.769	11.269	0.392	29.229	12.101	49.562
1990	5.146	1.203	11.234	2.248	4.249	0.337	18.069	2.092	26.512
1991	5.106	0.941	11.206	2.399	4.092	0.378	18.076	2.077	26.199
1992	4.909	0.785	10.918	2.423	4.460	0.370	18.171	2.227	26.093
1993	4.475	0.768	11.430	2.462	4.651	0.410	18.954	0.509	24.706
1994	4.690	1.048	11.370	2.538	5.245	0.570	19.722	2.160	27.622
1995	4.661	0.778	10.362	2.409	3.654	0.587	17.013	1.146	23.599
1996	4.708	1.004	12.060	2.390	3.950	0.603	19.002	5.316	30.031
1997	4.707	1.015	12.305	2.515	4.022	0.588	19.429	5.316	30.468

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Pollutant Emissions Trends Report, 1970-1997,* Table A-5 (EPA, OAQPS, Research Triangle Park, NC, 1998).

Notes: Fugitive dust category "Other" includes 0.001 million tons of wind erosion for each year 1990 through 1997. Totals may not agree with sum of components due to independent rounding.

Table 5.7 U.S. Emissions of Lead by Source, Five-Year Intervals, 1970-1980, and Annually, 1988-1997

Year	Industrial processes: Chemical industries	Metals processing	Petroleum industries	Other industries	Solvent utilization	Storage and transport	Waste disposal and recycling	Total industrial
	thousand tons							
1970	0.103	24.224	n/a	2.028	n/a	n/a	2.200	28.555
1975	0.120	9.923	n/a	1.337	n/a	n/a	1.595	12.975
1980	0.104	3.026	n/a	0.808	n/a	n/a	1.210	5.148
1988	0.136	1.965	n/a	0.172	n/a	n/a	0.817	3.09
1989	0.136	2.088	n/a	0.173	n/a	n/a	0.765	3.161
1990	0.136	2.169	n/a	0.169	n/a	n/a	0.804	3.278
1991	0.132	1.975	n/a	0.167	n/a	n/a	0.807	3.081
1992	0.093	1.773	n/a	0.056	n/a	n/a	0.812	2.734
1993	0.092	1.899	n/a	0.054	n/a	n/a	0.824	2.869
1994	0.096	2.027	n/a	0.053	n/a	n/a	0.829	3.005
1995	0.163	2.048	n/a	0.058	n/a	n/a	0.604	2.873
1996	0.167	2.052	n/a	0.051	n/a	n/a	0.622	2.892
1997	0.159	2.038	n/a	0.054	n/a	n/a	0.646	2.897

Year	Fuel combustion: Electric utilities	Industrial	Other	Total	On-road vehicles	Non-road sources	Miscellaneous	Total all sources
	thousand tons							
1970	0.327	0.237	10.052	10.616	171.961	9.737	n/a	220.869
1975	0.230	0.075	10.042	10.347	130.206	6.130	n/a	159.659
1980	0.129	0.060	4.111	4.299	60.501	4.205	n/a	74.153
1988	0.066	0.019	0.426	0.511	2.566	0.885	n/a	7.053
1989	0.067	0.018	0.420	0.505	0.982	0.820	n/a	5.468
1990	0.064	0.018	0.418	0.500	0.421	0.776	n/a	4.975
1991	0.061	0.018	0.416	0.495	0.018	0.574	n/a	4.168
1992	0.059	0.018	0.414	0.490	0.018	0.565	n/a	3.808
1993	0.061	0.019	0.415	0.495	0.019	0.529	n/a	3.911
1994	0.061	0.018	0.415	0.494	0.019	0.525	n/a	4.043
1995	0.057	0.017	0.414	0.488	0.019	0.544	n/a	3.924
1996	0.061	0.016	0.416	0.493	0.020	0.505	n/a	3.910
1997	0.064	0.017	0.415	0.496	0.019	0.503	n/a	3.915

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Pollutant Emissions Trends Report, 1970-1997,* Table A-8 (EPA, OAQPS, Research Triangle Park, NC, 1998), and earlier reports in this series.

Notes: n/a = not applicable. Non-road sources include non-road gasoline engines and aircraft.

Table 5.8 U.S. Emissions of Greenhouse Gases, 1990-1997

Gas	1990	1991	1992	1993	1994	1995	1996	1997
	million metric tons of carbon equivalent							
Carbon dioxide	1,356	1,341	1,361	1,394	1,414	1,428	1,479	1,501
Methane	173	174	174	170	171	172	167	167
Nitrous oxide	82	83	85	86	91	88	86	85
HFCs, PFCs and SF_6	22	22	23	23	26	31	35	38

Source: U.S. Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States, 1997,* DOE/EIA-0573(98) (GPO, Washington, DC, 1998).

Notes: HFCs = Hydrofluorocarbons. PFCs = Perfluorocarbons. SF_6 = Sulfur hexafluoridene. Emissions include direct and indirect effects. Data for 1997 are preliminary. Data in this table are revised from the data in the previous EIA report, *Emissions of Greenhouse Gases in the United States, 1996,* DOE/EIA-0573(97) (GPO, Washington, DC, 1997).

Table 5.9 U.S. Precipitation Chemistry by Region, 1985-1997

	Eastern United States						
Year	Ph	Hydro-gen ion	Sulfate ion	Nitrate ion	Ammon-ium ion	Calcium ion	Precip-itation
	units	*ug/l*	*milligrams per liter*				*cm*
1985	4.43	37.57	2.02	1.25	0.23	0.15	106.7
1986	4.42	38.16	2.14	1.30	0.24	0.13	102.2
1987	4.42	38.06	2.09	1.33	0.26	0.14	100.7
1988	4.43	37.05	2.14	1.33	0.21	0.17	95.9
1989	4.47	34.25	2.01	1.35	0.31	0.15	110.8
1990	4.49	32.71	1.80	1.18	0.27	0.12	122.6
1991	4.47	34.00	1.87	1.27	0.26	0.14	111.0
1992	4.49	32.04	1.77	1.22	0.25	0.12	108.4
1993	4.47	33.64	1.78	1.28	0.26	0.11	113.7
1994	4.48	33.07	1.71	1.24	0.28	0.13	111.9
1995	4.55	28.17	1.47	1.23	0.28	0.13	109.3
1996	4.60	28.01	1.49	1.22	0.28	0.14	123.0
1997	4.56	30.44	1.55	1.28	0.26	0.18	105.8

See next page for continuation of table.

Table 5.9 U.S. Precipitation Chemistry by Region, 1985-1997 (continued)

	Western United States						
Year	Ph	Hydro-gen ion	Sulfate ion	Nitrate ion	Ammon-ium ion	Calcium ion	Precip-itation
	units	*ug/l*		*milligrams per liter*			*cm*
1985	5.13	7.40	0.82	0.71	0.18	0.23	62.0
1986	5.18	6.57	0.78	0.68	0.17	0.19	72.4
1987	5.11	7.82	0.83	0.83	0.24	0.19	62.2
1988	5.10	7.93	0.93	0.83	0.16	0.27	56.6
1989	5.23	5.84	0.87	0.91	0.29	0.25	56.7
1990	5.21	6.22	0.80	0.87	0.29	0.22	66.2
1991	5.20	6.31	0.77	0.80	0.24	0.21	68.4
1992	5.23	5.86	0.77	0.83	0.28	0.18	65.1
1993	5.27	5.41	0.71	0.76	0.23	0.18	74.4
1994	5.07	8.53	0.76	0.92	0.28	0.20	62.0
1995	5.11	7.73	0.70	0.79	0.27	0.19	77.7
1996	5.24	6.99	0.70	0.86	0.29	0.21	74.5
1997	5.15	8.48	0.67	0.83	0.24	0.18	74.9

	Entire United States						
Year	Ph	Hydro-gen ion	Sulfate ion	Nitrate ion	Ammon-ium ion	Calcium ion	Precip-itation
	units	*ug/l*		*milligrams per liter*			*cm*
1985	4.57	27.07	1.60	1.06	0.21	0.17	91.1
1986	4.57	27.16	1.67	1.08	0.21	0.15	91.8
1987	4.56	27.53	1.65	1.15	0.25	0.15	87.3
1988	4.57	26.91	1.72	1.16	0.19	0.21	82.2
1989	4.61	24.35	1.61	1.20	0.30	0.19	91.9
1990	4.63	23.49	1.45	1.07	0.28	0.16	102.9
1991	4.61	24.36	1.49	1.11	0.26	0.16	96.1
1992	4.64	22.92	1.42	1.09	0.26	0.14	93.3
1993	4.62	23.81	1.41	1.10	0.25	0.14	100.0
1994	4.61	24.53	1.38	1.13	0.28	0.15	94.5
1995	4.68	21.04	1.20	1.08	0.28	0.15	98.3
1996	4.81	21.13	1.23	1.10	0.28	0.16	107.0
1997	4.76	22.79	1.24	1.13	0.25	0.14	95.1

Source: National Trends Network of the National Atmospheric Deposition Program, unpublished, Champaign, IL, 1999.

Notes: ug/l = micrograms per liter. cm = centimeters. Data are from 73 sites in the eastern United States and 39 sites in the western United States. Sites included in the computations are those where (1) precipitation amounts are available for at least 90% of the summary period and (2) at least 60% of the precipitation during the summary period is represented by valid samples.

Table 5.10 U.S. National Composite Mean Ambient Concentrations of Criteria Air Pollutants, 1978-1997

Year	Carbon monoxide	Lead	Nitrogen dioxide	Ozone	PM-10 particulates	Sulfur dioxide
	ppm	ug/m3	ppm	ppm	ug/m3	ppm
	(208 sites)	(160 sites)	(93 sites)	(320 sites)	na	(343 sites)
1978	9.7	1.16	0.024	0.149	na	0.0120
1979	9.5	1.01	0.024	0.137	na	0.0118
1980	8.8	0.76	0.023	0.139	na	0.0108
1981	8.5	0.60	0.022	0.127	na	0.0103
1982	7.9	0.53	0.021	0.125	na	0.0095
1983	7.8	0.39	0.021	0.139	na	0.0092
1984	7.8	0.35	0.021	0.124	na	0.0094
1985	7.0	0.24	0.021	0.123	na	0.0087
1986	7.0	0.15	0.021	0.119	na	0.0086
1987	6.7	0.12	0.021	0.125	na	0.0084
	(368 sites)	(195 sites)	(224 sites)	(660 sites)	(845 sites)	(486 sites)
1988	6.3	0.12	0.021	0.130	32.4	0.0089
1989	6.3	0.09	0.021	0.114	32.1	0.0087
1990	5.8	0.09	0.020	0.112	29.5	0.0081
1991	5.6	0.07	0.020	0.113	29.2	0.0079
1992	5.1	0.06	0.019	0.105	26.9	0.0073
1993	4.9	0.05	0.019	0.108	26.2	0.0072
1994	5.0	0.05	0.020	0.107	26.2	0.0069
1995	4.5	0.04	0.019	0.112	25.1	0.0056
1996	4.2	0.04	0.018	0.105	24.2	0.0056
1997	3.9	0.04	0.018	0.105	24.0	0.0054

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Quality and Emissions Trends Report, 1997,* Table A-9 (EPA, OAQPS, Research Triangle Park, NC, 1998).

Notes: ppm = parts per million. ug/m3 = micrograms per cubic meter. na = not available. Sulfur dioxide and nitrogen dioxide records are annual arithmetic means, Carbon monoxide records are arithmetic means of second maximum non-overlapping 8-hour concentrations. Ozone records are arithmetic means of second daily maximum 1-hour concentrations. Lead records are arithmetic means of maximum quarterly measurements. PM-10 records are weighted annual arithmetic means. The National Ambient Air Quality Standards for these pollutants are as follows: sulfur dioxide, 0.03 ppm; carbon monoxide, 9 ppm; ozone, 0.12 ppm; nitrogen dioxide, 0.053 ppm; PM-10, 50 ug/m3; and lead, 1.5 ug/m3.

Table 5.11 Air Quality Trends in Selected U.S. Urban Areas, 1988-1997

MSA	Trend sites	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	#	*number of PSI days greater then 100*									
Atlanta	9	44	17	52	24	19	42	13	43	22	26
Bakersfield	7	126	114	97	109	100	97	97	104	109	55
Baltimore	16	60	28	29	50	23	48	41	36	28	30
Boston	24	28	12	7	13	9	6	10	8	2	8
Chicago	42	40	16	5	21	4	3	8	21	6	9
Cincinnati	21	57	19	19	22	3	13	19	22	11	11
Cleveland	24	45	19	10	23	11	13	23	24	17	12
Dallas	8	37	18	24	2	11	11	15	36	12	15
Dayton	10	37	10	13	12	2	11	14	11	18	9
Denver	20	35	16	11	7	8	3	2	2	0	0
Detroit	30	35	18	11	28	8	5	13	14	13	12
El Paso	17	15	26	22	7	11	9	8	5	7	3
Houston	26	72	43	54	37	32	28	45	65	28	47
Indianapolis	31	39	15	9	12	7	9	22	19	13	12
Kansas City	22	23	5	2	11	1	3	10	22	10	18
Los Angeles	36	239	222	174	174	178	137	144	109	94	63
Memphis	12	44	8	24	9	14	16	11	18	17	14
Miami	10	8	6	1	1	3	6	1	2	1	3
Minn/St. Paul	24	11	8	4	2	3	0	2	7	2	0
New York	28	57	30	37	50	11	19	21	19	15	23
Orange City	12	56	58	46	35	38	25	15	9	9	3
Philadelphia	34	53	44	39	48	24	50	26	30	22	32
Phoenix	23	29	34	13	11	15	17	11	25	17	15
Pittsburgh	38	43	21	19	22	9	13	19	25	11	20
Riverside	36	185	190	158	159	175	167	148	125	118	106
Sacramento	13	88	71	66	69	48	22	37	34	33	2
St. Louis	53	44	29	24	33	16	9	32	35	20	15
San Diego	20	123	128	97	67	66	57	45	47	31	14
San Francisco	9	1	0	0	0	0	0	0	2	0	0
Seattle	16	20	7	10	5	3	0	3	0	6	1
Ventura	13	108	93	70	89	55	44	64	66	62	44
Wash, DC	32	56	27	26	49	15	47	21	30	18	28
Youngstown	9	25	8	3	14	5	2	0	11	5	3
Subtotal	725	1,883	1,360	1,176	1,215	927	932	940	1,026	777	653
Other sites	604	1,428	648	658	724	312	489	469	641	418	490
All sites	1,329	3,311	2,008	1,834	1,939	1,239	1,421	1,409	1,667	1,195	1,143

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Quality and Emissions Trends Report, 1997,* Table A-15 (EPA, OAQPS, Research Triangle Park, NC, 1998).

Notes: MSA = Metropolitan Statistical Area. PSI = Pollutant Standards Index. Minn = Minneapolis. The PSI index integrates information from many pollutants across an entire monitoring network into a single number which represents the worst daily air quality experienced in an urban area. PSI index ranges and health effect descriptor words are as follows: 0 to 50 (good); 51 to 100 (moderate); 101 to 199 (unhealthful); 200 to 299 (very unhealthful); and 300 and above (hazardous).

Table 5.12 Number of People Living in U.S. Counties with Air Quality Concentrations Above the Level of the National Ambient Air Quality Standards, 1986-1997

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	population, in millions											
SO_2	0.9	1.6	1.7	0.1	1.4	5.2	0.0	1.4	0.04	0.0	0.2	0.1
NO_2	7.5	7.5	8.3	8.5	8.5	8.9	0.0	0.0	0.0	0.0	0.0	0.0
CO	41.4	29.4	29.5	33.6	21.7	19.9	14.3	11.6	15.3	12.0	12.7	9.1
O_3	75.0	88.6	111.9	66.7	62.9	69.7	44.6	51.3	50.2	70.8	39.3	101.6[1]
Pb	4.5	1.7	1.6	1.6	5.3	14.7	4.7	5.5	4.4	4.8	4.1	2.4
PM-10	41.7	21.5	25.6	27.4	18.8	21.5	25.8	9.4	13.1	24.4	7.3	9.7[2]
Any NAAQS	na	101.8	121.3	84.4	47.4	86.4	53.6	59.1	62.0	79.8	46.6	107.0[3]

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Quality and Emissions Trends Report, 1997*, p. 9 (EPA, OAQPS, Research Triangle Park, NC, 1998) and earlier trends reports.

Notes: NAAQS = National Ambient Air Quality Standards. PM-10 = particulate matter with a diameter of 10 micrometers or less. [1]Data are based on the revised NAAQS. The population living in counties with air quality concentrations above the pre-existing NAAQS for ozone was 47.9 million. [2]Data are based on the revised NAAQS. The population living in counties with air quality concentrations above the pre-existing NAAQS for PM-10 was 7.9 million. Data for PM-2.5 not yet available. [3]Data are based on the revised NAAQS. The population living in counties with air quality concentrations above the pre-existing NAAQS was 52.6 million. Population estimates are intended to provide a relative measure of the extent of the problem for each pollutant in a single year. An individual living in a county that had a measured concentration above the level of the NAAQS may not actually be exposed to unhealthy air.

Table 5.13 Population in U.S. Nonattainment Areas Not Meeting at Least One of the National Ambient Air Quality Standards, 1991-1997

	1991	1992	1993	1994	1995	1996	1997
	1990 population in millions						
Population	150.53	148.86	147.07	145.28	132.48	122.75	113.00

Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Quality and Emissions Trends Report, 1997* (EPA, OAQPS, Research Triangle Park, NC, 1998) and earlier trends reports.

Notes: When an area does not meet the air quality standard for one of the criteria pollutants it may be subject to EPA's formal rule-making process which designates it as nonattainment. Population figures were obtained from 1990 census data. For nonattainment areas defined as only partial counties, population figures for just the nonattainment areas were used when these were available. Otherwise, whole county population figures were used. Population estimates in this table differ from those presented in Table 5.12 because formal nonattainment designations are based on multiple years data rather than a single year and generally do not follow county boundaries. For example, ozone nonattainment areas typically compose the entire metropolitan area, which may include additional counties that do not contain air quality monitors.)

Aquatic Resources

Table 6.1 U.S. Annual Average Precipitation Trends, 1895-1997

Year	Mean *inches*	Index *standardized z-score*	Year	Mean *inches*	Index *standardized z-score*	Year	Mean *inches*	Index *standardized z-score*
1895	26.73	-1.05	1930	25.01	-1.40	1965	28.95	0.40
1896	28.73	-0.14	1931	26.79	-0.66	1966	26.67	-1.13
1897	28.35	-0.09	1932	29.60	0.24	1967	28.61	-0.14
1898	28.93	-0.32	1933	26.80	-1.13	1968	29.52	0.35
1899	27.64	-0.71	1934	25.05	-2.06	1969	29.79	0.35
1900	30.02	-0.48	1935	28.85	-0.42	1970	28.54	-0.47
1901	26.85	-0.84	1936	26.59	-1.16	1971	29.29	0.32
1902	29.63	-0.30	1937	29.72	0.27	1972	30.77	0.50
1903	28.54	-0.58	1938	28.85	0.42	1973	33.99	1.43
1904	27.09	-1.23	1939	25.82	-1.48	1974	29.72	-0.30
1905	32.14	1.12	1940	29.63	0.50	1975	32.02	1.42
1906	31.49	1.58	1941	31.85	1.67	1976	25.62	-1.62
1907	30.01	0.72	1942	30.58	0.31	1977	29.62	0.51
1908	29.07	0.24	1943	26.07	-1.20	1978	29.17	0.48
1909	29.95	0.66	1944	30.08	0.41	1979	32.02	1.04
1910	24.17	-2.30	1945	32.25	1.11	1980	27.38	-0.52
1911	28.81	0.21	1946	30.42	0.55	1981	29.17	0.01
1912	29.56	0.56	1947	28.57	-0.39	1982	32.99	2.15
1913	29.12	0.47	1948	29.65	0.35	1983	33.81	2.11
1914	28.01	-0.26	1949	29.70	0.20	1984	30.48	0.85
1915	31.69	1.26	1950	29.99	-0.31	1985	29.41	0.47
1916	28.61	0.32	1951	30.33	0.78	1986	30.61	0.59
1917	24.37	-2.45	1952	25.63	-1.64	1987	28.46	-0.06
1918	28.02	0.38	1953	27.51	-0.85	1988	25.25	-1.52
1919	30.94	0.54	1954	25.23	-1.70	1989	28.42	-0.64
1920	30.37	0.87	1955	26.81	-1.05	1990	31.40	1.13
1921	27.68	-0.27	1956	24.57	-2.38	1991	31.77	0.89
1922	29.09	0.36	1957	32.90	1.38	1992	30.67	1.01
1923	30.78	1.19	1958	29.25	0.11	1993	31.41	1.39
1924	25.75	-1.76	1959	29.88	-0.05	1994	29.46	0.43
1925	26.06	-0.81	1960	27.95	-0.45	1995	31.03	1.04
1926	29.95	0.31	1961	30.41	0.19	1996	32.59	1.16
1927	30.93	1.06	1962	27.80	-0.53	1997	31.29	1.31
1928	28.59	-0.77	1963	24.77	-1.60			
1929	29.51	-0.12	1964	29.23	-0.31			

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Climate Variations Bulletin,* Vol. 7 (DOC, NOAA, NCDC, Asheville, NC, December 1997) and agency updates.

Notes: The U.S. national precipitation index expresses precipitation departure from the 60-year (1931-90) mean in terms of standard deviations. It is computed from data from the Cooperative Station Network. The monthly precipitation for all stations within each of the 344 divisions in the contiguous United States is averaged to compute a divisional monthly precipitation. The divisional precipitation values are standardized using the gamma distribution over the 1931-90 period. The divisional standardized precipitation index values are then weighted by area to compute a national precipitation index value. A national annual value is computed from the monthly national values. The annual index values are then normalized over the period of record.

Table 6.2 Severe to Extreme Drought and Wetness in the Conterminous United States, 1900-1997

Year	Severe to extreme drought	Severe to extreme wetness	Year	Severe to extreme drought	Severe to extreme wetness	Year	Severe to extreme drought	Severe to extreme wetness
	% area			% area			% area	
1900	15.5	5.8	1933	9.9	2.4	1966	8.2	5.6
1901	18.2	4.1	1934	46.4	0.4	1967	6.1	6.0
1902	22.5	6.8	1935	20.6	3.5	1968	3.2	8.4
1903	7.1	13.1	1936	22.1	2.7	1969	0.5	11.0
1904	13.5	9.1	1937	17.0	5.0	1970	0.6	6.1
1905	6.7	19.3	1938	7.2	7.0	1971	5.1	9.0
1906	0.9	25.9	1939	15.9	3.2	1972	3.5	12.9
1907	0.9	29.5	1940	17.7	2.3	1973	2.7	30.9
1908	2.2	16.2	1941	10.4	27.2	1974	4.0	15.3
1909	5.0	18.8	1942	3.7	28.7	1975	0.5	20.8
1910	14.6	7.4	1943	3.5	11.5	1976	6.9	9.2
1911	18.6	7.3	1944	4.9	8.7	1977	22.7	4.7
1912	0.8	17.3	1945	2.7	18.1	1978	2.8	14.0
1913	3.2	15.5	1946	1.9	9.4	1979	1.1	21.9
1914	6.6	17.8	1947	4.8	12.6	1980	5.1	11.6
1915	4.3	25.9	1948	5.9	10.2	1981	13.1	4.5
1916	1.0	29.4	1949	3.6	6.6	1982	1.1	17.5
1917	8.7	17.8	1950	6.3	10.1	1983	0.0	36.0
1918	13.1	5.0	1951	11.5	14.6	1984	2.2	26.3
1919	4.0	13.1	1952	11.0	11.0	1985	2.9	21.0
1920	1.7	20.9	1953	15.8	3.5	1986	4.4	15.1
1921	4.0	8.9	1954	36.6	2.7	1987	7.8	16.5
1922	4.8	5.2	1955	26.0	1.7	1988	22.2	5.8
1923	4.7	10.9	1956	34.1	4.3	1989	18.7	6.9
1924	11.8	11.2	1957	13.0	11.6	1990	19.0	7.2
1925	18.1	2.6	1958	1.6	18.4	1991	9.2	9.0
1926	9.4	7.0	1959	9.4	3.9	1992	10.8	18.3
1927	5.7	17.7	1960	9.5	6.7	1993	1.2	35.1
1928	5.1	15.3	1961	12.0	7.1	1994	6.9	14.8
1929	6.9	12.9	1962	3.1	6.0	1995	1.6	24.8
1930	12.1	4.7	1963	16.5	2.0	1996	7.9	23.2
1931	28.9	6.1	1964	18.3	3.0	1997	3.5	25.7
1932	8.6	8.9	1965	6.3	14.2			

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Climate Variations Bulletin,* Vol. 7 (DOC, NOAA, NCDC, Asheville, NC, December 1997) and agency updates.

Notes: This table presents the average annual values of the percent area experiencing severe to extreme drought and wet conditions based on the Palmer Drought Severity Index (PDSI). PDSI is based on a water balance model that consists of a hydrologic accounting between water supply and demand. The index values range from negative (indicating drought), to zero (near normal conditions), to positive (wet spell). The index has been calculated on a monthly basis for the contiguous United States since 1896.

Table 6.3 U.S. Water Use by Source and End-use Sector, 1900-1995

	Source		End-use sector					
Year	Ground water	Surface water	Public supply	Rural domestic and livestock	Irrigation	Thermoelectric utility	Commercial and other industrial	Total
	billions of gallons per day							
1900	na	na	3.0	2.0	20.0	5.0	10.0	40.0
1910	na	na	5.0	2.2	39.0	7.0	14.0	67.2
1920	na	na	6.0	2.4	56.0	9.0	18.0	91.4
1930	na	na	8.0	2.9	60.0	18.0	21.0	109.9
1940	na	na	10.0	3.1	71.0	23.0	29.0	136.1
1945	na	na	12.0	3.4	80.0	31.5	35.0	161.9
1950	34.0	150.0	14.0	3.6	89.0	40.0	37.0	183.6
1955	47.6	198.0	17.0	3.6	110.0	72.0	39.0	241.6
1960	50.4	221.0	21.0	3.6	110.0	100.0	38.0	272.6
1965	60.5	253.0	24.0	4.0	120.0	130.0	46.0	324.0
1970	69.0	303.0	27.0	4.5	130.0	170.0	47.0	378.5
1975	83.0	329.0	29.0	4.9	140.0	200.0	45.0	418.9
1980	83.9	361.0	34.0	5.6	150.0	210.0	45.0	444.6
1985	73.7	320.0	37.0	7.8	140.0	190.0	31.0	405.8
1990	80.6	327.2	38.5	7.9	137.0	195.0	29.9	408.8
1995	77.4	323.0	40.2	8.8	134.0	189.9	28.0	400.8

Sources: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States: Colonial Times to 1970*, Series J 92-103 (GPO, Washington, DC, 1975).

Solley, W.B., R.R. Pierce and H. A. Perlman, *Estimated Use of Water in the United States in 1995,* USGS Circular 1200 (GPO, Washington, DC, 1998) and earlier reports in this series.

Notes: na = not available. Totals may not agree with sum of components due to independent rounding.

Table 6.4 Designated-use Support in Surface Waters of the United States, 1996

Designated-use support	Rivers and streams	Lakes, ponds and reservoirs	Estuaries
	miles	*acres*	*square miles*
Fully supporting	390,873	8,626,903	16,753
Supporting, but threatened	54,978	1,651,685	1,041
Impaired	248,028	6,541,060	11,025
Total surface waters surveyed	693,905	16,819,769	28,819
Total surface waters not surveyed	2,940,247	24,865,133	11,020
Total surface waters	3,634,152	41,684,902	39,839

Source: U.S. Environmental Protection Agency, Office of Water, *National Water Quality Inventory: 1996 Report to Congress* (EPA, OW, Washington, DC, 1998).

Table 6.5 Trends in U.S. Stream Water Quality, 1980-1989

Water quality indicators	NASQAN* stations analyzed	Flow-adjusted concentrations		
		Upward trend	Downward trend	No trend
	number of stations			
Dissolved solids	340	28	46	266
Nitrate	344	22	27	295
Total phosphorus	410	19	92	299
Suspended sediments	324	5	37	282
Dissolved oxygen	424	38	26	360
Fecal coliform	313	10	40	263

Source: Smith, R.A., R.B. Alexander and K.J. Lanfear, “Stream Water Quality in the Conterminous United States -- Status and Trends of Selected Indicators During the 1980’s,” In *National Water Summary 1990-91, Hydrologic Events and Stream Water Quality*, R.W. Paulson, E.B. Chase, J.S. Williams and D.W. Moody, Compilers, Water Supply Paper 2400 (U.S. Department of the Interior, Geological Survey, Reston, VA, 1993), Figures 38-43.

Notes: *Analyses were made on data from the U.S. Geological Survey’s National Stream Quality Accounting Network (NASQAN) stations. Data for total phosphorus cover the period 1982-1989.

Table 6.6 Ambient Water Quality in U.S. Rivers and Streams: Violation Rates, 1975-1997

Year	Fecal coliform bacteria	Dissolved oxygen	Total phosphorus	Total cadmium, dissolved	Total lead, dissolved
	percent of all measurements exceeding national water quality criteria				
1975	36	5	5	*	*
1976	32	6	5	*	*
1977	34	11	5	*	*
1978	35	5	5	*	*
1979	34	4	3	4	13
1980	31	5	4	1	5
1981	30	4	4	1	3
1982	33	5	3	1	2
1983	34	4	3	1	5
1984	30	3	4	<1	<1
1985	28	3	3	<1	<1
1986	24	3	3	<1	<1
1987	23	2	3	<1	<1
1988	22	2	4	<1	<1
1989	30	3	2	<1	<1
1990	26	2	3	<1	<1
1991	15	2	2	<1	<1
1992	28	2	2	<1	<1
1993	31	<1	2	na	na
1994	28	2	2	na	na
1995	35	1	4	na	na
1996	na	1	1	<1	<1
1997	na	1	2	<1	<1

Source: U.S. Geological Survey, national-level data, unpublished, Reston, VA, 1999.

Notes: *Base figure too small to meet statistical standards for reliability of derived figures. na = not available. Violation levels are based on the following U.S. Environmental Protection Agency water quality criteria: fecal coliform bacteria—above 200 cells per 100 ml; dissolved oxygen—below 5 milligrams per liter; total phosphorus—above 1.0 milligrams per liter; cadmium, dissolved—above 10 micrograms per liter; and total lead, dissolved—above 50 micrograms per liter.

Table 6.7 Estimated Phosphorus Loadings to the Great Lakes, 1976-1991

Year	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
			metric tons		
1976	3,550	6,656	4,802	18,480	12,695
1977	3,661	4,666	3,763	14,576	8,935
1978	5,990	6,245	5,255	19,431	9,547
1979	6,619	7,659	4,881	11,941	8,988
1980	6,412	6,574	5,307	14,855	8,579
1981	3,412	4,091	3,481	10,452	7,437
1982	3,160	4,084	4,689	12,349	8,891
1983	3,407	4,515	3,978	9,880	6,779
1984	3,642	3,611	3,452	12,874	7,948
1985	2,864	3,956	5,758	11,216	7,083
1986	3,059	4,981	4,210	11,118	9,561
1987	1,949	3,298	2,909	8,381	7,640
1988	2,067	2,907	3,165	7,841	6,521
1989	2,323	4,360	3,227	8,568	6,728
1990	1,750	3,006	2,639	12,899	8,542
1991	2,709	3,478	4,460	11,113	10,475

Source: Great Lakes Water Quality Board, *Great Lakes Water Quality Surveillance Subcommittee Report to the International Joint Commission*, United States and Canada, (International Joint Commission, Windsor, ON, Canada, biennial).

Notes: The 1978 Great Lakes Water Quality Agreement set target loadings for each lake (in metric tons per year): Lake Superior, 3,400; Lake Michigan, 5,600; Lake Huron, 4,360; Lake Erie, 11,000; and Lake Ontario, 7,000. Data do not include loadings to the St. Lawrence River. Data analysis was discontinued after 1991.

Table 6.8 Oil Polluting Incidents Reported In and Around U.S. Waters, 1970-1997

Year	Number	Volume	Year	Number	Volume
	thousands	*million gallons*		*thousands*	*million gallons*
1970	3.71	15.25	1984	8.26	18.01
1971	8.74	8.84	1985	6.17	8.44
1972	9.93	18.81	1986	4.99	4.28
1973	9.01	15.25	1987	4.84	3.61
1974	9.99	15.72	1988	5.00	6.59
1975	9.30	21.52	1989	6.61	13.48
1976	9.42	18.52	1990	8.18	7.97
1977	9.46	8.19	1991	8.57	3.76
1978	10.64	10.86	1992	9.49	1.88
1979	9.83	20.89	1993	8.97	2.07
1980	8.38	12.60	1994	9.44	19.51
1981	7.81	8.92	1995	6.49	1.98
1982	7.48	10.35	1996	4.37	2.00
1983	7.92	8.38	1997	8.62	0.94

Source: U.S. Department of Transportation, United States Coast Guard, *Pollution Incidents In and Around U.S. Waters A Spill/Release Compendium: 1969-1997* (DOT, USCG, Washington, DC, 1999).

--, Bureau of Transportation Statistics, *National Transportation Statistics 1998*, Table 4-42 (DOT, BTS, Washington, DC, 1998).

Notes: Data for 1997 are preliminary. Includes oil spill data for vessels and non-vessels (e.g., facilities, pipelines, and other unknown sources).

Table 6.9 U.S. Shellfish Growing Waters, 1966-1995

Year	1966	1971	1974	1980	1985	1990	1995
	thousand acres						
Approved for harvest	8,100	10,362	10,560	10,685	11,402	12,304	14,853
Harvested limited	2,090	3,738	4,232	3,533	5,435	6,398	6,721
Conditionally approved	88	410	387	587	1,463	1,571	1,695
Restricted	na	30	34	55	637	463	2,106
Conditionally restricted	na	na	na	na	na	0	119
Prohibited	2,002	3,298	3,811	2,891	3,335	4,364	2,801
Total	10,190	14,100	14,792	14,218	16,837	18,701	21,573

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Office of Ocean Resources Conservation and Assessment, Strategic Environmental Assessments Division, *The 1995 National Shellfish Register of Classified Growing Waters* (DOC, NOAA, ORCA, Silver Spring, MD, 1997).

Notes: Based on National Shellfish Registers published only in years indicated. Data do not include Alaska, Hawaii, or waters designated as unclassified. The total acreage of classified shellfish growing waters varies with each register. There may be several reasons why shellfish harvest is prohibited, including water quality problems, lack of funding for complete surveying and monitoring, conservation measures, and other management/administrative actions.

Table 6.10 Status of Stock Levels of U.S. Fisheries, 1992-1994

Fishery	Current status relative to the level producing LTPY				
	Below	Near	Above	Unknown	Total
	number of species				
Northeast demersals	19	3	2	1	25
Northeast pelagics	1	2	3	0	6
Atlantic anadromous	4	0	1	0	5
Northeast invertebrates	0	3	2	1	6
Atlantic highly migratory pelagics	4	4	0	2	10
Atlantic sharks	1	0	1	1	3
Atlantic/Gulf coastal migratory pelagics	1	3	0	3	7
Atlantic/Gulf reef fish	9	2	0	17	28
Southeast drum and croaker	4	0	0	3	7
Southeast menhaden	0	2	0	0	2
Southeast/Caribbean invertebrates	3	6	0	5	14
Pacific coast salmon	2	3	0	0	5
Alaska salmon	1	1	3	0	5
Pacific coast and Alaska pelagics	3	4	0	0	7
Pacific coast groundfish	6	4	4	5	19
Western Pacific invertebrates	1	0	0	0	1
Western Pacific bottomfish*	3	3	0	0	6
Pacific highly migratory pelagics	2	12	0	1	15
Alaska groundfish	6	8	8	3	25
Alaska shellfish	3	0	1	1	5
Subtotal	73	60	25	43	201
Nearshore species	10	14	0	50	74
Total assessed species	83	74	25	93	275

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Our Living Oceans, Report on the Status of U.S. Living Marine Resources, 1995*, NOAA Technical Memorandum NMFS-F/SPO-19 (DOC, NOAA, NMFS, Washington, DC, 1996).

Notes: LTPY is long-term potential yield or the maximum long-term average catch that can be achieved from the resource. This term is analogous to the concept of maximum sustainable yield. Stock level relative to LTPY is a measure of stock status. The present abundance level of the stock is compared with the level of abundance which on average would support the LTPY harvest. This level is expressed as below, near, above, or unknown relative to the abundance level that would produce LTPY. Demersal = bottom-dwelling fishes such as flounders, skates, and dogfish. Pelagic = mid-water fishes such as blue fish, anchovies, sardines, and squids. Anadromous = fishes which ascend rivers to spawn, such as salmon, shad, and striped bass. Invertebrates = lobsters, clams, scallops, shrimp, etc. Highly migratory = high-seas (oceanic) fishes such as tunas, swordfish, and billfishes. Coastal migratory = fishes that range from the shore to the outer edge of the U.S. continental shelf, such as king and Spanish mackeral, dolphin fish, and cobia. Reef fish = fishes that prefer coral reefs, artificial structures, and other hard bottom areas, such as snappers, groupers, and amberjacks. Reef fish also include tilefishes that prefer sand bottom areas. *Also includes armorhead.

Table 6.11 Waterborne Disease Outbreaks and Cases in the United States, 1971-1996

Year	Waterborne disease outbreaks by water supply system: Community	Non-community	Individual	Total	Total cases
	number				*number*
1971	8	8	4	20	5,184
1972	9	19	2	30	1,650
1973	6	16	3	25	1,762
1974	11	9	5	25	8,356
1975	6	16	2	24	10,879
1976	9	23	3	35	5,068
1977	14	18	2	34	3,860
1978	10	19	3	32	11,435
1979	24	13	8	45	9,841
1980	26	20	7	53	20,045
1981	14	18	4	36	4,537
1982	26	15	3	44	3,588
1983	30	9	4	43	21,036
1984	12	5	10	27	1,800
1985	7	14	1	22	1,946
1986	10	10	2	22	1,569
1987	8	6	1	15	22,149
1988	6	10	1	16	2,169
1989	6	6	1	13	2,670
1990	6	7	2	15	1,748
1991	2	13	0	15	12,960
1992	6	10	3	19	4,504
1993	9	4	5	18	404,190
1994	5	6	2	13	651
1995	8	7	1	16	2,375
1996	2	3	1	6	192

Sources: M.H. Kramer, B.L. Herwaldt, G.F. Craun, R.L. Calderon and D.D. Juranek, "Surveillance for Waterborne-Disease Outbreaks—United States, 1993-1994," In *CDC Surveillance Summaries,* April 12, 1996, Morbidity and Mortality Weekly Report 42(SS-5) (U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Atlanta, GA), pp. 7-8, and earlier reports in this series.

D.A. Levy, M.S. Bens, G.F. Craun, R.L. Calderon, and B.L. Herwaldt, "Surveillance for Waterborne-Disease Outbreaks—United States, 1995-1996," *In CDC Surveillance Summaries,* December 11, 1998, Morbidity and Mortality Weekly Report 47(SS-5) (U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Atlanta, GA).

Notes: The number of waterborne disease outbreaks and the number of affected people or cases reported to the Centers for Disease Control and Prevention and to the U.S. Environmental Protection Agency represents a fraction of the total number that occur. Therefore, these data should not be used to draw firm conclusions about the true incidence of waterborne disease outbreaks.

Table 6.12 U.S. Wetlands by Type, Mid-1950s to Mid-1990s

Wetlands type	Mid-1950s	Mid-1970s	Mid-1980s	Mid-1990s
	million acres			
Estuarine wetlands	5.59	5.53	5.10	5.09
Palustrine marshes	33.07	24.31	25.88	25.01
Palustrine shrub wetlands	11.00	15.51	15.60	17.07
Palustrine forested wetlands	55.09	55.15	50.39	47.93
Other palustrine wetlands	2.70	5.35	5.14	5.79
Total wetland acreage	107.45	105.85	102.12	100.91

Sources: Dahl, T.E., R.D. Young and M.C. Caldwell, *Status and Trends of Wetlands in the Conterminous United States, 1980s to 1990s* (U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, Draft).

Dahl, T.E. and C.E. Johnson, *Status and Trends of Wetlands in the Conterminous United States, 1970s to 1980s* (U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, 1991).

Frayer, W.E., T.J. Monahan, D.C. Bowden and F.A. Graybill, *Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1950s to 1970s* (Colorado State University, Fort Collins, CO, 1983).

Note: Totals may not agree with sum of components due to independent rounding.

Table 6.13 Wetlands Losses by Current State Boundaries, 1780s-1980s

State	Total surface area of state	Wetlands area 1780s	Wetlands area 1980s	Wetlands losses
	million acres			*%*
Alabama	33.03	7.57	3.78	50
Alaska	375.30	170.20	170.00	<1
Arizona	72.90	0.93	0.60	36
Arkansas	33.99	9.85	2.76	72
California	101.56	5.00	0.45	91
Colorado	66.72	2.00	1.00	50
Connecticut	3.21	0.67	0.17	74
Delaware	1.32	0.48	0.22	54
Florida	37.48	20.33	11.04	46
Georgia	37.68	6.84	5.30	23
Hawaii	4.12	0.06	0.05	12
Idaho	53.47	0.88	0.39	56
Illinois	36.10	8.21	1.25	85
Indiana	23.23	5.60	0.75	87
Iowa	36.03	4.00	0.42	89
Kansas	52.65	0.84	0.44	48
Kentucky	25.85	1.57	0.30	81
Louisiana	31.05	16.19	8.78	46

See next page for continuation of table.

Table 6.13 Wetlands Losses by Current State Boundaries, 1780s-1980s (continued)

State	Total surface area of state	Wetlands area 1780s	Wetlands area 1980s	Wetlands losses
	million acres			%
Maine	21.26	6.46	5.20	20
Maryland	6.77	1.65	0.44	73
Massachusetts	5.28	0.82	0.59	28
Michigan	37.26	11.20	5.58	50
Minnesota	53.80	15.07	8.70	42
Mississippi	30.54	9.87	4.07	59
Missouri	44.60	4.84	0.64	87
Montana	94.17	1.15	0.84	27
Nebraska	49.43	2.91	1.91	35
Nevada	70.75	0.49	0.24	52
New Hampshire	5.95	0.22	0.20	9
New Jersey	5.02	1.50	0.92	39
New Mexico	77.87	0.72	0.48	33
New York	31.73	2.56	1.03	60
North Carolina	33.66	11.09	5.69	49
North Dakota	45.23	4.93	2.49	49
Ohio	26.38	5.00	0.48	90
Oklahoma	44.75	2.84	0.95	67
Oregon	62.07	2.26	1.39	38
Pennsylvania	29.01	1.13	0.50	56
Rhode Island	0.78	0.10	0.07	37
South Carolina	19.88	6.41	4.66	27
South Dakota	49.31	2.74	1.78	35
Tennessee	27.04	1.94	0.79	59
Texas	171.10	16.00	7.61	52
Utah	54.35	0.80	0.56	30
Vermont	6.15	0.34	0.22	35
Virginia	26.12	1.85	1.07	42
Washington	43.64	1.35	0.94	31
West Virginia	15.48	0.13	0.10	24
Wisconsin	35.94	9.80	5.33	46
Wyoming	62.66	2.00	1.25	38

Source: Dahl, T.E., *Wetlands Losses in the United States 1780s to 1980s* (U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, 1991).

Table 6.14 Average Annual Acres of U.S. Wetlands Converted to Upland Uses, Mid-1950s to Mid-1990s

Post-conversion land use	1954-1974[1]	1974-1983[2]	1985-1995[3]
	thousands of acres per year (average)		
Agriculture	398.5	156.6	na
Urban use	36.6	14.5	na
Other upland uses	23.4	118.9	na
Total	458.0	290.0	117.0
	percent of average annual conversion		
Agriculture	87	54	na
Urban use	8	5	na
Other upland uses	5	41	na
Total	100	100	100

Sources: [1]Frayer, W.E., T.J. Monahan, D.C. Bowden and F.A. Graybill, *Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1950s to 1970s* (U.S. Department of the Interior, Fish and Wildlife Service, Fort Collins, CO, 1983).

[2]Dahl, T.E. and C.E. Johnson, *Status and Trends of Wetlands in the Conterminous United States, 1970s to 1980s* (U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, 1991).

[3]Dahl, T.E., R.D. Young and M.C. Caldwell, *Status and Trends of Wetlands in the Conterminous United States, 1980s to 1990s* (U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, Draft).

Notes: Data reflect net wetlands losses (= losses plus gains) by category. Other upland uses include silvicultural activities, residential and recreational development in rural areas, and highway construction and improvements in rural areas. A significant portion of lands classified as “other” in the 1974-1983 study were wetlands that had been drained and cleared of vegetation, but the land had not been put to an identifiable use (as determined by interpretation of aerial photography and groundtruthing).

Terrestrial Resources

Table 7.1 Land Use and Ownership in the United States, 1900-1992

	Land use					Ownership	
Year	Crop-land	Grassland pasture & rangeland	Forest-use land	Special-use & other land	Total	Private & other public	Federal
	million acres					percent	
1900	319	1,044	366	175	1,904	52.7	47.3
1910	347	814	562	181	1,904	68.5	31.5
1920	402	750	567	185	1,904	73.8	26.2
1930	413	708	607	176	1,904	74.0	26.0
1945	451	660	602	193	1,905	73.7	26.3
1949	478	632	606	189	1,904	73.5	26.5
1954	466	634	615	191	1,904	73.5	26.5
1959	458	633	745	435	2,271	61.0	39.0
1964	444	640	732	450	2,266	60.4	39.6
1969	472	604	723	465	2,264	66.5	33.5
1974	465	598	718	483	2,264	66.5	33.5
1978	471	587	703	503	2,264	67.2	32.9
1982	469	597	655	544	2,265	67.9	32.2
1987	464	591	648	562	2,265	68.1	31.9
1992	460	591	648	564	2,263	71.3	28.7

Sources: Daugherty, A.B., *Major Uses of Land in the United States: 1992*, Agricultural Economic Report No. 723 (GPO, Washington, DC, 1995) and supporting database.

U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States* (GPO, Washington, DC, annual).

Notes: Prior to 1959, excludes Alaska and Hawaii. Other changes in total land area result from refinements in measuring techniques. Historical estimates are based on imperfect data. Estimates differ slightly from previously published due to minor adjustments made by ERS and published in Major Land Uses (1945-1992) diskette in 1996. Cropland estimates for 1987 and 1992 differ slightly from data in Table 7.4 from the 1997 Census of Agriculture and may be revised in future publications based on census data. Grassland and range includes grassland pasture and rangeland; excludes cropland used only for pasture which is included in the cropland category and forest land grazed which is included in the forest land category. Special-use land includes rural transportation areas, areas used primarily for recreation and wildlife purposes, various public installations and facilities, farmsteads and farm roads, and urban areas. Other includes areas in miscellaneous uses not inventoried, marshes, open swamps, bare rock areas, desert, tundra, and other land generally having low value for agricultural purposes. Federal includes original public-domain lands vested in the U.S. government by virtue of its sovereignty as well as lands acquired by the U.S. government by purchase, condemnation, and gift. Land-use and land-ownership estimates are not strictly comparable. Totals may not agree with sum of components due to independent rounding.

Table 7.2 Special and Other Land Uses in the United States, 1945-1992

	Transpor-tation	Parks & wilderness	National defense	Urban	Farm-steads	Other	Total
				million acres			
1945	22.61	22.58	24.76	15.01	15.03	93.42	193.41
1949	22.88	27.64	21.46	18.28	15.07	84.01	189.34
1954	27.49	27.50	27.40	18.56	12.24	80.50	193.70
1959	25.22	46.94	31.12	27.22	11.37	293.16	435.03
1964	25.99	75.51	31.88	29.27	10.51	276.71	449.86
1969	25.95	81.34	25.59	31.01	10.34	290.98	465.21
1974	26.32	87.47	25.04	34.82	8.07	300.78	482.49
1978	26.63	97.95	24.90	44.65	8.42	300.85	503.40
1982	26.73	211.02	23.95	50.18	8.04	224.00	543.92
1987	25.70	224.86	20.92	56.64	7.13	226.66	561.90
1992	25.24	228.85	20.48	58.91	6.21	224.44	564.12

Source: Daugherty, A.B., *Major Uses of Land in the United States: 1992*, Agricultural Economic Report No. 723 (GPO, Washington, DC, 1995) and supporting database.

Note: Other land is defined in the note to Table 7.1.

Table 7.3 Number of Farms and Land in Farms in the United States, 1900-1997

	Farm size									
	1 - 49 acres		50 - 499 acres		500 - 999 acres		1,000 + acres		Total	
Year	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
	millions									
1900	1.93	49	3.37	520	0.10	68	0.05	200	5.74	837
1910	2.25	49	3.93	570	0.13	84	0.05	167	6.37	870
1920	2.31	59	3.93	580	0.15	100	0.07	221	6.45	960
1925	2.42	57	3.75	550	0.14	97	0.06	224	6.37	928
1930	2.36	56	3.69	550	0.16	109	0.08	277	6.30	992
1935	2.69	59	3.86	540	0.17	114	0.09	310	6.81	1,023
1940	2.29	50	3.55	540	0.16	112	0.10	366	6.10	1,068
1945	2.25	47	3.32	520	0.17	119	0.11	460	5.86	1,146
1950	1.97	39	3.12	500	0.18	126	0.12	495	5.39	1,160
1954	1.70	32	2.76	460	0.19	132	0.13	531	4.78	1,155
1959	1.06	22	2.32	410	0.20	137	0.14	555	3.71	1,124
1964	0.82	17	1.98	360	0.21	145	0.15	585	3.16	1,107
1969	0.64	14	1.73	320	0.22	148	0.15	578	2.73	1,060
1974	0.51	11	1.44	273	0.21	142	0.16	590	2.31	1,024
1978	0.54	12	1.34	256	0.21	147	0.16	600	2.26	1,015
1982	0.64	13	1.24	233	0.20	141	0.16	600	2.24	987
1987	0.60	12	1.12	212	0.20	139	0.17	602	2.09	965
1992	0.56	11	1.01	190	0.19	129	0.17	615	1.93	945
1997	0.56	12	0.99	182	0.18	122	0.18	616	1.91	932

Sources: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States: Colonial Times to 1970* (GPO, Washington, DC, 1975).

U.S. Department of Agriculture, National Agricultural Statistical Service, *1997 Census of Agriculture*, *Vol. I: Part 51, Chapter 1. United States Summary National-Level Data, National, State and County Tables* (Internet accessible data tables as of February 22, 1999), and earlier census reports.

Table 7.4 Major Uses of U.S. Cropland, Agricultural Census Years, 1945-1997

Year	Cropland used for crops: Harvested	Cropland used for crops: Failed	Cropland used for crops: Cultivated summer fallow	Idle cropland	Cropland pasture	Total	Cropland idled by federal programs
	million acres						
1945	336	9	18	40	47	454	4.1
1949	352	9	26	22	67	478	0.0
1954	339	13	28	19	66	465	0.0
1959	317	10	31	33	66	457	22.5
1964	292	6	37	52	57	444	55.0
1969	286	6	41	51	88	472	57.5
1974	322	8	31	21	83	465	2.7
1978	330	7	32	26	76	471	18.3
1982	347	5	31	21	65	469	11.1
1987	282	4	35	57	65	443	76.2
1992	296	6	27	40	67	435	54.9
1997	309	4	21	33	65	431	29.5

Sources: U.S. Department of Agriculture, National Agricultural Statistical Service, *1997 Census of Agriculture*, *Vol. I: Part 51, Chapter 1. United States Summary National-Level Data, National, State and County Tables* (Internet accessible data tables as of February 22, 1999).

U.S. Department of Commerce, Bureau of the Census, *Census of Agriculture for 1992*, *Vol. I: Geographic Area Series, Part 51 United States Summary and State Data*, Table 7, p. 17, AC92-A-51 (GPO, Washington, DC, 1994), and earlier census reports.

Notes: Excludes Alaska and Hawaii. Fewer than 200,000 acres were used for crops in Alaska and Hawaii in 1997. A double-cropped acre is counted as one acre. Idle cropland also includes cropland voluntarily planted in cover crops, legumes, and soil-improvement grasses, but not harvested, not pastured, and not enrolled in the Conservation Reserve Program (CRP). Cropland is also idled under various federal farm programs, including in previous years the Agricultural Conservation Program (1936-1947), Soil Bank (1956-1970), Cropland Adjustment Program (1961-1977), Agricultural Reduction Program (1961-1995), and CRP (1986-1997). CRP data for 1997 also includes cropland idled by the Wetlands Reserve Program, but does not include 16.1 million acres of newly enrolled CRP land.

Table 7.5 Cropland Tillage Practices Used in the Production of U.S. Field Crops, 1989-1997

	Total area planted	Conven-tional tillage	Reduced tillage	Conservation tillage: No-till	Conservation tillage: Ridge-till	Conservation tillage: Mulch-till	Conservation tillage: Total
	million acres						
1989	279.6	137.3	70.7	14.1	2.7	54.7	71.7
1990	280.9	136.7	71.0	16.9	3.0	53.3	73.2
1991	281.2	129.8	72.3	20.6	3.2	55.3	79.1
1992	282.9	120.8	73.4	28.1	3.4	57.3	88.7
1993	278.1	107.9	73.2	34.8	3.5	58.9	97.1
1994	283.9	111.4	73.2	39.0	3.6	56.8	99.3
1995	278.7	109.7	70.1	40.9	3.4	54.6	98.9
1996	290.2	111.6	74.8	42.9	3.4	57.5	103.8
1997	294.6	107.6	77.3	46.0	3.7	60.0	109.8
	percent of planted acres						
1989	100	49.1	25.3	5.1	1.0	19.6	25.6
1990	100	48.7	25.3	6.0	1.1	19.0	26.1
1991	100	46.1	25.7	7.3	1.1	19.7	28.1
1992	100	42.7	25.9	9.9	1.2	20.2	31.4
1993	100	38.8	26.3	12.5	1.2	21.2	34.9
1994	100	39.3	25.8	13.7	1.3	20.0	35.0
1995	100	39.3	25.2	14.7	1.2	19.6	35.5
1996	100	38.4	25.8	14.8	1.2	19.8	35.8
1997	100	36.5	26.2	15.6	1.3	20.4	37.3

Source: Conservation Technology Information Center, *National Crop Residue Management Survey Annual Report* (CTIC, West Lafayette, IN, annual).

Notes: Conventional tillage leaves less than 15 percent residue after planting. Reduced tillage leaves 15-30 percent residue after planting. Conservation tillage leaves over 30 percent residue after planting. Conservation tillage includes no till (the soil is left undisturbed prior to planting, except for nutrient injection, and planting or drilling is accomplished in a narrow seedbed or slot created by coulters, row openers, disk openers, inrow chisels, or rototillers), ridge till (the soil is left undisturbed prior to planting, except for nutrient injection, and planting is completed in a seedbed prepared on ridges with sweeps, disk openers, coulters, or row cleaners; residue is left on the surface between ridges), and mulch till (the surface is disturbed before planting but 30 percent or more residue remains after planting).

Table 7.6 Erosion on U.S. Cropland, 1982-1992

Year	Sheet and rill erosion		Wind erosion	
	billion tons per year	*tons per acre per year*	*billion tons per year*	*tons per acre per year*
1982	1.7	4.1	1.4	3.3
1987	1.5	3.7	1.3	3.2
1992	1.2	3.1	0.9	2.5

Source: U.S. Department of Agriculture, National Resource Conservation Service, *Summary Report 1992 National Resources Inventory* (USDA, NRCS, Washington, DC, 1995).

Table 7.7 U.S. Agricultural Productivity Indexes, 1948-1996

	Farm input				Farm output			Total
Year	Purchased input	Labor	Capital	Total	Crops	Live-stock	Total	produc-tivity
	index (1948 = 100)							
1948	100	100	100	100	100	100	100	100
1949	112	98	111	106	95	106	100	94
1950	113	94	121	106	91	110	99	94
1951	118	90	129	107	95	116	104	97
1952	119	88	137	107	98	118	107	100
1953	119	83	141	106	98	120	107	102
1954	112	81	145	102	95	124	108	105
1955	122	82	147	107	99	127	111	104
1956	126	77	148	107	99	130	112	105
1957	130	72	147	106	98	128	111	105
1958	135	69	146	106	107	129	117	110
1959	143	69	147	109	109	135	120	110
1960	143	67	147	108	113	134	122	113
1961	140	65	144	106	113	140	125	118
1962	142	64	143	106	115	141	126	119
1963	146	63	144	107	119	145	130	122
1964	145	59	144	105	115	149	130	124
1965	145	58	144	104	123	144	132	128
1966	154	54	146	105	121	147	133	127
1967	156	51	150	104	127	152	138	132
1968	151	49	151	102	130	152	140	137
1969	156	48	151	103	134	152	142	138
1970	158	48	151	103	129	158	142	137
1971	156	47	153	103	144	160	151	147
1972	160	46	152	103	143	162	152	147
1973	163	47	157	105	153	164	158	150
1974	165	43	162	105	140	161	149	142
1975	159	43	163	103	160	152	158	154

See next page for continuation of this table.

Table 7.7 U.S. Agricultural Productivity Indexes, 1948-1996 (continued)

Year	Farm input: Purchased input	Farm input: Labor	Farm input: Capital	Farm input: Total	Farm output: Crops	Farm output: Live-stock	Farm output: Total	Total produc-tivity
	index (1948 = 100)							
1976	169	43	165	106	159	160	161	151
1977	166	41	167	105	173	163	170	162
1978	189	39	167	110	178	163	173	157
1979	198	38	170	113	195	166	184	163
1980	202	37	174	114	177	174	177	155
1981	192	37	173	111	204	177	194	174
1982	184	36	171	109	205	175	194	179
1983	185	35	161	105	160	179	170	161
1984	180	35	164	105	200	176	192	183
1985	175	32	161	102	210	181	200	196
1986	171	30	155	98	198	182	194	198
1987	173	30	147	97	201	186	197	204
1988	172	31	144	96	176	190	185	193
1989	171	31	144	96	202	191	200	210
1990	178	30	142	97	217	193	210	217
1991	179	32	141	98	215	198	211	216
1992	178	30	140	96	235	203	224	234
1993	186	29	137	96	210	204	211	219
1994	190	29	136	97	249	218	240	247
1995	193	28	135	97	225	223	227	235
1996	183	30	135	96	242	222	237	247

Source: U.S. Department of Agriculture, Economic Research Service, *Agricultural Outlook* (USDA, ERS, Washington, DC, monthly).

Notes: Productivity = output/input. Purchased input includes chemicals, fuels, electricity, feed, seed, and livestock purchases; contract labor and custom machine services; machine and building maintenance and repair; irrigation from public sellers of water; and miscellaneous farm production items. Labor includes both hired and self-employed labor. Capital includes durable equipment and real estate. Livestock output includes meat animals, dairy products, poultry, eggs, wool, mohair, horses, mules, goats, sheep, rabbits, fur animals, aquaculture, honey, and beeswax. Crop outputs include food grains, feed grains, oil crops, sugar crops, cotton, cottonseed, vegetables, fruit trees, nut trees, tobacco, floriculture, ornamentals, Christmas trees, mushrooms, legume seeds, grass seeds, hops, mint, broomcorn, popcorn, hemp, and flax.

Table 7.8 U.S. Commercial Fertilizer Use, 1960-1997

Year	Gross tonnage	Active ingredients (nutrient content)			
		Nitrogen	Phosphate	Potash	Total
	million tons	*million tons*			
1960	24.9	2.7	2.6	2.2	7.5
1961	25.6	3.0	2.6	2.2	7.8
1962	26.6	3.4	2.8	2.3	8.4
1963	28.8	3.9	3.1	2.5	9.5
1964	30.7	4.4	3.4	2.7	10.5
1965	31.8	4.6	3.5	2.8	10.9
1966	34.5	5.3	3.9	3.2	12.4
1967	37.1	6.0	4.3	3.6	14.0
1968	38.7	6.8	4.5	3.8	15.0
1969	38.9	7.0	4.7	3.9	15.5
1970	39.6	7.5	4.6	4.0	16.1
1971	41.1	8.1	4.8	4.2	17.2
1972	41.2	8.0	4.9	4.3	17.2
1973	43.3	8.3	5.1	4.6	18.0
1974	47.1	9.2	5.1	5.1	19.3
1975	42.5	8.6	4.5	4.5	17.6
1976	49.2	10.4	5.2	5.2	20.8
1977	51.6	10.6	5.6	5.8	22.1
1978	47.5	10.0	5.1	5.5	20.6
1979	51.5	10.7	5.6	6.2	22.6
1980	52.8	11.4	5.4	6.2	23.1
1981	54.0	11.9	5.4	6.3	23.7
1982	48.7	11.0	4.8	5.6	21.4
1983	41.8	9.1	4.1	4.8	18.1
1984	50.1	11.1	4.9	5.8	21.8
1985	49.1	11.5	4.7	5.6	21.7
1986	44.1	10.4	4.2	5.1	19.7
1987	43.0	10.2	4.0	4.8	19.1
1988	44.5	10.5	4.1	5.0	19.6
1989	44.8	10.6	4.1	4.8	19.5
1990	47.7	11.1	4.3	5.2	20.6
1991	47.3	11.3	4.2	5.0	20.5
1992	48.8	11.5	4.2	5.0	20.7
1993	49.2	11.4	4.4	5.1	20.9
1994	52.3	12.6	4.5	5.3	22.4
1995	50.7	11.7	4.4	5.1	21.3
1996	53.4	12.3	4.5	5.2	22.0
1997	55.0	12.3	4.6	5.4	22.3

Sources: The Association of American Plant Food Control Officials (AAPFCO), *Commercial Fertilizers, 1996* (AAPFCO, Lexington, KY, 1997) and earlier issues.

U.S. Department of Agriculture, Economic Research Service, *AREI UPDATES: Nutrient Use and Practices on Major Field Crops*, Table 1, p. 2 (USDA, ERS, Washington, DC, 1997) and agency updates.

Notes: Quantity refers to total fertilizer materials. Includes fertilizer use on farms, lawns, golf courses, home gardens, and other nonfarm lands. Includes Puerto Rico.

Table 7.9 Farm Pesticide Use on Major U.S. Crops, 1964-1995

Year	Herbicides	Insecticides	Fungicides	Other	Total
	million pounds of active ingredients				
1964	48.16	123.30	22.17	21.38	215.01
1966	79.38	119.24	23.24	18.75	240.61
1971	175.67	127.71	29.31	31.71	364.40
1976	341.39	131.73	26.63	30.74	530.49
1982	430.35	82.65	25.22	34.23	572.45
1990	344.64	57.39	27.77	67.90	497.69
1991	335.18	52.83	29.44	79.45	496.90
1992	350.53	60.05	34.92	90.02	535.52
1993	323.51	58.10	36.58	97.81	516.00
1994	350.45	67.90	43.06	129.64	591.04
1995	323.79	69.60	44.80	127.45	565.64

Source: Lin, B., M. Padgitt, H. Delvo, D. Shank, and H. Taylor, *Pesticide and Fertilizer Use and Trends in U.S. Agriculture*, AER 717 (USDA, ERS, Washington, DC, 1995) and unpublished USDA survey data.

Notes: Estimates include pesticide use on corn, soybeans, wheat, cotton, potatoes, other vegetables, citrus fruits, apples, and other fruit. Estimates are not directly comparable with Table 7.10 because of different survey methodologies.

Table 7.10 U.S. Commercial Pesticide Use by Sector and Type, 1979-1995

	Agriculture						Industry, commercial, & government					
	Herbicides	Insecticides	Fungicides	Other conven.	Other chemicals	Total	Herbicides	Insecticides	Fungicides	Other conven.	Other chemicals	Total
	million pounds of active ingredients											
1979	492	188	57	106	246	1,089	85	35	50	46	27	243
1980	504	163	59	100	227	1,053	83	35	45	46	25	234
1981	513	152	62	104	215	1,046	82	37	43	46	24	232
1982	503	142	59	101	207	1,012	80	39	41	45	24	229
1983	455	135	59	100	196	945	80	40	40	45	24	229
1984	516	129	56	100	194	995	78	41	38	41	24	222
1985	501	126	59	94	194	974	70	43	37	41	23	214
1986	481	121	59	94	188	943	68	45	36	41	23	213
1987	425	90	52	91	180	838	65	42	34	39	22	202
1988	450	100	54	95	177	876	64	41	32	39	22	198
1989	460	95	54	113	161	883	63	40	31	38	22	194
1990	455	90	50	133	164	892	63	39	31	38	22	193
1991	440	85	47	144	140	856	60	38	30	37	21	186
1992	450	90	45	150	161	896	58	35	28	36	21	178
1993	425	80	47	154	166	872	56	32	25	36	20	169
1994	485	90	48	163	163	949	52	30	23	34	20	159
1995	461	91	49	170	168	939	48	29	20	31	22	150

	Home & garden						Total					
	Herbicides	Insecticides	Fungicides	Other conven.	Other chemicals	Total	Herbicides	Insecticides	Fungicides	Other conven.	Other chemicals	Total
	million pounds of active ingredients											
1979	33	32	17	3	70	155	610	255	124	155	343	1,487
1980	35	30	18	3	69	155	622	228	122	149	321	1,442
1981	36	29	17	3	68	153	631	218	122	152	307	1,430
1982	37	29	17	3	67	153	620	210	117	149	298	1,394
1983	38	29	16	3	67	153	573	204	115	148	287	1,327
1984	40	27	15	3	67	152	634	197	109	145	284	1,369
1985	40	24	14	3	67	148	611	193	110	138	284	1,336
1986	41	22	14	3	67	147	590	188	109	138	278	1,303
1987	42	20	14	3	67	146	532	152	100	133	269	1,186
1988	43	20	13	3	67	146	557	161	99	137	266	1,220
1989	44	19	13	2	68	146	567	154	98	154	251	1,224
1990	46	19	10	2	66	143	564	148	91	173	252	1,228
1991	46	18	9	2	65	140	546	141	86	182	226	1,181
1992	46	18	8	2	64	138	554	143	81	189	246	1,213
1993	46	18	8	2	62	136	527	130	80	192	248	1,177
1994	46	18	8	2	61	135	583	138	79	199	244	1,243
1995	47	17	8	2	59	133	556	137	77	203	249	1,222

Source: Aspelin, A.L., *Pesticide Industry Sales and Usage: 1994 and 1995 Market Estimates* (U.S. Environmental Protection Agency, Washington, DC, 1997).

Notes: Other conven. = other conventional pesticides. Other chemicals = chemicals produced mainly for other purposes but also used as pesticides (e.g., chlorine, sulfur).

Table 7.11 Irrigated U.S. Farmland, 1890-1997

Year	Seventeen Western states	Other states	Total
	million acres		
1890	3.5	0.1	3.5
1900	7.5	0.3	7.8
1910	11.3	0.4	11.7
1920	13.9	0.5	14.5
1930	14.1	0.6	14.7
1940	17.2	0.7	18.0
1950	24.3	1.5	25.8
1959	30.7	2.4	33.2
1964	33.2	3.9	37.1
1969	34.8	4.3	39.1
1974	36.6	4.6	41.2
1978	43.2	7.2	50.3
1982	41.3	7.7	49.0
1987	37.5	8.9	46.4
1988	38.9	9.7	48.6
1989	40.0	9.5	49.5
1990	39.4	9.8	49.2
1991	39.9	10.1	50.0
1992	39.1	10.3	49.4
1993	39.6	10.2	49.8
1994	40.8	11.0	51.8
1995	41.2	10.8	52.0
1996	42.2	11.1	53.3
1997	43.0	12.1	55.1

Sources: U.S. Department of Agriculture, Economic Research Service, *Agricultural Resources and Environmental Indicators, 1996-97,* AH-712 (USDA, ERS, Washington, DC, 1997) and earlier ERS reports.

U.S. Department of Agriculture, National Agricultural Statistical Service, *1997 Census of Agriculture*, *Vol. I: Part 51, Chapter 2. United States Summary and State Data, State Tables* (Internet accessible data tables as of February 22, 1999).

U.S. Department of Commerce, Bureau of the Census. *Census of Agriculture for 1992*, *Vol. I: Geographic Area Series, Part 51 United States Summary and State Data*, Table 9, p. 18, AC92-A-51 (GPO, Washington, DC, 1994) and earlier census reports.

Notes: The seventeen Western states include Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. Data for 1890-1992 and 1997 are from the Census of Agriculture. Data for other years are estimates constructed from data provided by the USDA, National Agricultural Statistics Service (NASS).

Table 7.12 Condition of U.S. Nonfederal Rangeland, Selected Years, 1963-1992, and Bureau of Land Management Rangeland, Selected Years, 1936-1997

Rangeland	Nonfederal					Bureau of Land Management				
condition	1963	1977	1982	1987	1992	1936	1966	1975	1986	1997
	% rangeland acreage									
Excellent	5	12	4	3	6	2	2	2	4	4
Good	15	28	30	30	34	14	17	15	30	32
Fair	40	42	45	47	44	48	52	50	41	37
Poor	40	18	16	14	15	36	30	33	18	13
Unclassified	na	na	5	6	1	na	na	na	na	13

Sources: U.S. Department of Agriculture, Natural Resources Conservation Service, *National Resources Inventory* (USDA, NRCS, Washington, DC, 1977, 1982, 1987, and 1992).

U.S. Department of the Interior, Bureau of Land Management, *Public Land Statistics* (DOI, BLM, Washington, DC, annual).

Notes: na = not available. Rangeland condition refers to the present state of the vegetation at a rangeland site in relation to the climax (natural potential) plant community for that site. It is expressed as the degree of similarity of present vegetation to the climax plant community: Excellent (equivalent to Potential Natural Community) = 76-100% similarity; Good (Late Seral) = 51-75% similarity; Fair (Mid Seral) = 26-50% similarity; and Poor (Early Seral) = 0-25% similarity. Unclassified includes rangeland for which data and estimates are not available, dry lakebeds, rock outcrops, and other areas for which data cannot be gathered. NRI is conducted every five years; BLM data are updated annually to reflect new information and changes in rangeland condition classes. NRI and BLM data are not strictly comparable because of different survey methodologies.

Table 7.13 Timberland in the United States by Ownership, 1952-1992

Year	Farmer and other private	Forest industry	National forests	Other public	Total
	million acres				
1952	304.5	59.0	94.7	50.7	508.9
1962	307.5	61.4	96.8	49.3	515.1
1977	285.3	68.9	88.7	49.5	491.1
1987	283.6	70.3	85.2	45.8	484.9
1992	287.6	70.5	84.7	46.8	489.6

Source: Powell, D.S., J.L. Faulkner, D.R. Darr, Z. Zhu and D.W. MacCleery, *Forest Statistics of the United States, 1992*, General Technical Report RM-234 (U.S. Department of Agriculture, Forest Service, Washington, DC, 1993).

Table 7.14 Annual Net Growth and Removals of U.S. Growing Stock, 1952-1991, and Volume of U.S. Growing Stock, 1952-1992

	Net growth and removals of growing stock									
	Farmer and other private		Forest industry		National forests		Other public		Total	
Year	Net Growth	Re-movals	Net Growth	Re-movals	Net Growth	Re-movals	Net Growth	Re-movals	Net Growth	Re-movals
	billion cubic feet									
1952	8.1	6.9	2.6	3.3	2.1	1.1	1.2	0.6	13.9	11.9
1962	9.5	6.4	3.2	3.0	2.5	1.9	1.6	0.7	16.7	12.0
1976	12.6	6.8	4.2	4.2	3.1	2.1	2.0	1.1	21.9	14.2
1986	12.1	8.2	4.3	5.4	3.4	2.3	2.3	1.2	22.1	16.0
1991	12.1	8.0	4.3	5.3	3.3	2.0	1.9	1.0	21.6	16.3

	Volume of growing stock									
	Farmer and other private		Forest industry		National forests		Other public		Total	
Year	Soft-wood	Hard-wood	Soft-wood	Hard-wood	Soft-wood	Hard-wood	Soft-wood	Hard-wood	Soft-wood	Hard-wood
	billion cubic feet									
1952	94.8	133.7	77.4	20.3	204.4	13.6	55.2	16.5	431.8	184.1
1962	104.3	152.5	76.1	25.4	213.7	17.2	55.7	20.7	449.8	215.8
1977	125.3	185.8	74.5	32.3	208.1	21.6	59.0	26.5	467.0	266.1
1986	136.6	220.8	72.8	35.3	186.3	25.1	57.3	31.4	452.9	312.6
1992	143.4	242.3	71.0	34.8	185.6	25.6	50.0	33.0	449.9	335.7

Sources: Powell, D.S., J.L. Faulkner, D.R. Darr, Z. Zhu and D.W. MacCleery, *Forest Statistics of the United States, 1992*, General Technical Report RM-234 (U.S. Department of Agriculture, Forest Service, Washington, DC, 1993).

Table 7.15 U.S. Production of Timber Products by Major Product, Five-Year Intervals, 1950-1965, and Annually, 1966-1994

Year	Lumber	Plywood & veneer	Pulp products	Fuel	Miscel- laneous	Total
	million cubic feet, roundwood equivalent					
1950	5,905	345	1,500	2,270	770	10,800
1955	5,785	575	2,200	1,745	630	10,970
1960	5,080	705	2,575	1,300	510	10,220
1965	5,665	1,030	3,095	915	567	11,477
1966	5,630	1,035	3,190	845	582	11,522
1967	5,325	1,025	3,195	780	562	11,227
1968	5,545	1,120	3,385	700	101	11,776
1969	5,415	1,050	3,585	620	601	11,681
1970	5,215	1,020	3,840	535	575	11,655
1971	5,390	1,170	3,560	500	538	11,548
1972	5,535	1,300	3,520	475	562	11,932
1973	5,670	1,320	3,755	505	621	12,446
1974	5,095	1,150	4,220	535	635	12,090
1975	4,890	1,170	3,485	570	583	11,153
1976	5,585	1,355	3,810	600	625	12,530
1977	5,950	1,425	3,650	1,000	646	13,196
1978	6,155	1,460	3,745	1,525	619	14,089
1979	6,115	1,370	4,105	2,205	690	15,150
1980	5,305	1,175	4,390	3,105	693	15,228
1981	4,775	1,180	4,125	3,180	646	14,336
1982	5,048	1,119	3,819	3,355	603	14,457
1983	6,044	1,426	4,285	3,235	591	16,141
1984	6,396	1,391	4,681	3,620	590	17,237
1985	6,210	1,426	4,561	3,450	599	16,861
1986	7,077	1,538	4,857	3,096	616	17,768
1987	7,588	1,587	5,137	3,076	633	18,678
1988	7,642	1,538	5,221	3,066	713	18,948
1989	7,440	1,406	5,429	3,041	781	19,121
1990	7,213	1,368	5,353	3,019	805	18,720
1991	6,677	1,226	5,434	3,028	842	18,139
1992	6,864	1,265	5,463	3,044	877	18,389
1993	6,660	1,257	5,391	3,084	864	18,042
1994	6,880	1,268	5,417	3,134	910	18,392

Sources: Howard, J.L., *U.S. Timber Production, Trade, Consumption, and Price Statistics, 1965-1994*, Table 4a, p. 12, General Technical Report FPL-GTR-98 (U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, WI, 1997) and earlier reports in this series.

Notes: Miscellaneous includes cooperage logs, poles and pilings, fence posts, hewn ties, round mine timbers, box bolts, excelsior bolts, chemical wood, shingle bolts, log and pulp chip exports, and other products not specified.

Table 7.16 Logging Residues from U.S. Growing Stock and Timber Product Output from U.S. Nongrowing Stock, 1952-1991

	Logging residues		Output from nongrowing stock	
Year	Softwood	Hardwood	Softwood	Hardwood
	% of timber product removals from growing stock		*% of timber supplies*	
1952	9.8	22.2	10.4	20.9
1962	9.6	20.7	10.0	18.5
1970	10.0	19.7	7.0	13.9
1976	8.4	17.1	6.9	14.0
1986	9.0	13.2	11.5	38.5
1991	7.5	12.0	11.9	37.5

Sources: Haynes, R.W., D.M. Adams and J.R. Mills, *The 1993 RPA Timber Assessment Update*, Table 7, p. 16, and Table 8, p. 17 (U.S. Department of Agriculture, Forest Service, Washington, DC, 1995).

Notes: Logging residues are lower quality material, such as small stem, chunks, and low-quality stems. Declining amounts of residues reflect increased stumpage prices, improved logging technology, and increased demand for wood products. Timber supplies from nongrowing stock include salvable dead trees, rough and rotten trees, tops and limbs, defective sections of growing stock trees in urban areas, along fence rows, and on forested lands other than timberlands. Output from these sources has been greatly influenced by markets for pulpwood and fuelwood since the late 1970s.

Table 7.17 U.S. Wildland Fire Damage and Tree Planting, Ten-Year Intervals, 1930-1950, and Annually, 1951-1997

Year	Wildland fire damage	Tree planting	Year	Wildland fire damage	Tree planting
	million acres			*million acres*	
1930	52.3	0.14	1973	1.9	1.75
1940	25.9	0.52	1974	2.9	1.60
1950	15.5	0.50	1975	1.8	1.93
1951	10.8	0.45	1976	5.1	1.89
1952	14.2	0.52	1977	3.2	1.98
1953	10.0	0.71	1978	3.9	2.09
1954	8.8	0.81	1979	3.0	2.06
1955	8.1	0.78	1980	5.3	2.27
1956	6.6	0.89	1981	4.8	2.35
1957	3.4	1.14	1982	2.4	2.37
1958	3.3	1.53	1983	5.1	2.45
1959	4.2	2.12	1984	3.0	2.55
1960	4.5	2.14	1985	5.2	2.70
1961	3.0	1.76	1986	3.2	2.75
1962	4.1	1.37	1987	5.0	3.03
1963	7.1	1.33	1988	5.7	3.39
1964	4.2	1.31	1989	3.5	3.02
1965	2.7	1.29	1990	4.6	2.86
1966	4.6	1.28	1991	2.2	2.56
1967	4.7	1.37	1992	2.6	2.55
1968	4.2	1.44	1993	2.3	2.42
1969	6.7	1.43	1994	4.7	2.78
1970	3.3	1.60	1995	2.3	2.42
1971	4.3	1.69	1996	6.7	2.41
1972	2.6	1.68	1997	3.7	2.49

Sources: U.S. Department of Agriculture, Forest Service, Fire and Aviation management, *1991-1997 Wildland Fire Statistics* (USDA, FS, Washington, DC, 1998) and earlier reports in this series.

--, *U.S. Forest Planting Report* (USDA, FS, Washington, DC, annual).

Notes: Tree planting refers to acres planted in seedlings and direct seeded. Year = calendar year for wildland fire damage and fiscal year for tree planting.

Table 7.18 U.S. Forestland Damaged by Insects, 1968-1997

Year	Spruce budworm	Western spruce budworm	Gypsy moth	Mountain pine beetle	Southern pine beetle
			million acres		
1968	1.3	5.3	0.1	na	na
1969	1.2	4.6	0.3	na	na
1970	2.0	4.0	1.0	na	na
1971	1.6	4.8	1.9	na	na
1972	2.8	5.5	1.4	na	na
1973	4.2	4.4	1.8	na	na
1974	10.8	5.5	0.8	na	na
1975	9.2	5.3	0.5	na	na
1976	9.1	5.8	0.9	na	na
1977	10.3	6.5	1.6	na	na
1978	7.7	5.2	1.3	4.0	na
1979	6.6	5.0	0.6	4.4	15.0
1980	6.6	4.0	5.0	4.7	12.1
1981	4.5	5.5	12.9	4.7	0.9
1982	4.2	8.7	8.2	4.2	7.3
1983	6.5	11.0	2.4	3.6	11.4
1984	6.1	10.6	1.0	3.3	na
1985	5.2	12.8	1.7	3.3	15.5
1986	1.0	13.2	2.4	3.5	26.4
1987	0.8	8.0	1.3	2.4	13.8
1988	0.3	6.1	0.7	2.2	7.9
1989	0.2	3.1	3.0	1.6	5.3
1990	0.2	4.6	7.3	0.9	4.2
1991	0.1	7.2	4.2	0.6	10.7
1992	0.1	4.6	3.1	15.8	14.3
1993	0.1	0.5	1.8	0.8	10.4
1994	1.0	0.5	0.9	0.4	5.3
1995	0.8	0.5	1.4	0.6	21.7
1996	0.5	0.3	0.2	0.3	7.3
1997	0.4	0.4	(s)	0.3	8.5

Sources: U.S. Department of Agriculture, Forest Service, *Forest Insect and Disease Conditions in the United States, 1979-1983* (USDA, FS, Washington, DC, 1985).

--, *Forest Insect and Disease Conditions in the United States* (USDA, FS, Washington, DC, annual from 1986).

Notes: na = not available. (s) = 47,300 acres; lowest acreage since 1959. Acreage for spruce budworm from 1991 forward includes spruce budworm in Alaska since it is the same species of budworm as in the eastern United States (i.e., it is not the western spruce budworm). Mountain pine beetle data for 1992 includes 15.2 million acres in California not previously reported.

Pollution Prevention, Recycling, Toxics and Waste

Table 8.1 U.S. Municipal Solid Waste Trends, 1960-1996

Year	Gross discards	Recovery for recycling	Recovery for composting	Net discards	Com-bustion	Discards to landfills	Per capita waste generation
	million tons						*lbs/day*
1960	88.12	5.61	**	82.51	27.00	55.51	2.68
1970	121.06	8.02	**	113.04	25.10	87.94	3.25
1980	151.64	14.52	**	137.12	13.70	123.42	3.66
1990	205.21	29.38	4.20	171.63	31.90	139.73	4.51
1996	209.66	46.01	11.32	152.33	36.09	116.24	4.33

Source: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. *Characterization of Municipal Solid Waste in the United States: 1997 Update,* Table 34, p. 119 and Table B-2, p. 162 (EPA, Washington, DC, 1998).

Note: **Negligible (less than 500,000 tons).

Table 8.2 U.S. Municipal Solid Waste Trends by Waste Type, 1960-1996

	Paper		Glass		Metals*		Aluminum		Plastics		Rubber and leather	
Year	Generation	Recovery	Generation	Recovery	Generation	Recovery	Generation	Recovery	Generation	Recovery	Generation	Recovery
	million tons											
1960	29.99	5.08	6.72	0.10	10.48	0.05	0.34	**	0.39	**	1.84	0.33
1970	44.31	6.77	12.74	0.16	13.03	0.48	0.80	0.01	2.90	**	2.97	0.25
1980	55.16	11.74	15.13	0.75	13.78	0.91	1.73	0.31	6.83	0.02	4.20	0.13
1990	72.73	20.23	13.10	2.62	13.74	3.31	2.81	1.01	17.13	0.37	5.79	0.37
1996	79.93	32.61	12.35	3.17	13.09	5.34	2.98	1.02	19.76	1.06	6.20	0.59

	Textiles		Wood		Other		Food		Yard		Miscellaneous	
Year	Generation	Recovery	Generation	Recovery	Generation	Recovery	Generation	Recovery	Generation	Recovery	Generation	Recovery
	million tons											
1960	1.76	0.05	3.03	**	0.07	**	12.20	**	20.00	**	1.30	**
1970	2.04	0.06	3.72	**	0.77	0.30	12.80	**	23.20	**	1.78	**
1980	2.53	0.16	7.01	**	2.52	0.50	20.00	**	27.50	**	2.25	**
1990	5.81	0.67	12.21	0.13	3.19	0.68	13.20	**	35.00	4.20	2.90	**
1996	7.76	0.95	10.84	0.49	3.69	0.78	21.90	0.52	29.75	10.80	3.20	**

Source: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. *Characterization of Municipal Solid Waste in the United States: 1997 Update,* Table 1, p. 27 and Table 2, p. 28 (EPA, Washington, DC, 1998).

Notes: *Ferrous and other nonferrous metals except aluminum. **Negligible (less than 5,000 tons). Other includes electrolytes in batteries and disposable paper diapers.

Table 8.3 U.S. Inventory of Low-level Nuclear Waste, 1965-1997

Commercial low-level nuclear waste shipped for disposal					
Year	Volume	Radioactivity	Year	Volume	Radioactivity
	million cubic meters	*million curies*		*million cubic meters*	*million curies*
1965	0.034	0.273	1982	0.929	4.568
1966	0.049	0.355	1983	1.007	4.732
1967	0.071	0.428	1984	1.083	4.954
1968	0.091	0.529	1985	1.160	5.282
1969	0.112	0.687	1986	1.213	5.059
1970	0.138	0.855	1987	1.265	4.924
1971	0.169	2.000	1988	1.306	4.793
1972	0.208	2.287	1989	1.352	5.284
1973	0.255	2.732	1990	1.387	4.979
1974	0.309	2.754	1991	1.426	5.272
1975	0.367	3.040	1992	1.476	5.708
1976	0.442	3.268	1993	1.499	5.709
1977	0.514	3.765	1994	1.524	5.841
1978	0.593	4.383	1995	1.544	5.376
1979	0.676	4.539	1996	1.551	5.020
1980	0.768	4.547	1997	1.560	5.030
1981	0.852	4.483			

Source: U.S. Department of Energy, Office of Environmental Management, *Integrated Data Base Report - 1996: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics,* Revision 13 (DOE, EM, Washington, DC, December 1997).

Notes: Volumes and radioactivity are cumulative. Radioactivity added each year is decayed. Data for 1997 are projections.

Table 8.4 U.S. Inventory of High-level Nuclear Waste, 1980-1997

Year	Volume	Radioactivity	Year	Volume	Radioactivity
	thousand cubic meters	*million curies*		*thousand cubic meters*	*million curies*
1980	329.7	1,362.6	1989	381.1	1,113.9
1981	339.3	1,628.5	1990	372.3	1,050.8
1982	342.0	1,369.4	1991	370.7	1,007.4
1983	352.7	1,299.7	1992	370.7	1,081.2
1984	363.5	1,355.2	1993	375.4	1,045.3
1985	357.1	1,459.5	1994	354.8	958.8
1986	365.9	1,419.0	1995	349.5	915.4
1987	381.4	1,303.1	1996	347.3	894.8
1988	384.9	1,206.7	1997	341.7	847.8

Source: U.S. Department of Energy, Office of Environmental Management, *Integrated Data Base Report - 1996: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics,* Revision 13 (DOE, EM, Washington, DC, December 1997).

Notes: Volumes and radioactivity are cumulative. Radioactivity added each year is decayed. Data for 1997 are projections.

Table 8.5 U.S. Inventory of Spent Nuclear Fuel by Reactor Type, 1971-1996

	Boiling-water reactors		Pressurized-water reactors		Total light-water reactors	
Year	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
	metric tons initial heavy metal					
1971	65	81	44	83	109	164
1972	146	226	100	183	246	410
1973	94	320	67	250	161	570
1974	242	562	208	458	449	1,020
1975	226	787	322	780	548	1,567
1976	298	1,085	401	1,181	699	2,266
1977	383	1,469	467	1,648	850	3,116
1978	384	1,852	699	2,346	1,082	4,199
1979	400	2,252	721	3,068	1,121	5,320
1980	620	2,872	618	3,686	1,238	6,558
1981	459	3,331	676	4,362	1,135	7,692
1982	357	3,688	640	5,002	998	8,690
1983	491	4,179	771	5,773	1,263	9,952
1984	498	4,677	841	6,614	1,339	11,291
1985	532	5,209	861	7,475	1,393	12,684
1986	458	5,667	996	8,472	1,454	14,139
1987	597	6,264	1,109	9,581	1,706	15,844
1988	536	6,799	1,117	10,697	1,652	17,497
1989	698	7,497	1,215	11,913	1,913	19,410
1990	633	8,130	1,504	13,417	2,137	21,547
1991	588	8,718	1,271	14,688	1,859	23,406
1992	695	9,413	1,596	16,284	2,291	25,697
1993	700	10,113	1,532	17,816	2,232	27,929
1994	675	10,788	1,207	19,024	1,882	29,811
1995	627	11,415	1,514	20,538	2,141	31,952
1996	690	12,105	1,610	22,148	2,300	34,252

Source: U.S. Department of Energy, Office of Environmental Management, *Integrated Data Base Report - 1996: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics,* Revision 13 (DOE, EM, Washington, DC, December 1997).

Note: Data for 1996 excludes 70 MTIHM of discharged fuel assemblies that are expected to be reinserted.

Table 8.6 U.S. Toxics Release Inventory Releases and Transfers, 1988 and 1994-1996

	1988	1994	1995	1996	1988-1996 change
	pounds				*percent*
On-site releases					
Air	2,180,862,321	1,280,285,817	1,191,260,290	1,095,413,106	-49.8
Fugitive air	680,928,993	351,433,000	304,738,454	276,183,228	-59.4
Point source air	1,499,933,328	928,852,817	886,521,836	819,229,878	-45.4
Surface water	164,551,386	39,794,843	35,918,865	45,144,135	-72.6
Underground	161,969,132	114,135,765	139,908,494	118,222,387	-27.0
Land	459,114,111	289,341,251	272,424,588	299,979,550	-34.7
Total	2,966,496,950	1,723,557,676	1,639,512,237	1,558,759,178	-47.5
Off-site releases					
To disposal	386,461,584	259,228,230	255,777,935	265,005,866	-31.4
Total releases	3,352,958,534	1,982,785,906	1,895,290,172	1,823,765,044	-45.6
Other on-site waste mgt.					
Recycled	na	6,518,368,024	6,139,069,594	6,209,509,900	na
Energy recovery	na	3,138,177,326	2,688,189,212	2,585,785,910	na
Treated	na	4,566,261,474	4,855,675,960	5,246,425,791	na
Total	na	14,222,806,824	13,682,934,766	14,041,721,601	na
Transfers off-site					
To recycling	na	2,200,760,073	2,173,558,832	2,094,268,207	na
To energy recovery	na	459,576,125	488,954,630	446,487,845	na
To treatment	369,204,491	221,230,371	236,496,866	248,020,028	-32.8
To POTWs	254,808,420	159,934,847	155,173,872	141,995,045	-44.3
To other	43,279,087	5,094,462	2,186,886	3,078,759	na
Total	na	3,046,595,878	3,056,371,086	2,933,849,884	na

Source: U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, *1996 Toxics Release Inventory: Public Data Release* (EPA, Washington, DC, 1998).

Notes: na = not available. Data do not include delisted chemicals, chemicals added in 1994-96, and aluminum oxide, ammonia, hydrochloric acid, and sulfuric acid. Transfers for recycling or energy recovery were not required to be reported in 1988. For 1994-96, other includes transfers reported without a valid waste management code.

Table 8.7 U.S. Toxics Release Inventory On-site and Off-site Releases by Industry, 1988 and 1994-1996

Industry	1988	1994	1995	1996	1988-1996 change
	pounds				*percent*
Food	8,377,717	6,013,560	5,120,357	5,120,503	-38.9
Tobacco	341,927	134,771	95,226	73,415	-78.5
Textiles	35,798,377	16,346,332	15,655,607	15,280,411	-57.3
Apparel	1,025,697	1,380,947	1,259,986	1,741,831	69.8
Lumber	32,981,807	32,986,266	30,434,637	27,116,641	-17.8
Furniture	62,363,120	52,134,945	41,530,300	35,651,541	-42.8
Paper	207,603,004	185,334,196	178,774,984	172,799,131	-16.8
Printing	61,187,518	34,386,679	30,895,852	28,269,786	-53.8
Chemicals	1,047,782,223	537,482,685	539,600,255	513,043,111	-51.0
Petroleum	72,780,821	46,877,100	42,593,318	43,076,652	-40.8
Plastics	158,313,799	125,462,108	114,765,358	105,358,191	-33.4
Leather	13,023,617	5,104,391	4,026,421	3,813,502	-70.7
Stone/Clay/Glass	40,539,364	17,359,182	19,053,390	23,263,716	-42.6
Primary Metals	629,353,951	433,885,649	455,029,353	496,662,641	-21.1
Fabricated Metals	160,369,759	99,572,056	90,440,941	77,610,533	-51.6
Machinery	69,747,296	27,120,215	22,851,633	19,162,054	-72.5
Electrical Equip.	132,719,036	36,671,754	31,457,129	33,753,037	-74.6
Transportation Equip .	208,391,846	128,139,353	114,746,256	105,231,558	-49.5
Measure./Photo .	58,084,824	14,328,227	12,955,213	10,358,619	-82.2
Miscellaneous	32,592,710	15,350,168	13,285,855	9,843,403	-69.8
Multiple Codes 20-39	308,351,079	149,011,079	122,436,826	91,157,789	-70.4
No Codes 20-39	11,229,042	17,704,243	8,281,275	5,376,979	-52.1
Total	3,352,958,534	1,982,785,906	1,895,290,172	1,823,765,044	-45.6
Federal Facilities	na	7,920,210	5,907,355	4,091,563	n/a

Source: U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, *1996 Toxics Release Inventory: Public Data Release* (EPA, Washington, DC, 1998).

Notes: na = not available. n/a = not applicable.

Table 8.8 U.S. Toxics Release Inventory On-site and Off-site Releases by State, 1988 and 1994-1996

State	1988	1994	1995	1996	1988-1996 change
	pounds				*percent*
Alabama	109,689,614	96,649,203	100,495,399	89,468,520	-18.4
Alaska	3,714,569	1,095,396	2,164,144	1,683,698	-54.7
American Samoa	0	0	0	0	n/a
Arizona	66,236,322	30,774,930	33,875,255	46,258,274	-30.2
Arkansas	41,078,310	29,329,078	24,494,563	22,915,254	-44.2
California	109,318,413	42,361,649	36,146,068	30,988,706	-71.7
Colorado	15,736,129	4,080,707	3,489,143	3,690,197	-76.5
Connecticut	37,799,558	11,219,092	8,643,867	6,387,666	-83.1
Delaware	8,635,152	4,096,180	2,902,307	1,986,174	-77.0
District of Columbia	500	55,560	56,965	9,460	1,792.0
Florida	61,526,840	71,434,211	52,110,580	46,914,430	-23.7
Georgia	86,766,834	43,827,310	39,791,760	38,467,754	-55.7
Guam	0	0	3,100	3,000	n/a
Hawaii	847,805	531,471	562,284	448,355	-47.1
Idaho	7,348,539	9,148,741	10,081,185	10,752,902	46.3
Illinois	134,593,529	89,071,039	82,881,648	76,549,404	-43.1
Indiana	184,554,149	82,653,253	88,801,423	91,418,953	-50.5
Iowa	43,027,871	22,728,352	21,124,247	17,499,568	-59.3
Kansas	30,301,296	17,408,245	17,611,936	17,569,997	-42.0
Kentucky	66,443,750	32,512,132	30,569,980	30,940,570	-53.4
Louisiana	250,845,496	114,823,665	122,286,440	129,789,110	-48.3
Maine	15,355,970	6,879,400	6,593,629	5,273,360	-65.7
Maryland	20,037,261	11,450,775	11,857,911	9,380,959	-53.2
Massachusetts	31,878,653	9,950,179	8,351,331	8,951,366	-71.9
Michigan	132,693,208	103,054,956	85,889,256	78,425,842	-40.9
Minnesota	55,947,771	20,825,514	18,338,087	15,846,403	-71.7
Mississippi	59,600,174	42,834,108	39,671,257	39,321,344	-34.0
Missouri	90,703,961	56,771,910	50,552,453	49,769,859	-45.1
Montana	35,629,903	46,459,564	42,643,724	47,204,182	32.5
Nebraska	16,935,710	13,734,915	11,171,399	8,880,693	-47.6
Nevada	2,352,366	3,208,708	3,368,990	3,294,005	40.0
New Hampshire	13,865,650	2,394,720	1,939,853	1,749,609	-87.4
New Jersey	45,018,440	14,024,665	12,399,476	10,644,699	-76.4
New Mexico	30,386,119	17,230,438	17,945,764	18,339,076	-39.6
New York	99,656,137	37,901,900	30,361,469	26,028,249	-73.9
North Carolina	132,027,139	80,752,697	72,492,552	67,973,108	-48.5
North Dakota	1,195,389	987,938	1,206,622	772,995	-35.3
Ohio	202,151,571	116,095,889	122,236,396	115,227,944	-43.0
Oklahoma	32,894,841	15,344,174	15,995,029	15,215,680	-53.7

See next page for continuation of table.

Table 8.8 U.S. Toxics Release Inventory On-site and Off-site Releases by State, 1988 and 1994-1996 (continued)

State	1988	1994	1995	1996	1988-1996 change
	pounds				*percent*
Oregon*	21,562,415	18,011,164	18,448,805	24,647,444	14.3
Pennsylvania	134,852,351	95,109,558	95,914,412	90,528,698	-32.9
Puerto Rico	12,828,707	9,693,032	8,840,075	7,467,738	-41.8
Rhode Island	7,712,568	6,789,350	3,017,334	2,452,269	-68.2
South Carolina	66,070,190	47,639,871	48,112,037	47,373,602	-28.3
South Dakota	2,393,242	2,108,149	1,871,676	1,364,448	-43.0
Tennessee	126,484,405	104,914,555	94,684,331	88,190,525	-30.3
Texas	318,631,665	199,765,449	205,724,168	187,485,411	-41.2
Utah	123,835,686	67,175,197	69,143,942	73,876,112	-40.3
Vermont	1,734,453	631,876	543,553	293,732	-83.1
Virgin Islands	2,592,912	1,516,211	1,235,660	1,232,271	-52.5
Virginia	112,328,804	43,828,869	40,612,569	40,555,452	-63.9
Washington	28,273,090	20,770,473	22,336,381	21,889,503	-22.6
West Virginia	39,415,713	20,852,490	19,678,685	17,444,543	-55.7
Wisconsin	60,706,773	39,396,974	32,874,642	31,565,607	-48.0
Wyoming	16,740,621	880,024	1,144,410	1,356,324	-91.9
Total	3,352,958,534	1,982,785,906	1,895,290,172	1,823,765,044	-45.6

Source: U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, *1996 Toxics Release Inventory: Public Data Release* (EPA, Washington, DC, 1998).

Notes: n/a = not applicable. Oregon reported 6,211,171 pounds of fugitive air emissions in error for 1996 (included in table above); the correct amount is 750 pounds. The change for Oregon should be a decrease of 3,125,392 pounds or -14.5 percent

Table 8.9 U.S. Superfund Inventory, 1980-1997

Year	Superfund	NPL
	number of sites	
1980	8,689	0
1981	13,893	0
1982	14,697	160
1983	16,023	551
1984	18,378	547
1985	22,238	864
1986	24,940	906
1987	27,274	967
1988	29,809	1,195
1989	31,650	1,254
1990	33,371	1,236
1991	35,108	1,245
1992	36,869	1,275
1993	38,169	1,321
1994	39,099	1,360
1995	15,622	1,374
1996	12,781	1,210
1997	9,245	1,194

Source: U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, *Superfund Cleanup Figures* (an Internet accessible report; April 1, 1998).

Notes: NPL = National Priorities List. The 1995 data reflect the removal of over 24,000 sites from the Superfund inventory as part of EPA's Brownfields initiative to help promote economic redevelopment of these properties.

Table 8.10 Contaminant Levels in Herring Gull Eggs from Great Lakes Colonies, 1974-1996

Year	Lake Superior				
	DDE	Dieldrin	Mirex	HCB	PCBs
	parts per million in whole egg samples, wet weight				
1974	16.59	0.51	1.04	0.26	62.08
1975	23.10	0.38	0.96	0.18	76.24
1976	na	na	na	na	na
1977	11.92	0.38	0.33	0.24	55.22
1978	9.64	0.39	0.28	0.12	41.57
1979	6.83	0.60	0.26	0.14	58.74
1980	3.67	0.34	0.13	0.08	25.58
1981	5.74	0.44	0.14	0.12	33.84
1982	6.29	0.39	0.37	0.08	34.74
1983	3.17	0.33	0.15	0.05	21.42
1984	2.94	0.36	0.12	0.05	16.91
1985	3.13	0.32	0.11	0.05	15.89
1986	3.22	0.34	0.11	0.05	14.10
1987	2.52	0.20	0.10	0.04	12.35
1988	2.94	0.34	0.06	0.05	13.43
1989	2.50	0.34	0.07	0.05	15.09
1990	2.64	0.30	0.06	0.03	11.62
1991	3.60	0.27	0.07	0.04	14.09
1992	3.69	0.40	0.07	0.05	13.95
1993	4.09	0.19	0.08	0.03	15.70
1994	2.39	0.15	0.10	0.03	12.30
1995	2.49	0.11	0.08	0.02	11.15
1996	2.88	0.15	0.08	0.04	12.60

See next page for continuation of table.

Table 8.10 Contaminant Levels in Herring Gull Eggs from Great Lakes Colonies, 1974-1996 (continued)

	Lake Michigan				
Year	DDE	Dieldrin	Mirex	HCB	PCBs
	parts per million in whole egg samples, wet weight				
1974	na	na	na	na	na
1975	na	na	na	na	na
1976	33.40	0.82	0.36	0.14	118.42
1977	29.25	0.68	0.14	0.24	107.80
1978	22.36	0.87	0.21	0.12	90.74
1979	na	na	na	na	na
1980	12.17	0.70	0.10	0.09	57.83
1981	na	na	na	na	na
1982	15.86	0.81	0.09	0.09	65.41
1983	6.46	0.61	0.05	0.05	30.27
1984	7.85	0.53	0.09	0.06	31.47
1985	6.98	0.47	0.12	0.05	31.94
1986	7.48	0.38	0.07	0.07	27.25
1987	3.95	0.33	0.06	0.04	16.58
1988	5.04	0.55	0.03	0.04	19.14
1989	4.74	0.54	0.04	0.04	21.00
1990	8.12	0.54	0.06	0.05	32.19
1991	10.52	0.34	0.12	0.05	31.27
1992	6.71	0.41	0.04	0.04	20.25
1993	na	na	na	na	na
1994	10.10	0.34	0.08	0.05	32.85
1995	6.38	0.19	0.05	0.03	23.30
1996	6.10	0.21	0.08	0.04	22.70

See next page for continuation of table.

Table 8.10 Contaminant Levels in Herring Gull Eggs from Great Lakes Colonies, 1974-1996 (continued)

	Lake Huron				
Year	DDE	Dieldrin	Mirex	HCB	PCBs
	parts per million in whole egg samples, wet weight				
1974	17.40	0.50	1.34	0.38	71.01
1975	14.03	0.36	0.51	0.21	42.67
1976	na	na	na	na	na
1977	16.17	0.54	0.44	0.36	70.28
1978	6.53	0.22	0.21	0.11	32.38
1979	2.30	0.30	0.19	0.10	28.66
1980	2.71	0.24	0.11	0.07	20.41
1981	3.82	0.24	0.26	0.07	25.39
1982	4.43	0.28	0.48	0.08	34.29
1983	2.74	0.22	0.15	0.05	18.28
1984	2.56	0.22	0.34	0.07	19.95
1985	2.77	0.30	0.22	0.06	16.90
1986	2.05	0.21	0.12	0.05	12.00
1987	1.32	0.22	0.08	0.02	8.33
1988	1.40	0.22	0.07	0.04	8.83
1989	1.57	0.20	0.09	0.03	10.19
1990	1.86	0.14	0.11	0.03	11.34
1991	1.97	0.16	0.11	0.03	10.00
1992	2.36	0.16	0.05	0.05	10.20
1993	3.18	0.19	0.06	0.03	10.95
1994	2.19	0.13	0.10	0.03	11.25
1995	1.60	0.10	0.06	0.03	8.95
1996	2.01	0.13	0.14	0.08	10.05

See next page for continuation of table.

Table 8.10 Contaminant Levels in Herring Gull Eggs from Great Lakes Colonies, 1974-1996 (continued)

	Lake Erie				
Year	DDE	Dieldrin	Mirex	HCB	PCBs
	parts per million in whole egg samples, wet weight				
1974	7.13	0.35	0.64	0.29	72.46
1975	7.41	0.33	0.32	0.19	62.30
1976	na	na	na	na	na
1977	7.49	0.40	0.45	0.37	68.70
1978	4.29	0.24	0.20	0.09	44.43
1979	3.10	0.25	0.17	0.11	48.44
1980	2.98	0.21	0.18	0.09	46.38
1981	3.90	0.22	0.25	0.09	56.49
1982	3.07	0.25	0.13	0.08	58.89
1983	2.39	0.20	0.17	0.05	37.31
1984	3.23	0.33	0.22	0.06	46.20
1985	2.83	0.19	0.14	0.06	38.41
1986	2.77	0.23	0.14	0.06	33.35
1987	1.77	0.14	0.12	0.03	23.16
1988	2.07	0.17	0.10	0.05	27.50
1989	2.69	0.17	0.18	0.05	39.21
1990	2.01	0.10	0.11	0.03	30.09
1991	2.12	0.08	0.07	0.02	26.55
1992	1.68	0.13	0.05	0.04	24.45
1993	1.49	0.10	0.07	0.02	21.70
1994	1.55	0.08	0.08	0.03	22.90
1995	1.21	0.08	0.07	0.03	23.55
1996	1.25	0.06	0.09	0.03	15.50

See next page for continuation of table.

Table 8.10 Contaminant Levels in Herring Gull Eggs from Great Lakes Colonies, 1974-1996 (continued)

	Lake Ontario				
Year	DDE	Dieldrin	Mirex	HCB	PCBs
	parts per million in whole egg samples, wet weight				
1974	22.30	0.47	6.99	0.58	152.37
1975	22.80	0.29	4.70	0.33	143.11
1976	na	na	na	na	na
1977	14.88	0.39	2.48	0.80	102.50
1978	10.65	0.26	1.59	0.32	72.43
1979	8.94	0.21	1.89	0.21	69.60
1980	7.62	0.19	1.65	0.17	56.43
1981	11.00	0.28	2.67	0.24	78.90
1982	10.04	0.28	3.05	0.16	62.90
1983	4.78	0.18	1.43	0.08	42.59
1984	6.26	0.21	1.87	0.12	51.11
1985	6.02	0.15	1.47	0.07	35.58
1986	4.41	0.16	1.10	0.07	27.86
1987	2.60	0.13	0.68	0.04	16.48
1988	4.25	0.15	0.82	0.07	23.53
1989	5.28	0.22	1.15	0.07	32.45
1990	3.36	0.10	0.64	0.03	18.44
1991	3.53	0.14	0.58	0.03	17.05
1992	5.01	0.13	0.77	0.05	21.20
1993	5.27	0.13	0.82	0.04	21.05
1994	3.83	0.13	0.80	0.04	19.70
1995	2.23	0.05	0.57	0.02	13.60
1996	3.03	0.10	0.68	0.04	16.15

Source: Environment Canada, Canadian Wildlife Service, Canada Centre for Inland Waters, Organochlorine Contaminant Concentrations in Herring Gull Eggs from Great Lakes Colonies, unpublished, Burlington, ON, 1996.

Notes: DDE = Derivative of Dichloro-diphenyl-trichloro ethane (DDT). HCB = Hexachloro-benzene. PCBs = Polychlorinated biphenyls. na = not available. Data for Lake Michigan for 1996 are based on only one count per sampling site.

Table 8.11 Pesticide Residues in U.S. Domestic Surveillance Food Samples by Commodity Group, 1978-1997

	Commodity group						
Year	Grains & grain products	Milk, dairy products & eggs	Fish, shellfish & meats	Fruits	Vegetables	Other	Total
	percentage of samples without residues found						
1978	46	57	20	52	66	58	53
1979	46	53	19	42	65	53	51
1980	48	64	29	47	60	64	54
1981	57	68	23	44	63	66	56
1982	58	66	28	51	64	68	59
1983	58	68	39	48	59	69	57
1984	46	69	25	62	67	69	63
1985	48	78	35	64	66	78	65
1986	40	79	32	43	61	52	56
1987	43	76	27	50	63	63	58
1988	51	81	28	49	65	72	60
1989	56	87	35	56	68	80	65
1990	54	91	32	51	62	79	60
1991	58	78	58	49	68	81	64
1992	61	94	48	51	69	81	65
1993	66	94	53	70	39	83	64
1994	61	93	59	44	66	88	63
1995	33	100	80	48	48	80	54
1996	53	97	62	46	64	75	64
1997	60	97	68	44	69	83	66

Source: U.S. Department of Health and Human Services, Food and Drug Administration, *Pesticide Program Residues Monitoring 1997* (HHS, FDA, Washington, DC, 1998) and earlier annual reports.

Notes: Domestic food samples are collected as close as possible to the point of production. Fresh produce is analyzed as the unwashed whole, raw commodity. Although a percentage of samples contain pesticide residues, the percent of samples with over-tolerance residues (as set by EPA) is low. Between 1973 and 1986; 3 percent of samples were classed as violative; between 1987 and 1996 less than 1 percent were violative; and in 1997, 1.2 percent were violative.

Table 8.12 U.S. Production of Selected Ozone-depleting Chemicals, 1958-1994

Year	CFC-11	CFC-12	HCFC-22	CFC-113	CH_3CCl_3
	thousand metric tons of CFC-11 equivalent				
1958	22.9	59.6	0.76	0.0	0.0
1959	27.4	71.3	0.83	0.0	0.0
1960	32.8	75.5	0.91	1.6	0.0
1961	41.2	78.7	1.03	2.4	0.0
1962	56.6	94.3	1.12	3.2	0.0
1963	63.6	98.6	1.23	3.6	0.0
1964	67.4	103.4	1.34	4.3	0.0
1965	77.3	123.1	1.46	5.1	0.0
1966	77.3	129.9	1.59	5.8	0.0
1967	82.7	140.5	1.78	7.6	13.7
1968	92.7	147.7	1.96	9.1	14.6
1969	108.2	166.8	2.14	10.9	15.6
1970	110.9	170.3	2.28	13.1	16.6
1971	117.0	176.7	2.55	15.6	17.4
1972	135.9	199.2	2.80	18.2	18.2
1973	151.4	221.7	3.09	21.4	19.0
1974	154.7	221.1	3.21	23.2	19.9
1975	122.3	178.3	2.99	24.8	20.8
1976	116.2	178.3	3.85	29.7	24.8
1977	96.4	162.3	4.07	36.2	28.8
1978	87.9	148.4	4.67	41.0	29.2
1979	75.8	133.3	4.78	47.0	32.5
1980	71.7	133.8	5.16	36.7	31.4
1981	73.8	147.6	5.71	38.6	27.9
1982	63.7	117.0	3.95	40.0	27.0
1983	73.1	134.3	5.35	42.2	26.6
1984	83.9	152.7	5.76	60.2	30.6
1985	79.7	136.9	5.34	65.8	39.4
1986	91.6	146.2	6.15	69.2	29.6
1987	89.7	151.9	6.23	72.3	31.5
1988	113.0	187.7	7.54	79.2	32.8
1989	83.3	141.2	7.24	80.4	35.5
1990	61.0	94.6	6.94	55.9	36.4
1991	44.9	71.3	7.13	47.2	29.2
1992	45.5	73.9	7.48	28.5	31.4
1993	32.8	83.7	6.61	11.4	20.5
1994	na	57.5	6.93	na	na

Source: U.S. International Trade Commission, *Synthetic Organic Chemicals, United States Production and Sales* (GPO, Washington, DC, annual).

Notes: CFC-11 = Trichlorofluoromethane. CFC-12 = Dichlorodifluoromethane. HCFC-22 = Chlorodifluoromethane. CFC-113 = Trichlorotrifluoroethane. CH_3CCL_3 = Trichloroethane or methyl chloroform. This series ended after the publication of the 1994 data.

Energy

Table 9.1 Proved Reserves of Liquid and Gaseous Hydrocarbons in the United States, 1977-1997

Year	Crude oil	Natural gas	Natural gas liquids
	billion barrels	*trillion cubic feet*	*billion barrels*
1977	31.8	207.4	na
1978	31.4	208.0	6.8
1979	29.8	201.0	6.6
1980	29.8	199.0	6.7
1981	29.4	201.7	7.1
1982	27.9	201.5	7.2
1983	27.7	200.5	7.9
1984	28.4	197.5	7.6
1985	28.4	193.4	7.9
1986	26.9	191.6	8.2
1987	27.3	187.2	8.1
1988	26.8	168.0	8.2
1989	26.5	167.1	7.8
1990	26.3	169.3	7.6
1991	24.7	167.1	7.5
1992	23.7	165.0	7.5
1993	23.0	162.4	7.2
1994	22.5	163.8	7.2
1995	22.4	165.1	7.4
1996	22.0	166.5	7.8
1997	22.6	167.2	7.9

Source: U.S. Department of Energy, Energy Information Administration, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 1997 Annual Report*, Table 1, p. 3 and Appendix D, Historical Reserves Statistics, DOE/EIA-0216(97) (GPO, Washington, DC, 1998).

Table 9.2 U.S. Energy Production by Source, 1960-1997

Year	Coal	Crude oil & NGPL	Natural gas	Hydro-electric power	Nuclear	Geothermal & other renewables	Total
				quadrillion Btu			
1960	10.82	16.40	12.66	1.61	0.01	<0.01	41.49
1961	10.45	16.76	13.10	1.66	0.02	<0.01	41.99
1962	10.90	17.12	13.72	1.82	0.03	<0.01	43.58
1963	11.85	17.68	14.51	1.77	0.04	<0.01	45.85
1964	12.52	17.97	15.30	1.89	0.04	<0.01	47.72
1965	13.06	18.40	15.78	2.06	0.04	<0.01	49.34
1966	13.47	19.56	17.01	2.06	0.06	<0.01	52.17
1967	13.83	20.83	17.94	2.35	0.09	0.01	55.04
1968	13.61	21.63	19.07	2.35	0.14	0.01	56.81
1969	13.86	21.98	20.45	2.65	0.15	0.01	59.10
1970	14.61	22.91	21.67	2.63	0.24	0.01	62.07
1971	13.19	22.58	22.28	2.82	0.41	0.01	61.29
1972	14.09	22.64	22.21	2.86	0.58	0.03	62.42
1973	13.99	22.06	22.19	2.86	0.91	0.04	62.06
1974	14.07	21.05	21.21	3.18	1.27	0.05	60.84
1975	14.99	20.10	19.64	3.15	1.90	0.07	59.86
1976	15.65	19.59	19.48	2.98	2.11	0.08	59.89
1977	15.76	19.78	19.57	2.33	2.70	0.09	60.22
1978	14.91	20.68	19.49	2.94	3.02	0.06	61.10
1979	17.54	20.39	20.08	2.93	2.78	0.09	63.80
1980	18.60	20.50	19.91	2.90	2.74	0.11	64.76
1981	18.38	20.45	19.70	2.76	3.01	0.12	64.42
1982	18.64	20.50	18.32	3.27	3.13	0.11	63.96
1983	17.25	20.58	16.59	3.53	3.20	0.13	61.28
1984	19.72	21.12	18.01	3.39	3.55	0.17	65.96
1985	19.33	21.23	16.98	2.97	4.15	0.21	64.87
1986	19.51	20.53	16.54	3.07	4.47	0.23	64.35
1987	20.14	19.89	17.14	2.63	4.91	0.25	64.95
1988	20.74	19.54	17.60	2.33	5.66	0.24	66.11
1989	21.35	18.28	17.85	2.80	5.68	0.22	66.16
1990	22.46	17.75	18.36	3.00	6.16	3.06	70.78
1991	21.59	18.01	18.23	2.96	6.58	3.08	70.45
1992	21.59	17.59	18.38	2.58	6.61	3.25	69.98
1993	20.22	16.90	18.58	2.85	6.52	3.26	68.34
1994	22.07	16.49	19.35	2.65	6.84	3.32	70.71
1995	21.98	16.33	19.10	3.18	7.18	3.27	71.04
1996	22.65	16.25	19.30	3.56	7.17	3.39	72.32
1997	23.17	16.11	19.47	3.68	6.69	3.20	72.32

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 1.2, p. 7, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: NGPL = Natural gas plant liquids. Hydroelectric includes pumped storage which represents total pumped storage facility production minus energy used for pumping. Other renewables include electricity produced from wood, waste, wind, and solar sources. There is a discontinuity in this time series between 1989 and 1990 due to expanded coverage of nonelectric utility use of renewable energy beginning in 1990. Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications.

Table 9.3 U.S. Coal Production by Rank, Mining Method, and Location, 1960-1997

	Rank				Mining method		Location		
Year	Bituminous	Subbituminous	Lignite	Anthracite	Underground	Surface	West	East	Total
	million tons								
1960	415.5	i	i	18.8	292.6	141.7	21.3	413.0	434.3
1961	403.0	i	i	17.4	279.6	140.9	21.8	398.6	420.4
1962	422.1	i	i	16.9	287.9	151.1	21.4	417.6	439.0
1963	458.9	i	i	18.3	309.0	168.2	23.7	453.5	477.2
1964	487.0	i	i	17.2	327.7	176.5	25.7	478.5	504.2
1965	512.1	i	i	14.9	338.0	189.0	27.4	499.5	527.0
1966	533.9	i	i	12.9	342.6	204.2	28.0	518.8	546.8
1967	552.6	i	i	12.3	352.4	212.5	28.9	536.0	564.9
1968	545.2	i	i	11.5	346.6	210.1	29.7	527.0	556.7
1969	547.2	8.3	5.0	10.5	349.2	221.7	33.3	537.7	571.0
1970	578.5	16.4	8.0	9.7	340.5	272.1	44.9	567.8	612.7
1971	521.3	22.2	8.7	8.7	277.2	283.7	51.0	509.9	560.9
1972	556.8	27.5	11.0	7.1	305.0	297.4	64.3	538.2	602.5
1973	543.5	33.9	14.3	6.8	300.1	298.5	76.4	522.1	598.6
1974	545.7	42.2	15.5	6.6	278.0	332.1	91.9	518.1	610.0
1975	577.5	51.1	19.8	6.2	293.5	361.2	110.9	543.7	654.6
1976	588.4	64.8	25.5	6.2	295.5	389.4	136.1	548.8	684.9
1977	581.0	82.1	28.2	5.9	266.6	430.6	163.9	533.3	697.2
1978	534.0	96.8	34.4	5.0	242.8	427.4	183.0	487.2	670.2
1979	612.3	121.5	42.5	4.8	320.9	460.2	221.4	559.7	781.1
1980	628.8	147.7	47.2	6.1	337.5	492.2	251.0	578.7	829.7
1981	608.0	159.7	50.7	5.4	316.5	507.3	269.9	553.9	823.8
1982	620.2	160.9	52.4	4.6	339.2	499.0	273.9	564.3	838.1
1983	568.6	151.0	58.3	4.1	300.4	481.7	274.7	507.4	782.1
1984	649.5	179.2	63.1	4.2	352.1	543.9	308.3	587.6	895.9
1985	613.9	192.7	72.4	4.7	350.8	532.8	324.9	558.7	883.6
1986	620.1	189.6	76.4	4.3	360.4	529.9	325.9	564.4	890.3
1987	636.6	200.2	78.4	3.6	372.9	545.9	336.8	581.9	918.8
1988	638.1	223.5	85.1	3.6	382.2	568.1	370.7	579.6	950.3
1989	659.8	231.2	86.4	3.3	393.8	586.9	381.7	599.0	980.7
1990	693.2	244.3	88.1	3.5	424.5	604.5	398.9	630.2	1,029.1
1991	650.7	255.3	86.5	3.4	407.2	588.8	404.7	591.3	996.0
1992	651.8	252.2	90.1	3.5	407.2	590.3	409.0	588.6	997.5
1993	576.7	274.9	89.5	4.3	351.1	594.4	429.2	516.2	945.4
1994	640.3	300.5	88.1	4.6	399.1	634.4	467.2	566.3	1,033.5
1995	613.8	328.0	86.5	4.7	396.2	636.7	488.7	544.2	1,033.0
1996	630.8	340.3	88.1	4.8	409.8	654.0	500.2	563.7	1,063.9
1997	629.3	366.9	87.6	4.9	419.1	669.5	511.3	577.3	1,088.6

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 7.2, p. 191, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: i = included in bituminous coal. Location refers to east and west of the Mississippi River. Totals may not agree with sum of components due to independent rounding. Previous-year data may have been revised. Current-year data are estimates and may be revised in future publications.

Table 9.4 U.S. Petroleum Production and Net Imports, 1950-1997

Year	Production: Crude oil	Production: NGPL	Production: Total	Net imports	Year	Production: Crude oil	Production: NGPL	Production: Total	Net imports
	million barrels per day					*million barrels per day*			
1950	5.41	0.50	5.91	0.55	1974	8.77	1.69	10.46	5.89
1951	6.16	0.56	6.72	0.42	1975	8.37	1.63	10.01	5.85
1952	6.27	0.61	6.87	0.52	1976	8.13	1.60	9.74	7.09
1953	6.46	0.65	7.11	0.63	1977	8.24	1.62	9.86	8.56
1954	6.34	0.69	7.03	0.70	1978	8.71	1.57	10.27	8.00
1955	6.81	0.77	7.58	0.88	1979	8.55	1.58	10.14	7.99
1956	7.15	0.80	7.95	1.01	1980	8.60	1.57	10.17	6.36
1957	7.17	0.81	7.98	1.01	1981	8.57	1.61	10.18	5.40
1958	6.71	0.81	7.52	1.42	1982	8.65	1.55	10.20	4.30
1959	7.05	0.88	7.93	1.57	1983	8.69	1.56	10.25	4.31
1960	7.04	0.93	7.96	1.61	1984	8.88	1.63	10.51	4.72
1961	7.18	0.99	8.17	1.74	1985	8.97	1.61	10.58	4.29
1962	7.33	1.02	8.35	1.91	1986	8.68	1.55	10.23	5.44
1963	7.54	1.10	8.64	1.91	1987	8.35	1.60	9.94	5.91
1964	7.61	1.16	8.77	2.06	1988	8.14	1.62	9.76	6.59
1965	7.80	1.21	9.01	2.28	1989	7.61	1.55	9.16	7.20
1966	8.30	1.28	9.58	2.37	1990	7.36	1.56	8.91	7.16
1967	8.81	1.41	10.22	2.23	1991	7.42	1.66	9.08	6.63
1968	9.10	1.51	10.60	2.61	1992	7.17	1.70	8.87	6.94
1969	9.24	1.59	10.83	2.93	1993	6.85	1.74	8.58	7.62
1970	9.64	1.66	11.30	3.16	1994	6.66	1.73	8.39	8.05
1971	9.46	1.69	11.16	3.70	1995	6.56	1.76	8.32	7.89
1972	9.44	1.74	11.18	4.52	1996	6.46	1.83	8.29	8.50
1973	9.21	1.74	10.95	6.02	1997	6.41	1.84	8.25	8.90

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 5.1, p. 117, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: Crude oil includes lease condensate. NGPL = Natural gas plant liquids. Net imports = imports minus exports. Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications.

Table 9.5 U.S. Natural Gas Production, 1960-1997

Year	Well with-drawals	Repres-suring	Nonhydro-carbon gas removal	Vented and flared	Marketed production	Extraction loss	Total pro-duction
	trillion cubic feet						
1960	15.09	1.75	na	0.56	12.77	0.54	12.23
1961	15.46	1.68	na	0.52	13.25	0.59	12.66
1962	16.04	1.74	na	0.43	13.88	0.62	13.25
1963	16.97	1.84	na	0.38	14.75	0.67	14.08
1964	17.54	1.65	na	0.34	15.55	0.72	14.82
1965	17.96	1.60	na	0.32	16.04	0.75	15.29
1966	19.03	1.45	na	0.38	17.21	0.74	16.47
1967	20.25	1.59	na	0.49	18.17	0.78	17.39
1968	21.33	1.49	na	0.52	19.32	0.83	18.49
1969	22.68	1.46	na	0.53	20.70	0.87	19.83
1970	23.79	1.38	na	0.49	21.92	0.91	21.01
1971	24.09	1.31	na	0.28	22.49	0.88	21.61
1972	24.02	1.24	na	0.25	22.53	0.91	21.62
1973	24.07	1.17	na	0.25	22.65	0.92	21.73
1974	22.85	1.08	na	0.17	21.60	0.89	20.71
1975	21.10	0.86	na	0.13	20.11	0.87	19.24
1976	20.94	0.86	na	0.13	19.95	0.85	19.10
1977	21.10	0.93	na	0.14	20.03	0.86	19.16
1978	21.31	1.18	na	0.15	19.97	0.85	19.12
1979	21.88	1.25	na	0.17	20.47	0.81	19.66
1980	21.87	1.37	0.20	0.13	20.18	0.78	19.40
1981	21.59	1.31	0.22	0.10	19.96	0.77	19.18
1982	20.27	1.39	0.21	0.09	18.58	0.76	17.82
1983	18.66	1.46	0.22	0.09	16.88	0.79	16.09
1984	20.27	1.63	0.22	0.11	18.30	0.84	17.47
1985	19.61	1.92	0.33	0.09	17.27	0.82	16.45
1986	19.13	1.84	0.34	0.10	16.86	0.80	16.06
1987	20.14	2.21	0.38	0.12	17.43	0.81	16.62
1988	21.00	2.48	0.46	0.14	17.92	0.82	17.10
1989	21.07	2.48	0.36	0.14	18.10	0.78	17.31
1990	21.52	2.49	0.29	0.15	18.59	0.78	17.81
1991	21.75	2.77	0.28	0.17	18.53	0.83	17.70
1992	22.13	2.97	0.28	0.17	18.71	0.87	17.84
1993	22.73	3.10	0.41	0.23	18.98	0.89	18.10
1994	23.58	3.23	0.41	0.23	19.71	0.89	18.82
1995	23.74	3.57	0.39	0.28	19.51	0.91	18.60
1996	24.05	3.51	0.52	0.27	19.75	0.96	18.79
1977	24.31	3.66	0.50	0.26	19.89	0.93	18.96

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 6.2, p. 169, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: Withdrawals are from both gas and oil wells. Extraction loss refers to volume reduction resulting from the removal of natural gas plant liquids. Total production refers to dry natural gas. Beginning in 1965, all volumes are shown on a pressure base of 14.73 p.s.i.a. at 60 degrees F. Totals may not agree with sum of components due to independent rounding. Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications.

Table 9.6 U.S. Electricity Utility Net Generation, 1960-1997

Year	Coal	Natural gas	Petroleum	Nuclear electric power	Conventional hydroelectric power	Geothermal energy	Other renewable energy	Total
	billion kilowatt-hours							
1960	403.1	158.0	48.0	0.5	145.8	(s)	0.1	755.5
1961	421.9	169.3	48.5	1.7	152.2	0.1	0.1	793.8
1962	450.2	184.3	48.9	2.3	168.6	0.1	0.1	854.5
1963	493.9	201.6	52.0	3.2	165.8	0.2	0.1	916.8
1964	526.2	220.0	57.0	3.3	177.1	0.2	0.1	984.0
1965	570.9	221.6	64.8	3.7	193.9	0.2	0.3	1,055.3
1966	613.5	251.2	78.9	5.5	194.8	0.2	0.3	1,144.4
1967	630.5	264.8	89.3	7.7	221.5	0.3	0.3	1,214.4
1968	684.9	304.4	104.3	12.5	222.5	0.4	0.4	1,329.4
1969	706.0	333.3	137.8	13.9	250.2	0.6	0.3	1,442.2
1970	704.4	372.9	184.2	21.8	247.7	0.5	0.1	1,531.9
1971	713.1	374.0	220.2	38.1	266.3	0.5	0.1	1,612.6
1972	771.1	375.7	274.3	54.1	272.6	1.5	0.1	1,749.7
1973	847.7	340.9	314.3	83.5	272.1	2.0	0.1	1,860.7
1974	828.4	320.1	300.9	114.0	301.0	2.5	0.1	1,867.1
1975	852.8	299.8	289.1	172.5	300.0	3.2	0.0	1,917.6
1976	944.4	294.6	320.0	191.1	283.7	3.6	0.1	2,037.7
1977	985.2	305.5	358.2	250.9	220.5	3.6	0.3	2,124.3
1978	975.7	305.4	365.1	276.4	280.4	3.0	0.2	2,206.3
1979	1,075.0	329.5	303.5	255.2	279.8	3.9	0.3	2,247.4
1980	1,161.6	346.2	246.0	251.1	276.0	5.1	0.3	2,286.4
1981	1,203.2	345.8	206.4	272.7	260.7	5.7	0.2	2,294.8
1982	1,192.0	305.3	146.8	282.8	309.2	4.8	0.2	2,241.2
1983	1,259.4	274.1	144.5	293.7	332.1	6.1	0.2	2,310.3
1984	1,341.7	297.4	119.8	327.6	321.2	7.7	0.5	2,416.3
1985	1,402.1	291.9	100.2	383.7	281.1	9.3	0.7	2,469.8
1986	1,385.8	248.5	136.6	414.0	290.8	10.3	0.5	2,487.3
1987	1,463.8	272.6	118.5	455.3	249.7	10.8	0.8	2,572.1
1988	1,540.7	252.8	148.9	527.0	222.9	10.3	0.9	2,704.3
1989	1,553.7	266.6	158.3	529.4	265.1	9.3	2.0	2,784.3
1990	1,559.6	264.1	117.0	576.9	283.4	8.6	2.1	2,808.2
1991	1,551.2	264.2	111.5	612.6	280.1	8.1	2.0	2,825.0
1992	1,575.9	263.9	88.9	618.8	243.7	8.1	2.1	2,797.2
1993	1,639.2	258.9	99.5	610.3	269.1	7.6	2.0	2,882.5
1994	1,635.5	291.1	91.0	640.4	247.1	6.9	2.1	2,910.7
1995	1,652.9	307.3	60.8	673.4	296.4	4.7	1.7	2,994.5
1996	1,737.5	262.7	67.3	674.7	331.1	5.2	1.9	3,077.4
1997	1,788.7	283.6	79.0	629.4	341.4	5.5	1.9	3,125.5

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 8.3, p. 213, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: (s) = less than 0.0005 quadrillion Btu. Other renewable energy includes wood, waste, wind, and solar energy. Totals may not agree with sum of components due to independent rounding. Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications.

Table 9.7 U.S. Nuclear Power Plant Operations, 1958-1997

Year	Operable nuclear generating units	Net generation of electricity	Year	Operable nuclear generating units	Net generation of electricity
	number of units	*billion kilowatt-hours*		*number of units*	*billion kilowatt-hours*
1958	1	0.2	1978	70	276.4
1959	2	0.2	1979	69	255.2
1960	3	0.5	1980	71	251.1
1961	3	1.7	1981	75	272.7
1962	9	2.3	1982	78	282.8
1963	11	3.2	1983	81	293.7
1964	13	3.3	1984	87	327.6
1965	13	3.7	1985	96	383.7
1966	14	5.5	1986	101	414.0
1967	15	7.7	1987	107	455.3
1968	13	12.5	1988	109	527.0
1969	17	13.9	1989	111	529.4
1970	20	21.8	1990	112	576.9
1971	22	38.1	1991	111	612.6
1972	27	54.1	1992	109	618.8
1973	42	83.5	1993	110	610.3
1974	55	114.0	1994	109	640.4
1975	57	172.5	1995	109	673.4
1976	63	191.1	1996	109	674.7
1977	67	250.9	1997	107	629.4

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 9.1, p. 241 and Table 9.2, p. 243, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: Operable nuclear generating units are those facilities holding full-power licenses, or equivalent permission to operate at the end of the year. Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications.

Table 9.8 U.S. Net Energy Imports by Source, 1960-1997

Year	Coal	Natural gas (dry)	Petroleum	Other	Total
			quadrillion Btu		
1960	-1.02	0.15	3.57	0.04	2.74
1965	-1.37	0.44	5.01	- 0.02	4.06
1966	-1.35	0.47	5.21	- 0.01	4.32
1967	-1.35	0.50	4.91	- 0.02	4.04
1968	-1.37	0.58	5.73	- 0.02	4.90
1969	-1.53	0.70	6.42	- 0.02	5.56
1970	-1.93	0.77	6.92	- 0.04	5.72
1971	-1.54	0.88	8.07	(s)	7.41
1972	-1.53	0.97	9.83	0.05	9.32
1973	-1.42	0.98	12.98	0.14	12.68
1974	-1.57	0.91	12.66	0.19	12.19
1975	-1.74	0.90	12.51	0.08	11.75
1976	-1.57	0.92	15.20	0.09	14.65
1977	-1.40	0.98	18.24	0.20	18.02
1978	-1.00	0.94	17.06	0.33	17.32
1979	-1.70	1.24	16.93	0.27	16.75
1980	-2.39	0.96	13.50	0.18	12.25
1981	-2.92	0.86	11.38	0.33	9.65
1982	-2.77	0.90	9.05	0.28	7.46
1983	-2.01	0.89	9.08	0.36	8.31
1984	-2.12	0.79	9.89	0.40	8.96
1985	-2.39	0.90	8.95	0.41	7.87
1986	-2.19	0.69	11.53	0.36	10.38
1987	-2.05	0.94	12.53	0.49	11.91
1988	-2.45	1.22	14.01	0.37	13.15
1989	-2.57	1.28	15.33	0.14	14.18
1990	-2.70	1.46	15.29	0.03	14.08
1991	-2.77	1.67	14.22	0.25	13.37
1992	-2.59	1.94	14.96	0.33	14.64
1993	-1.78	2.25	16.40	0.32	17.19
1994	-1.69	2.52	17.26	0.50	18.58
1995	-2.14	2.74	16.87	0.42	17.90
1996	-2.19	2.85	18.21	0.39	19.26
1997	-2.00	2.88	19.12	0.39	20.39

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 1.4, p. 11, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: Net imports = imports minus exports. Other includes coal coke and small amounts of electricity transmitted across U.S. borders with Canada and Mexico. (s) = less than 0.0005 quadrillion Btu. Totals may not agree with sum of components due to independent rounding. Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications.

Table 9.9 U.S. Energy Consumption by Sector, 1960-1997

Year	Residential & commercial	Industrial	Transportation	Total
	quadrillion Btu			
1960	13.04	20.16	10.60	43.80
1961	13.44	20.25	10.77	44.46
1962	14.27	21.04	11.23	46.53
1963	14.71	21.95	11.66	48.32
1964	15.23	23.27	12.00	50.50
1965	16.03	24.22	12.43	52.68
1966	17.06	25.50	13.10	55.66
1967	18.10	25.72	13.75	57.57
1968	19.23	26.90	14.86	61.00
1969	20.59	28.10	15.50	64.19
1970	21.71	28.63	16.09	66.43
1971	22.59	28.57	16.72	67.89
1972	23.69	29.86	17.71	71.26
1973	24.14	31.53	18.60	74.28
1974	23.72	30.70	18.12	72.54
1975	23.90	28.40	18.25	70.55
1976	25.02	30.24	19.10	74.36
1977	25.39	31.08	19.82	76.29
1978	26.09	31.39	20.61	78.09
1979	25.81	32.61	20.47	78.90
1980	26.65	30.61	19.69	75.96
1981	25.24	29.24	19.51	73.99
1982	25.63	26.14	19.07	70.85
1983	25.63	25.75	19.13	70.52
1984	26.48	27.86	19.80	74.14
1985	26.70	27.22	20.07	73.98
1986	26.85	26.63	20.81	74.30
1987	27.62	27.83	21.45	76.89
1988	28.92	28.99	22.30	80.22
1989	29.42	29.36	22.56	81.35
1990	29.45	32.12	22.54	84.12
1991	30.12	31.78	22.12	84.03
1993	30.05	33.03	22.46	85.55
1993	31.17	33.31	23.88	87.37
1994	31.42	34.26	23.57	89.25
1995	32.30	34.48	24.07	90.86
1996	33.69	35.51	24.66	93.87
1997	33.72	35.67	24.81	94.21

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 2.1, p. 37, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: Energy sources include coal, natural gas, petroleum, electricity, and electrical system energy losses. Beginning in 1990, sources also include renewable energy. Industrial also includes hydroelectric power and net imports of coal coke. Totals may not agree with sum of components due to independent rounding. Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications.

Table 9.10 U.S. Energy Consumption per Capita and per Dollar of Gross Domestic Product, 1960-1997

Year	Total energy consumption	Population	Energy consumption per capita	Gross Domestic Product (GDP)	Energy consumption per dollar of GDP
	quadrillion Btu	*million people*	*million Btu*	*billion chained (1992) dollar*	*thous Btu per chained (1992) $*
1960	43.80	179.3	244	2,262.9	19.36
1961	44.46	183.0	243	2,314.3	19.21
1962	46.53	185.8	250	2,454.8	18.96
1963	48.32	188.5	256	2,559.4	18.88
1964	50.50	191.1	264	2,708.4	18.64
1965	52.68	193.5	272	2,881.1	18.29
1966	55.66	195.6	285	3,069.2	18.13
1967	57.57	197.5	292	3,147.2	18.29
1968	61.00	199.4	306	3,293.9	18.52
1969	64.19	201.4	319	3,393.6	18.92
1970	66.43	203.2	327	3,397.6	19.55
1971	67.89	206.8	328	3,510.0	19.34
1972	71.26	209.3	340	3,702.3	19.25
1973	74.28	211.4	351	3,916.3	18.97
1974	72.54	213.3	340	3,891.2	18.64
1975	70.55	215.5	327	3,873.9	18.21
1976	74.36	217.6	342	4,082.9	18.21
1977	76.29	219.8	347	4,273.6	17.85
1978	78.09	222.1	352	4,503.0	17.34
1979	78.90	224.6	351	4,630.6	17.04
1980	75.96	226.5	335	4,615.0	16.46
1981	73.99	229.6	322	4,720.7	15.67
1982	70.85	232.0	305	4,620.3	15.33
1983	70.52	234.3	301	4,803.7	14.68
1984	74.14	236.5	314	5,140.1	14.42
1985	73.98	238.7	310	5,323.5	13.90
1986	74.30	241.1	308	5,487.7	13.54
1987	76.89	243.4	316	5,649.5	13.61
1988	80.22	245.8	326	5,865.2	13.68
1989	81.35	248.2	328	6,062.0	13.42
1990	84.12	248.8	338	6,136.3	13.71
1991	84.03	252.1	333	6,079.4	13.82
1992	85.55	255.0	336	6,244.4	13.70
1993	87.37	257.8	339	6,389.6	13.67
1994	89.25	260.3	343	6,610.7	13.50
1995	90.86	262.8	346	6,742.1	13.48
1996	93.87	265.2	354	6,928.4	13.55
1997	94.21	267.6	352	7,189.6	13.10

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997,* Table 1.5, p. 13, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications.

Table 9.11 U.S. Renewable Energy Production by Source, 1960-1997

Year	Conventional hydroelectric power	Geothermal energy	Biofuels	Solar energy	Wind energy	Total renewable energy	Percentage of total U.S. energy production
	quadrillion Btu						*%*
1960	1.608	0.001	0.002	0	0	1.610	3.88
1961	1.656	0.002	0.001	0	0	1.660	3.95
1962	1.816	0.002	0.001	0	0	1.820	4.18
1963	1.771	0.004	0.001	0	0	1.776	3.87
1964	1.886	0.005	0.002	0	0	1.892	3.96
1965	2.059	0.004	0.003	0	0	2.066	4.19
1966	2.062	0.004	0.003	0	0	2.069	3.97
1967	2.347	0.007	0.003	0	0	2.357	4.28
1968	2.349	0.009	0.004	0	0	2.362	4.16
1969	2.648	0.013	0.003	0	0	2.665	4.51
1970	2.634	0.011	0.004	0	0	2.649	4.27
1971	2.824	0.012	0.003	0	0	2.839	4.63
1972	2.864	0.031	0.003	0	0	2.899	4.64
1973	2.861	0.043	0.003	0	0	2.907	4.68
1974	3.177	0.053	0.003	0	0	3.232	5.31
1975	3.155	0.070	0.002	0	0	3.227	5.39
1976	2.976	0.078	0.003	0	0	3.057	5.10
1977	2.333	0.077	0.005	0	0	2.416	4.01
1978	2.937	0.064	0.003	0	0	3.005	4.92
1979	2.931	0.084	0.005	0	0	3.020	4.73
1980	2.900	0.110	0.005	0	0	3.014	4.65
1981	2.758	0.123	0.004	0	0	2.885	4.48
1982	3.266	0.105	0.003	0	0	3.374	5.28
1983	3.527	0.129	0.004	0	(s)	3.661	5.97
1984	3.386	0.165	0.009	0	(s)	3.560	5.40
1985	2.970	0.198	0.014	0	(s)	3.183	4.91
1986	3.071	0.219	0.012	0	(s)	3.303	5.13
1987	2.635	0.229	0.015	0	(s)	2.879	4.43
1988	2.334	0.217	0.017	0	(s)	2.569	3.89
1989	2.798	0.197	0.020	(s)	(s)	3.015	4.56
1990	3.032	0.344	2.632	0.063	0.023	6.094	8.61
1991	3.005	0.349	2.642	0.066	0.027	6.089	8.64
1992	2.618	0.361	2.788	0.068	0.030	5.864	8.38
1993	2.893	0.375	2.784	0.071	0.031	6.154	9.01
1994	2.683	0.370	2.838	0.072	0.036	5.999	8.48
1995	3.206	0.321	2.846	0.073	0.033	6.479	9.12
1996	3.594	0.339	2.938	0.075	0.035	6.981	9.65
1997	3.723	0.366	2.723	0.075	0.039	6.925	9.57

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 1.2, p. 7, DOE/EIA-0035(97) (GPO, Washington, DC, 1998).

Notes: (s) = less than 0.0005 quadrillion Btu. Current-year data are preliminary and may be revised in future publications. This table provides detail on renewable energy production summarized in Part III, Table 9.2. See Part III, Table 9.12 for definitions of different renewable energy sources.

Table 9.12 U.S. Renewable Energy Consumption by Sector, 1990-1997

Year	Residential and commercial	Industrial	Trans-portation	Electric utility	Total
	quadrillion Btu				
1990	0.645	2.217	0.082	3.252	6.197
1991	0.680	2.234	0.065	3.326	6.304
1992	0.714	2.360	0.079	2.975	6.128
1993	0.664	2.449	0.088	3.225	6.426
1994	0.656	2.533	0.097	3.023	6.309
1995	0.717	2.487	0.104	3.454	6.763
1996	0.722	2.633	0.074	3.886	7.315
1997	0.553	2.612	0.097	3.883	7.145

Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1997*, Table 10.2, p. 251, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

Notes: Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications. Renewable energy refers to energy derived from the following sources: conventional hydroelectric power, geothermal power, biofuels, solar energy, and wind energy. Hydroelectricity generated by pumped storage is not included in renewable energy estimates. Conventional hydroelectric power includes electricity net imports from Canada that are derived from hydroelectric energy. Geothermal power includes electricity imports from Mexico that are derived from geothermal energy. Geothermal includes only grid-connected electricity; excludes shaft power and remote electrical power. Biofuels are wood, wood waste, peat, wood sludge, municipal solid waste, agricultural waste, straw, tires, landfill gases, fish oil, and/or other waste, and ethanol blended into motor gasoline. Solar energy includes photovoltaic energy. Wind energy includes only grid-connected electricity; excludes direct heat applications. Previous-year data may have been revised. Current-year data are preliminary and may be revised in future publications.

Table 9.13 Estimates of U.S. Energy Intensity by Sector, Selected Years, 1977-1996

				Transportation	
Year	Residential	Commercial	Manufacturing	Passenger automobiles	Freight trucks
	million Btu per household	*thousand Btu per sq. ft.*	*thous. Btu per 1987 $ value of shipments*	*thous. Btu per vehicle-mile*	*thous. Btu per vehicle-mile*
1977	na	na	6.0	8.96	23.87
1978	138	na	5.8	8.84	24.01
1979	126	115.0	5.7	8.65	24.26
1980	114	na	5.5	7.92	24.43
1981	114	na	5.4	7.67	24.89
1982	103	na	4.9	7.49	24.30
1983	na	98.2	4.7	7.38	23.74
1984	105	na	4.5	7.22	23.36
1985	na	na	4.4	7.18	23.02
1986	na	86.6	4.2	7.21	22.92
1987	101	na	4.2	6.98	22.39
1988	na	na	4.3	6.70	22.59
1989	na	91.6	4.3	6.60	22.39
1990	98	na	4.3	6.18	22.77
1991	na	na	4.4	5.93	22.71
1992	na	80.9	na	5.97	22.56
1993	104	na	na	6.10	22.31
1994	na	na	5.0	6.04	22.16
1995	na	90.5	na	5.92	22.17
1996	na	na	na	5.87	21.96

Sources: Davis, T.C., *Transportation Energy Databook: Edition 18,* Table 2.14, p. 2-16, and Table 2.15, p. 2-17, ORNL-6941 (U.S. Department of Energy, Oak Ridge National Laboratory, Oak Ridge, TN, 1998).

U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1995*, Table 2.4, p. 45, DOE/EIA-0384(95) (GPO, Washington, DC, 1996).

--, *Annual Energy Review 1997* Table 2.4, p. 43 and Table 2.11, p. 57, DOE/EIA-0384(97) (GPO, Washington, DC, 1998).

--, 1994 MECS Tables and Spreadsheets (Internet accessible data files; release date May 14, 1998) (DOE, EIA, Washington, DC, 1998).

Notes: na = not available. Residential energy intensity data are derived from the Residential Energy Consumption Survey which was first conducted in 1978 and then triennially since 1984. (Residential energy consumption data for 1997 were not available at the time of this printing.) Commercial energy intensity data are from the Commercial Buildings Energy Consumption Survey, first conducted in 1979 and then triennially since 1983. Manufacturing energy intensity data are derived from the triennial Manufacturing Energy Consumption Survey (MECS). The next MECS will be conducted for the reporting year 1998, with subsequent MECS's being conducted every 4 years thereafter. Transportation energy intensity data are reported annually. Freight trucks refers to heavy single-unit and combination trucks.

Transportation

Table 10.1 U.S. Passenger-Miles of Travel, Five-Year Intervals, 1960-1990, and Annually, 1991-1996

Year	Highway	Transit	Rail	Air	Total
	billion passenger-miles				
1960	1,418.00	4.20	17.10	33.40	1,473.00
1965	1,678.00	4.10	13.30	57.60	1,753.00
1970	2,092.00	4.60	6.20	117.50	2,220.00
1975	2,362.00	4.50	3.90	147.40	2,518.00
1980	2,562.00	39.90	4.50	219.00	2,803.00
1985	2,845.90	39.60	4.80	290.10	3,158.00
1990	3,305.00	41.10	6.00	358.90	3,689.00
1991	3,631.00	40.70	6.30	350.30	4,007.00
1992	3,746.00	40.30	6.10	365.50	4,137.00
1993	3,825.00	39.40	6.20	372.30	4,223.00
1994	3,918.00	39.60	5.90	398.80	4,343.00
1995	3,868.00	39.80	5.50	414.40	4,308.00
1996	3,962.00	41.30	5.10	445.20	4,412.00

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics 1998*, Table 1-10 (DOT, BTS, Washington, DC, 1998).

Notes: BTS has rounded the categories on this table as follows: to the nearest billion passenger-miles; Passenger-Miles, total; Highway; to the nearest 100 million passenger-miles: Air; Transit; and Rail. Highway includes passenger car and taxi, motorcycle, other 2-axle 4-tire vehicle, single unit 2-axle 6-tire or more truck, combination truck, intercity bus, and school bus. Highway passenger-miles are calculated by multiplying vehicle-miles of travel as cited by the U.S. Department of Transportation, Federal Highway Administration by the number of occupants for each vehicle type (as estimated by the U.S. Department of Transportation, Federal Highway Administration using the Nationwide Personal Transportation Survey). Transit includes motor bus, light rail, heavy rail, trolley bus, commuter rail, demand response, ferry boat, and other. Transit passenger-miles are the cumulative sum of the distance ridden by each passenger. Rail includes intercity/Amtrak, which began operations in 1971. Rail passenger-miles represent the movement of one passenger for one mile. Does not include contract commuter passengers. Air includes air carrier, certified domestic service and general aviation. Air carrier passenger-miles are computed by the summation of the products of the aircraft miles flown on each inter-airport hop multiplied by the number of passengers carried on that hop.

Table 10.2 U.S. Ton-Miles of Freight, Five-Year Intervals, 1960-1990, and Annually, 1991-1996

Year	Intercity truck	Class I rail	Domestic air carrier	Domestic water	Oil pipeline
			billion ton-miles		
1960	285.00	572.31	0.55	413.33	229.00
1965	359.00	697.88	1.35	489.80	306.40
1970	412.00	764.81	2.19	596.20	431.00
1975	454.00	754.25	3.47	565.98	507.00
1980	555.00	918.96	4.53	921.84	588.20
1985	610.00	876.98	5.16	892.97	564.30
1990	735.00	1,033.97	9.06	833.54	584.10
1991	758.00	1,038.88	8.86	848.40	578.50
1992	815.00	1,066.78	9.82	856.69	588.80
1993	861.00	1,109.31	10.68	789.66	592.90
1994	908.00	1,200.70	11.80	814.92	591.40
1995	921.00	1,305.69	12.52	807.73	601.10
1996	986.00	1,355.98	12.86	764.69	619.20

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics 1998*, Table 1-11 (DOT, BTS, Washington, DC, 1998).

Notes: Air includes revenue ton-miles of freight, U.S. and foreign mail, and express. Rail includes revenue ton-miles. Domestic water excludes intraterritorial traffic, for which ton-miles were not compiled. Domestic water data for 1980 reflect start up between 1975 and 1980 of Alaska pipeline and subsequent water transport of crude petroleum from Alaskan ports to mainland U.S. for refining.

Table 10.3 Average Annual U.S. Vehicle-Miles of Travel and Average Miles Traveled per Gallon of Fuel Consumed by Vehicle Type, 1960-1997

Year	Passenger cars[1]		Buses[2]		Other 2-axle, 4-tire vehicles[3]		Single-unit trucks[4]		Trailer combin-ation trucks	
	1,000 vmt	*vmt/ gallon*	*1,000 vmt*	*vmt/ gallon*	*1,000 vvmt*	*vmt/ gallon*	*1,000 vmt*	*vmt/ gallon*	*1,000 vmt*	*vmt/ gallon*
1960	9.52	14.3	15.97	5.3	na	na	na	na	na	na
1961	9.52	14.4	15.71	5.3	na	na	na	na	na	na
1962	9.49	14.3	15.67	5.3	na	na	na	na	na	na
1963	9.59	14.6	15.06	5.4	na	na	8.60	8.8	42.63	4.9
1964	9.67	14.6	15.12	5.3	na	na	8.68	8.7	41.48	4.9
1965	9.60	14.5	14.90	5.3	na	na	9.20	9.3	40.26	4.8
1966	9.73	14.1	14.06	5.4	8.08	9.7	6.55	6.2	39.00	5.2
1967	9.85	14.1	13.69	5.4	7.88	9.8	6.63	6.3	40.25	5.2
1968	9.92	13.9	14.00	5.4	8.38	9.9	6.56	6.5	39.64	5.0
1969	9.92	13.6	13.23	5.4	8.36	9.8	7.34	6.7	38.70	4.8
1970	9.99	13.5	12.04	5.5	8.68	10.0	7.36	6.8	38.82	4.8
1971	10.10	13.6	12.09	5.7	9.08	10.2	7.69	6.9	40.49	4.9
1972	10.17	13.5	13.14	5.8	9.53	10.3	8.02	6.5	42.34	5.0
1973	9.88	13.4	13.63	5.9	9.78	10.5	8.15	6.4	44.37	5.1
1974	9.22	13.6	12.72	5.9	9.45	11.0	7.94	6.4	42.37	5.1
1975	9.31	14.0	13.10	5.8	9.83	10.5	8.18	6.4	41.32	5.1
1976	9.42	13.8	13.08	6.0	10.13	10.8	8.37	6.4	40.56	5.1
1977	9.52	14.1	11.87	6.0	10.61	11.2	8.84	6.3	44.92	5.1
1978	9.50	14.3	11.65	5.9	10.97	11.6	9.46	6.1	46.95	5.2
1979	9.06	14.6	11.29	6.0	10.80	11.9	9.33	6.0	48.32	5.2
1980	8.81	16.0	11.46	6.0	10.44	12.2	9.10	5.8	48.47	5.3
1981	8.87	16.5	11.48	5.9	10.24	12.5	8.88	5.8	54.82	5.1
1982	9.05	16.9	10.41	5.9	10.28	13.5	9.40	6.0	55.93	5.2
1983	9.12	17.1	8.92	5.9	10.50	13.7	10.12	6.1	56.43	5.3
1984	9.25	17.4	7.95	5.7	11.15	14.0	10.94	6.1	57.74	5.5
1985	9.42	17.5	7.55	5.4	10.51	14.3	9.89	6.1	55.63	5.6
1986	9.46	17.4	7.94	5.3	10.76	14.6	10.58	6.2	57.56	5.6
1987	9.72	18.0	8.85	5.8	11.11	14.9	11.47	6.4	55.89	5.7
1988	9.97	18.8	8.89	5.8	11.47	15.4	11.06	6.4	53.11	5.8
1989	10.16	19.0	9.07	6.0	11.68	16.1	11.26	6.5	53.82	5.8
1990	10.28	20.3	9.13	6.4	11.90	16.1	11.57	6.2	55.21	5.8
1991	10.32	21.2	9.11	6.7	12.25	17.0	11.81	6.5	57.14	5.7
1992	10.57	21.0	8.96	6.6	12.38	17.3	12.33	6.5	59.40	5.8
1993	10.55	20.6	9.36	6.6	12.43	17.4	12.88	6.7	61.37	5.8
1994	10.76	20.8	9.56	6.6	12.16	17.3	12.49	6.8	64.78	5.8
1995	11.20	21.1	9.37	6.6	12.02	17.3	12.48	6.8	68.08	5.8
1996	11.33	21.2	9.45	6.6	11.81	17.2	12.17	6.8	68.08	5.9
1997	11.58	21.5	9.80	6.7	12.11	17.2	12.63	7.0	69.55	6.1

Sources: U.S. Department of Transportation, Federal Highway Administration, Office of Highway Information Management, *Highway Statistics 1997*, Table VM-1 (GPO, Washington, DC, 1998) and earlier reports in this series.

Notes: [1]Includes motorcycles. [2]Includes commercial, school, and non-revenue buses. [3]Includes vans, pickup trucks, and sport/utility vehicles which are considered passenger vehicles. Prior to 1966, these vehicles were included in the single-unit truck category. [4]Includes 2-axle, 6-tire or more trucks on a single frame.

Table 10.4 U.S. Personal Travel per Household, Driver, and Mode, 1969, 1977, 1983, 1990, and 1995

Characteristics		Year				
of personal travel	Unit	1969	1977	1983	1990	1995
Persons per household	*no.*	3.16	2.83	2.69	2.56	2.44
Licensed drivers per household	*no.*	1.65	1.69	1.72	1.75	1.79
Vehicles per household	*no.*	1.16	1.59	1.68	1.77	1.78
Daily vehicle trips per household	*no.*	3.83	3.95	4.07	4.66	6.35
Daily vehicle miles per household	*mi.*	34.01	32.97	32.16	41.37	57.25
Average vehicle occupancy rate	*per./veh.*	na	1.90	1.70	1.60	1.59
Home to work	*per./veh.*	na	1.30	1.30	1.10	1.14
Family & personal business	*per./veh.*	na	2.00	1.80	1.80	1.82
Shopping	*per./veh.*	na	2.10	1.80	1.70	1.79
Social & recreation	*per./veh.*	na	2.40	2.10	2.10	2.17
Average vehicle trip length	*mi.*	8.90	8.40	7.90	9.00	9.10
Home to work	*mi.*	9.40	9.10	8.50	10.60	11.60
Family & personal business	*mi.*	6.50	6.80	6.70	7.40	na
Shopping	*mi.*	4.40	5.00	5.30	5.10	na
Social & recreation	*mi.*	13.10	10.30	10.50	11.80	na
Vacation	*mi.*	160.00	77.90	113.90	114.90	na
Average distance to work	*mi.*	9.40	9.20	8.50	10.60	11.60
by automobile	*mi.*	9.40	9.10	9.90	10.40	na
by truck	*mi.*	14.20	10.60	11.40	13.00	na
by bus	*mi.*	8.70	7.20	8.60	9.30	na
Average annual travel per driver	*1,000 mi.*	8.69	9.92	10.29	13.13	na
by male drivers	*1,000 mi.*	11.35	13.40	13.96	16.64	na
by female drivers	*1,000 mi.*	5.41	5.94	6.38	9.53	na
Average annual personal travel*	*1,000 mi.*	7.66	9.47	9.14	10.42	na
by private vehicle	*1,000 mi.*	na	8.15	7.52	9.18	na
by public vehicle	*1,000 mi.*	na	0.25	0.24	0.24	na
by other mode	*1,000 mi.*	na	1.06	1.37	0.97	na

Sources: U.S. Department of Transportation, Federal Highway Administration, *1990 NPTS Databook: Nationwide Personal Transportation Study*, Vol. I (DOT, FHWA, Washington, DC, 1993).

--, *1990 NPTS Databook: Nationwide Personal Transportation Study*, Vol. II (DOT, FHWA, Washington, DC, 1995).

--, *Our Nation's Travel: 1995 NPTS Early Results Report, Technical Appendix* (DOT, FHWA, Washington, DC, 1997).

Notes: *per person. Household vehicles include automobiles, station wagons, and vanbuses/mini-buses, and, except for 1969, light pickups and other light trucks. Household vehicles are those that are owned, leased, rented, or company owned and left at home to be regularly used by household members. They also include vehicles used solely for business purposes or business-owned vehicles if left at home and used for the home-to-work trip (e.g., taxicabs and police cars). Average vehicle trip length for 1969 is for automobiles only. Family and personal business includes vehicle trips to shop, pickup or deposit passengers, shoe repair, haircuts, etc. Social/recreation includes vehicle trips to visit relatives and friends, go to a movie or play, attend or participate in a sporting event, etc. Private vehicle modes of travel include automobile, van, pick-up truck, and motorcycle. Public transportation includes bus, commuter rail, subway, elevated rail, streetcar, and trolley. Other includes airplane, Amtrak, taxi, school bus, moped, bicycle, and, except for 1969, walking.

Table 10.5 Journey-To-Work Mode for U.S. Working Population, 1960-1990

Mode of transportation	1960	1970	1980	1990
	U.S. working population, in millions			
Private vehicle	42.99	61.96	83.02	101.29
Public transit	7.81	6.51	6.01	5.89
Walked to work	6.42	5.69	5.41	4.49
Worked at home	4.66	2.69	2.18	3.41
Total	61.87	76.85	96.62	115.07
	percent of U.S. working population			
Private vehicle	69.48	80.63	85.92	88.02
Public transit	12.62	8.48	6.22	5.12
Walked to work	10.37	7.40	5.60	3.90
Worked at home	7.54	3.49	2.26	2.96

Source: U.S. Department of Commerce, Bureau of the Census, *Census of Population and Housing* for 1960, 1970, 1980, and 1990 (GPO, Washington, DC, decennial).

Table 10.6 Congestion on U.S. Urban Interstate Highways, Selected Years, 1975-1997

Year	Peak-hour travel time under congested conditions	Peak-hour miles traveled under congested conditions	Average daily vehicles per lane
	percent with V/SF > or = 0.80		thousands
1975	41	23	na
1978	48	29	na
1980	52	28	na
1982	53	28	na
1984	55	30	9.99
1985	61	36	10.33
1986	63	37	10.79
1987	64	38	11.21
1988	67	42	11.68
1989	69	44	11.99
1990	69	45	12.26
1991	70	47	12.42
1992	70	46	12.38
1993	53	32	12.58
1994	68	45	12.81
1995	55	34	13.11
1996	54	33	13.38
1997	55	35	14.16

Source; U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA), *Highway Statistics 1997,* Chart "Urban Interstate System Congestion Trends," p. V-68 (DOT, FHWA, Washington, DC, 1998).

Notes: The FHWA uses several procedures to measure congestion on urban interstate highways: the Volume/Service Flow (V/SF) Ratio; Volume per Lane (average daily travel/lane); and hours of delay/1,000 Vehicle Miles of Travel. Data derived from the first two procedures are presented in this table. The V/FS is a computed numerical value based upon traffic volume information and roadway capacity. As this ratio gets larger, traffic slows and eventually stops as the theoretical value of 1.00 (the volume of traffic = service flow capacity of the facility) is approached. A V/SF ratio value of greater than or equal to 0.80 is used to indicate congestion. Methods used to calculate V/SF have been revised based on research that showed that drivers are willing to follow each other more closely and at higher speeds than previously. Although this change in driving habits occurred over a period of years, the change in procedure occurred abruptly, starting with data for 1993. Thus congestion data for 1993 forward are not strictly comparable to data for previous years. The second measure is calculated from actual counts of average daily travel and the number of lanes per segment of interstate highway. States are required to report annual average daily travel (AADT) for all interstate and principal arterials on a 3-year cycle. AADT is updated annually.

Global Environment

Table 11.1 World Population, Energy Consumption, and Energy-Related Carbon Dioxide Emissions by Region, 1986-1995

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
North America										
Population	346	350	354	358	363	369	374	379	383	388
Energy consumption	89	92	96	98	98	98	99	101	103	106
CO_2 emissions	1,385	1,436	1,515	1,541	1,474	1,494	1,527	1,527	1,663	1,694
Cen. & So. America										
Population	327	333	339	346	352	358	364	370	376	383
Energy consumption	13	13	14	14	14	15	15	16	17	17
CO_2 emissions	163	175	178	179	177	186	194	204	224	234
Western Europe										
Population	446	448	451	454	457	460	463	466	468	471
Energy consumption	61	62	63	64	64	65	64	64	64	66
CO_2 emissions	909	912	883	912	920	900	885	872	859	890
Eastern Europe										
Population	379	382	383	385	390	392	392	392	392	393
Energy consumption	70	72	74	73	71	67	63	59	53	51
CO_2 emissions	1,298	1,347	1,368	1,335	1,223	1,173	1,060	1,009	880	934
Middle East										
Population	116	119	123	126	130	134	137	141	145	149
Energy consumption9	10	10	11	11	11	12	13	13	14	
CO_2 emissions	147	146	157	163	167	312	200	208	235	243
Africa										
Population	574	591	608	624	641	661	682	703	724	746
Energy consumption	10	10	10	10	10	11	11	11	12	12
CO_2 emissions	169	168	178	180	182	186	194	195	198	196
Far East & Oceania										
Population	2,740	2,785	2,836	2,887	2,934	2,982	3,030	3,078	3,145	3,195
Energy consumption	61	64	69	72	74	77	80	86	91	96
CO_2 emissions	1,199	1,256	1,356	1,383	1,449	1,534	1,611	1,659	1,785	1,875
WORLD										
Population	4,927	5,009	5,094	5,180	5,266	5,356	5,442	5,528	5,634	5,724
Energy consumption	313	323	335	341	343	343	345	351	354	362
CO_2 emissions	5,270	5,440	5,635	5,693	5,593	5,785	5,671	5,674	5,844	6,066

Sources: U.S. Department oif Energy, Energy Information Administration, *International Energy Annual 1995*, Appendix Table E1, pp. 169-170, and Appendix Table B1, pp.121-124, DOE/EIA-0219(95) (GPO, Washington, DC, 1996).

Marland, G. and T. Boden, Oak Ridge National Laboratory, *Global CO_2 Emissions From Fossil-Fuel Burning, Cement Production, and Gas Flaring :1751-1996* (an Internet accessible numerical database) (Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, TN, 1999).

Notes: Population is expressed in millions, energy consumption in quadrillion Btu, and CO_2 emissions in million metric tons of carbon (to convert the latter to carbon dioxide gas emitted, multiply times 3.664). Energy-related carbon dioxide emissions refers to emissions from fossil fuel burning and gas flaring; excludes emissions from cement production. Regional grouping of countries in sources have been reconciled as follows: North America includes Mexico; Western Europe includes Germany and Turkey; Eastern Europe includes the former USSR, and Far East and Oceania includes Centrally Planned Asia.

Table 11.2 Global Emissions of Carbon Dioxide From Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring, Five-Year Intervals, 1950-1960, and Annually, 1961-1996

	Fossil-fuel burning			Cement	Gas		Per
Year	Solids	Liquids	Gas	manufacture	flaring	Total	capita
	million metric tons of carbon						*tons of carbon*
1950	1,070	423	97	18	23	1,630	0.65
1955	1,208	625	150	30	31	2,043	0.74
1960	1,411	850	235	43	39	2,578	0.85
1961	1,349	905	254	45	42	2,595	0.84
1962	1,351	981	277	49	44	2,701	0.86
1963	1,397	1,053	300	51	47	2,849	0.89
1964	1,435	1,138	328	57	51	3,009	0.92
1965	1,461	1,221	351	59	55	3,146	0.94
1966	1,478	1,325	380	63	60	3,306	0.97
1967	1,448	1,424	410	65	66	3,413	0.98
1968	1,448	1,552	445	70	73	3,589	1.01
1969	1,487	1,674	487	74	80	3,802	1.05
1970	1,556	1,838	516	78	87	4,076	1.10
1971	1,556	1,946	554	84	88	4,227	1.12
1972	1,572	2,055	583	89	94	4,395	1.14
1973	1,580	2,240	608	95	110	4,633	1.18
1974	1,577	2,244	618	96	107	4,641	1.16
1975	1,671	2,131	623	95	93	4,613	1.13
1976	1,708	2,313	647	103	109	4,880	1.17
1977	1,770	2,389	646	108	104	5,018	1.19
1978	1,786	2,383	674	116	107	5,066	1.18
1979	1,882	2,534	714	119	100	5,348	1.22
1980	1,936	2,406	725	120	89	5,276	1.19
1981	1,908	2,270	735	121	72	5,105	1.13
1982	1,970	2,178	730	121	69	5,068	1.10
1983	1,976	2,162	732	125	63	5,058	1.08
1984	2,067	2,183	790	128	58	5,226	1.10
1985	2,223	2,171	821	131	57	5,402	1.11
1986	2,284	2,276	840	137	54	5,590	1.13
1987	2,334	2,287	902	143	51	5,718	1.14
1988	2,398	2,390	949	152	53	5,941	1.16
1989	2,432	2,427	983	156	50	6,048	1.16
1990	2,373	2,495	1,019	157	60	6,103	1.15
1991	2,307	2,608	1,036	161	71	6,182	1.15
1992	2,336	2,505	1,024	167	63	6,095	1.12
1993	2,276	2,502	1,056	176	63	6,072	1.10
1994	2,343	2,544	1,082	187	65	6,221	1.10
1995	2,422	2,568	1,154	196	67	6,408	1.13
1996	2,460	2,592	1,196	202	67	6,518	1.13

Source: Marland, G., T. A. Boden, R.J. Andres, A.L. Brenkert, and C.A. Johnston, *Global CO_2 Emissions From Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-1996* (an Internet accessible numerical database) (Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, TN, 1999).

Table 11.3 Global Production and Atmospheric Release of Chlorofluorocarbons, 1960-1996

	CFC-11 Annual		CFC-11 Cumulative			CFC-12 Annual		CFC-12 Cumulative		
Year	Prod	Rel	Prod	Rel	Unrel	Prod	Rel	Prod	Rel	Unrel
	million kilograms									
1960	50	41	287	252	39	99	89	828	695	155
1961	61	52	347	305	48	109	100	937	794	166
1962	78	65	425	370	62	128	115	1,065	909	183
1963	93	80	519	450	77	146	134	1,211	1,043	199
1964	111	95	630	545	94	170	156	1,381	1,198	218
1965	123	108	753	653	111	190	175	1,571	1,374	237
1966	141	121	894	775	133	216	195	1,788	1,569	264
1967	160	138	1,053	912	157	243	220	2,030	1,788	293
1968	183	157	1,237	1,069	186	268	247	2,298	2,035	320
1969	217	182	1,454	1,251	225	297	274	2,595	2,309	351
1970	238	207	1,692	1,457	260	321	300	2,916	2,609	380
1971	263	227	1,955	1,684	300	342	322	3,258	2,931	408
1972	307	256	2,262	1,940	356	380	350	3,638	3,281	448
1973	349	292	2,611	2,233	418	423	387	4,061	3,668	495
1974	370	321	2,981	2,554	472	443	419	4,504	4,087	530
1975	314	311	3,295	2,865	479	381	404	4,885	4,491	516
1976	340	317	3,635	3,182	508	411	390	5,296	4,881	547
1977	321	304	3,955	3,486	529	383	371	5,678	5,252	568
1978	309	284	4,264	3,769	559	372	341	6,050	5,594	608
1979	290	264	4,554	4,033	589	357	338	6,408	5,931	637
1980	290	251	4,843	4,284	632	350	333	6,758	6,264	663
1981	287	248	5,130	4,532	675	351	341	7,109	6,604	683
1982	271	240	5,402	4,771	711	328	337	7,437	6,942	681
1983	292	253	5,693	5,024	755	355	343	7,793	7,285	702
1984	312	271	6,006	5,295	801	382	359	8,175	7,645	735
1985	327	281	6,332	5,576	851	376	368	8,551	8,013	752
1986	350	295	6,683	5,871	912	398	377	8,949	8,389	784
1987	382	311	7,065	6,182	989	425	387	9,374	8,776	833
1988	376	315	7,441	6,496	1,056	421	393	9,795	9,169	871
1989	303	265	7,743	6,761	1,098	380	365	10,175	9,533	896
1990	233	216	7,976	6,978	1,118	231	311	10,406	9,844	822
1991	214	188	8,190	7,166	1,147	225	272	10,631	10,116	781
1992	186	171	8,376	7,337	1,165	216	255	10,847	10,371	747
1993	147	158	8,523	7,495	1,156	215	328	11,062	10,609	729
1994	60	137	8,583	7,632	1,080	134	212	11,195	10,820	655
1995	33	124	8,616	7,756	989	83	189	11,278	11,009	551
1996	22	118	8,638	7,874	893	49	166	11,327	11,175	435

Source: Alternative Fluorocarbons Environmental Acceptability Study, *Production, Sales and Atmospheric Release of Fluorocarbons Through 1996* (an Internet accessible dataset).

Notes: Prod = Produced. Rel = Released. Unrel = Unreleased. Data are rounded to the nearest million kilograms. Production data are voluntarily reported by the chemical industry through a survey conducted by an independent accountant, Grant Thornton LLP. The companies surveyed have production in the following countries: Argentina, Australia, Brazil, Canada, the European Union, Japan, Mexico, South Africa, United States, and Venezuela. Data collected by AFEAS for 1996 represent a fraction of global CFC production, informally estimated to be less than 35%. Global coverage for previous years is estimated to be as follows: 1982, 87%; 1983, 86%; 1984, 85%; 1985, 83%; 1986, 82%; 1987, 80%; 1988, 79%; 1989, 78%; 1990, 70%; 1991, 70%; 1992, 75%; 1993, <75%; 1994, <60%, and 1995, <50%. For years prior to 1982, global coverage is assumed to be 100%. Atmospheric release of CFCs is calculated using data compiled by Grant Thornton LLP and assumptions about the release from end-use applications.

Table 11.4 Global Atmospheric Concentrations of Greenhouse and Ozone-depleting Gases, 1970-1997

Year	Carbon dioxide (CO_2)	Carbon tetra-chloride (CCl_4)	Methyl chloro-form	CFC-11 (CCl_3F)	CFC-12	CFC-113	Total chlorine (gas)	Nitrous oxide (N_2O)	Meth-ane (CH_4)
	ppm	*ppt*	*ppt*	*ppt*	*ppt*	*ppt*	*ppt*	*ppb*	*ppb*
1970	325.5	na	na	na	na	na	na	na	na
1971	326.2	na	na	na	na	na	na	na	na
1972	327.3	na	na	na	na	na	na	na	na
1973	329.5	na	na	na	na	na	na	na	na
1974	330.1	na	na	na	na	na	na	na	na
1975	331.0	na	na	na	na	na	na	na	na
1976	332.0	na	na	na	na	na	na	na	na
1977	333.7	na	na	na	na	na	na	na	na
1978	335.3	88	58	139	257	na	1,457	298	na
1979	336.7	88	63	147	272	na	1,529	299	na
1980	338.5	90	71	158	289	na	1,622	299	na
1981	339.8	91	76	166	305	na	1,698	299	na
1982	341.0	93	82	175	325	26	1,871	301	na
1983	342.6	94	86	182	341	28	1,945	302	na
1984	344.3	95	89	190	355	31	2,024	303	na
1985	345.7	97	93	200	376	36	2,127	304	na
1986	347.0	98	97	209	394	40	2,222	305	1,600
1987	348.8	100	100	219	411	48	2,321	306	1,611
1988	351.3	101	104	231	433	53	2,432	306	1,619
1989	352.8	101	108	240	452	59	2,531	306	1,641
1990	354.0	102	111	249	469	66	2,626	307	1,645
1991	355.5	102	114	254	483	71	2,691	307	1,657
1992	356.3	101	118	260	496	77	2,762	308	1,673
1993	357.0	101	112	262	508	81	2,768	308	1,678
1994	358.9	92	106	262	512	81	2,774	309	1,673
1995	360.9	99	97	261	519	82	na	309	1,681
1996	362.7	98	85	261	524	82	na	310	1,683
1997	363.8	97	73	260	528	83	na	311	1,690

Sources: Carbon dioxide: Keeling, C.D. and T.P. Whorf, Scripps Institution of Oceanography, *Atmospheric CO_2 Concentrations Derived From In Situ Air Samples Collected at Mauna Loa Observatory, Hawaii, 1958-1998* (an Internet accessible numerical database) (Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, TN, 1998).

Trace gases: Prinn, R.G., et al., *Continuous High Frequency Gas Chromatographic Measurements of CH_4, N_2O, CFC-11, CFC-12, CFC-113, Methyl Chloroform, and Carbon Tetrachloride From the ALE/GAGE/AGAGE Network Station at Cape Grim, Tasmania* (an Internet accessible numerical database) (Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, TN, 1998).

Notes: ppm = parts per million. ppb = parts per billion. ppt = parts per trillion. CFC = Chlorofluorocarbon. All estimates are by volume.

Table 11.5 Global and Regional Surface Temperature Anomalies, 1960-1996

	Global	North. Hemi-sphere	South. Hemi-sphere	Trop-ical	South Polar	South Tem-perate	S. Sub-trop-ical	Equa-tor	N. Sub-trop-ical	North Tem-perate	North Polar
	degrees Centigrade										
1960	0.00	-0.11	0.11	0.05	-0.85	0.52	0.23	0.02	-0.09	-0.15	-0.19
1961	0.24	0.24	0.28	0.00	0.24	0.57	0.10	0.11	-0.22	0.55	0.67
1962	0.12	0.13	0.13	-0.05	-0.66	0.68	0.09	-0.11	-0.11	0.23	0.60
1963	0.09	0.16	0.01	0.04	-0.23	0.27	-0.10	-0.04	0.26	0.29	-0.09
1964	-0.24	-0.31	-0.18	-0.23	-0.52	-0.09	-0.08	-0.21	-0.40	-0.27	-0.30
1965	-0.17	-0.24	-0.10	-0.20	-0.43	0.20	-0.18	-0.22	-0.20	-0.40	0.02
1966	-0.05	-0.22	0.11	-0.06	0.60	0.20	-0.19	0.05	-0.03	0.09	-1.45
1967	0.04	0.06	0.01	-0.13	0.39	-0.11	0.03	-0.15	-0.26	0.38	0.30
1968	-0.10	-0.07	-0.13	-0.18	-0.28	0.11	-0.34	-0.04	-0.16	0.05	-0.15
1969	-0.14	-0.14	-0.14	0.23	0.12	-0.68	0.10	0.21	0.37	-0.83	-0.15
1970	-0.05	0.09	-0.19	0.05	0.06	-0.47	-0.11	0.01	0.26	-0.08	0.17
1971	-0.22	-0.16	-0.28	-0.21	0.10	-0.55	-0.20	-0.29	-0.15	-0.16	-0.05
1972	-0.19	-0.20	-0.19	-0.01	0.20	-0.62	-0.05	0.02	0.02	-0.45	-0.34
1973	0.19	0.25	0.13	0.40	0.53	-0.48	0.40	0.37	0.43	-0.13	0.50
1974	-0.03	-0.06	0.01	-0.03	1.01	-0.37	-0.13	0.03	0.01	-0.26	0.15
1975	0.07	0.16	-0.02	0.00	1.09	-0.52	-0.07	-0.01	0.08	0.40	0.01
1976	-0.24	-0.15	-0.33	-0.11	-0.27	-0.49	-0.34	-0.09	0.10	-0.41	-0.20
1977	0.16	0.12	0.20	0.31	0.70	-0.14	0.23	0.28	0.41	-0.09	-0.24
1978	0.10	0.16	0.06	0.24	-0.14	0.03	0.01	0.37	0.34	-0.14	0.15
1979	0.18	0.12	0.23	0.29	0.43	0.16	0.01	0.57	0.29	-0.01	-0.45
1980	0.38	0.31	0.46	0.53	0.97	0.12	0.61	0.32	0.67	0.02	0.15
1981	0.42	0.58	0.26	0.30	0.96	0.07	0.13	0.20	0.57	0.71	0.75
1982	0.20	0.16	0.25	0.43	-0.07	0.07	0.54	0.37	0.37	0.06	-0.29
1983	0.43	0.53	0.34	0.43	0.97	-0.36	0.65	0.46	0.18	1.11	0.12
1984	0.29	0.25	0.34	0.33	0.93	-0.21	0.69	0.11	0.19	0.28	0.44
1985	0.02	-0.21	0.25	0.18	0.53	0.16	0.21	0.24	0.10	-0.69	-0.31
1986	0.14	0.13	0.16	0.26	0.45	-0.17	0.26	0.31	0.21	-0.05	0.13
1987	0.46	0.30	0.61	0.92	0.42	0.10	0.96	1.12	0.68	-0.01	-0.63
1988	0.37	0.41	0.33	0.45	1.37	-0.46	0.44	0.65	0.26	0.45	0.40
1989	0.24	0.48	-0.01	0.15	-0.29	-0.14	0.11	0.28	0.07	0.73	1.02
1990	0.56	0.76	0.36	0.50	0.57	0.01	0.38	0.79	0.33	1.04	1.04
1991	0.48	0.46	0.51	0.55	1.25	-0.03	0.62	0.59	0.44	0.33	0.64
1992	0.14	0.08	0.20	0.40	0.76	-0.69	0.84	0.15	0.22	0.05	-0.23
1993	0.16	0.30	0.02	0.33	-0.09	-0.42	0.35	0.32	0.32	-0.14	1.10
1994	0.35	0.54	0.15	0.55	-0.42	-0.10	0.42	0.65	0.59	0.54	0.36
1995	0.64	0.98	0.28	0.76	0.17	-0.40	0.85	0.64	0.78	1.13	1.45
1996	0.46	0.49	0.42	0.67	1.54	-0.32	0.62	0.35	1.05	-0.16	0.84

Source: Angell, J.K. NOAA Air Resources Laboratory, *Annual and Seasonal Global Temperature Anomalies in the Troposphere and Low Stratosphere, 1958-1996* (Carbon Dioxide Information Analysis Center, Oak Ridge, TN, 1997).

Notes: Estimates are calculated relative to a 1958-1977 reference period mean. Zonal regions are defined as follows: Northern Hemisphere (equator - 90 N); Southern Hemisphere (equator - 90 S); Tropical (30 S - 30 N); South Polar (90 S - 60 S); South Temperate (60 S - 30 S); South Subtropical (30 S - 10 S); Equator (10 N - 10 S); North Subtropical (10 N - 30 N); North Temperate (30 N - 60 N); and North Polar (60 N - 90 N).

Table 11.6 Annual Average Global Temperature, 1866-1997

Year	^oC	^oF	Year	^oC	^oF	Year	^oC	^oF	Year	^oC	^oF
1866	13.93	57.07	1899	13.84	56.91	1932	14.00	57.20	1965	13.85	56.93
1867	13.92	57.06	1900	14.00	57.20	1933	13.87	56.97	1966	13.93	57.07
1868	13.75	56.75	1901	13.96	57.13	1934	14.03	57.25	1967	13.98	57.16
1869	14.03	57.25	1902	13.77	56.79	1935	13.90	57.02	1968	13.90	57.02
1870	13.89	57.00	1903	13.67	56.61	1936	14.01	57.22	1969	14.00	57.20
1871	13.85	56.93	1904	13.57	56.43	1937	14.12	57.42	1970	14.04	57.27
1872	13.95	57.11	1905	13.76	56.77	1938	14.16	57.49	1971	13.89	57.00
1873	13.76	56.77	1906	13.88	56.98	1939	13.98	57.16	1972	13.95	57.11
1874	13.89	57.00	1907	13.61	56.50	1940	14.15	57.47	1973	14.18	57.52
1875	13.86	56.95	1908	13.75	56.75	1941	14.12	57.42	1974	13.94	57.09
1876	13.89	57.00	1909	13.71	56.68	1942	14.11	57.40	1975	13.97	57.15
1877	14.13	57.43	1910	13.79	56.82	1943	14.04	57.27	1976	13.77	56.79
1878	14.17	57.51	1911	13.74	56.73	1944	14.10	57.38	1977	14.15	57.47
1879	13.74	56.73	1912	13.72	56.70	1945	13.99	57.18	1978	14.06	57.31
1880	13.84	56.91	1913	13.76	56.77	1946	14.01	57.22	1979	14.12	57.42
1881	13.87	56.97	1914	14.00	57.20	1947	14.13	57.43	1980	14.26	57.67
1882	13.89	57.00	1915	14.05	57.29	1948	13.98	57.16	1981	14.39	57.90
1883	13.85	56.93	1916	13.79	56.82	1949	13.91	57.04	1982	14.08	57.34
1884	13.57	56.43	1917	13.59	56.46	1950	13.85	56.93	1983	14.34	57.81
1885	13.70	56.66	1918	13.69	56.64	1951	13.98	57.16	1984	14.15	57.47
1886	13.67	56.61	1919	13.93	57.07	1952	14.05	57.29	1985	14.13	57.43
1887	13.50	56.30	1920	13.87	56.97	1953	14.14	57.45	1986	14.17	57.51
1888	13.76	56.77	1921	13.95	57.11	1954	13.93	57.07	1987	14.34	57.81
1889	14.04	57.27	1922	13.91	57.04	1955	13.92	57.06	1988	14.42	57.96
1890	13.68	56.62	1923	13.86	56.95	1956	13.84	56.91	1989	14.28	57.70
1891	13.52	56.34	1924	13.89	57.00	1957	14.09	57.36	1990	14.49	58.08
1892	13.62	56.52	1925	13.85	56.93	1958	14.10	57.38	1991	14.43	57.97
1893	13.60	56.48	1926	14.07	57.33	1959	14.04	57.27	1992	14.14	57.45
1894	13.65	56.57	1927	13.95	57.11	1960	13.98	57.16	1993	14.16	57.49
1895	13.68	56.62	1928	14.00	57.20	1961	14.09	57.36	1994	14.29	57.72
1896	13.77	56.79	1929	13.79	56.82	1962	14.05	57.29	1995	14.43	57.97
1897	13.85	56.93	1930	13.96	57.13	1963	14.04	57.27	1996	14.32	57.78
1898	13.78	56.80	1931	14.02	57.24	1964	13.75	56.75	1997	14.36	57.85

Source: Hansen, J. et al., Goddard Institute for Space Studies, Table of Global-mean Monthly, Annual, and Seasonal dTs Based on Met.station Data, 1866-present (an Internet accessible data file).

Notes: ^oC = degrees Centigrade. ^oF = degrees Fahrenheit. Data are derived from global temperature anomalies in 0.01 degrees Centigrade based on a 1951-1980 reference period mean. Data were checked and adjusted for urban warming.

Appendix

NEPA Statistical Tables

Note to Readers: In *Environmental Quality 1996,* Tables 1, 2, and 4 in the National Environmental Policy Act statistical tables regrettably omitted statistics from the Department of Interior and its agencies and bureaus. These tables should therefore not be relied on for cumulative totals.

Table 1. NEPA Cases by Agency, 1997

Lead Defendent	Number of cases filed	Number of injunctions resulting from 1997 issued cases
Department of Agriculture	30	1
Department of the Army	11	0
Department of Commerce	2	0
Department of Energy	6	0
Department of Housing and Urban Development	2	0
Department of the Interior	29	0
Department of the Navy	2	0
Department of State	1	0
Department of Transportation	14	1
Environmental Protection Agency	1	0
General Services Administration	1	0
U.S. Postal Service	1	0
The President/CEQ	2	0
TOTAL	102	2

Table 2. Lead Plaintiffs for NEPA Lawsuits, 1997

Plaintiffs	Number
Public Interest Organizations and Citizen Groups	56
Individuals	19
Local Governments	7
Business Groups	7
Landowner Associates	4
State and Territorial Governments	3
Members of Congress	2
Unions	1
Water Users Association	1
Intertribal Cooperative	1
Political Party	1
TOTAL	102

Table 3. 1997 Environmental Impact Statements Filed with the Environmental Protection Agency

Agency/Subject	Totals by Subject	Totals
U.S. Department of Agriculture		128
Natural Gas and Oil: Drilling and Exploration	1	
Forestry and Range Management	86	
Parks, Recreation Areas,Wilderness Areas, National Seashores	15	
Land Acquisition or Disposal, Management Jurisdiction Transfer	1	
Watershed Protection and Flood Control	8	
Pesticides, Herbicides Use	5	
Road Construction	1	
Mining (Non-Energy)	6	
Irrigation, Desalination of Return Flow, Agriculture Water Supply	2	
Other Water Projects	3	
U.S. Department of Commerce		15
Wetlands, Estuary and Ocean Use (Sanctuary, Disposal, etc)	3	
Fisheries	4	
Wildlife Refuges, Fish Hatcheries	1	
Other Water Projects	4	
Comprehensive Resource Management	2	
Buildings, Federally Licensed or Assisted (Including Production Facilities)	1	
U.S. Department of the Air Force		14
Military Installations (Conventional, Chemical, Nuclear, etc)	14	
U.S. Department of the Army		13
Military Installations (Conventional, Chemical, Nuclear, etc)	12	
Forestry and Range Management	1	
U.S. Department of the Navy		23
Military Installations (Conventional, Chemical, Nuclear, etc)	21	
Defense Systems	2	
U.S. Marine Corps		4
Military Installations (Conventional, Chemical, Nuclear, etc)	1	
Sewage Treatment and Sewage Facilities	1	
Watershed Protection and Flood Control	2	
U.S. Army Department of the Corps of Engineers		48
Military Installations (Conventional, Chemical, Nuclear, etc)	3	
Beach Erosion, Hurricane Protection, River/Lake Bank Stabilization	3	
Navigation	7	
Dredge and Fill	7	
Watershed Protection and Flood Control	14	
Other Water Projects	5	
Drainage	2	

See next page for continuation of table.

Table 3. 1997 Environmental Impact Statements Filed with the Environmental Protection Agency (continued)

Agency/Subject	Totals by Subject	Totals
U.S. Army Department of the Corps of Engineers (continued)		
Road Improvements	1	
Mining (Non-Energy)	3	
Wetlands, Estuary and Ocean Use (Sanctuary, Disposal, etc.)	1	
Multi-Purpose Impoundments	2	
U.S. Department of Energy		17
Power Facilities: Hydroelectric	1	
Power Facilities: Transmission	2	
Power Facilities: Nuclear (e.g., AEC, TVA)	2	
Power Facilities: Conservation and Other	3	
Comprehensive Resource Management	2	
Radioactive Waste Disposal	2	
Nuclear Development (e.g., Fuel, Reactors)	1	
Other Water Projects	1	
Fisheries	1	
Natural Gas and Oil: Transportation/Pipeline/Storage	2	
U.S. Environmental Protection Agency		5
Dredge and Fill	1	
Mining	3	
Other Water Projects	1	
U.S. General Service Administration		10
Buildings for Federal Use	5	
Road Improvements	1	
Buildings, Federally Licensed or Assisted (including Production Facilities)	4	
U.S. Department of the Interior		80
Natural Gas and Oil: Drilling and Exploration	4	
Land Acquisition or Disposal, Management Jurisdiction Transfer	3	
Parks, Recreation Areas, Wilderness Areas, National Seashores	17	
Forestry and Range Management	19	
Mining (Non-Energy)	15	
Comprehensive Resource Management	3	
Other Water Projects	5	
Wildlife Refuges, Fish Hatcheries	5	
Mining	3	
Irrigation, Desalination of Return Flows, Agriculture Water Supply	3	
Road Construction	1	
Municipal and Industrial Water Supply Systems (Not Multi-Purpose Impoundments)	2	

See next page for continuation of table.

Table 3. 1997 Environmental Impact Statements Filed with the Environmental Protection Agency (continued)

Agency/Subject	Totals by Subject	Totals
U.S. Nuclear Regulatory Commission		2
Power Facilities: Conservation and Other Mining	2	
U.S. Tennessee Valley Authority		6
Power Facilities: Fossil	1	
Power Facilities: Conservation and Other	1	
Power Facilities: Nuclear (e.g., AEC, TVA)	2	
Power Facilities: Transmission	1	
Other Water Projects	1	
U.S. Department of Transportation		100
Road Construction	75	
Airport Improvements	11	
Bridge Permits	5	
Other Permits/Approvals	3	
Mass Transportation	5	
Military Installations (Conventional, Chemical, Nuclear, etc.)	1	
U.S. Federal Energy Regulatory Commission		20
Power Facilities: Hydroelectric	5	
Power Facilities: Conservation and Other	3	
Power Facilities: Transmission	2	
Natural Gas and Oil: Transportation/Pipeline/Storage	7	
U.S. National Capital Planning Commission		2
Parks, Recreation Areas, Wilderness Areas, National Seashores	2	
U.S. Department of Justice		3
Buildings for Federal Use	3	
U.S. Safety Transportation Board		2
Railroads	2	
U.S. National Aeronautics/Space Administration		5
Space Programs	5	
Utah Reclamation Mitigation and Conservation Commission		1
Other Water Projects	1	
TOTAL ALL AGENCIES		498