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Forest Service

Forest
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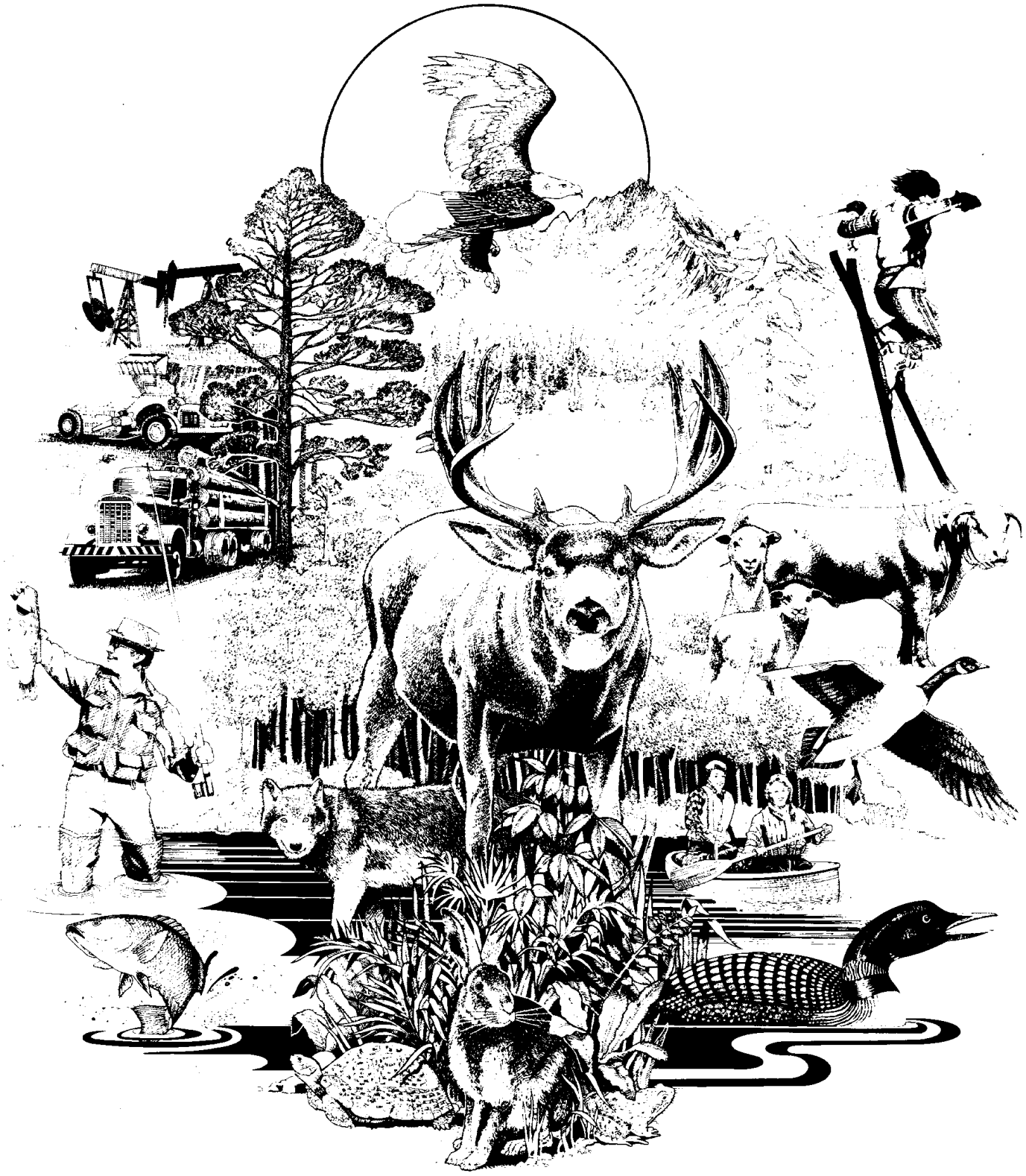
RPA Assessment of the Forest and Rangeland Situation in the United States, 1989



Forest Service Regions and Assessment Regions

United States
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Foreword

The Renewable Resources Planning Act of 1974 (RPA) gives the Forest Service an opportunity to assess the future of the Nation's natural resources.

This 1989 Assessment is the third done since 1974. Its findings are straightforward and not surprising when viewed against the backdrop of the past 5 decades. During this time, the U.S. population increased over 90 percent, and the gross national product more than tripled. Although the economy was affected by World War II, recession, and inflation, the long-term trend was continued growth. The U.S. population and economy will continue to grow in the future. This in turn will increase demands for renewable natural resources, creating investment opportunities on both private and public lands.

A significant feature of the renewable resource base in the United States has been its resilience to use and responsiveness to management. Today, America's renewable resource base is meeting the demands of over 100 million more people than it supplied just 5 decades ago. More intensive use of the renewable resource base in the future will require continued management for multiple uses. But all projections suggest that the opportunitites for increased productivity with balanced attention to all resources will continue to be available.

All of us would like to make the quality of life in the United States even better than it is today. Our renewable resources are the building blocks for the quality of life in America. We can maintain and increase the productivity and quality of the renewable resource base.

This Assessment document identifies opportunities but does not choose among them. It provides the factual basis to formulate possible renewable resource management programs for the future, including the 1990 RPA Recommended Program.

F. Dale Robertson
Chief

Preface

The Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), P.L. 93-378, 88 Stat. 475, as amended, directed the Secretary of Agriculture to prepare a Renewable Resources Assessment by December 31, 1975, with an update in 1979 and each 10th year thereafter. This Assessment is to include "an analysis of present and anticipated uses, demand for, and supply of the renewable resources of forest, range, and other associated lands with consideration of the international resource situation, and an emphasis of pertinent supply, demand and price relationship trends" (sec. 3.(a)).

The 1989 RPA Assessment is the third prepared in response to the RPA legislation. It is composed of 12 documents. This one—the summary Assessment document—presents an overview of analyses of the present situation and the outlook for the land base, outdoor recreation and wilderness, wildlife and fish, forest-range grazing, minerals, timber, and water. Complete analyses for each of these resources are contained in seven supporting technical documents. There are also technical documents presenting information on interactions among the various resources, the basic assumptions for the Assessment, a description of Forest Service programs, and the evolving use and management of the Nation's forests, grasslands, croplands, and related resources.

The Forest Service has been carrying out resource analyses in the United States for over a century. Congressional interest was first expressed in the Appropriations Act of August 15, 1876, which provided $2,000 for the employment of an expert to study and report on forest conditions. Between that time and 1974, Forest Service analysts prepared a number of assessments of the timber resource situation intermittently in response to emerging issues and perceived needs for better resource information. The 1974 RPA legislation established a periodic reporting requirement and broadened the resource coverage from timber alone to all renewable resources from forest and range lands.

Contents

The Setting

Since the 1979 RPA Assessment, the Forest Service has completed new analyses of supply and demand for all of the renewable resources and the land base. The basic data on timber inventory have been updated to 1986 from 1976. The analyses that rely on annual time-series data now include another decade of observations. During this decade, population, incomes, and economic activity expanded, leading to increased consumption or use of nearly all products of forest and range lands and the associated inland waters. We expect population and the economy to continue to grow in the future, which will induce greater use and production from the renewable forest and rangeland resource. More intensive use will increase the value of these resources.

Demands and supplies of renewable resources are dynamic. Consumers of these resources accommodate the changing nature of resource supplies in various ways, including adoption of technologies that change the ways renewable resource outputs are used. Supplies of renewable resource outputs change in response to use, management, and withdrawals. Resource owners and managers respond to the changing demands by varying the amount and character of resource supplies. For example, over the past 3 decades, evolving legislation has provided direction to managers of national forests and thus influenced supplies of renewable resource outputs from these lands. Private landowners sometimes respond to increased demands by charging fees for access to renewable resources that they traditionally provided for free. In other instances, they deny or limit public access to the resources. But the record of the past decades has demonstrated the resiliency of the U.S. renewable resource base and documented that it is possible to improve the quality and quantity of natural resources, even as they are put to beneficial uses. In the future, as in the past, accommodations will be made between demands and supplies through policy actions and management to influence the amount, quality, and value of renewable resource outputs and conditions.

It is the purpose of this Assessment document to summarize the present condition and the prospective demand and supply outlook for the Nation's renewable resources and to identify the implications of these likely future trends for renewable resource management, production, and conditions.

Some of the key assumptions and findings from the 1979 RPA Assessment have been updated to reflect new data and expectations about the future:

1. Recycling of paper and paperboard will become more important as a source of fiber in the United States, just as it has already in Japan and parts of Europe (fig. 1). We currently have a recycling rate of 25 percent, compared to 51 percent in Japan and 47 percent in the European Economic Community. In the Assessment, we assume that the U.S. recycling rate will reach 31 percent by 2040.

2. Consumption of water will lessen as irrigation for agriculture is reduced in the West, but demands for high-quality water, such as for drinking, will continue to grow with the western population.

3. Annual per capita consumption of beef, veal, lamb, and mutton is assumed to remain constant to the year 2040 at 110 lb (carcass weight). (In the 1979 RPA Assessment, it was assumed to increase significantly.) Productivity of private rangeland is assumed to increase because of the consensus view that landowners will implement currently available technologies.

4. Demands for outdoor recreation will generally continue to grow with population growth. An increasing share

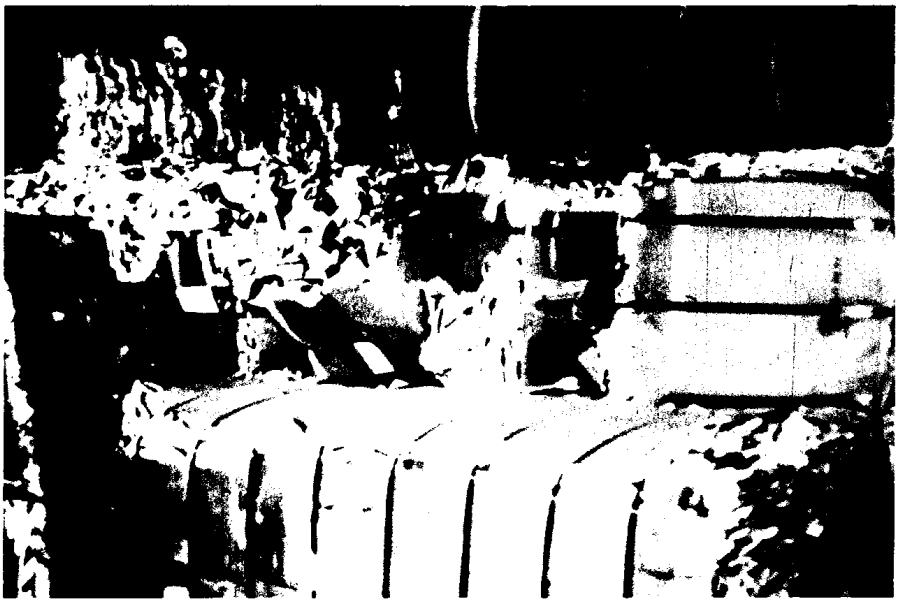


Figure 1—Recycling of paper and paperboard is expected to increase.

Basic Assumptions About Future Determinants of Demand and Supply

of the outdoor recreation demand will be accounted for by recreationists taking shorter trips close to home.

5. The number of people participating in nonconsumptive wildlife recreation, in both warm and cold water fishing and in migratory bird hunting, is expected to rise over the next 5 decades.

6. In general, domestic demand for metallic minerals and precious metals will continue to increase, but demand for any given metallic mineral is likely to be highly variable and dependent on technology and the evolution of end-use markets.

7. Changes in global climate can significantly affect the productivity, health, and diversity of forest and range ecosystems.

In the future, as in the past, demands and supplies of renewable resource products will be determined largely by growth in population, income, and economic activity; technological and institutional changes; energy costs; capital availability; and levels of private and public investments in forest, range, and water management, utilization, and research.

Population

In the past 5 decades, the population of the United States increased by over 100 million people, to some 242 million in 1986, the base year for demand and supply analyses (fig. 2, app. table 1). Projections by the Wharton Econometrics Forecasting Associates using Bureau of the Census assumptions about future population demographics indicate that population will continue to grow, to about 333 million in 2040. The population assumptions are the middle series projections developed by the Bureau of the Census, except that net immigration is assumed to be 750,000 people per year rather than the 450,000-person assumption used in the middle series. This adjustment in the immigration assumption is to account for net illegal immigration.

Economic Activity and Income

Economic activity, as measured by the official gross national product in constant dollars (1982 dollars net of inflation and deflation), increased more than fivefold in the past 5 decades and reached $3.7 trillion in 1986. In this period, there have been major

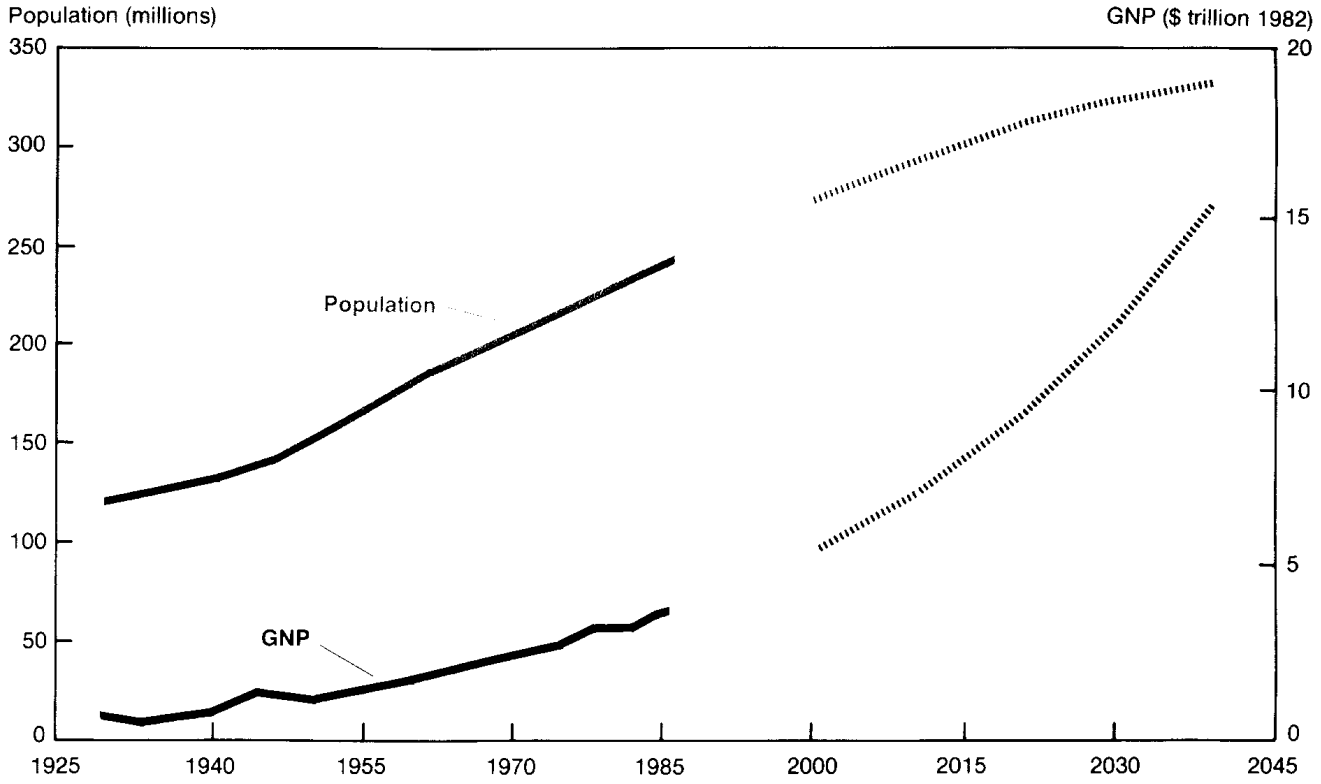


Figure 2—United States population and gross national product, 1929–86, with projections to 2040.

recessions, a world war, and other major shocks to the U.S. economy. In each case, the national economy has recovered, and it is expected to continue to do so in the future. The basic forces for longrun economic growth will continue. Wharton Econometrics projections indicate that the gross national product will reach $15.6 trillion in 2040, over four times its level in 1986. Associated disposable personal income rises to $9.6 trillion, over a threefold increase. Per capita disposable income will increase over 2.5 times, to $28,790.

The assumptions about population, gross national product, and disposable personal income suggest a future with many more people with greater purchasing power—a future with strong growth in demand continuing the historical trend.

Technological and Institutional Change

Past changes in demands and supplies have reflected the interactions and direct influences of institutional and technological changes. We assume that the stream of institutional and technological changes will continue and that the effects of these changes on demands and supplies of renewable resources will be similar to those that have taken place and are included in the historical data base used in making the projections. For some products and/or processes, however, we identified possible future technological changes and made specific allowances for them in projections (fig. 3).

Institutional changes that lead to the reservation of forests and rangelands for designated uses such as wilderness, parks, and wildlife refuges have occurred for a long time. This development is specifically taken into account in the projections of forest and rangeland areas. Assumptions on important technological changes affecting product yields and other uses of the renewable resources are specified in the individual resource Assessment documents as appropriate.

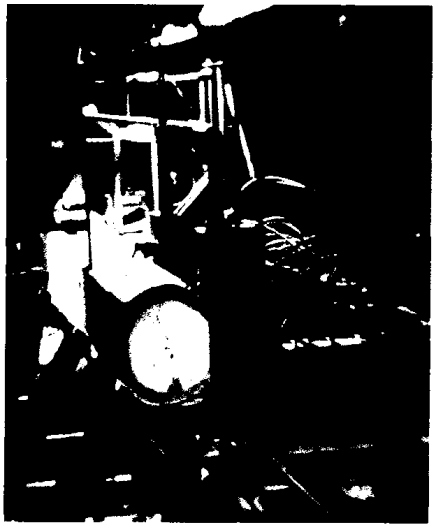


Figure 3—Allowances have been made for expected future changes in technology.

Energy Costs

The apparent consensus view of the long-term outlook for energy costs can be confusing because of the weakness of energy prices in the 1980's. Projections of the U.S. Department of Energy reflect the consensus view of the long-term outlook. These projections show world crude oil prices increasing from $12.22 per barrel in 1986 to $50 per barrel in 2020. Prices are in 1982 dollars net of inflation or deflation. The price of $50 is assumed to be high enough to stimulate development of alternative energy sources with implications for the demand for timber and timber products, especially fuelwood. Thus energy prices are assumed constant from 2020 through 2040. Rising energy prices have been taken into account in projecting demands and supplies for those products.

Capital Availability and Investments

Capital availability has occasionally been raised as an issue in making judgments about the likelihood that future output levels will be realized. Over the years, various analyses have supported the assumption that capital would not be a limiting factor for future production levels. Wharton Econometrics projections of growth in gross national product indicate a growing economy with capital generation. Therefore, we assume that capital will not be a limiting factor for projected outputs of products from forest and range lands and associated waters.

Future supplies will be determined in large measure by management intensity (the level of investment in forest and range lands and associated water resources). Assumptions about future management intensities vary by resource and are discussed as part of the supply outlook for each resource. In general, however, demand and supply projections are strongly influenced by the past historical trend of their basic determinants and reflect the effects of past public programs for assistance.

The Resource Base—Its Size and Ownership

Forest, Rangeland, and Water Areas

Some 1.7 billion acres (about 66 percent of the Nation's total area) are classified as forest or rangeland or are covered with water (fig. 4, app. table 2). A little less than half of this

Figure 4—Forests, rangelands, and water cover two-thirds of the Nation's total area.

territory is currently classified as rangeland. This is land on which the native vegetation (climax or natural potential plant communities) is predominantly grasses, grasslike plants, forbs, or shrubs suitable for domestic livestock or wildlife grazing or browsing use. It includes natural grasslands, savannas, most deserts, shrublands, tundra, alpine plant communities, coastal marshes, wet meadows, and introduced plant communities managed like rangelands. Most of the rangeland is found from the Pacific coast east to include the Great Plains, and in Alaska. Most of the land east of the Great Plains is forested or managed in such a way as to preclude its classification as rangeland.

Almost half of the 1.7 billion acres is also classified as forest and transition land—land that is at least 10 percent stocked with trees, or formerly had such cover, and not developed for other purposes. The two-thirds of the forest land (482 million acres) that can grow more than 20 cubic feet of industrial wood per acre per year is called timberland. In 1986, about 90 percent of the timber harvested came from this area.

Nearly three-quarters of the timberland is in the eastern half of the country. Most of the timberland in the West is located in the Pacific Coast States and in Montana, Idaho, and Colorado.

The Nation's forests and rangelands are underlain by extensive mineral resources. The greatest concentrations occur in the Western Overthrust Belt, the Northern Great Plains, and the Appalachian region.

The rest of the area of the United States, about 5 percent or 109 million acres, is covered by water. A little over half of this area is in lakes (exclusive of the Great Lakes), ponds, and waterways. The rest is in the Great Lakes and coastal waters such as bays, sounds, and straits.

Ownership of Forest and Range Lands and Water

Forest Land and Rangeland—Same 41 percent of the Nation's rangeland is in Federal ownership (fig. 5, app. table 3). Most of this is in the arid and semiarid lands of the Southwest and the tundra, shrub, and muskeg-bog lands of interior Alaska. The rangeland in private ownership is concentrated in the Rocky Mountain and Great Plains States.

A little more than one-third of the Nation's forest land is in Federal ownership. These lands are concentrated in the Rocky Mountains and Pacific Coast States. Their wood volume is mostly timber that has never been harvested, and they contain a large part of the Nation's softwood timber inventory. Some of the high-elevation forests also have great scenic beauty and contribute in important ways to meeting the demand for outdoor recreation.

About three-fourths of the Nation's privately owned forest land is in the eastern part of the country. Much of this area has good soils and other conditions favorable for growing trees and is close to the largest markets for timber products. These private forests are likewise closest to the most highly populated areas of the country and provide opportunities for many kinds of outdoor recreation.

Water—Ownership of inland water is difficult to define because the concept of ownership and access to water can vary by State with private, State, and Federal rights at stake. Water resource laws can originate from several sources, such as Federal and State constitutions and acts of Congress and State legislatures interpreted by the courts and issued by various Federal and State agencies in the form of administrative laws.

In the United States, there are two general doctrines in water law—the appropriation and the riparian. The law of appropriation, which is generally associated with the West, has two basic tenets: (1) a water right can be acquired by the party diverting the water from the water course and applying it to a beneficial use and (2) in accordance with the date of acquisition, an earlier acquired water right will have priority over other, later acquired water rights.

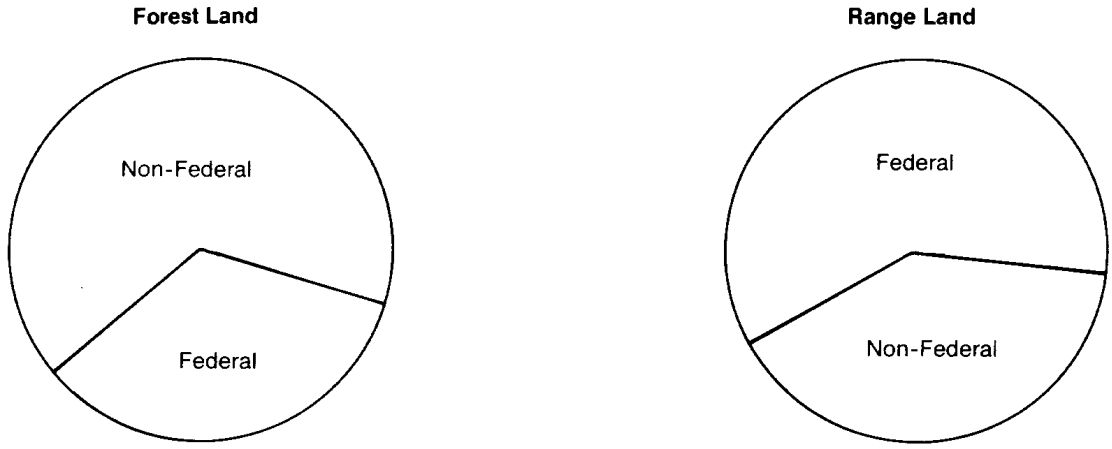


Figure 5—Percentage of forest and range land by ownership.

Generally, in the East, the law of riparian rights entitles adjacent riparian landowners to reasonable use of streamflow in competition with those who divert the stream for economic uses. The major thrust of the riparian law has been to protect private rather than public rights.

Access rights for recreational use of water are also complex. In general, trespass laws apply to land adjoining water, and private owners can deny access. Once access has been achieved, however, water can generally be used for recreation despite the existence of adjacent, posted land.

Thus, well over one-half of the Nation's forest and range land is in private ownership, and rights to water use are predominantly in the hands of the private sector. The dominant ownership of resources by the private sector is reflected in the analyses of demands and supplies presented later in this Assessment.

Productivity of Forest and Range Lands and Water

The productivity (output per acre or other measure of input) of forest and range lands varies widely as a result of differences in climate, soils, elevation, and latitude. Over the years, public and private forestry activities have demonstrated that the land is responsive to management and that productivity and resource quality can be increased through management. For example, one measure of productivity—an index of softwood growing stock growth per unit of inventory—has been increasing over the past several decades (fig. 6, app. table 3). This same measure for hardwoods has been declining because we are harvesting only half the growth (fig. 7, app. table 4). By any measure, the biological potential exists to increase the output of all renewable resource products. New technology or the wider use of existing technology from research is another source of higher productivity. The economic efficiency of any investment depends on the specifics of costs and revenues. Costs and revenues associated with investments are not generally considered explicitly in this Assessment document, but they are considered in the development of the 1990 RPA Program.

Water yields from forest and range lands can be improved by various management practices. Water quality can be improved, and flooding and soil erosion and the associated sedimentation of streams can be restrained.

Forest and range lands in the United States provide forage and browse for over 70 million cattle, 8 million sheep, 55,000 wild horses and burros, 20 million deer, 400,000 elk, 600,000 antelope, and many other grazing animals. Vegetation management

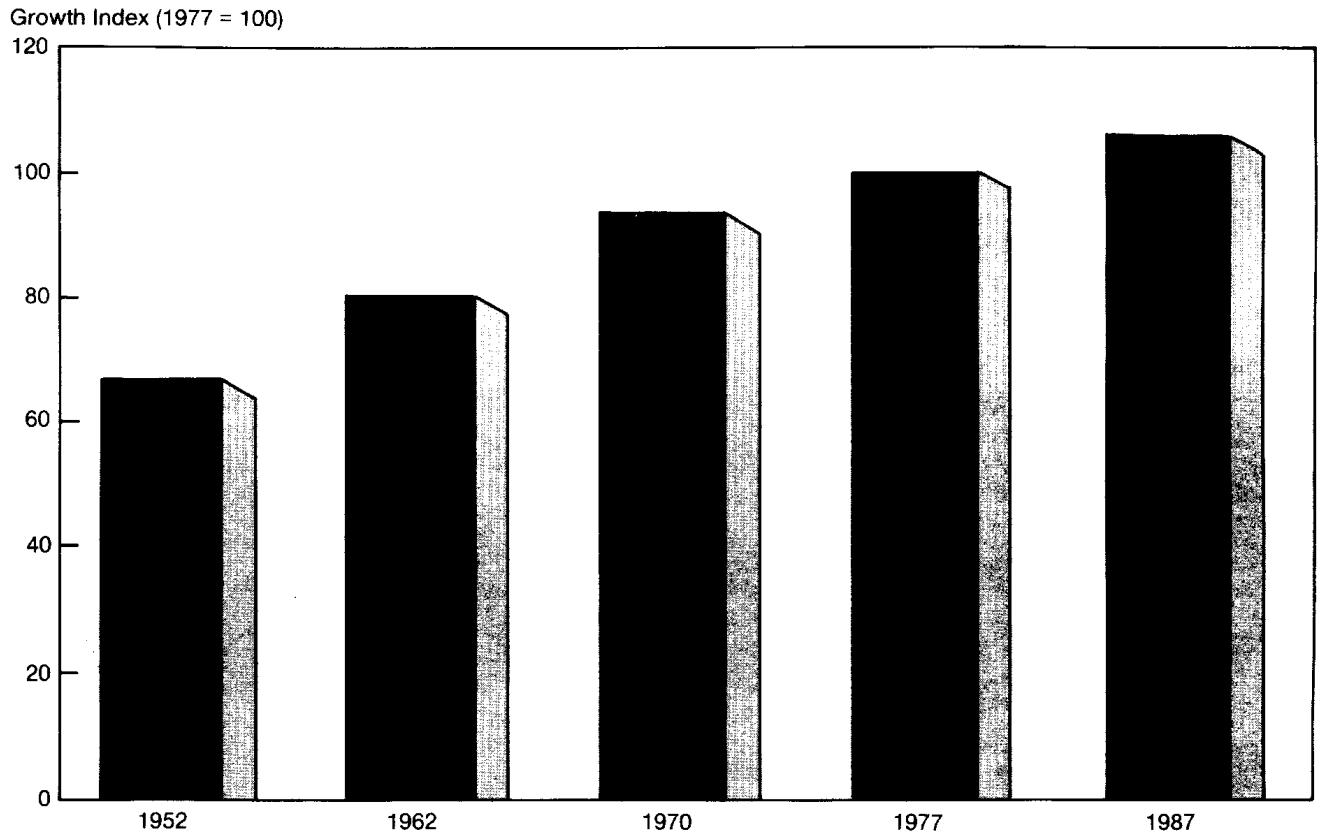


Figure 6—Softwood growth inventory index, all owners, 1952–87.

practices can enhance the production of forage and browse for these animals while protecting fragile soils and watersheds. For example, range forage productivity is assumed to rise 0.7 percent per year on private lands.

The 1.7 billion acres of forest and range lands and water have a large but unmeasured capacity to supply opportunities for picnicking, camping, hiking, skiing, hunting and fishing, wildlife observation, canoeing, swimming, and most other kinds of outdoor recreation far in excess of present use.

Forest and range lands and water also have the potential to foster diversity and increased numbers of most species of wildlife, including those of recreational and commercial importance and endangered or threatened species.

Finally, the known mineral resources on these lands are substantial, and there are undoubtedly reserves yet to be discovered. Thus, there exists the physical potential to increase the productivity of the minerals resource. Productivity in the case of minerals is difficult to define but could be improved by the application of technologies that enhance discovery and by the facilitation of exploratory work.

If it occurs, global climate change can cause major changes in the productivity, health, and diversity of forest and range ecosystems with associated impacts on other renewable resources. How the productivity and health of forest and range ecosystems will change in response to stress associated with changing physical and chemical climate components will be a major scientific and policy issue in the coming decades (fig. 8).

In summary, the Nation's forest and range lands and water have the physical capacity to produce much larger quantities of renewable resource products and support much higher levels of use. A primary objective of this Assessment is to identify opportunities for management of the renewable resource base. These

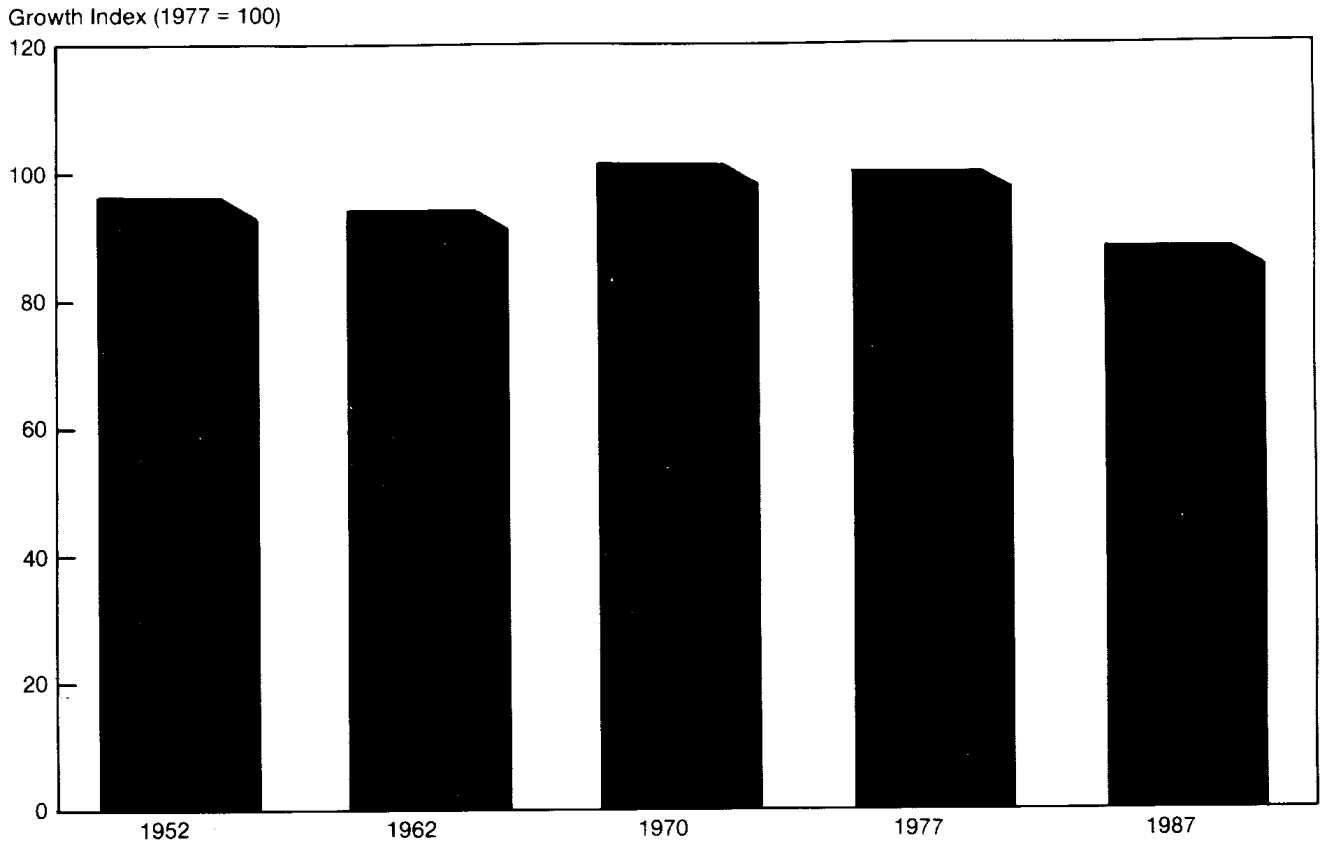


Figure 7—Hardwood growth inventory index, all owners, 1952–87.

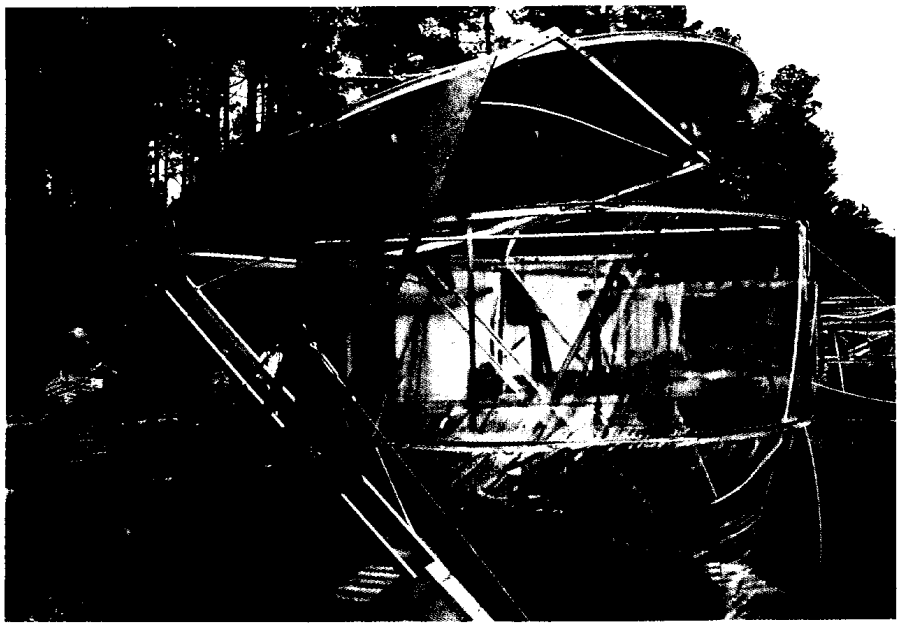


Figure 8—Research is needed to determine the potential effects of global climate change on the productivity of forest and range land. Apparatus such as this open-top chamber are used in climate research.

opportunities may lead to increases in the quantity and/or quality of the use of the resources.

Trends in Areas

In recent years, the area of forest and range land has been declining as these lands have been converted to other uses. The water area has been increasing due to the construction of ponds and lakes (reservoirs). The total output of products from forest and

Timber Demand–Supply—The Outlook

range lands is likely to be affected in the future by changes in area.

These trends in forest and rangeland areas will be influenced somewhat by the Food Security Act of 1985, which established the Conservation Reserve Program and offered incentives for landowners to enroll acreages of highly erodible cropland for conversion to grass or forest land. The law intends that landowners enroll not less than 40 million nor more than 45 million acres in the program. To the extent practicable, not less than one-eighth of the acreage placed in the conservation reserve shall be devoted to trees. In part because of this program, we project the area of rangeland to increase from today's 770 million acres to 820 million acres.

Although the Conservation Reserve Program should add several million acres to the forest land base, an even larger area of existing forest land is expected to be converted to other uses. The net loss is expected to be about 28 million acres by 2040, mainly in the South and Pacific coast regions. Much of the loss in forest land is due to conversions associated with roads and urban space utilized by a growing population.

Outlook Overview

- Demands for all of the major timber products are expected to increase over the next 5 decades.

- Total demands for hardwoods from the domestic timber resource are expected to increase 79 percent, and for softwoods, 35 percent.

- Changes in technology that affect product recovery from roundwood and increased recycling of paper and paperboard are reflected in projections.

- Harvest on forest industry lands is projected to increase 31 percent, to 7.2 billion cubic feet in 2040, reflecting the assumption that these lands will be managed intensively in the future.

- Harvest on other private lands is projected to increase 70 percent, to 15.6 billion cubic feet in 2040.

- For national forests, harvest levels are assumed to reach the sum of harvests for the final forest plans and the preferred alternatives where plans are not yet final by 2000 and to follow these plans after 2000, reaching 2.4 billion cubic feet in 2040 compared with 2.0 billion cubic feet in recent years.

- Supplies from other public lands are assumed relatively constant at recent harvest levels (1.35 billion cubic feet).

- Supplies will meet demands in the U.S. market, but prices will be higher.

- If global climate or other changes in the natural environment were to cause extensive reductions in timber growth, this would have major impacts on the domestic situation, with the effects building over time.

Trends in Timber Use and Projected Demands

Between 1950 and 1980, there was a slight upward trend in lumber consumption, punctuated by well-defined short-term fluctuations (fig. 9). Demand for lumber follows cycles in new housing starts and other general measures of the economy. For example, the severe recession of the early 1980's caused a decline in housing that forced a drop in lumber demand. This was followed in the mid-1980's by record consumption brought on by reduced interest rates that stimulated both new housing and repair and remodeling of existing structures. Demand for softwood plywood rose rapidly through the decades of the 1950's and 1960's, reaching a peak in the early 1970's (fig. 10). Much of this growth was due to the substitution of plywood for lumber in many end uses. By the 1970's, opportunities for this substitution had largely been captured, and demand for plywood began to follow housing cycles, much as for lumber.

The late 1970's and 1980's were years of major changes in the plywood and structural panel industries. Fiber-based structural panels began to make significant inroads into markets for solid softwood plywood. These fiber-based panels have now been accepted in the marketplace and should have major influences on the species and quality of roundwood needed in the structural panel industry. The new panels can be made from almost any species of wood, with the preference being soft hardwoods such as aspen. After the recession of the early 1980's, consumption of structural panels reached record levels in response to the strong markets of the mid-1980's. Future growth in demand for structural panels is expected to be strongest for the new fiber-based panels until 2010,

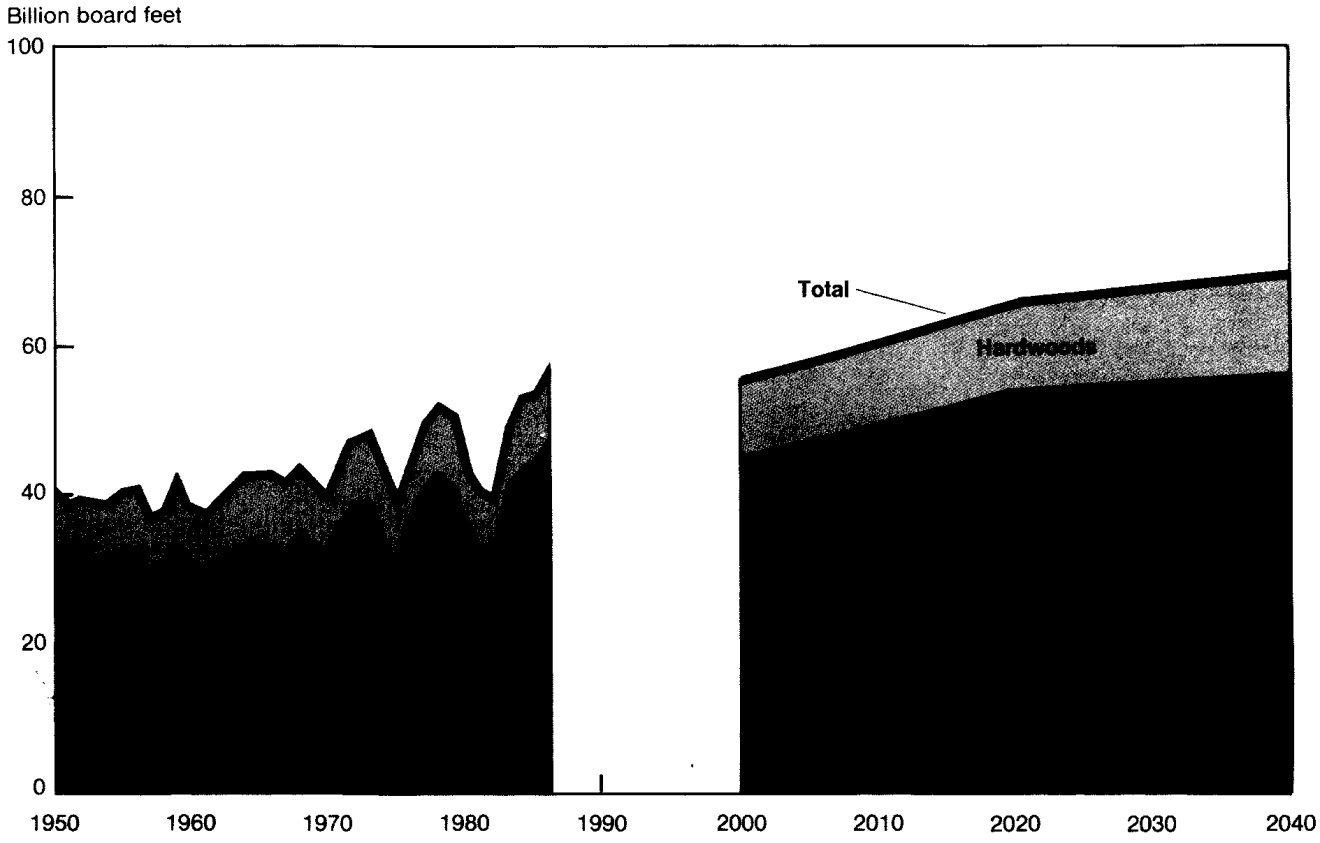


Figure 9—Lumber consumption, 1950–86, with projections to 2040.

when consumption of softwood plywood also begins to rise.

Consumption of wood in the manufacture of pulp, paper, and paperboard grew rapidly in the decades following World War II (fig. 11). This growth in demand was in response to rapid growth in the economy, which stimulated consumption of packaging and other pulp-based products. Much of the increase in consumption of wood fiber during the 1960's and 1970's came from the byproducts of lumber and plywood manufacture. In recent years, the use of hardwood roundwood has increased, and this is expected to continue in the future. In the 1970's, demand for pulp, paper, and paperboard became more susceptible to economic cycles. By the mid-1980's, however, consumption was again at record levels.

The oil-price shocks of the 1970's caused many structural shifts in the U.S. economy. The major impact on timber demand in the United States was the reversal of a long decline in the use of fuelwood (fig. 12). Rising costs for oil and natural gas stimulated both commercial and noncommercial demand for wood as fuel. These structural shifts involved new investments in technology and equipment that are not easily reversed. As a result, consumption of fuelwood continued to increase in the 1980's despite sharp declines in crude oil prices. Although there has been a respite in energy price rises in the 1980's, these prices will probably increase significantly after the turn of the century, with the result that fuelwood demand is expected to continue to grow over the long term. Demand may be dampened by concerns over the effect of woodburning on air quality and by the increasing cost of insurance for homes burning wood.

The longrun demands for all major timber products are projected to go up over the next 5 decades. The projection methodology used takes into account the effects of supplies of products and projects market equilibrium measures of demand and supply. Consumption levels for pulpwood and fuelwood rise

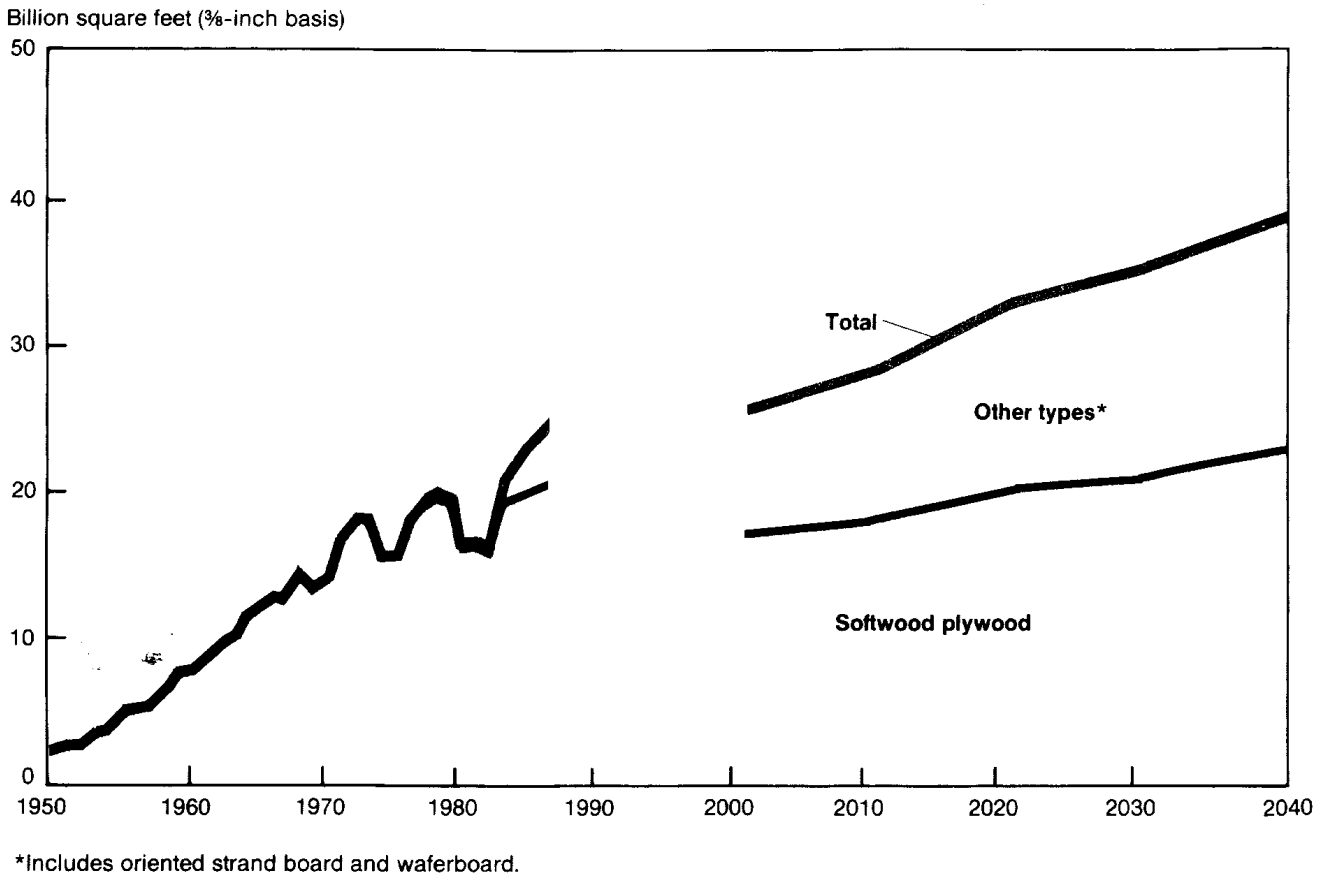


Figure 10—Structural panel consumption, 1950–86, with projections to 2040.

faster than for lumber and plywood. The product mix of future demands will influence the way the Nation's forests are managed in the coming decades (fig. 13). Consumption levels have been presented in the standard measurement units for the various products—board feet for lumber, square feet for plywood, and cords for pulpwood and fuelwood. In table 1, these are converted to cubic feet roundwood equivalent—the volume of roundwood needed from the Nation's forests to produce the various products.

Table 1—Roundwood supplies from U.S. timber resources, by softwoods and hardwoods, specified years, 1952–86, with projections to 2040

Year	Total	Softwoods	Hardwoods
	Billion cubic feet, roundwood equivalent		
1952	9.5	6.9	2.6
1962	9.6	7.1	2.5
1970	11.5	8.7	2.8
1976	12.5	9.5	3.0
1986	18.0	11.7	6.3
	Projections		
2000	20.5	12.1	8.4
2010	23.9	13.4	10.5
2020	25.6	14.5	11.1
2030	26.6	15.3	11.3
2040	27.1	15.8	11.3

Note: Does not include fuelwood from sources other than growing stock.

Consumption of softwoods continues to grow through the projection period, reflecting a growing economy and repair and remodeling of an aging housing inventory. Also, experts believe that, over time, new houses will be bigger, consuming more lumber and structural panels than today's new homes. By 2010, softwood timber consumption will be about 1.2 times consumption in 1986 and in 2040, 1.3 times.

Projected consumption of hardwood timber in 2010 will be some 1.7 times consumption in 1986 and in 2040, 1.8 times, largely due to the rising demands of a growing economy. Demands for pulpwood, fuelwood, and

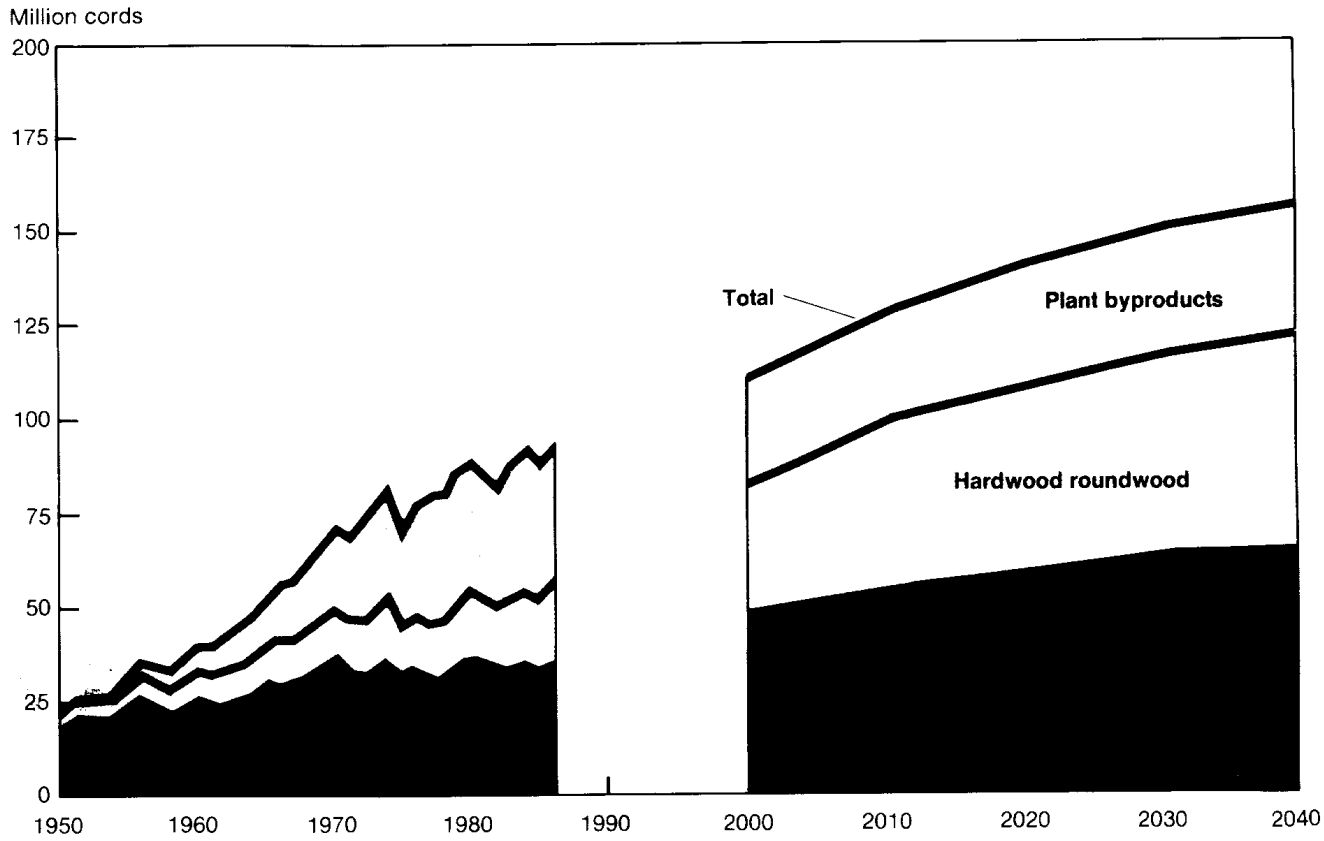


Figure 11—Pulpwood consumption, 1950–86, with projections to 2040.

pallets in particular are expected to increase.

Imports of timber products have been rising and have supplied important parts of the Nation's woodpulp, newsprint, and softwood lumber. Net imports (imports minus exports), however, are expected to decrease from current levels of about 2 billion to 1.6 billion cubic feet by 2040. Much of the decrease is in the later decades of the projection period. Most imports originate from Canada. The 1980's were characterized by several trade disputes with Canada centered on softwood lumber, western redcedar shakes and shingles, and softwood plywood. Similar disagreements have characterized this bilateral trade relationship in earlier decades of the 20th century. It is assumed that the current issues will be resolved over time and that future imports from Canada will be determined largely by U.S. demand and the extent and competitiveness of Canada's timber resource. Canada's longrun supply potential is currently unknown, but many experts feel that historical rates of growth in harvest volume cannot continue in the future. This consensus is reflected in projections of softwood lumber imports from Canada, which stabilize after the turn of the century.

Exports of timber products have also been going up. The outlook for exports varies by product, however. Because of assumed offsetting trends among various products, annual export volumes are projected to increase from 2.0 billion cubic feet currently to 2.5 billion cubic feet by the turn of the century and stay at this level through the projection period.

The volume of imports of logs into the United States has generally been small over the years and has not been a major trade or domestic issue. Beginning in the 1960's and continuing today, however, the export of softwood logs has at various times been a national issue. These exports originate mainly in Washington and Oregon and affect roundwood prices and the structure of the timber industries in that part of the country. The existing prohibition on roundwood exports from Federal lands

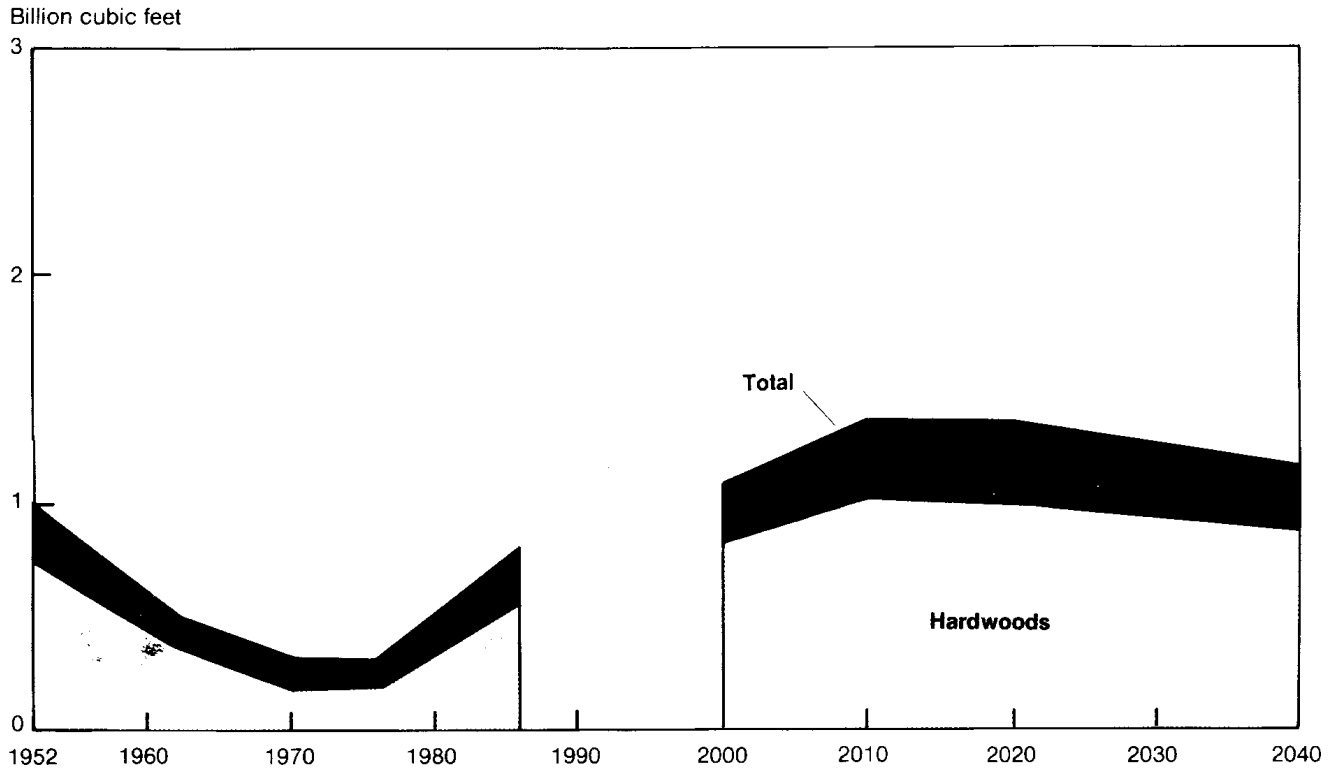


Figure 12—Roundwood fuelwood from growing stock, selected years, 1952–86, with projections to 2040.

Figure 13—Technology is changing the way the timber resource is utilized. Aspen is now being used for structural panels.

in the West has been in effect since 1974 and is assumed to continue. Currently, there are no restrictions on exports from State and private lands, and none are assumed in the future. If restrictions were to be placed on State lands in the West, there would be major effects in local roundwood markets but not much effect on the overall demand-supply situation. The volumes of log exports from State lands are relatively small compared with total U.S. log supply.

It is apparent from the above trends that domestic forest lands must supply most of the higher demands projected for the future.

The Timber Resource

The Nation's timberlands contain some 831 billion cubic feet of roundwood (app. table 5); 91 percent of this is in growing stock (live, sound trees suited for roundwood products) and the remaining 9 percent is in rotten, cull, and salvable dead trees. Some of the latter may be suitable for lumber and veneer, but most is usable only for pulp, fuel, and other products where there are no significant log quality requirements.[1]

Timber inventories rise when net annual growth (total growth less mortality) is greater than the volumes removed by timber harvesting, clearing, or changing land use (timber removals). The growth–removals balance for the United States is positive for all species (1.37), for softwoods (1.13), and for hardwoods (1.90). The ratios in the North are very high, indicating continued substantial increases in growing stock volume. The softwood ratio for the South is declining and approaching 1.00. The growth–removals ratio in the Rocky Mountains exceeds 2.00, and for the Pacific coast, it is 1.07.

The Rocky Mountain region has had a growth–removal balance greater than 1.00 for a long time, but inventories have increased slowly because many of the stands are old, mortality is high, and thus net annual growth is low.

Projected Trends in Timber Supplies

The outlook for timber supplies depends on the trend in area of timberland, current level of inventories, stumpage prices, growth and removals, institutional constraints on timber harvest rates, and investments in forest management.

The area of timberland has been declining consistently for the past couple of decades in the South and Pacific coast regions (fig. 14). Because recent increases in the North and Rocky Mountain regions are believed to be temporary, we assume that timberland area will decline in all regions over the coming decades. By 2040, the loss in area is expected to be some 21 million acres for the country as a whole.

The current growth–removal balances for timber show that the hardwood forests and eastern softwood forests can support additional harvests. However, these balances will change, and future harvests, particularly in the decades beyond 2000, could vary over a wide range. Nonetheless, assuming that timberland owners continue to respond as they have in the past to price and inventory changes and manage their timber stands as projected, timber harvests will be increased substantially in most regions. Total projected softwood roundwood harvests rise from 11.7 billion cubic feet in 1986 to 15.8 billion cubic feet in 2040, an increase of 35 percent. Projected hardwood harvests increase by 79 percent, rising from 6.3 billion cubic feet in 1986 to 11.3 billion in 2040. The largest increases will be in the South.

Assumptions about future management intensities vary by ownership. Forest industry lands in the South and western Washington and Oregon are assumed to be managed intensively to the point where all economic opportunities for management are captured. The projection of intensified management of forest industry lands has important implications for expectations of future harvests on private lands in western Oregon and Washington and the South. In western Oregon and Washington, previous projections of harvests using assumptions of lower management intensity on the industry portion of private lands indicated that current harvest levels could not be maintained for the private ownership category. If industry-owned lands are managed intensively in the future, current total private harvest of about 1.6 billion cubic feet could be maintained and possibly increase as second-growth timber reaches merchantable size after 2010. Research is currently underway to assess the potential of this second growth to be the base for expanded timber harvests in the future. In part because of unexplained growth declines on natural pine stands in the South, harvest volumes are near or exceed net annual growth in some areas. After the turn of the century,

[1] There are additional and large volumes of fiber in treetops, limbs, and bark; in trees under 5 inches in diameter at breast height; and in trees on forest land other than timberland. These volumes, also found in fence rows and in urban areas, are usable for fuel, pulp, and other products where there are no significant log quality requirements. Much of the fuelwood now being used for domestic heating comes from these sources.

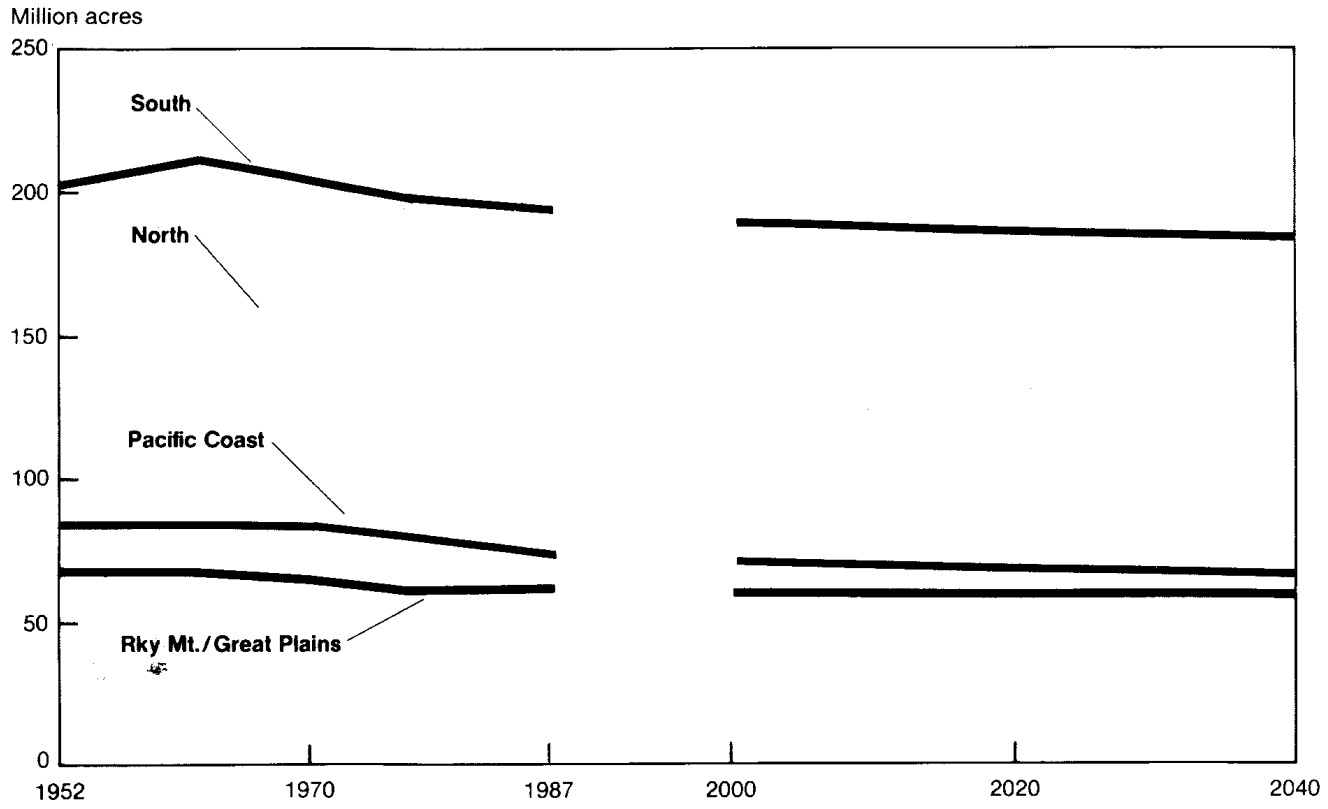


Figure 14—Area of timberland by region, 1952–87, with projections to 2040.

timber from intensively managed plantations forms the basis for expansion of harvests from current levels of some 5 billion cubic feet to over 6.5 billion cubic feet.

Management on private lands other than industry-owned lands is assumed to continue as reflected in the latest inventory remeasurements. Harvests from these lands have generally increased over the past decade, leading to increased landowner interest in regeneration of harvested softwood stands. Management reflects the influence of current government and industry programs, market incentives, and increasing stumpage prices.

Harvests from national forest lands are assumed to gradually change over time and equal the sum of preferred alternatives in forest plans by 2000. Beyond 2000, harvests are assumed to follow the forest plans. Harvest on other public lands is assumed to remain constant at recent levels.

Timber Demand–Supply Comparisons

The projected demand-supply situation implies rising prices for timber. In the U.S. economy, demand and supply for market commodities are equated through price adjustments and the workings of the market. When demand increases faster than supply, price brings the two together by reducing demand and inducing supply increases. This type of situation has existed for lumber at least since the early 1800's (fig. 15). Although there have been long periods when the price of lumber did not increase relative to the general price level, the trend over the long term has continued upward.

In general, it is expected that the price of softwood roundwood will follow the historic trend and continue to increase throughout the projection period, an indicator that demand pressures are rising faster than supply responses. For example, in the South, the real price for softwood sawtimber measured net of inflation or deflation is expected to go up an average rate of 1.03 percent a year during the coming decades. For western Oregon and western Washington, the price increase is projected to be 1.14 percent.

The price outlook for the bulk of the hardwood timber—the smaller sized timber of common species—is for lower prices than for softwood timber. However, after 2000, as hardwood inventories begin to show substantial declines in response to increased removals, stumpage prices are expected to rise.

During recent decades, there have been demand pressures on high-quality preferred hardwood species such as select white and red oak, walnut, hard maple, and black cherry. The resulting stumpage price increases led to the development of substitutes such as plastic overlays for furniture. Although analyses of the past decade have been mixed as to continuation of price rises, it is assumed that prices for preferred species will rise in the future because of strong demands for these species. Rising stumpage prices will be reflected in prices of timber products. For example, softwood lumber prices measured in real terms increase at annual rates of about 0.5 percent over the projection period.

Outlook Overview

- Water demands will increase significantly in the years ahead.

- Limits on water supplies will force reallocation of available supplies among users, especially in some parts of the West.

- Reallocation of supplies will generally be from uses such as irrigation (where quality is not an overriding concern) to municipal use (where quality can be all important).

- Markets may facilitate reallocation of water use, but management of some watersheds, especially on public lands, may become more important from the

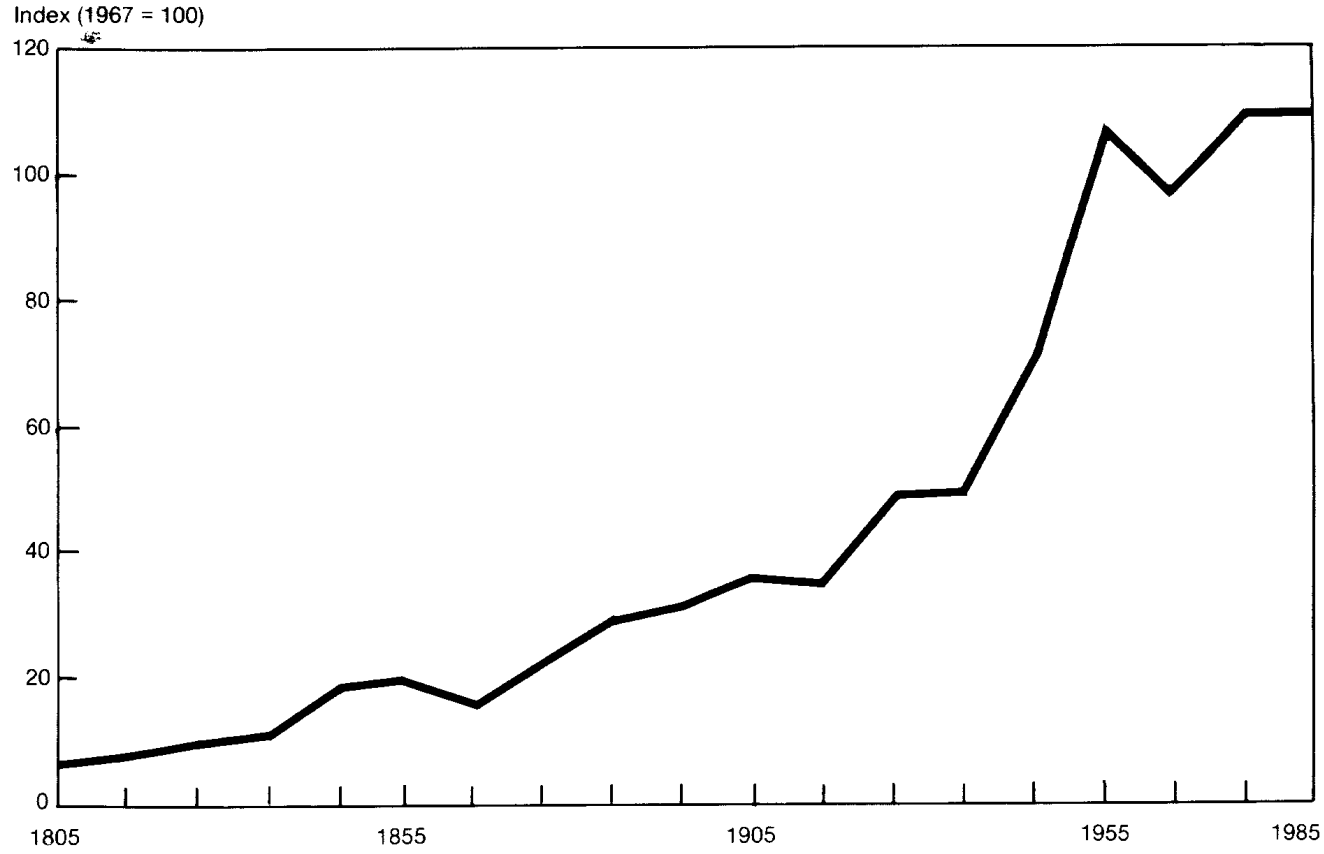


Figure 15—Relative producer price index for lumber, 1805–1985.

standpoint of both water quantity and quality.

- Surface-water quality has been a concern for much of this century. Legislation in the early 1970's targeted point sources of pollution. The private sector's response and strict enforcement of the laws have reduced point sources of pollution and created a real success story—up to 90 percent of our inland surface waters are now fishable and swimmable.

- Various nonpoint sources of pollution are the principal sources of residual problems where surface waters do not meet designated use standards. Ground-water quality concerns could engender significant changes in agricultural practices. Also, water management policies may create situations where uses are not compatible, such as management of water levels in reservoirs without regard to effects on fish and wildlife.

- With regard to fish and wildlife, it is estimated that about 80 percent of the Nation's flowing waters have opportunities to improve water quantity, water quality, fish habitat, or composition of the fish community. However, it is also estimated that some two-thirds of U.S. streams have habitat adequate for sports fish.

- In general, water quality has improved significantly in the last decade, and continued monitoring and enforcement of laws and regulations should make it even better.

- Average annual flood damages are expected to increase in the future mainly due to increased development and rising property values on flood plains.

The Water Resource

The water resource may be viewed as moving in a never-ending cycle. Rain or other precipitation soaks into the soil or runs off the land; water is used or stored in reservoirs or aquifers; it evaporates or is transpired by vegetation and becomes rain again. The quality of the resource at each stage in the hydrologic cycle is important in assessing the status of the water resource.

The quantity of freshwater in rivers and streams is largely a function of the amount of precipitation falling on watersheds. Average annual precipitation ranges from a few tenths of an inch in some desert watersheds of the Southwest to nearly 400 inches in some Hawaiian watersheds. About two-thirds of the precipitation that falls either evaporates directly or is taken up by plants and transpired back to the atmosphere. The remaining third either runs over the soil surface to streams or percolates into the soil and moves through the soil profile to streams via flows of ground water. There is much variation around the country in the percentage of water that actually ends up as part of the Nation's usable water resource. Climate, vegetative cover, topography, and soil type all influence the type and amount of runoff that occurs in each geographic area.

The renewable water supply of the coterminous United States amounts to about 1.4 trillion gallons per day. The available supply is not likely to change much in the future, but there is much uncertainty in trying to estimate short-term supplies because of droughts, major storms, and other natural phenomena.

The volume of ground water in storage in the upper half-mile of the Earth's crust within the coterminous United States has been estimated to be 55 quadrillion gallons. Not all of this water is suitable for human uses. The recharge to the ground-water system is 1 trillion gallons per day. The total ground water withdrawn in 1985 represented about 24 percent of the total freshwater withdrawals in the United States. The ground-water resource situation varies around the country, depending, for example, on the extent of irrigation and changes in ground-water quality.

Reservoirs provide a means to store water when plentiful and use it when needed. At present, there are 2,654 reservoirs and controlled natural lakes having capacities of 5,000 acre-feet (1.63 billion gallons) or more in the United States and Puerto Rico. They have a combined storage capacity of 480 million acre-feet (156.4 trillion gallons). In addition, there are at least 50,000 smaller reservoirs with capacities in the range of 500 to 5,000 acre-feet and about 2 million farm ponds used for storage. There remain about 750 million acre-feet (244 trillion gallons) of potential storage in the continental United States where building dams is feasible from an engineering perspective. Most of the cost-effective sites have been developed, however, and the Nation's reservoir capacity may be gradually approaching the limit of economically viable development.

The quality of water in many major streams has improved markedly over the past two decades. Laws mandating pollution abatement have worked, and major point sources of pollution are being brought under control. Experts

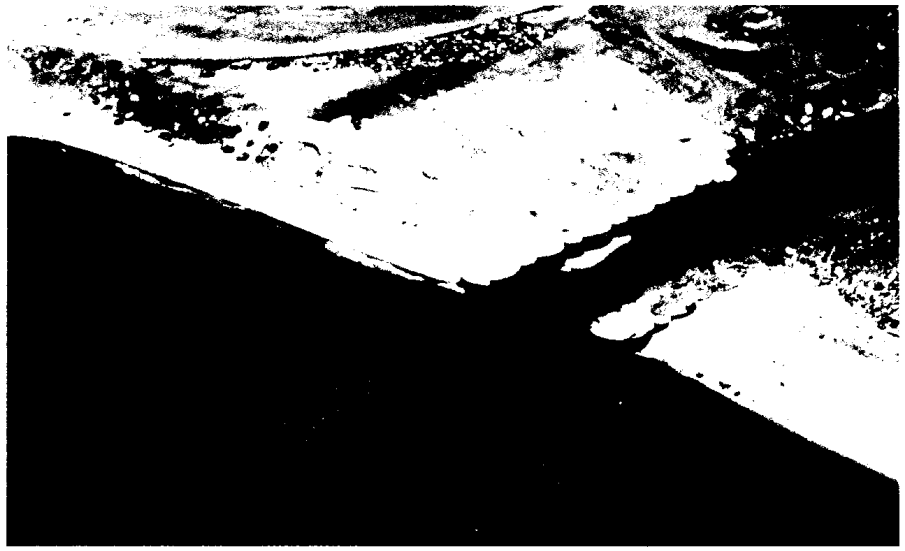


Figure 16—Now that many point sources of pollution are under control, nonpoint sources have become relatively more important as contributors to residual pollution of inland surface waters. (Photo courtesy of USDA Soil Conservation Service.)

believe that further significant improvements in water quality from this type of control will be expensive and difficult to achieve.

With achievement of control of many point sources of pollution, nonpoint sources have become relatively more important as contributors to residual pollution of inland surface waters (fig. 16). Nonpoint sources of pollution include land disturbance and management activities on the land. Relatively minor changes in the environment caused by nonpoint sources of pollution can have major impacts on the composition of fish and wildlife populations in local situations.

The Demand Situation for Water

Three types of water use must be considered in any assessment of the water situation: withdrawal use (water removed from a stream or aquifer), consumptive use (that part of water withdrawals that is not returned to a stream or aquifer for reuse), and instream use (for navigation, hydroelectric power generation, recreation, and fish and wildlife habitat).

The growth of the United States as an industrialized nation has been closely tied to the use of water. Water was the source of transportation, food, and power for use in industry. The development of the steam engine in the early 1800's freed industries from dependence on water power, and the Industrial Revolution was well on its way. From colonial days to the beginning of the 20th century, demand for drinking water and water for waste disposal increased the most rapidly. By then, civilization had tainted most coastal waters and many inland streams. Water-related diseases were common. Destructive floods often occurred as flood control structures were not yet built.

During the next 75 years, the Nation came a long way in the management of its water resource. By the early 1970's, it became clear that while previous policies and actions solved many volume-related water problems, much remained to be done about problems of water quality. Legislation was passed with the intent of significant improvement in the quality of the Nation's waters. Coincidentally, the water-quality-related legislation resulted in a major shift in the relationships among population, gross national product, and water withdrawals. Water conservation and recycling became more attractive under the new legislation, and it had the effect of retarding the growth in demand for withdrawals and consumption.

Trends in Water Use and Projected Demands

In 1985, total freshwater withdrawals in the United States totaled some 344 billion gallons per day—84 billion from ground water, 259 billion from surface water, and 0.6 billion from waste water. Consumption in 1985 totaled 94 billion gallons per day, or 27 percent of withdrawals and less than 7 percent of daily precipitation (app. table 6-8).

Data from the U.S. Geological Survey indicate that total water withdrawals in the United States increased 59 percent between 1960 and 1985 and consumption, 53 percent (fig. 17). These totals mask significant differences in withdrawal and consumption among geographic regions and uses (app. tables 6–8). Between 1960 and 1985, withdrawals in the South and Rocky Mountains rose 89 and 76 percent, respectively, as compared with increases of 40 percent in the North and 32 percent on the Pacific coast.

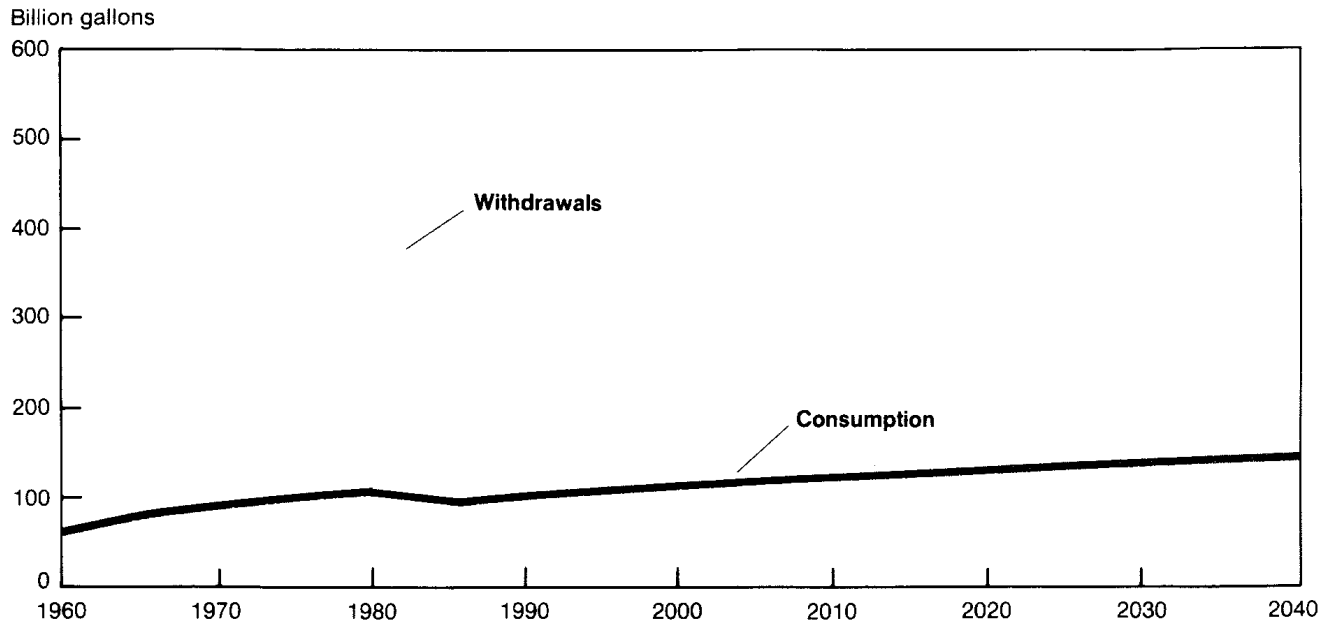


Figure 17—Total freshwater consumption and withdrawals, 1960–85, with projections to 2040.

Because the North is more heavily industrialized than other parts of the country, it showed the largest percentage increases in consumption of water between 1960 and 1985 (132 percent). Increases were much smaller for the South (68 percent), the Pacific coast (49 percent), and the Rocky Mountains (37 percent). The U.S. and regional totals for withdrawals and consumption also mask significant differences among the major categories of water use: thermoelectric steam cooling, irrigation, municipal central supplies, industrial self-supplies, domestic self-supplies, and livestock watering. Projections of water demands were made for these six categories by Assessment region (see frontispiece) and form the basis for the following presentation of projected demands.

The projections of water withdrawals to 2040 are estimates of future demand levels if recent trends in demand for water continue.

Thermoelectric Steam Cooling

With thermoelectric power, the principal method of generating electricity is to convert water into steam and then use steam pressure to propel a generator's turbine. Most of the new electrical generating capacity in the United States in the past 15 years has been based on coal and nuclear fuel. The Northeast relies primarily upon nuclear and oil-fired units, and the Pacific coast, on natural gas and hydropower. All other regions depend mainly on coal as a source of energy. Consumption of water is only a fraction of withdrawals for thermoelectric steam cooling. The primary concern over water quality is the heating of water prior to discharge back to the source—a concern that has largely been alleviated through cooling towers and other means.

The oil-price shocks of the 1970's caused many structural shifts in energy consumption that have lowered the relationship between electricity demand and gross national product. More efficient motors, better electricity generation and transmission technologies, and other conservation measures have contributed to an expected slowing in the rate of increase of future demands for electricity. There is also potential for increased imports of hydro-based electricity from Canada. This outlook does not mean reduced needs for water for thermoelectric power generation—it means a slowing in the growth in demand in the short term. After the turn of the century, it is expected that relatively large increases in generating capacity will be necessary (fig. 18). By 2040, withdrawals for thermoelectric cooling are projected to be 228.3 billion gallons per day, with consumption amounting to only 6 percent of withdrawals. Most of the added capacity is assumed to be in the North and South.

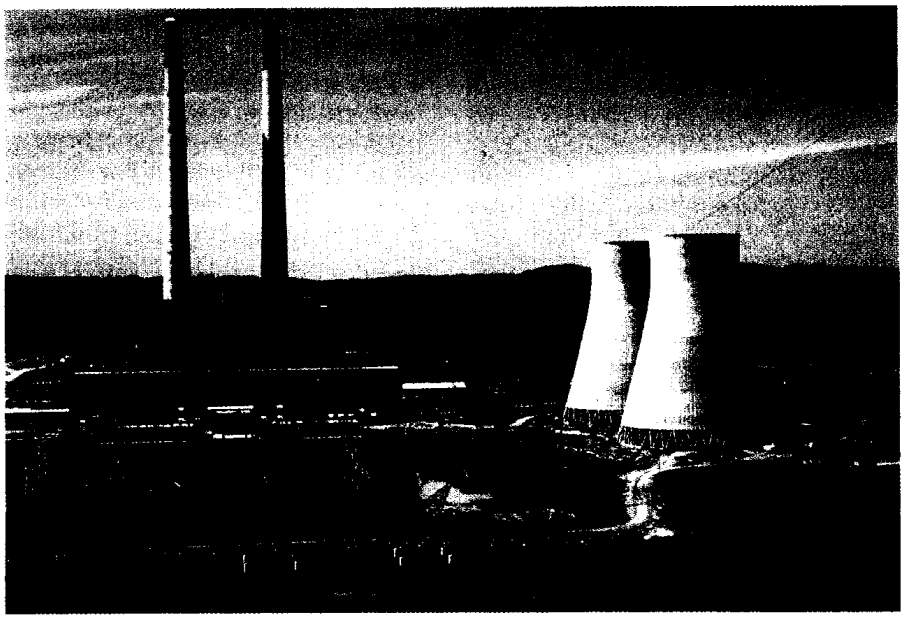


Figure 18—Thermoelectric cooling is expected to be the most important source of demand for water withdrawals. (Photo courtesy of USDA Soil Conservation Service.)

Irrigation

Irrigation—the act of applying water to land to promote the growth of vegetation—covers a multitude of uses from watering agricultural crops to golf courses to home lawns and gardens. Irrigation water comes from wells, surface sources on the site, and surface sources provided by offsite suppliers such as irrigation districts and ditch companies. Irrigation withdrawals in 1985 totaled 142.5 billion gallons per day, with 40 percent originating from wells and 60 percent from surface sources. Three of every four gallons from surface sources are provided by offsite suppliers. Irrigators in the Great Plains rely most heavily on groundwater withdrawals; those in other parts of the Rocky Mountain and Pacific coast regions rely most heavily on off-farm suppliers.

Because both wells and onfarm surface-water sources must be pumped to deliver water to crops, the energy expenses of irrigating farmland can be large and have a major impact on the extent of irrigation. During the past decade of high energy prices, for example, irrigated farmland acreage fell by 11 percent. Decreased export demands and lower commodity prices also contributed to reduced use of irrigation for agriculture.

About half of the withdrawals for irrigation are consumed. Irrigation is the largest consumptive user by far, accounting for 73.8 billion gallons per day—79 percent of the total consumption of water for all uses (fig. 19). Thus, of all the uses, the outlook for water used as irrigation will have the most influence on the overall demand–supply outlook for water.

Irrigation water usage is projected to grow at a much slower rate over the next 50 years than over the previous 25 years. Irrigation is expected to remain important, however, in all regions except the North. The primary reasons for expecting this slowdown are higher pumping costs and the potential of technology for conserving water used in irrigation. The expected increases in energy costs in the future will increase pumping costs, thereby reducing the returns per acre from irrigation and forcing some acreage into dry-land crop production. Competition from higher value uses and lack of additional water supplies will also be important in raising irrigation costs. Increased water costs may provide market incentives for adoption of existing water-saving technologies such as drip or trickle irrigation systems.

Other Water Uses

The remaining water uses are municipal central supplies, industrial self-supplies, domestic self-supplies, and livestock watering.[2] In total, they accounted for 16.7 percent of consumption and 20.6 percent of withdrawals in 1985. Each of these uses is expected to grow in the future, and by 2040, they collectively account for 19.6 percent of consumption and 23.7 percent of withdrawals.

Trends and projections in withdrawals and consumption for each of the other uses are in appendix tables 6 and 8.

[2] The term "municipal central supplies" refers to water withdrawn by public or private water-supply utilities that distribute treated water through a network of pipes to household, commercial, and industrial users. Self-supplied industrial water use is defined in this Assessment as water withdrawn and consumed by industries for their own use, other than cooling thermoelectric power plants. Water for domestic self-supplies includes water for household consumption, drinking water for livestock and other uses such as dairy sanitation, evaporation from stock-watering ponds, cleaning, and waste disposal. Livestock watering includes water provided for drinking by livestock and water used to maintain sanitary living conditions for livestock.

Summary of Water Demands

Projected withdrawal demands increase for all the major end uses of water. By 2040, thermoelectric steam cooling is projected to have the largest withdrawals, followed by irrigation. These two uses account for about three-quarters of water demand in 2040. There will be large increases in demands for both ground-water and surface-water withdrawals.

Total demands for freshwater withdrawals are expected to increase in all regions. The largest percentage increase in demand between 1985 and 2040 is for the North, and the smallest percentage increase is for the Rocky Mountain region.

Water Supplies

Precipitation in the form of rain, snow, sleet, and hail is the source of both surface and ground water. Various management practices can affect local supplies, but the Nation's annual supply of water is beyond direct control and depends on the forces of nature.

Water Demand-Supply Comparisons

It is apparent that precipitation provides enough surface and ground water (1.4 trillion gallons a day) to meet present and prospective withdrawals (some 500 billion gallons a day by 2040). By 2040, water consumption still amounts to only 10 percent of precipitation. There are, however, serious imbalances caused by the geographic, seasonal, and annual variations in supplies.

Water-quantity problems exist in the Rio Grande, upper and lower Colorado, Great Basin, and California water resource regions.

The water supply situation in some areas—such as the High Plains, which extends from central Texas and eastern New Mexico north into eastern Colorado, Kansas, and southern Nebraska—is being affected by ground-water mining. As a result of ground-water mining and rising energy costs, the use of ground water for irrigation over substantial areas may become uneconomic during the next 2 decades or so. Demand–supply situations in arid parts of the Southwestern United States are stimulating studies of ways to develop water markets. Such markets are mostly lacking under current institutional arrangements.

Most of the Nation's water shortages are caused by annual and seasonal variations in precipitation and water flows. Variations caused by unusual storms bring about another major problem—flooding. Flooding occurs in all parts of the United States. Flood damages are greatest in coastal and southern California, in a broad range extending up the Mississippi River drainage, and in another broad area extending up the Atlantic coast from South Carolina to Maine.

Water quality will continue to be a concern under the projected demand–supply situation. For example, nonpoint sources of pollution are especially important for fish habitat and the composition of the fish community. These concerns will continue to be reflected in public policies aimed at management of water quality.

Range Forage Demand-Supply—The Outlook

Outlook Overview

- Per capita consumption of beef, veal, lamb, and mutton is projected to remain near current levels during the coming decades.

- Thus, future demand will grow in line with the growth in the total U.S. population.

- After taking into account imports and exports, total demand on the domestic range forage resource is expected to increase 54 percent by 2040.

- Forage from public lands accounts for less than 10 percent of total forage consumption.

- Management of Forest Service rangelands will be oriented to vegetation management, with multiple uses as the desired output mix.

- It is assumed that forage production on private lands will become more productive over time.

- Thus, much of the current and prospective range forage supply situation depends on private lands.

- Total supply of range forage is expected to increase 52 percent by 2040, with most of the increase coming from private lands.

- Multiple-use management of rangelands will be necessary to accommodate domestic livestock, wildlife, recreation, and other uses of rangeland.

The Range Forage Resource

The range forage resource consists of grasses, grasslike plants, forbs, and shrubs associated with rangeland and

some forest ecosystems. Management of the range resource affects a number of resource outputs, including forage production, water yields and quality, wildlife and fish populations, and the suitability of the land for various kinds of outdoor recreation (fig. 20). In addition, managers of public rangeland must keep in mind provisions of the Wild Horses and Burros Protection Act of 1971 and the Endangered Species Act of 1973. The range forage assessment in this document concentrates on the forage resource that comes from rangelands.

The demand for range forage for use in feeding domestic livestock competes with the use of forests and rangelands for wildlife, watershed protection, recreation, and other outputs. The forage demand for domestic livestock is derived from consumers' demands for livestock outputs such as meat, hides, tallow, and other products produced from grazing animals. Thus the demand for forage will be affected by factors such as changes in technology producing feed substitutions or feed mixtures, and the demand for meat. We therefore analyzed the demand for forage as being derived from the demand for livestock and meat production. Projections of the forage demand for wildlife are derived from wildlife population projections presented in the demand–supply outlook for wildlife and fish.

Figure 20—Range management affects not only forage production but also water yields and quality, wildlife and fish populations, and the suitability of the land for various kinds of outdoor recreation.

The reliance of livestock operations on grazed forages varies by type of animal. Dairy cattle and horses use small amounts of grazed forage, but 61 percent of the annual feed requirements for beef cattle and some 90 percent of the feed requirements for sheep and goats are supplied by grazed forages. Wild herbivores obtain nearly all their feed needs from grazed forages. The 17 coterminous Western States support about 85 percent of the Nation's sheep inventory, and sheep production in this region is heavily dependent on grazing.

Forage produced on the lands managed by the Forest Service and Bureau of Land Management amounts to about 7 percent of the total forage consumed by domestic livestock in the United States (app. table 9). Forage produced on private lands represents 88 percent of the total grazed forages produced, and crop residue, the remaining 5 percent.

The relative importance of public grazing lands as a source of forage for beef cattle and sheep varies around the country. Public grazing land contributes more than 50 percent of the total feed mix in the Pacific Northwest. In all other regions, private lands provide most of the forage needed for beef cattle and sheep. Seasonal availability of even a small percentage of the total feed mix on public lands is critical in maintaining livestock operations or viability of wildlife herds, however.

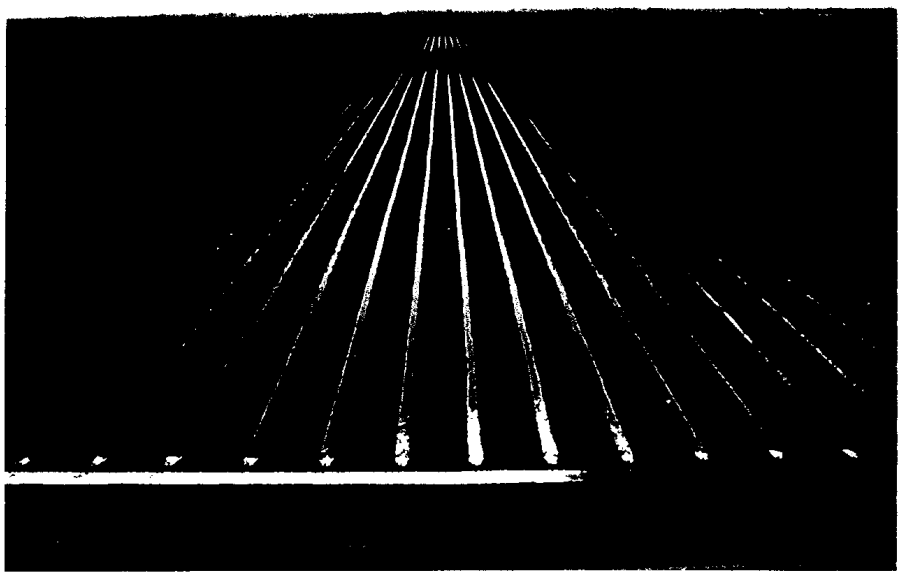


Figure 19—Irrigation is expected to be the most important consumptive use of water. (Photo courtesy of USDA Soil Conservation Service.)

Since 1930, cattle numbers have had cyclical movements up and down (fig. 21). Sheep numbers that peaked in 1942 at 56 million head have dropped to 10.3 million head. Domestic livestock grazing on National Forest System lands has remained fairly constant since 1953. Domestic livestock grazing on Bureau of Land Management lands has declined as a result of reductions in stocking rates on some allotments and a transfer of BLM-administered lands to other agencies. Permitted grazing on National Forest System lands has declined in the Southwestern, Northern, and Eastern Regions. It has increased in the Pacific Southwest and Pacific Northwest Regions and shown no discernible long-term trend in the Southern Region.

International Trade

The rapid expansion in worldwide meat production in the 1970's has slowed in the 1980's. The total world meat output that enters international trade is approximately 7 percent of world production. Available information suggests that future international meat trade will not expand greatly. Many developing countries are moving toward self-sufficiency in poultry and pork. Beef imports into the United States have amounted to about 8 percent of consumption since 1970, and exports, less than 1 percent of production until recently. There is little basis for expecting major changes in the trade situation. Therefore, future demand for meat in the United States will be primarily a function of domestic demands.

U.S. Consumption and Demand for Meat

Beef consumption in the United States increased steadily after World War II and reached a peak of 91.7 lb (edible weight) per capita in 1976 (fig. 22). Consumption then declined to a low of 76.5 pounds in 1980 and has remained below 80 pounds since then. Per capita consumption of lamb has declined from 4.8 lb in 1960 to 1.4 lb in 1986. Per capita consumption of other meat products, especially poultry, and fish has increased.

The cause for the past sluggish behavior in the beef market is uncertain despite extensive study of the situation. Possible reasons for the recent pattern of beef consumption include changes in consumer spending patterns, the lower relative prices of poultry and other beef substitutes, concerns over the role of meat in the daily diet, and the innovative products being made from

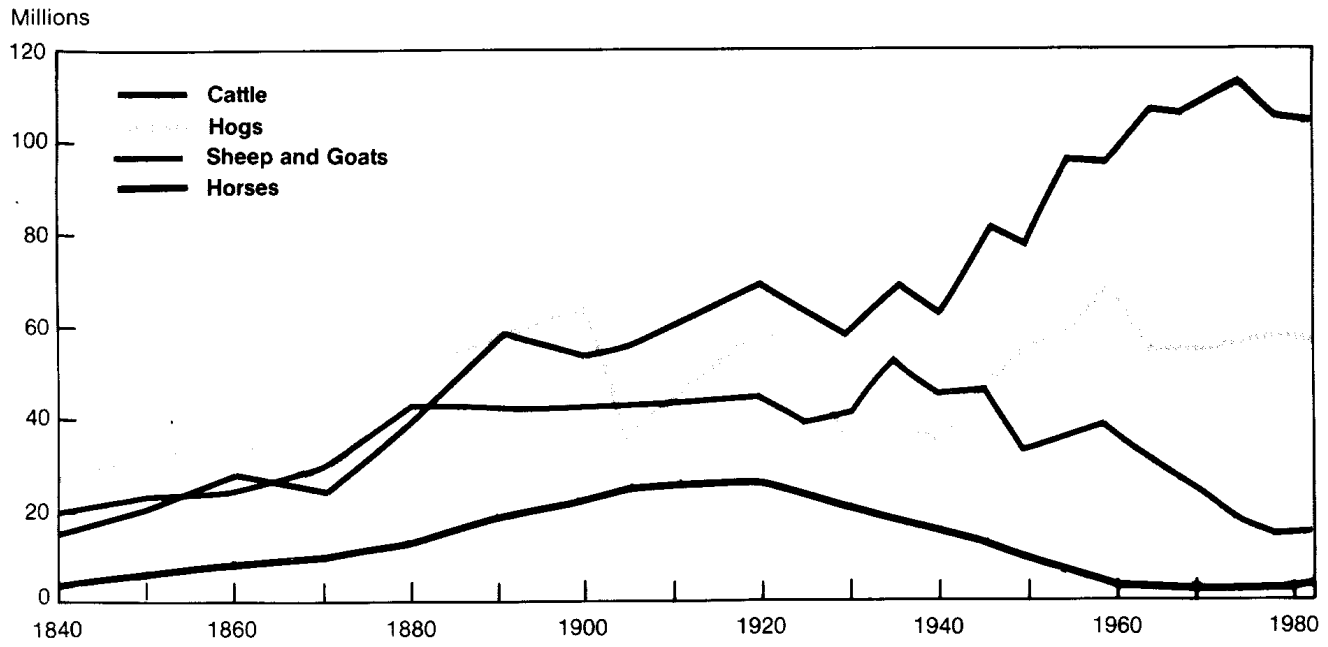
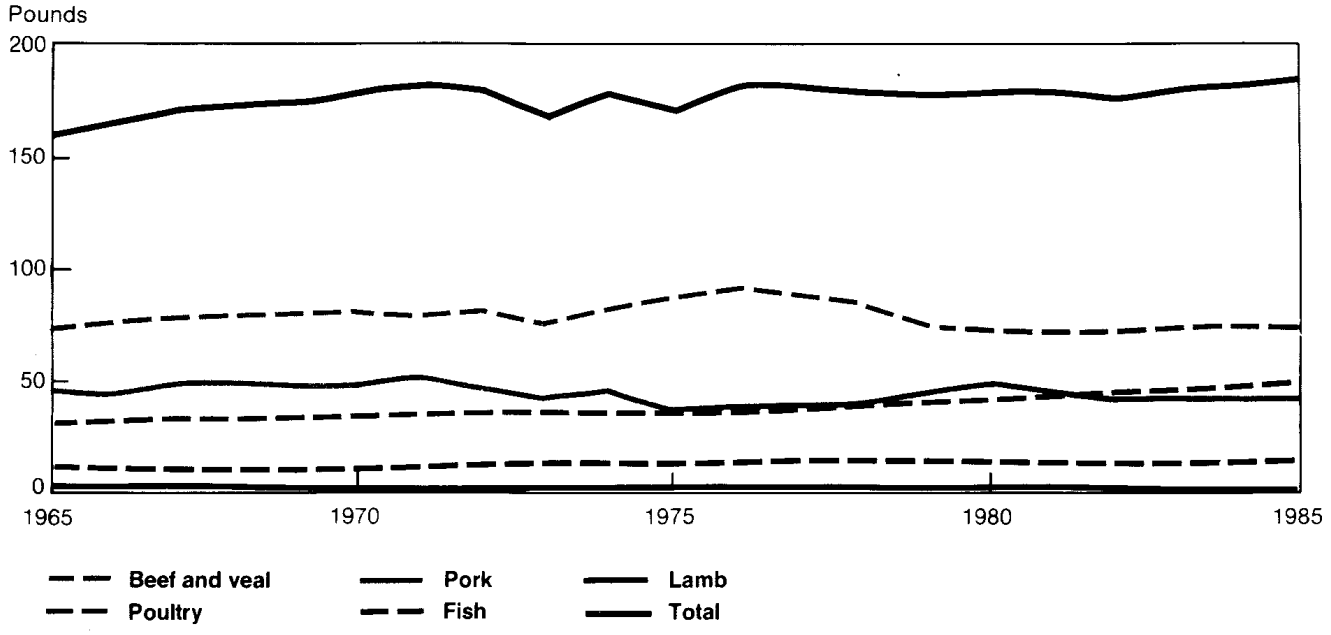


Figure 21—Number of livestock on farms in the United States, for selected years, 1840–1982.



Source: USDA Economic Research Service, 1986.

Figure 22—Per capita meat consumption in the United States, by edible weight, 1965–85.

beef substitutes. The beef industry is working on marketing and product development that may stimulate beef consumption. Other studies and expert opinion on future consumption suggest that per capita demand for meat will be steady or slowly rise. For the purposes of this assessment, per capita demands for beef, veal, lamb, and mutton are assumed to remain constant and, in total, amount to 110 lb (carcass weight) per person. This is a departure from the 1979 RPA Assessment, which projected per capita consumption of 148 lb by 2030, and reflects trends of the past decade. Thus, total U.S. demand for beef, veal, lamb, and mutton is expected to increase in line with population growth.

Projections to 2040 indicate a 56-percent increase in beef and veal production compared with 1985 levels. Lamb and mutton production are expected to remain near 1985 levels. The 56-percent increase in derived demand is higher than the 38-percent increase in U.S. population in part because imports are expected to decline as compared with 1985.

We derived estimates of grazed forage consumption from the projections for production of beef, veal, mutton, and lamb. By 2040, total forage consumption for cattle and sheep is expected to be nearly 660 million animal unit-months (the amount of forage required for a 1,000-pound cow, or the equivalent, for 1 month), compared with 431 million in 1985.

Projected Forage Supply

The forage to be supplied in the future depends on both the area of rangeland and production per unit area. It is assumed that cropland placed in the Conservation Reserve Program will remain in permanent cover and not be returned to crop production. After taking account of the effects of this program, we project that rangeland area will increase some 5 percent by 2040.

Through the implementation of existing technology, productivity of private rangeland is assumed to increase 0.7 percent per year for the 1987-2040 period. Some 150 technologies have been identified as potentially increasing the future productivity of agriculture and livestock production. These do not include genetic engineering of animals but do include genetic engineering of the plants used for forage. They also include further application of traditional management practices such as fencing. We assume that market and other incentives will lead to the adoption of these technologies. Under these assumptions, by 2040, forage

production per acre is expected to increase 47 percent compared with 1985 levels. Forage outputs on National Forest System lands are expected to increase slightly, from 9.8 million to 10.3 million animal unit-months. The percentage increase in forage output on National Forest System lands is lower than for private lands. This reflects the Forest Service's future emphasis on vegetation management for multiple uses such as recreation and improved riparian habitat and water quality.

Range Forage Demand–Supply Comparisons

The derived demand for forage is expected to increase 54 percent above the demand in 1985 by the year 2040 (fig. 23). This demand represents the demand for all sources of grazed forages, including the demand for forages from range and forest lands. The combination of increased rangeland area (5 percent) and productivity increase (47 percent) would lead to a 52-percent increase in supply by 2040. Forage supplies approximately equal demands under these assumptions.

Based on projected population estimates for the Western United States, we project that wild herbivores will need 19 percent more forage in 2000 than they did in 1985. Since forage supplies were projected to approximate the forage demand for livestock, wildlife forage needs may require attention through range enhancement.

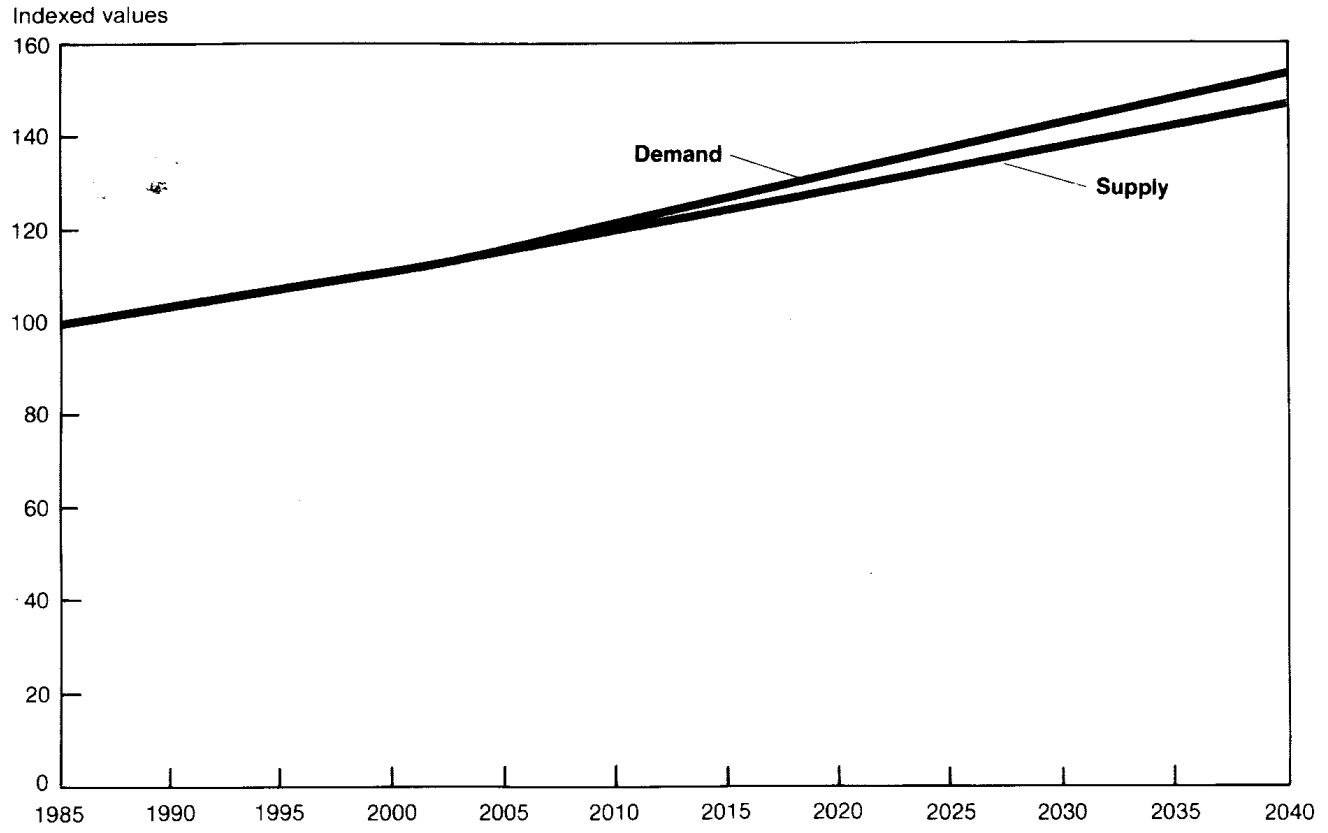


Figure 23—Forage demand and supply projections to 2040.

Outdoor Recreation Demand–Supply—The Outlook

Outlook Overview

- The number of people participating in recreation is expected to increase across all recreational activities during the next 5 decades.

- The percentage of the total population participating in recreation has stabilized in recent years, as has the per capita allocation of leisure time to recreational pursuits.

- Thus, total demand for recreation would grow at least in line with population growth if this pattern continues in the future.

- In addition, real per capita income is projected to more than double by 2040. This extra income will contribute to differential rates of growth in recreational activities. For example, demands for snow-related recreation are expected to grow at a faster rate than for most land- and water-based activities, but the latter activities will continue to dominate total recreation patterns.

- If the public and private sectors continue to provide and expand opportunities at rates comparable to recent trends, the projected increases in supplies will meet most of the projected increases in demands.

- The effect of continuing to close more private lands to public access is evident in the projected shortfall in land- and snow-based opportunities near roaded, partially developed sites.

- To meet these shortfalls, fees, especially for recreational use of private land, will become more important in the recreational supply picture in the future. Most of the increase in demand will be near existing population centers, which are generally far away from the bulk of the Federal lands located in the West.

- National forests and other public lands in the North, South, and Pacific coast region are expected to become relatively more important for all forms of recreation if access remains generally unrestricted and free.

- Rather than national trends affecting all regions alike, the differential rates of growth in activities indicate that specific regions and areas of the country will be affected in different ways by the expected growth in recreation. For example, growth in demand for downhill skiing has obvious implications for areas of the country with the unique terrain needed for this activity.

The Resource Base

Although most forest and range lands and water are suitable for some forms of outdoor recreation, relatively little acreage is managed for recreation that involves large capital investments and intensive use. Parks, reservoirs, and picnic areas account for a large proportion of the area that is managed for intensive use. Most of these areas are administered by the U.S. Department of the Interior's National Park Service, the U.S. Army Corps of Engineers, and park agencies of State and local governments.

Most of the outdoor recreation activities that involve capital-intensive, convenience-oriented facilities and high-density use areas (such as recreational vehicle parks, marinas, and swimming pools) are on private lands with privately owned facilities. Most of America's major ski areas are located on public lands but built and managed by private firms. In contrast, most of the dispersed recreational activities that require little in the way of convenience facilities are provided publicly on public lands, particularly those managed by the Forest Service and the Bureau of Land Management, mainly in the West, and lands managed by the States in the East. Most of the public lands managed by these agencies are also used for multiple purposes, including the production of timber, water, forage, and wildlife. The distinction between the types of activities provided on public and private lands is not exact: all types of recreation occur on both public and private lands. There are, however, some notable differences important in considering the recreational resource situation in the United States.

Private lands are generally more intensively roaded than public lands. Thus, they can provide fewer remote recreation opportunities than public lands. Over 350 million acres of public recreation lands, or about 55 percent of the total, are estimated to be more than one-half mile from roads and thus provide backcountry opportunities. Only about 27 million acres of private rural lands, or about 2 percent of their total, are that remote.

Private Lands

Recreational opportunities on private lands depend in part on the land cover and in part on access to the land. About 95 percent of the privately owned rural land in the contiguous 48 States is classed as nonindustrial private and held by an estimated 14.1 million owners. These lands are owned for a variety of purposes including crop production, grazing, timber production, and especially "country living" and hobby farming. Increasingly, people own land for recreational purposes.

About one-third of this 1.2 billion acres is in each of the three land-use categories of forest, range/pasture, and crops/hay.

Of the estimated 1.2 billion acres of land in nonindustrial private ownership in the contiguous United States, about 23 percent is open for public use free, on payment of a daily fee, or through lease. Much of this open land is in the East and in the Rocky Mountain/Great Plains regions. Some activities tend to be permitted and some, forbidden. For example, hunting, birdwatching, and hiking are usually allowed, but off-road driving, camping, and target shooting are generally not permitted. In part because of liability problems, access to the remaining private land is restricted. About 58 million acres are completely closed to recreation. Over 318 million acres are open for the exclusive use of the owners and their immediate families. We estimate that access to 579 million acres, or 45 percent of the private land base, is open to people personally acquainted with the owner. Thus, despite liability problems, most of the private land is used for some form of recreational activity. Access to the general public is becoming more limited, however. Over the past 10 years, the percentage of private lands open to the public for recreation has dropped from 29 to 23 percent.

About 4 percent (47 million acres) of nonindustrial lands are leased for recreational use at an annual average fee of $2.97 per acre. About two-thirds of this leased area is in the South. The proportion of landowners reporting a leasing arrangement has grown from 2 percent in 1977 to 7 percent in 1987. The principal reasons for leasing include paying land taxes, supplementary income, and protection of the land. Hunting leases are the most common type.

There are many different types of commercial enterprises associated with outdoor recreation and wilderness. They include guides and outfitters, equipment rental firms such as boat rentals, private campgrounds, bed and breakfast operations, marinas, and skiing facilities.

The number of campgrounds on private lands in the United States decreased 1 percent between 1978 and 1987. This decline was due to the closing of smaller, marginal operations with low economic returns. Even though the number of campgrounds has decreased slightly, their size has been increasing. The average number of sites per campground grew 32 percent between 1977 and 1987. Now, there are nearly 1.3 million campsites in private campgrounds nationwide. Approximately 55 percent of all campgrounds are privately owned. They account for over 70 percent of total capacity and 97 percent of full-hookup sites. Over 70 percent of private campgrounds and campsites are in the eastern half of the country, close to population concentrations.

Nonprofit recreational organizations provide access to resources and recreation settings and organize activities and trips that might otherwise be unavailable to their individual members. Membership in nonprofit organizations has grown rapidly. These organizations have special concerns over resource protection, access and multiple use of lands, and recognition of the rights of individuals.

Federal Lands and Water

The Federal recreation land base has many parts and dimensions. It is administered by seven different agencies, each having its own legislative authority and its own recreation objectives, standards, and programs.

About 690 million acres of Federal lands are available for access to various types of recreational activities. Primarily, these lands provide undeveloped–remote or roaded–partially developed recreational opportunities. Even though these Federal lands account for over one-third of the Nation's recreational space, they accommodate only about 13 percent of outdoor recreation participation. The largest proportion of Federal recreation land is in the West, and relatively remote from population concentrations except for cities on the west coast and in the Pacific Southwest.

There are about 5,000 campgrounds on Federal lands in the United States. The Forest Service manages 70 percent of them, and the Corps of Engineers, 17 percent. About two-thirds of the Federal campgrounds are in the Rocky Mountain and Pacific coast regions, where less than one-fifth of the U.S. population lives. In general, Federal campgrounds have fewer amenities and are smaller than private campgrounds.

Federal agencies operate over 63,000 picnic areas. There are also over 144,000 miles of roads and 160,000 miles of trails on lands managed by these agencies. Federal agencies provide a variety of water-based recreational opportunities. For example, there are 7,178 miles of rivers in the National Wild and Scenic Rivers system with management responsibility allocated primarily among the Forest Service, the National Park Service, the Bureau of Land Management, and the Fish and Wildlife Service. Boat ramps, swimming areas, and beaches are also found on Federal lands. A number of

these are in the 31 National Recreation Areas in the contiguous 48 States and Alaska. These specially designated areas cover over 6 million acres, of which more than 90 percent is managed by public agencies. Some of the areas are especially important to urban residents because they are close to major cities, such as New York, Los Angeles, Atlanta, and Cleveland.

In the wintertime, roads, trails and other resources that serve different recreational purposes during the rest of the year are used for cross-country skiing, snowmobiling, and winter camping. Over 240 million acres of Federal lands receive at least 16 inches of snowfall each year and thus are suitable for winter sports. Most downhill ski areas and almost 60 percent of hourly lift capacity are on national forests, mainly in the Rocky Mountain and Pacific coast regions.

State Lands and Water

There are some 52.6 million acres of State land available for access to recreational uses. Of this total, 50 percent is managed by State forest agencies, 19 percent by State park agencies, and 31 percent by fish and game agencies. States manage nearly a full range of recreation opportunities across these three agencies, including wilderness areas, developed camping, and various water-based activities.

Local Government Recreation Opportunities

Outdoor recreation provided by local governments includes most types of opportunities. The emphasis of local government is partially developed and developed site opportunities, unlike that of Federal or State Governments. The average local park and recreation agency manages about 160 acres, nationwide totaling 2.2 million acres. About one-quarter of this acreage is partially developed and mostly natural. Typical municipal or county departments provide several playgrounds, athletic fields, tennis and basketball courts, swimming pools, and often a golf course or fitness trail. Nationwide, these local departments also provide an estimated 65,000 acres of lakes and about 30,000 miles of various types of trails.

Of all public recreation lands, local sites are distributed most like the largely urban U.S. population (fig. 24). Because local facilities are closest to people's homes and thus are most easily accessible, the approximately 2.2 million acres of local government recreation and natural lands and waters receive the most intensive use. Although data are fragmentary, we estimate that local governments provide over one-half of all U.S. outdoor recreation use.

Trends in Participation in Outdoor Recreation

Typically, realized demand—defined as actual participation in outdoor recreation—is used to describe demand trends. Participation has two dimensions—number of participant occasions and proportion of the population or number of people who participate.

The choice to participate in any recreational activity depends on many factors, such as cost, time required, and the physical demands of the activity. As one or more of these factor becomes limiting, people may choose a substitute compatible with their circumstances. Both the number of people who participate in an activity and the frequency and duration of their participation are key factors in attempting to assess longrun demands for various recreational activities. Together, these factors determine the total number of recreational trips the public consumes and the number of visits to public lands.

Figure 24—Local recreation sites are distributed most like the largely urban U.S. population.

One of the most important changes to occur in outdoor recreation participation in the last few years has been a shift from taking a few, long vacations to taking shorter but more numerous weekend and long weekend trips (fig. 25). This shift has had several major consequences. First, the number of trips or occasions taken to participate in activities has risen relative to the percentage of the population participating and to total hours spent recreating. Second, this shift has made recreation opportunities close to home a much more important component of recreation supply.

About 89 percent of the American public participates in outdoor recreation at least once during any given year. Over the past 20 years, the number of participants in most activities has grown, sometimes more rapidly than the U.S. population. Growth has been partly due to increases in frequency of participation, caused by a succession of progressively more active generations, and partly due to increased numbers of people in the population base. In general, over the past 2 decades, the more physically demanding outdoor pursuits have gained in popularity. As a result, they have shown the fastest percentage growth in numbers of participants. Percentage growth of participants in other, less physical activities such as picnicking and sightseeing still account for most of the Nation's recreation (fig. 26).

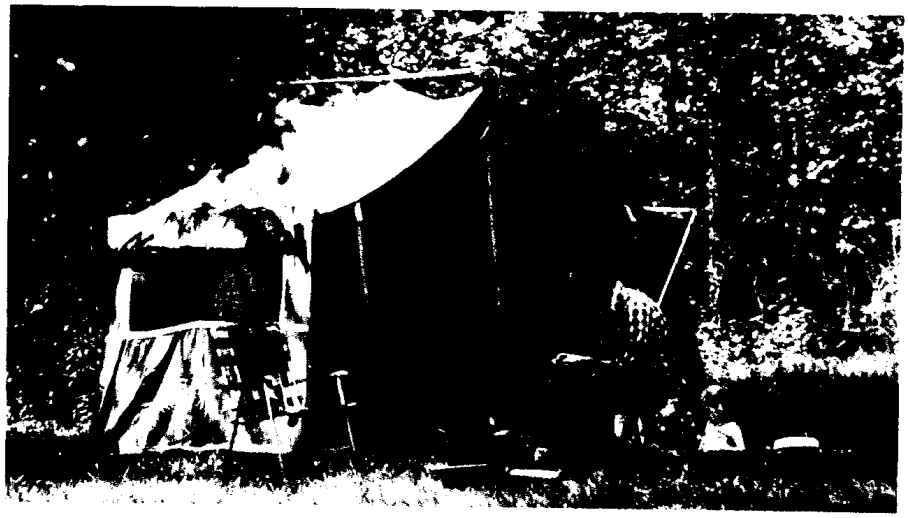


Figure 26—Traditional recreation activities will continue to account for most of the Nation's recreation.

Figure 25—More people are recreating by taking shorter trips close to home.

Besides American recreationists, the activities of foreign visitors to this country also affect our economy and recreation resources. Information is limited on outdoor recreation opportunities for foreign visitors to the United States. However, these visitors are known to comprise a significant market segment for internationally famous attractions such as the Grand Canyon and Yellowstone National Parks. Foreign visitation may increase in the future, but it is likely to be cyclical and dependent on the value of the U.S. dollar relative to other currencies.

There are other indicators of trends in recreation participation. For example, the total number of visits to Federal recreation areas has generally increased, although there have been reductions in the rate of growth and, in some instances, in total time spent

recreating at Federal areas. Increasingly, people are lodging at commercial accommodations near the more removed Federal areas, and they are day visiting close-to-home Federal areas more frequently than in the past.

Other recreation demand indicators include expenditures for selected equipment, licenses, and transportation. When viewed in constant dollars, spending for "big ticket" items, such as boats and recreational vehicles, has declined while spending on sporting goods and bicycles has grown by 20 percent since 1977.

Participation styles vary with both the recreation activity and the characteristics of the individual. Some activities, such as walking for pleasure, are enjoyed often by a broad spectrum of society. Others, such as hunting, are enjoyed primarily by a small percentage of adult males for just a few days each year. Age, disability, race, education, and income are the personal characteristics most strongly related to the outdoor recreation participation choices of Americans.

Projections of Future Participation

Projections of likely future recreation participation show expected increases across all recreational activities, including simple activities such as picnicking, day hiking, and sightseeing that can be enjoyed close to home (fig. 27 and app. table 10). Demand is also projected to increase for more expensive, time-consuming, and adventuresome activities, such as downhill skiing, canoeing, kayaking, and backpacking, as well as for convenient, active recreational pursuits that contribute to physical fitness, including running, jogging, swimming, walking, hiking, and bicycling (fig. 28).

Demands for snow-related recreation are expected to grow at a faster rate than for most land- and water-based activities. However, the present numbers of trips taken for land and water recreation are so large that even a very small percentage growth in one of these types of recreation will mean several million more trips and participants each year, much greater numbers than for snow-based recreation.

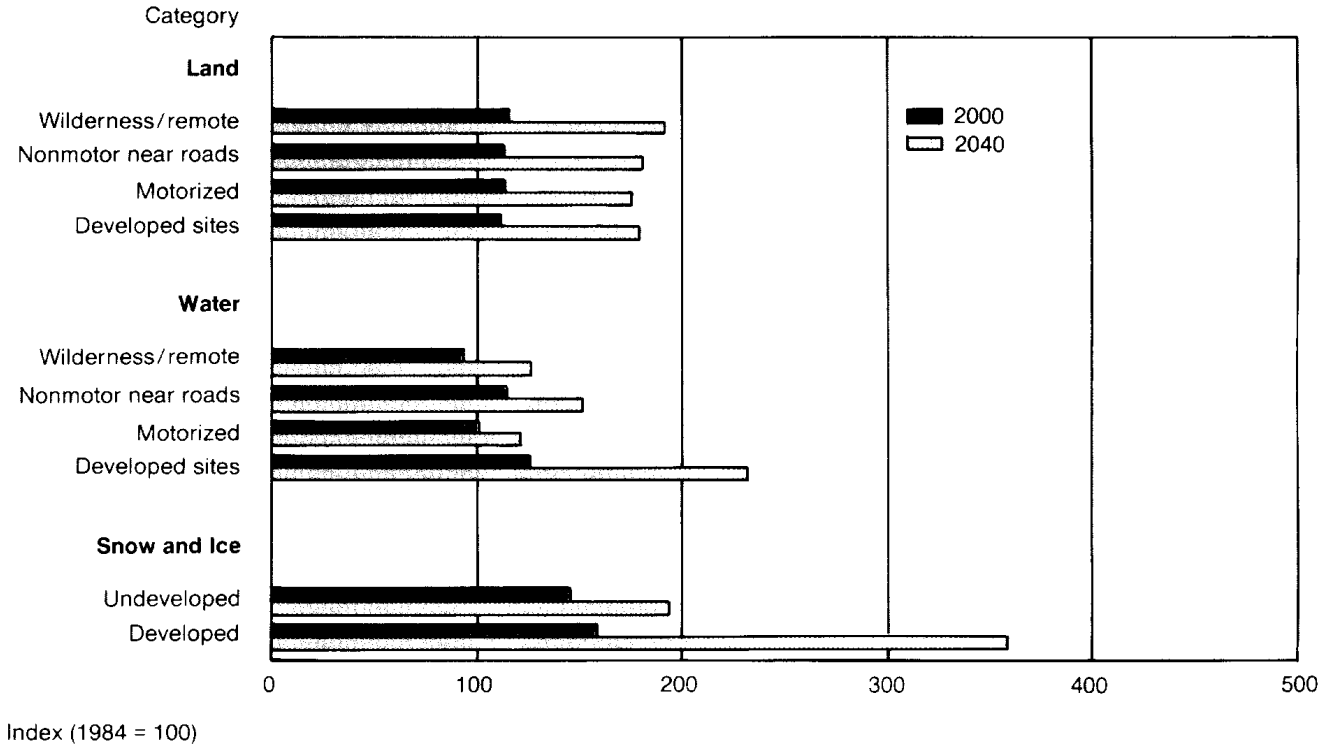


Figure 27—Projected indexes of outdoor recreation demand by category, 2000 and 2040.

Figure 28—Demands for adventuresome activities are expected to increase.

Outdoor Recreation Demand–Supply Comparisons

If the public and private sectors continue to provide opportunities and to increase them at rates comparable to recent trends, the projected changes in supplies will meet most of the projected increases in demands. For others, where the number of recreational trips Americans would prefer to take exceeds the expected supply of opportunities for trips, demands will be brought into balance through increased fees, higher densities of use, or rationing. In general, demand pressures are projected to be greatest for dispersed land-based activities, such as day hiking and backpacking, and dispersed snow-based activities, such as cross-country skiing. For other activities, continuing past trends in resources means that sufficient growth will occur in resources to allow Americans to take as many activity-specific recreational trips as they choose. These activities include developed camping, downhill skiing, picnicking, swimming, and motor boating.

Of the situations where recreation demand exceeds supply, some are tied to specific changes occurring in resource availability. For example, the effect of continuing to close more private lands to public access is clearly evident in the projected shortfalls of land- and snow-based opportunities near roads. Lack of access to private land opportunities will tend to add to use pressures on public lands and the remaining open private lands, especially in the East. For some particular activities, substantial shortfalls are expected: backpacking, day hiking, cross-country skiing, wildlife observation, and horseback riding.

Wilderness Demand–Supply–The Outlook

Outlook Overview

- About 89 million acres are currently in the National Wilderness Preservation System.
- About 1 of every 6 acres in the National Forest System is designated as "wilderness."
- Wilderness use accounts for less than 1 percent of all outdoor recreation.
- Total time spent in wilderness areas has been relatively stable in recent years.
- Wilderness areas contribute to maintenance of species diversity and protection of habitat for threatened and endangered species; and they are in other ways important unrelated to onsite recreation.
- Major future growth of the National Wilderness Preservation System is not expected.

Wilderness Areas

The National Wilderness Preservation System is composed of lands dedicated by the Congress to the preservation of their scenic and natural characteristics (fig. 29). About 89 million acres currently are in this system, and more acreage has been proposed. About 56 million of these acres are in Alaska. The National Park Service manages 37 million acres of wilderness, almost all in Alaska. The Fish and Wildlife Service manages 19.3 million acres, and the Bureau of Land Management, 369,000 acres. The Forest Service manages about 32 million acres of wilderness. Thus, about 1 of every 6 acres in the National Forest System is designated as wilderness.

Figure 29—Congress has dedicated some 89 million acres to the National Wilderness Preservation System.

State agencies manage over 2.6 million acres of State-designated wilderness. More than 88 percent is on State forest lands of the Northeast; most of the rest is in State parks along the Pacific coast. Local governments and private organizations, such as the Nature Conservancy, currently manage over 1.3 million acres of protected natural areas. Over 40 percent of these acres are in the Northeast; about 30 percent more are in the Southeast.

In addition to formally protected wilderness, there remains extensive land acreage (over 300 million acres) under Federal and State jurisdictions. These lands provide primitive, dispersed recreational experiences similar to those that can be enjoyed in designated wilderness.

Major future growth of the National Wilderness Preservation System is not expected. Preservation of natural areas by State and local governments and by private sector organizations, however, appears to be growing. Total acreage will be small, however.

Wilderness Uses

The number of visits to national forest wilderness areas grew rapidly in the 1960' and 1970's. More recently, growth in wilderness visits has slowed to about 4.5 percent per year, and some declines have recently occurred in specific areas. Much of the increase over the past 10 years was due to additions to the National Wilderness Preservation System on National Forest System lands and not growth of visitation per area. After rising quickly during the 1970's, overnight use of national park backcountry, which includes designated wilderness, entered a period of decline about 1980. These trends are indicative of the shift from the less frequent, multiple-day trips of the past to the shorter, more frequent trips of the 1980's. More trips to wilderness areas now are for day use, rather than for overnight and multiday visits. In addition, total time spent in wilderness areas has been relatively stable in recent years. Wilderness use accounts for 5 percent of national forest recreation use and less than 1 percent of all outdoor recreation.

Onsite recreation is only one of the ways in which wilderness resources are important. Some people value knowing that wilderness exists, whether or not they personally make a visit. Also, maintenance of species diversity, protection of habitat for threatened and endangered species, and preservation of social and spiritual values are ways that the wilderness resource is important. Wilderness areas also serve a number of scientific and research needs, especially for studying undisturbed natural processes. Some areas also support commercial uses such as mining, grazing, and subsistence living, and many are important for watershed protection.

Wildlife and Fish Demand–Supply—The Outlook

Outlook Overview

- As land use intensifies on private lands, the National Forest System and other public lands will become more important for their unique wildlife and fish habitats, and especially significant for the some 166 threatened and endangered species found on national forests.

- Big- and small-game hunting are expected to decline slowly but steadily in the next 5 decades.

- Migratory-bird hunting will also decline somewhat to 2000 before it rises again.

- Increases in supply of opportunities for cold-water fishing, migratory-bird hunting, big-game hunting, and small-game hunting could lead to somewhat higher demand trends for these wildlife and fish recreation activities.

- Increases in nonconsumptive uses will grow about twice as fast as population to 2000, while warm- and cold-water fishing will increase about the same as population growth. Rates of growth will accelerate slightly after 2000.

- Analysis of participation rates for wildlife recreation opportunities indicates that national forests and other public lands are expected to become relatively more important for big- and small-game hunting and cold-water fishing if access remains generally unrestricted and free.

- Hunting in designated areas for a fee, especially on private lands is expected to become more important in the future and increase the pressure on public lands.

Context for Analysis

Wildlife and fish are integral parts of all environments—from pristine wilderness to urban settings. The values associated with wildlife and fish have broadened from the utilitarian views held by early subsistence and market hunters. Wildlife and fish populations are now recognized as barometers of the health and diversity of ecosystems, providing important social, environmental, and economic benefits to society as a whole. This is reflected in the passage of laws intended to ensure protection and bring about management of this resource, in the membership increases enjoyed by wildlife and fish interest groups, and in public interest in policies and programs affecting wildlife and fish.

The supply of wildlife and fish is a function of the quality and quantity of habitat, animal and fish populations, and investment in management. The demand for fish and wildlife is a function of the number of people actively using fish and wildlife resources, their preferences, and their willingness to allocate time and dollars to hunting and fishing. Thus, the demand-supply outlook for wildlife and fish is described in terms of habitat, population levels, numbers of users, and harvest levels.

Current Status and Recent Historical Trends in Habitat

Viable populations of fish and wildlife require appropriate habitat—availability of food, cover, and water. There are many different ways to measure and classify habitat. The most straightforward for wildlife that lives on land is habitat by land cover and how the land is used—whether it is forest, range, or cropland.

Forest Land—The plant cover on forest land is diverse and varied around the country. For example, 73 percent of all U.S. vegetation types are represented on National Forest System lands. Because of this diversity, it is estimated that at least 90 percent of the total bird, amphibian, and fish species and at least 80 percent of the mammal and reptile species can be found on forested lands.

Over time, the forest cover on any area changes, either naturally or through human actions. Changes in forest cover, trends in forest successional stages, and trends in the size, shape, and spatial distribution of different habitats affect the health and diversity of fish and wildlife populations.

Maintaining the diversity of wildlife or fish species that are potential inhabitants of any forest ecosystem type requires not only that all successional stages of forest vegetation be represented but also that important structural characteristics within plant communities be maintained. Many species are benefited by a mosaic of forest conditions; other species require large tracts of homogeneous forest.

Over time, the area of forest land has declined in the North and South and stayed about the same in the West, but there have been changes in the forest cover on some of these lands.

Rangeland—Rangeland cover supports a wide diversity of wildlife and fish species. For example, 84 percent of the mammal species found in the United States are associated with rangeland ecosystems during some part of the year. In addition, 38 percent of the Nation's fish species and 58 percent of its amphibious species occur on rangelands despite the dry climates

that usually characterize these environments.

As with forest lands, natural and human-caused changes in rangeland habitats can affect fish and wildlife diversity. For example, grazing by domestic livestock affects the amount and type of forage left for wildlife, and it affects riparian habitat for fish. In total over recent decades, there have been minor declines in the area of rangeland.

Wetlands—Wetlands are at the transition between land and water areas. Of existing wetland habitats, 74 percent are under private ownerships with the remaining acreage distributed among Federal, State, and local jurisdictions (fig. 30). Wetlands are among the most productive of ecological systems. This inherent productivity sustains nearly one-third of the Nation's threatened and endangered species, provides nursery and spawning grounds for 60 to 90 percent of U.S. commercial fish catches, provides breeding and wintering grounds for millions of waterfowl and shore birds, and supports numerous other species of birds, mammals and reptiles. Wetlands are used for commercial fishing and trapping, nonconsumptive recreation and study, waterfowl hunting, recreational fishing, and other activities.

Because of their inherent productivity, some wetlands have been drained and used for various types of commodity production. Conversions to these other uses have contributed to a net decline in the area of wetlands from an original area exceeding 200 million acres to about 100 million acres today.

Local, State, and Federal agencies have been promoting wetland conservation and restoration programs. For example, the Food Security Act of 1985 has greatly reduced the incentive for some wetland conversion by making ineligible for price supports and other publicly provided benefits any person who produces an agricultural commodity on wetland converted after passage of the legislation.

Flowing Waters and Associated Impoundments—The condition of flowing waters and associated impoundments affects the wildlife and fisheries resource. About 80 percent of the Nation's flowing waters have problems with fish habitat, or composition of the fish community related to water quantity or quality. Water quality is affected by turbidity, high temperature, nutrient surplus, toxic substances, and dissolved oxygen. Some of these problems result from soil and vegetative manipulation associated with agriculture, forestry, and other human activities.

Agricultural Lands—Because of the large areas involved, agricultural cropping significantly affects fish and wildlife populations. Across the country, land used for crops declined between the late 1940's and early 1970's but increased through the early 1980's. Changes in farming practices associated with increased cropping adversely affect wildlife populations. For example, the continuation of fencerow-to-fencerow farming would eliminate in the affected areas much of the nesting, feeding, and winter cover that wildlife need for survival. One way to make farming practices consistent with wildlife habitat is to make farmers aware that wildlife can be managed as a crop capable of generating income. In this way, the marketplace could provide incentives for making provisions for wildlife habitat a normal part of agricultural cropping. Conversion of surplus cropland to permanent cover under the Conservation Reserve Program should improve habitat conditions for some species in some regions.

Figure 30—Wetlands are among the most productive ecological systems.

Trends in Wildlife and Fish Population, Use, and Harvests

Nongame Wildlife—Nongame wildlife is typically not hunted for sport, food, or profit, and comprises the majority of the 3,000 vertebrate wildlife and fish species around the country. Information on population levels of nongame fish and wildlife is limited. The most detailed surveys—for various bird species—indicate that species associated with wetland habitat are the most likely to decline in number. Increases in forest fragmentation will also contribute to declines in populations of some forest-dwelling birds. Other bird populations can be cited as increasing in number, however.

Nonconsumptive Uses—Nonconsumptive uses of wildlife and fish are those that do not result in the death or attempted death of individual animals. Available information shows that this use of fish and wildlife has increased greatly over the past 2 decades. For example, the percentage of people 16 years of age and older who participated in some form of nonconsumptive wildlife-related recreation increased from 55 percent in 1980 to 74 percent in 1985.

Migratory Game Birds—Migratory game birds include waterfowl—ducks, geese, and swans—and webless migratory species such as woodcock and mourning doves. In total, the country's duck population declined from 44 million birds in the early 1970's to about 30 million birds in the mid-1980's. This decline is attributed to deterioration in the quantity and quality of wetland area.

Although there are exceptions for individual species, goose populations have increased significantly over the past 20 years. Wintering populations of geese have risen from 2.6 million in 1966 to 5.6 million in 1985. Remote breeding areas free from disturbance, management of cropland as a food source, and introduction of geese into suitable nesting areas have all contributed to the population increase.

Annual populations of swans have ranged between 72,000 and 148,000 since the 1960's. Woodcock breeding populations have been relatively stable throughout the range of the species in the last 20 years, although there is concern over recent declines in the eastern subpopulation. The population of breeding mourning doves has declined.

Migratory Game-Bird Hunters and Harvests—The number of duck and goose hunters has declined steadily in all three of the Nation's primary flyways (fig. 31). Although reasons for the decline are not known, lack of land accessibility and crowded hunting conditions probably are contributing factors. Data are fragmentary on the number of hunters of woodcock and mourning doves, but the total number of hunters of these species has probably been declining.

The harvest of ducks has shown a mixed trend over the past 20 years, reaching a peak of 16 million in 1971. The number of geese harvested has shown an increasing trend since 1965. It has been estimated that the harvest of woodcock and mourning doves has declined over time.

Big Game—Big game includes large mammals and wild turkey. Most big-game populations are now more secure, more widely distributed, and more abundant than they were at the turn of the century (fig. 32). Over time, enactment of protective legislation and management and extensive State and Federal habitat restoration programs have contributed to the recovery of

Figure 31—The number of duck and goose hunters has declined steadily in all three of the Nation's primary flyways.

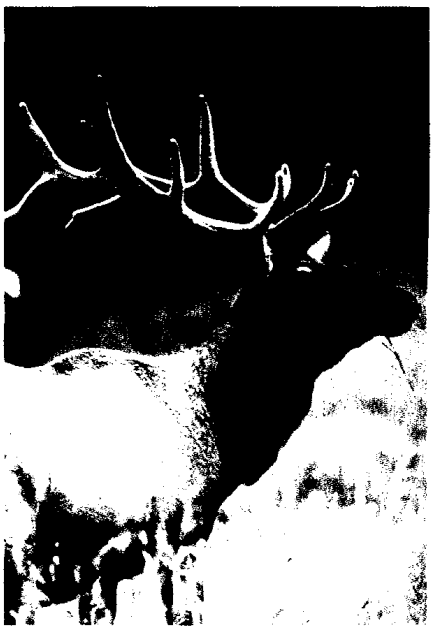


Figure 32—Most big-game populations are now more secure, more widely distributed, and more abundant than they were at the turn of the century.

many big-game species. However, the need for shortened and limited-entry hunting seasons has affected the quality of hunting opportunities and increased wildlife management costs.
Deer and wild turkey are the two most common big-game species hunted. Over 95 percent of all big-game hunters pursued deer, and over 12 percent hunted turkey in recent years. Nationwide, the population of these two species has more than doubled from 1965 to 1985.

Regional trends in big-game populations have also been upward. In the North, this includes white-tailed deer, black bear, and wild turkey. The two most important big-game species in the South are white-tailed deer and wild turkey. Over the past 20 years, populations of both species have increased across the South. The West has a greater diversity of big-game animals than the East. Species include deer, elk, pronghorn, bighorn sheep, and moose. Harvest regulations, habitat management, and transplanting programs have all contributed to increased populations during the past decade or so. An exception is a decline in mule deer populations on the Pacific coast from 1965 through 1980, which is attributed to a decline in habitat quality.

Big-Game Hunters and Harvests—Trends in the number of big-game hunters are influenced by harvest regulations, the cost of hunting, and changes in people's preferences over time. Although the actual number of big-game hunters has increased over time, there has been a declining national rate of participation in this sport. The decline has been attributed in part to decreasing land accessibility, a declining rural population, and crowded hunting areas. The actual number of big-game hunters has increased in all regions of the country except the Pacific coast, where it has declined.

Deer and turkey harvests have been rising in the North and South. Although there are exceptions, such as deer on the Pacific coast, harvest numbers have been increasing for big-game species in the West.

Small Game—Grouse, squirrels, rabbits, quail, and pheasant are generally considered to be small game. Small-game numbers are strongly influenced by habitat. Animals such as pheasants, quail, and rabbits, which are dependent on agriculture-related habitat, have shown a decline in numbers. Populations of animals such as grouse and squirrels are associated with forest cover and have remained stable or increased slightly.

Small-Game Hunters and Harvests—Until recently, the number of small-game hunters has represented a large percentage of the U.S. population. Since 1975, the number of small-game hunters relative to the U.S. population has declined slightly. The number of small-game hunters has been declining in all regions since 1980, with the greatest declines occurring in the North and South. Reasons for the decline include lack of access to land, crowded hunting areas, and lack of game.

For small game, there is generally a high degree of correlation between population size and number of small game harvested. Thus, the harvest has declined for animals dependent on agriculture-related habitat. Pheasant and quail harvests have declined by about 50 percent since 1965. The harvest of species associated with forested habitats has increased or shown mixed trends.

Fish—Although fish are found in all types of water around the country, few data are available on their distribution and populations. The best available estimates are that 79 percent of the Nation's streams contain fish. The diversity and abundance of fish species depend on the quality of habitat. The remaining 21 percent support no fish largely due to lack of water in intermittent streams.

A portion of this decreased streamflow is due to water diversions and watershed conditions resulting from historic land management practices. This has resulted in the enactment of protective State legislation and the development of cooperative projects among resource management agencies, landowners, and water users to restore and enhance watersheds and stream habitats in many locations.

Number of People Who Fish and Fish Harvests—Fishing is one of the most popular outdoor recreation activities, exceeded only by walking and swimming. The number of people who fish for fun has been increasing over the last 20 years, although the trend varies by type of fishing (fig. 33). Freshwater fishing accounts for 86 percent of the total number of people fishing, and this percentage has been increasing over time. There has been a steady increase in the number of people who fish commercially for all species during the past 20 years. In part, this has been due to increased demands for fish as food.

There are few data available on recreational fish harvests. Of the fish harvested commercially, salmon is by far the most important. After dropping to about 200 million lb in the early 1970's, the annual catch of salmon increased to a high of around 730 million lb in 1985.

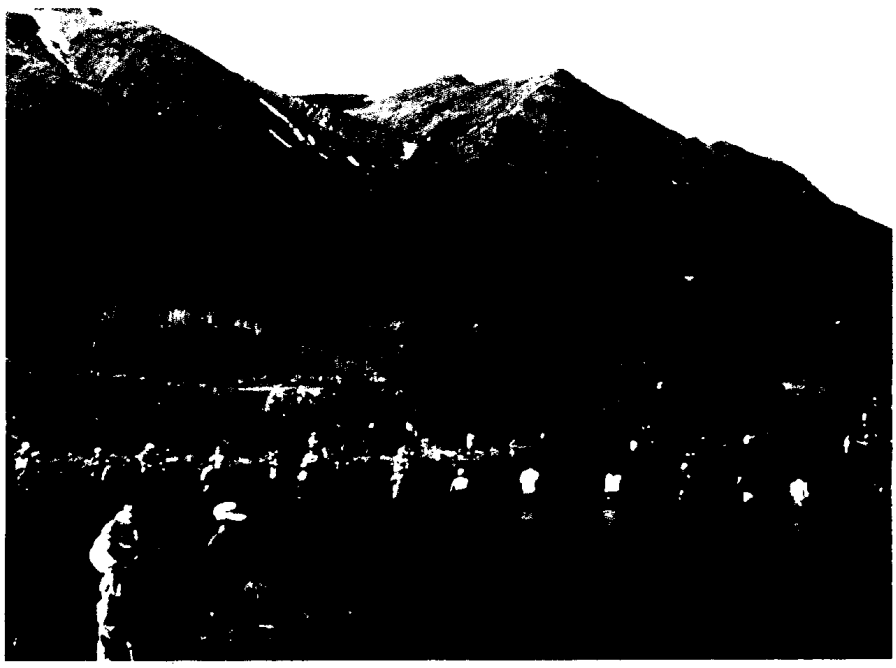


Figure 33—The number of people who fish for fun has been increasing.

Threatened and Endangered Species—A series of laws passed in the late 1960's and early 1970's had major effects on the management of some species of wildlife and fish. The most significant was the Endangered Species Act of 1973.

There are 565 animal species listed as being threatened or endangered. Some, such as the alligator and peregrine falcon, have made spectacular comebacks under legislative protection. Others, such as the California condor and black-footed ferret, have not recovered despite extraordinary attempts to save the species. Habitat changes contribute to changes in wildlife and fish populations. Improvement of our understanding of habitat needs and the location of all threatened and endangered species would facilitate management of these species.

Unique Role of Public Lands

Public land ownerships collectively constitute a huge area. The stability of public ownerships in terms of area and management philosophy and the diversity of habitats found on them give them unique status in evaluating the future outlook for fish and wildlife supplies. For example, much of America's elk and cold-water fishing habitat is found on public lands.

Although public land ownerships are concentrated in the West, they exist in all parts of the country. On these lands, various Federal, State, and local laws mandate that the conservation and enhancement of wildlife and fish and their habitats be given consideration in land management.

As land use intensifies on private ownerships in response to increased demands for commodity goods, the quantity and quality of habitat provided on public lands will become relatively more important for maintaining the health and diversity of wildlife and fish populations and recreational opportunities associated with them.

Of federally managed land units, the National Forest System is unique because of the extent and diversity of the wildlife and fish resources on its lands. This uniqueness is measured in terms of wildlife and fish habitats and the number and variety of wildlife and fish species found on National Forest System lands. For example, national forests contain approximately 128,000 miles of streams, 2.2 million acres of lakes, 16,500 miles of coastline, and more than half of the Nation's big-game habitat. These aquatic and terrestrial habitats support over 3,000 species of wildlife and fish. Some 50 percent of the trout streams are on the national forests, as is 50 percent of the spawning and rearing habitat for salmon and steelhead trout in the Pacific Northwest and California.

The Forest Service has habitat management responsibility for approximately 31 percent of the Nation's threatened and endangered plant and animal species. Present numbers of listed species occurring on National Forest System lands are expected to increase as habitat loss continues on other lands, new species are listed, and new information on species distributions becomes available.

Projected Inventories and Uses of Wildlife and Fish

The future availability of fish and wildlife depends on the availability and quality of habitat (fig. 34). Nationwide, it is expected that rangeland area will increase somewhat over the coming decades and that the acreage of forest land will decline. The area of land used

Figure 34—The future availability of fish and wildlife will depend on the availability and quality of habitat.

for crops will probably decline over the coming decades, but this outlook could change depending on the world food situation and the future for use of fertilizers and pesticides. Surplus agriculture production was the driving force behind the Conservation Reserve Program of 1985. Much of the acreage of erosion-prone cropland converted under this program will go into grass cover, with beneficial effects for certain species of wildlife. Most of the wildlife and fish benefits from the Conservation Reserve Program will be in the Rocky Mountain and Great Plains regions.

In general, it appears that any future changes in habitat as measured by land cover will occur slowly, except for areas affected by the Conservation Reserve Program. As timberland is harvested over time, there will be some changes in the type of forest cover, however.

If, as projected, the number of hunters declines, more of the operating budgets of State management agencies will have to come from public appropriations, user fees will have to increase, or other innovative management structures will have to be developed if current programs are to be maintained or increased.

Projected Populations and Harvests

State wildlife and fish agencies estimated future wildlife population and harvest numbers with consideration of historical population trends, likely future changes in land use, and proposed wildlife-management practices. About future big-game populations and harvests, these agencies are optimistic. They expect stable or increasing numbers of animals for most species in all regions of the country.

State agency projections of small-game populations and harvests are less optimistic. Historical declines in populations and harvests of bobwhite quail and other grassland-dependent species are expected to continue. The historical decline in the pheasant population in most regions is expected to be offset somewhat by habitat improvements as a result of set-asides for the Conservation Reserve Program.

Projections of big-game populations on national forests generally show stable or increasing populations with the exception of the black-tailed deer in the Pacific coast region.

Projections of Wildlife and Fish Recreation

We based projections of numbers of participants in wildlife and fish recreation on various assumptions about factors affecting supply and demand. Nonconsumptive activities, warm- and cold-water fishing, and migratory-bird hunting are expected to experience increases in the number of participants over the next 5 decades (fig. 35). Nonconsumptive recreation and cold-water fishing show the largest percentage gains. The number of persons participating in big-game hunting and small-game hunting is expected to decline. More people are expected to be involved in migratory-bird hunting, however. Hunting in designated areas for a fee is expected to become more important in the future.

Comparison of projected participation rates for recreational activities across ownerships shows that national forests are expected to become relatively more important in providing opportunities for hunting. This is especially true in the West, where, historically, the harvest of big-game species has come almost exclusively from Federal ownerships.

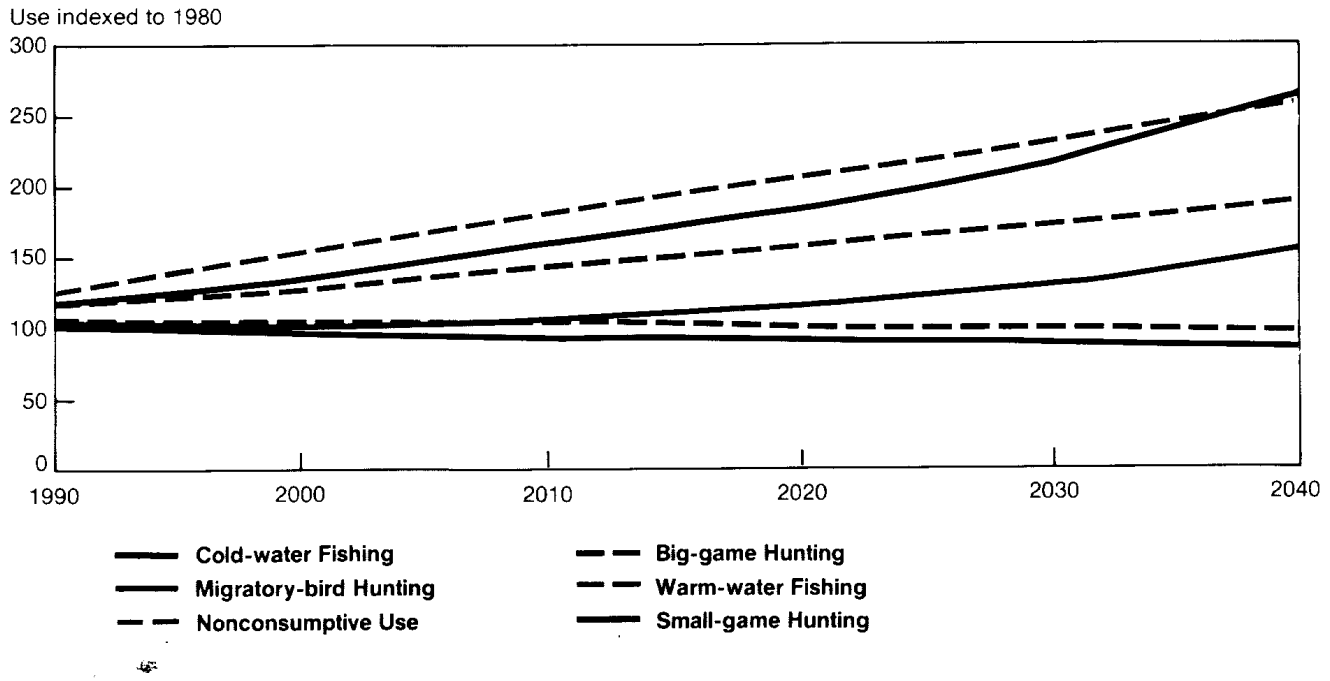


Figure 35—Projected participation in major wildlife- and fish-associated recreational activities.

We estimate that some 68 percent of all hunting is done on private land. Thus, access to private lands will continue to be a critical factor in evaluating future demands and supplies of wildlife, especially in the East, where much of the privately owned land is located.

Wildlife and Fish Demand–Supply Comparisons

The number of people who hunt and fish is determined in part by the availability of wildlife and fish habitats and populations. There are no reliable estimates of supply variables for use in comparing fish and wildlife supplies with demands. Demand and supply together determine consumption, which is measured by numbers of hunting trips, animals harvested, or other means. Because it is so difficult to separate demand and supply in analysis, it is difficult to interpret demand-supply projections. For example, the demand for hunting might decrease because there are fewer animals to hunt.

To test these demand and supply interrelationships, we examined future consumption under conditions of increased supply. This examination indicated that the biggest potential gap between demand and supply is for cold-water fishing, followed by migratory-bird hunting, big-game hunting, and small-game hunting. For these activities, increases in supply would lead to increases in consumption.

The big increases in demands for nonconsumptive uses and all forms of fishing imply that constraints on the use of the public lands and increased access fees may be necessary to match the capabilities of the resource with the desires of the Nation's people. This may create some investment opportunities on private land (fig. 36).

Although demands for most forms of hunting are not expected to increase, there will still be millions of people who want to hunt in the future. Management of the fish and wildlife resource to provide this experience will be especially challenging because of the competing demands that will be placed on the forest and range resource by a growing and affluent citizenry.

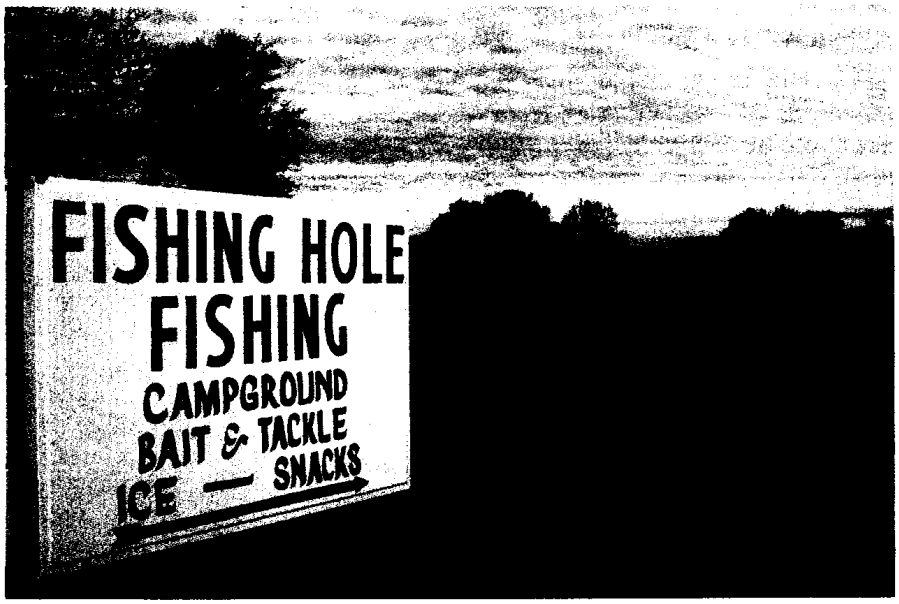


Figure 36—The big increase in demand for fishing may create some investment opportunities on private lands.

Outlook Overview

For the purposes of this Assessment, minerals[3] are grouped into three categories: (1) energy minerals—oil, natural gas, coal, geothermal steam, and uranium; (2) metallic minerals—copper, lead, molybdenum, gems, gold, and silver; and (3) industrial minerals and mineral materials—phosphate rock, limestone, and sand and gravel. These categories include most of the minerals that are of special significance to the U.S. economy.

- Although the United States is a mineral-rich Nation, it imports significant quantities of some minerals, especially petroleum.

- Demands for energy minerals will increase, with domestic energy production and energy prices dependent on foreign competition and technological developments in minerals exploration and recovery.

- Overall, there will be no quantitative shortage of any energy materials worldwide, although the price of oil is expected to increase significantly after the turn of the century.

- In general, domestic demand for metallic minerals and precious metals will continue to increase, but demand for any given metallic mineral is likely to be highly variable and dependent on technology developments and the evolution of end-use markets.

- The United States has supplies of many metallic minerals and precious metals sufficient to accommodate

[3] To simplify the discussion further, this report frequently uses the term "mineral" when actually talking about the constituent elements of minerals. For example, iron is referred to in this report as a mineral when, in actuality, it is an element found in many minerals such as hematite, bornite, etc.

domestic demand through 2040. For some minerals that the United States imports, availability of supplies will be influenced by the politics and the stability of the government of the producing country as well as the physical availability of the resource.

- Demands for minerals materials and construction are likely to follow trends in population growth and gross national product, but with agricultural use dependent on technology and demands for agricultural commodities.

- The domestic supply of minerals materials used in construction historically has been in equilibrium with demand. No national quantitative shortage is anticipated, but local shortfalls may occur.

Trends in Minerals Use and Projected Demands

The United States is among the world's leaders in the consumption of many important minerals. With only 5.8 percent of the world's population, America consumes more than 30 percent of the natural gas, 26 percent of the petroleum, 27 percent of the silver, and more than 21 percent of the lead and copper.

The historical trends in U.S. consumption vary among the three classes of minerals.

Total consumption of energy in the United States has increased steadily since World War II, but the pattern varies among petroleum, natural gas, and coal. Coal consumption has increased sharply in recent years while consumption of the other two energy minerals has declined.

Demands for metallic and industrial minerals and mineral materials have varied from metal to metal. In general, consumption of metallic minerals rises and falls in consonance with domestic and worldwide economic prosperity and recessions, and periods of relative peace and military conflict. This happens because metals contribute many of the primary materials for consumer products like cars and homes and for military weapons systems.

Demands for industrial minerals and mineral materials have been dependent on the fortunes of specific industries such as steel, agriculture, and construction. Thus, trends in consumption have tended to be cyclical.

Although the United States relies on significant importation of some minerals, especially petroleum, the Nation gets most of its coal and many other individual minerals from domestic sources.

Given the anticipated growth in the U.S. economy and population, it is reasonable to expect that demand for energy minerals will grow in the future (fig. 37). Exactly how much it will increase is uncertain—rising prices for energy would stimulate conservation and the development of alternative energy sources.

As with energy minerals, the general demand for metallic minerals has been linked to population growth, gross national product, and disposable income. The vigor of the domestic durable-goods manufacturing sector and communications and defense industries has a bearing on the domestic demand for metallic minerals. The use of gold and silver largely will be influenced by the world supply and price of these precious metals. Although we expect the demand for metallic minerals to rise, it is impossible to anticipate technologies that may have a profound influence on consumption of individual minerals.

The chemical and industrial sector is the biggest user of lime, the commodity produced from limestone, and we expect the demand for this mineral to

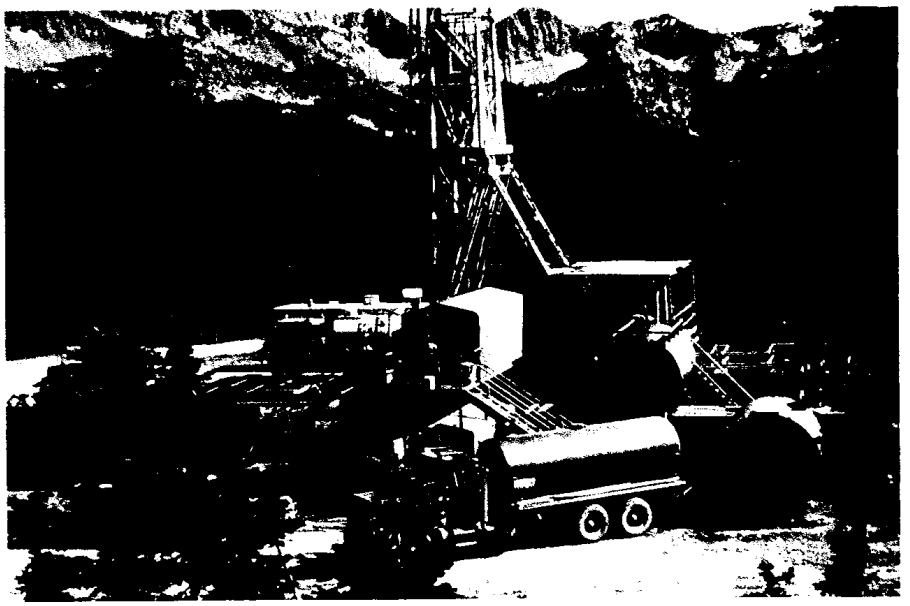


Figure 37—Growing demands for energy minerals should stimulate domestic production.

increase in line with the growth of these industries. Demands for phosphate rock are tied largely to the fate of U.S. and world agricultural production, which will increase in total, with production in any one country dependent on economic factors and government policies. We expect demand for sand and gravel to increase in line with the demand for construction.

The Minerals Supply Situation

The Nation is rich in many of the minerals it requires. In 1986, the United States was among the top three mineral-producing nations worldwide for 33 of 87 important minerals. It has significant known reserves of many mineral commodities, including some that are imported. Various types of minerals can be found in many parts of the country. Most of the coal reserves are under forest lands in the Appalachian region and rangelands in the northern Great Plains. Most of the metallic minerals occur under forest and range lands in the Rocky Mountain region.

There is little information on the quantities of minerals in public and private ownership. While significant amounts of minerals are believed to lie beneath Federal lands, these lands account for a relatively small proportion of total domestic minerals production, indicating that large amounts of minerals are in private ownership.

On National Forest System lands, the greatest potential for minerals activity is likely to be in coal, oil and gas, phosphate, molybdenum, and certain precious metals.

All of the areas in Federal ownership are subject to some mitigation requirements to protect surface resources where mining occurs. Some of the forest and range land in this ownership has been withdrawn specifically to protect against land-disturbing activities, which include minerals exploration and development. Other, much larger, areas have been reserved (dedicated) for particular public purposes or uses (parks, wilderness, etc.) and may not be available for producing minerals, timber, or range forage.

It is difficult to generalize about management investment and its effects on minerals outputs because minerals must be "discovered." However, management investment can affect exploration and subsequent monitoring of development.

Minerals are traded in world markets to a far greater degree than other forest and rangeland resources. Thus, domestic reserves are only one possible source of the minerals required to satisfy the Nation's needs. For most minerals the United States requires, there appear to be adequate supplies worldwide available to anyone with the money to buy them. Although there are abundant supplies of metallic minerals worldwide, their cost and security of supply raise questions about their stable and long-term availability. The market for many minerals is global in scope and extremely complex, and for some minerals there are frequent periods of shortages or oversupply. A number of minerals critical to the U.S. economy or important for national defense are controlled by unstable or unfriendly governments or are vulnerable to disruption by regional conflict.

Recycling is another source of supply. In the case of a few minerals, recycled material is an important domestic source. For example, there is no significant domestic source for tin, yet in 1986, about 20 percent of the 45.7 million metric tons consumed came from recycled material. Recycling is affected by the cost of recycling relative to the purchase of new supplies. This margin has gone through business cycles over time, and the boom-and-bust nature of the recycling business has impeded additional reuse of mineral products.

Minerals Demand–Supply Comparisons

Demand–supply comparisons for minerals suggest that there is not likely to be any lack of physical availability of the various minerals used in the United States. History, however, tells us that the future demand–supply situation for many minerals will be dynamic, with many short-term fluctuations in prices and other measures of the market. For example, we expect that the demand for metallic minerals will increase moderately overall, but new technologies will stimulate demand for some minerals and reduce consumption of others. Overall, there will be no physical shortage of any energy minerals, although the price of oil is expected to increase significantly. Price will influence the effective supply of oil, natural gas, oil shale, and tar sands, as rising prices stimulate exploration and development. The outlook for supplies of natural gas is relatively bright.

The United States has supplies of many metallic minerals and precious metals sufficient to accommodate domestic demand through 2040. However, the United States does not have supplies of some metallic minerals of economic and strategic importance. For those minerals present in the United States, the cost of foreign supplies compared with the cost of domestic production

largely determines how much of the demand is met by domestic sources.

Because of their relatively low value per unit of weight and bulk, mineral materials used for construction are typically mined near where they are to be used. The Nation has sufficient supplies of mineral materials, although there are local areas where mineral materials used in construction, such as sand and gravel and rock aggregate, do not occur or occur only in limited amounts.

Background

Projections of longrun demands and supplies are strongly influenced by prevailing shortrun conditions. The 1980's have been a turbulent time as measured by fiscal and monetary policies around the world and other indicators of the macroeconomic situation. The basic assumptions for this Assessment, however, are consistent with historical conditions, and the assumptions are generally consistent with long-held national goals of continued economic growth and increasing income. The future may be different from that described in the basic assumptions. In recognition of this uncertainty, the Assessment analysis presents the results of five alternative futures. These futures differ from the Assessment projection in key assumptions about the future. The following descriptions highlight key points in each of the futures.

The base Assessment projection is to be interpreted as the most likely given the associated explicit and implicit assumptions about variables that determine demand and supply. Key assumptions relate to management intensities on private lands, future outputs from national forests, and domestic and foreign demands for the various renewable resources. Projection results for other futures are compared with the base Assessment projections of consumption and other key measures of the renewable resource base. The five alternative futures are basically timber-oriented simply because data and analytic capabilities in other resource areas are not sufficiently advanced to differentiate meaningfully among alternative futures.

Description of Futures

Alternative future number 1 can be described as increased productivity of sawmill processing. It is the base Assessment projection modified by increasing lumber and product yields in the Pacific coast and Rocky Mountain regions so that they match changes projected for the South.

Alternative future number 2 can be described as high exports of timber products. It is the base Assessment projection modified by increasing the projected exports of lumber, plywood, and pulpwood (including pulpwood and the pulpwood equivalent of pulp, paper, and board) by 20 percent in 2000, 40 percent in 2010, 60 percent in 2020, 80 percent in 2030, and 100 percent in 2040.

Alternative future number 3 can be described as reduced tree growth. It is the base Assessment projection modified by reducing the net annual growth on timberland in the North and South shown in the empirical yield tables used in developing the Assessment projections. Hardwood growth is adjusted downward 5 percent and softwood growth, 10 percent. Growth reductions already observed in local situations have generally been less than 10 percent (fig. 38). Except in isolated areas in California, growth reductions have not been a major phenomenon in the Rocky Mountain and Pacific coast regions.

Alternative future number 4 can be described as surplus crop and pastureland (fig. 39). It is the base Assessment projection modified by assuming that all surplus crop and pastureland projected in the review draft of the Second Resources Conservation Act Appraisal (prepared by the USDA Soil Conservation

Figure 38—Growth reductions already observed, such as for red spruce, have generally been less than 10 percent.

Figure 39—There may be more surplus cropland in the future, and that could lead to more abandoned farmland.

Service) reverts to natural cover with a 10-year timelag. It is recognized by both the Forest Service and the Soil Conservation Service that the time required to reach climax vegetation varies considerably by area and could take over 100 years. The purpose of this future is to examine the possible effects of early reversion of surplus crop and pastureland to natural cover.

Alternative future number 5 can be described as the recycling future. It is the base Assessment projection modified by increasing the use of recyclable paper in the production of paper and board, reaching a utilization rate of 39 percent in 2040, compared with 31 percent assumed in the Assessment projection. From 25 percent in 1987, the utilization rate is increased to 27 percent in 2000, to 30 percent in 2010, to 34 percent in 2020, and to 37 percent in 2030. Lack of landfill space is now or soon will be a major problem in some areas, especially in the East. Publicly mandated recycling of paper and paperboard and the economics of disposal versus recycling may lead to significant recycling of these materials. The purpose of this future is to demonstrate the potential effects of increased recycling on the forestry sector.

Effects

In general, the various futures had only marginal effects on the demand–supply outlook at the national level. The effects that did occur for each future were in the expected directions. The high productivity future (future number 1) leads to a more competitive sawmilling industry with associated decreases in softwood lumber imports from Canada and increased domestic production. There were marginal decreases in prices for softwood stumpage and lumber. Higher exports (future number 2) tend to raise stumpage and lumber prices and increase imports from Canada. Reduced tree growth (future number 3) causes stumpage and lumber prices to increase, but the effects occur gradually over time, in part because of the availability of existing timber inventories. Much of the surplus

cropland (future number 4) identified in the Second Resources Conservation Act Appraisal is in the Great Plains, where range is the natural cover. Some acreage in the South would go into forest cover, but not enough to change the national demand–supply outlook.

The recycling future (number 5) leads to decreased softwood stumpage prices in the South. Much of the expansion of pulp capacity projected in the Assessment is expected to be in this region. Recycled paper and paperboard materials substitute for pulpwood otherwise destined for papermaking. Softwood lumber prices also decrease because of the lower overall demand for wood.

Although increased recycling could affect the national demand–supply outlook, there are a number of logistical and technical problems to be resolved before significant increases in recycling can occur. For example, it is difficult to remove from paper the ink used in laser printers. As the waste disposal problem becomes more severe, however, these problems may be resolved.

Social, Economic, and Environmental Implications of Projected Demand–Supply Comparisons and Opportunities for Responding to Them

Continuing population and economic growth in the United States implies growing demands for all renewable resources. The projected expansion of private and public resource investments and supporting research will expand supplies of all renewable resources. Equilibrium will be established between demands and supplies for each renewable resource in the future as it has been in the past. Social, economic, and environmental implications flow from the equilibrium levels of renewable resource outputs and the ways that equilibriums are established.

There are opportunities for investment in and management of the Nation's renewable resources so as to increase supplies. Increases in supplies would affect the equilibrium between supply and demand and thereby affect the social, economic, and environmental implications of the projected demand–supply situations for the various renewable resources. These opportunities exist on both public and private lands, but the distribution of opportunities across ownerships can vary by renewable resource. Increases in supplies in response to demand growth will increase national economic welfare. Increased supplies, however, would benefit some sectors of the economy at the expense of other sectors. The appropriate mix of Forest Service activities to influence supplies of renewable resources is considered in the RPA Program.

Timber

Implications—It seems clear that real timber prices (net of inflation or deflation) will continue to rise in the future under a wide range of plausible demand and supply situations. These market signals will lead to shifts in how wood is used and how it is grown. Rising prices will increase the value of the timber resource regardless of ownership.

The equilibrating mechanism of rising prices has obvious but differing effects on consumers and producers of timber products. Rising prices for lumber, for example, would have a marginal effect on the cost of a house, influencing some people to reconsider decisions about the type and size of housing they could afford (fig. 40). Rising incomes will offset somewhat the influence of rising prices, however. Owners of timberland, on the other hand, may invest more money into land management because their real wealth will increase as prices increase and investment opportunities become more attractive.

In the long run, consumers use less of a product that costs more in real terms. When lumber, plywood, and pulp become costlier, the markets for competing materials will improve at the timber industry's expense. Higher prices may also provide market signals that lead to economizing in the way that Americans use wood and to changes in building practices that minimize wood use.

Exports of most timber products are determined largely by the capability of U.S. producers to compete on a price basis with producers in other countries. Consequently, rising real prices will also constrain the country's export potential and affect the balance-of-payments situation.

As stumpage and timber product prices rise relative to other materials, use of substitute products, such as concrete, steel, aluminum, and plastic, will increase above the levels that otherwise would have prevailed. Widespread substitution will cause changes in the types of environmental impacts associated with use of renewable resources. Changes in the use of building materials will lead to adjustments of various types in some local economies. For example, some sawmills may close, and new sources of sand and gravel may have to be found and developed.

Opportunities—There are three major ways to increase supplies in response to rising demands for timber: (1)

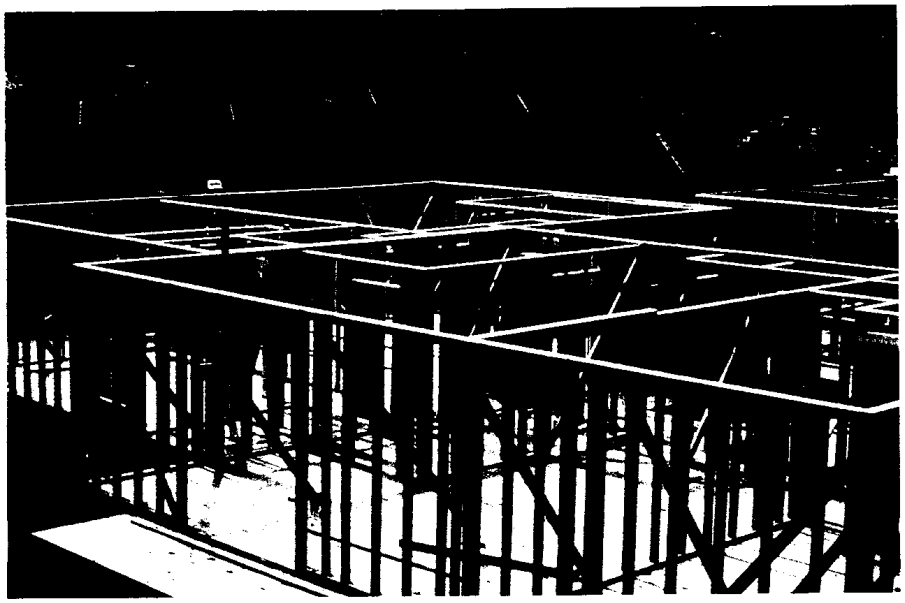


Figure 40—Rising prices for lumber will affect the cost of housing.

extending supplies through improved utilization, (2) increasing harvests from the existing timber resource, and (3) increasing net annual growth.

Timber supplies can be extended by: —Increasing the useful life of wood products by preservative treatments, improving designs of new structures, and renovating and maintaining existing structures rather than replacing them. —Improving efficiency in harvesting, milling, construction, and manufacturing. —Utilizing unused wood materials such as logging residues; treetops and limbs; rough, rotten, and salvable dead trees; trees in urban areas, fencerows, and low-productivity forest areas; and urban wood wastes. —Increased recycling of paper and paperboard (fig. 41).

Harvests from the existing timber resource can be increased by: —Increasing softwood and hardwood timber harvests on forests in the East. —Accelerating harvests on national forests in Washington, Oregon, northern California, northern Idaho, and western Montana that have large inventories of old-growth softwood timber.

Sustaining increased harvests on the national forests in the West and on the forest lands in the East beyond a few decades will require investments in regeneration and more-intensive management to increase net annual growth, especially for control of fire, insects, disease, and weeds.

Net annual timber growth can be increased by: —Regenerating nonstocked and poorly stocked timberlands, harvesting and regenerating mature stands, and converting existing stands to more desired species (fig. 42). —Applying intensive timber management practices such as species and spacing regulation, fertilization, and use of genetically improved trees. —Using management and harvesting practices to prevent or reduce losses caused by natural mortality (suppression), undesirable vegetation, wildfire, insects, diseases, and poor logging practices.

Water

Implications—Most of the effects associated with prospective increases in demands will fall directly on

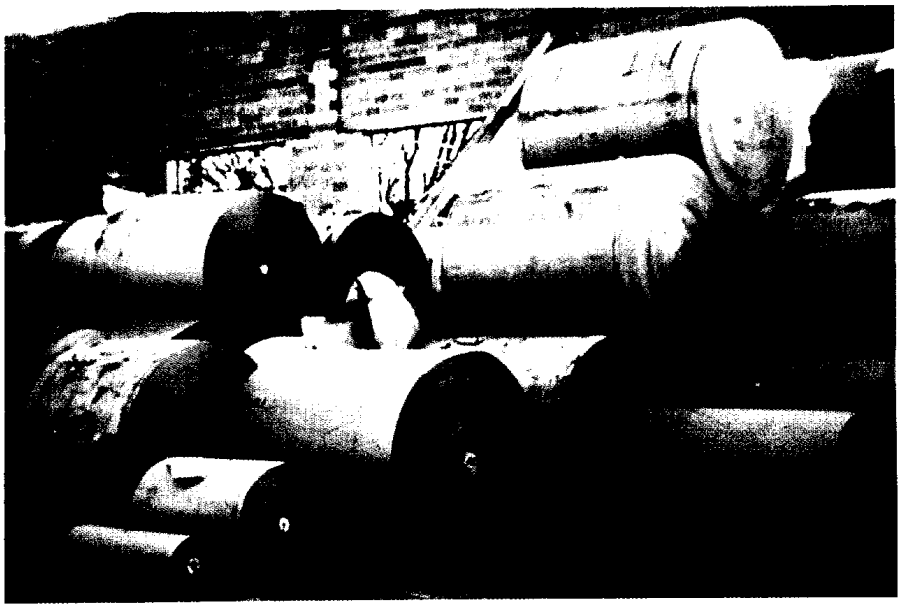


Figure 41—Timber supplies can be extended by increased recycling of paper.

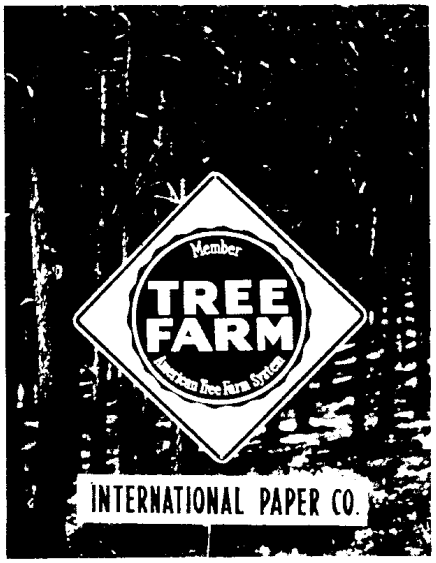


Figure 42—Net annual growth can be increased by harvesting and regenerating mature stands.

agriculture, but there are implications for all users of water, especially fish and wildlife. Unlike most other kinds of water withdrawals, irrigation is a large consumer of water. In some places, such as the areas on the High Plains of Texas and adjoining States where ground-water mining occurs, water production costs will rise and the water for crop and pastureland irrigation will become less economic. That will induce some shifts to dryland farming or range grazing. In most other water resource regions where expanding water demands pressure existing supplies, such as California and upper and lower Colorado, more and more of the available water is likely to go to the higher value uses such as domestic and manufacturing.

The changes in agriculture will also contribute to changes in land use around the country, with economic adjustments to local communities and established industries. For example, movement of more agriculture into the lower Mississippi Valley would add further pressure on the wetlands resource.

Irrigation based on surface water from streams and impoundments has implications for both fish and wildlife habitat (fig. 43). Meeting the demands projected for water use in irrigation implies that additional streamflows will be drawn down to the point where they can no longer support preferred species of fish or some species of water-dependent wildlife.

The expected increases in population and economic growth for the United States carry with them the expansion of possible sources of water pollution. However, enforcement of national water quality goals should alleviate the potential for new sources of pollution. Increases in America's population will also add pressures for development of floodplains.

Opportunities—There are opportunities in local areas on forest and range lands to increase and extend water supplies, ameliorate the effects of flooding, and improve water quality. Depending on the local situation, these opportunities can be achieved by:

—Improving vegetation management to enhance the natural recharge of surface and ground water, to reduce evaporation and transpiration losses, and to change the timing of waterflows.
—Improving protection of watersheds from wildfire.
—Maintaining wetlands.

In addition,

Water supplies can be increased by:
—Expanding and improving reservoirs to increase storage, regulate flows, and reduce evaporation.
—Improving snow management.

Water supplies can be extended by:

—Improving conservation, including more reuse.

Expected increases in flood damage can be limited by:
—Controlling floatable debris, such as logging residues.
—Increasing use of structures to control waterflows, providing that

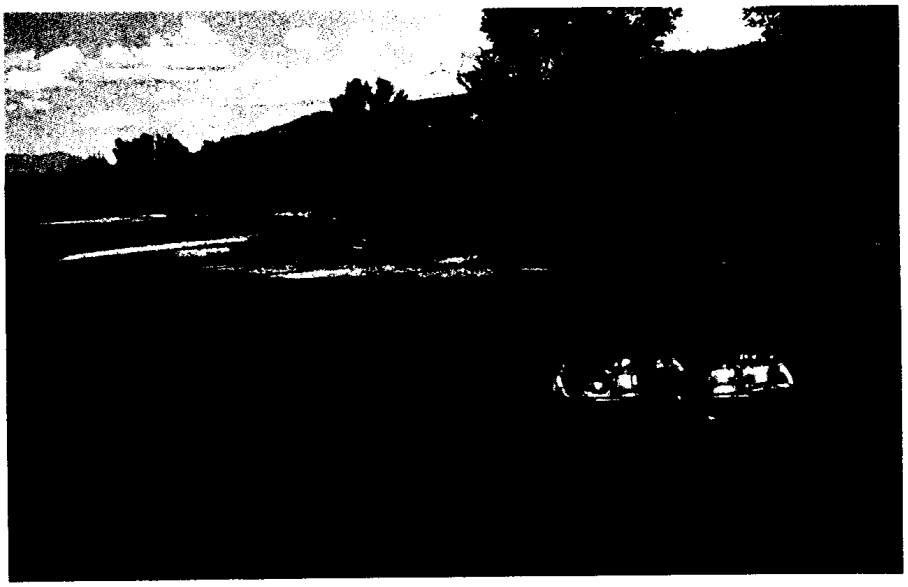


Figure 43—The Snake River, on the border between Idaho and Oregon, provides both irrigation and recreation.

further floodplain development can be restricted.
—Strengthening enforcement and restrictions against development of flood plains.
—Expanding land-treatment programs to improve watershed conditions.

Water quality can be improved by:
—Reducing contamination from rural septic systems.
—Reducing leaks from underground storage tanks.
—In the use of pesticides and fertilizers, improving techniques that reduce quantities to efficient levels and also inhibit transport into ground or surface water (fig. 44).
—Improving timber harvesting and road building practices.
—Increasing reclamation of mine sites to reduce erosion and acid flows from abandoned mines.
—Rehabilitating deteriorated watershed conditions.

Range Forage

Implications—Comparisons of future range forage supply and demand indicate that demands will be met through more-intensive management (higher investments per acre) of private rangeland, the management of wild and domestic grazers and browsers, and coordinated planning across all resources. Private rangeland will be managed more intensively only if the profit motive justifies doing so.

The expected growth in total demand for beef, veal, mutton, and lamb will lead to more-intensive management of the private range resource. At the same time, the rangeland resource is expected to become more important as a source of recreation and for other uses. Multiple-use management will become more important as a way to resolve conflicts in resource use as management of the range resource intensifies.

The expected small increase in output of forage from public lands, coupled with the projected large increases in total demand for meat, means that there will be structural changes for some producers in the livestock industry (fig. 45). Some livestock operations will have to use other than public lands to obtain forage for all seasons of the year. This is not possible in some parts of the country and could lead to shifts away from public lands, causing economic and social changes in the way of life for some families and individuals in the predominantly rural livestock industry. For example, ranching operations may not be viable unless fees are charged for other uses of the rangeland such as for hunting or recreation.

Opportunities—The opportunities for management of the range forage resource relate to range vegetation management, management of grazers and browsers, resolving social issues, and more effective planning for multiple demands on rangelands.

Range vegetation management is the management of vegetation for a mix of resource outputs, including herbaceous and shrub forage for domestic and wild animals, water quality and quantity, air quality, open space, genetic material, recreational use, plant diversity, community stability, and scenic quality (fig. 46).

Opportunities for range vegetation management include:
—Increasing the seasonal availability of forages by interseeding of species, converting part of the grazing land to other forage species, or adjusting the mix of animal species.
—Integrating range forage management more fully with the management of forest and range lands for other renewable resources, especially for wildlife and fish and water in riparian zones.

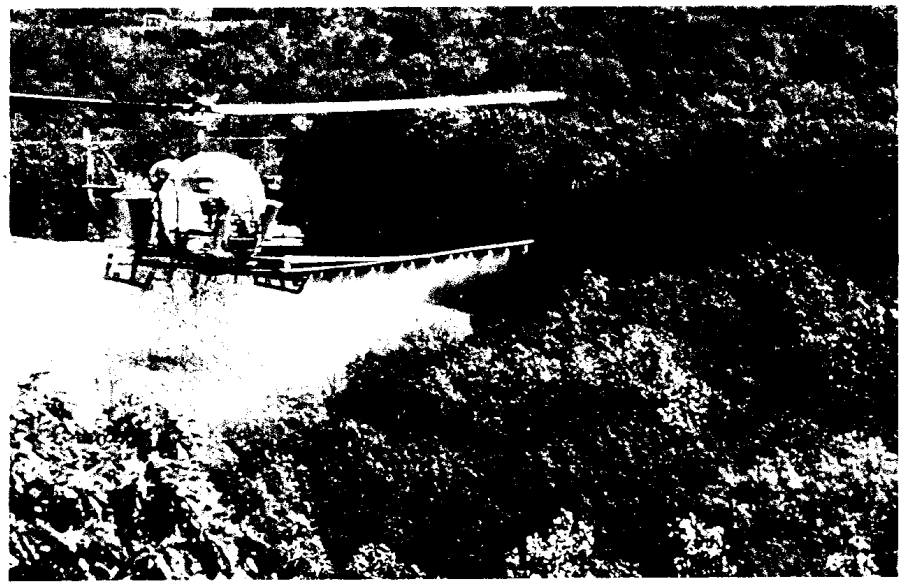


Figure 44—Water quality can be improved by spraying nonchemical pesticides such as the Bacillus thuringiensis (Bt) sprayed here to control the gypsy moth in Pennsylvania.

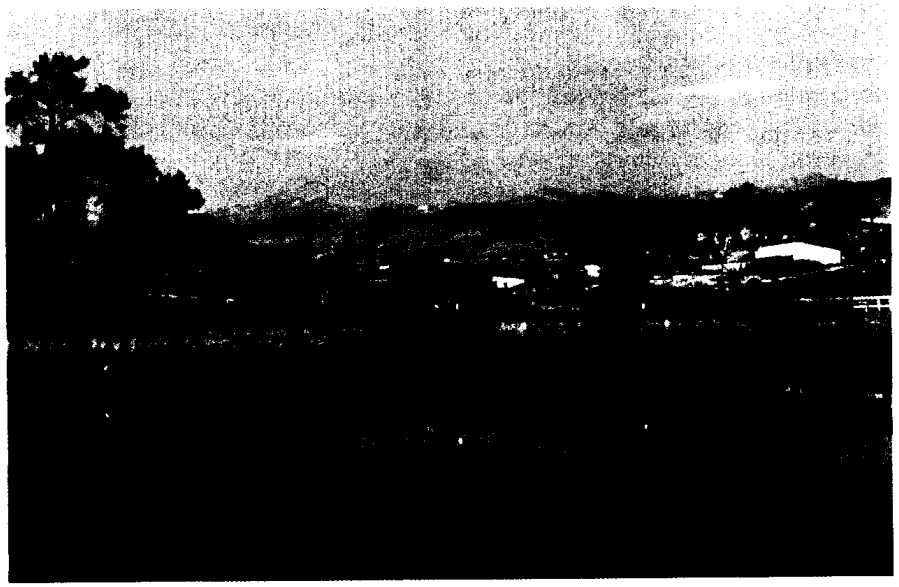


Figure 45—Leasing of rangeland for recreation may become more common in the future as a way for ranch owners to diversify operations. (Photo courtesy of Colorado State University.)

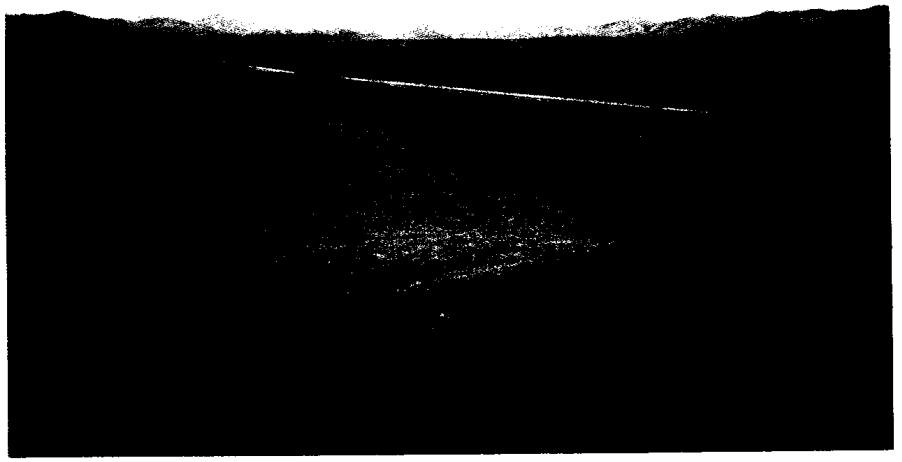


Figure 46—Range managers seek to produce a mix of resource outputs, including forage for domestic and wild animals, water quality and quantity, air quality, open space, recreation, plant diversity, community stability, and scenic quality.

—Developing biological controls for noxious weeds.
—Restoration of rangeland currently in deteriorated condition.

Opportunities for management of grazers and browsers include:
—Increasing the use of multiple-species grazing management so as to take full advantage of forage capabilities and improve range vegetation.
—Increasing the use of livestock as a vegetative-management tool to meet resource objectives for forage, timber, wildlife, and recreation.
—Predator control.
—Increasing domestic livestock reproduction and forage utilization efficiency.

Opportunities for responding effectively to social issues include:
—Increasing communication between land managers and the public to promote understanding of how proper livestock grazing practices contribute to soil productivity and water quality, the protection of watersheds, improvement of wildlife habitat, survival of threatened and endangered plants and animals, ecological diversity, and forage production for domestic and wild herbivores.

Opportunities for more effective planning include:
—Increasing multiresource planning across ownerships, public agencies, and resources.
—Developing an understanding of biological and ecological concepts applicable to multiple-use management of rangelands.

Outdoor Recreation

Implications—Most of the projected increases in demands for outdoor recreation on forest and range lands and inland waters can be met. It is difficult to quantify the social, economic, and environmental implications of the projected demand-supply situation, however. The projected situation varies somewhat by activity. For some activities, more-intensive use of available resources may lead to less satisfying experiences for some people, but in general, rising incomes will give consumers more freedom in choosing among activities (fig. 47). As total demand grows for most activities, it will also lead to

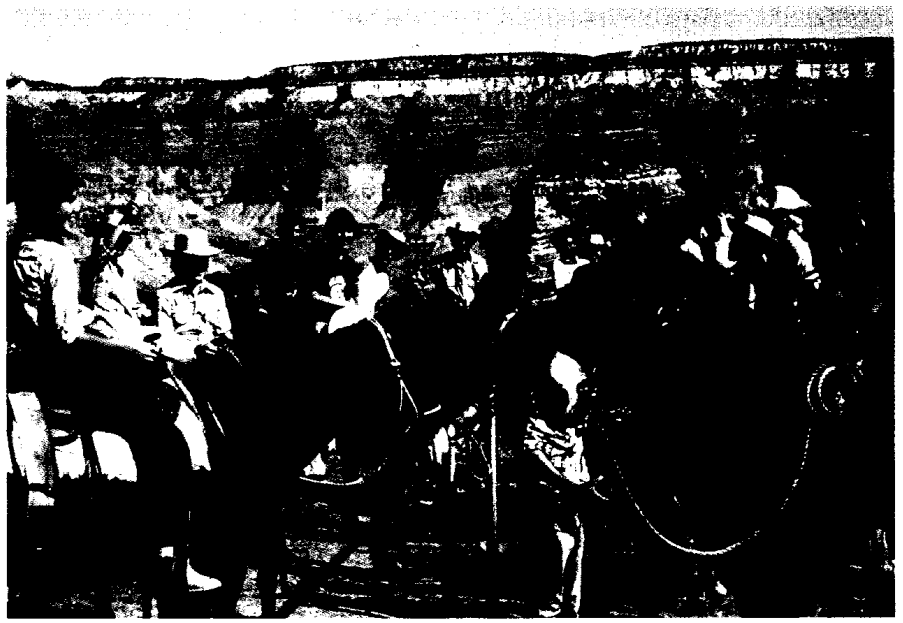


Figure 47—Rising incomes will give consumers more freedom in choosing among activities, but time available for recreation will affect their choices.

increased values for recreation resources to the point that private landowners may provide additional recreational opportunities on a fee basis. This is obviously beneficial to resource owners, but may be considered undesirable by some people who have become accustomed to and prefer free access. At the margin, some people may be denied access to some recreation simply because they do not choose to pay the fee.

Outdoor recreation and wilderness have important social significance to many Americans. Individuals, groups, communities, regions, and the Nation as a whole are affected to varying degrees by recreation and wilderness demand and supply. Providing preferred recreation opportunities to some segments of American society, including the elderly, less educated, some racial minorities, the economically disadvantaged, and those living in central cities, will be an important challenge in the future.

Some recreational and wilderness uses are compatible, but others are not. Thus, growth in recreational demands could lead to situations requiring management of competing uses of the forest and rangeland resource in some local areas. For example, some recreational activities are not compatible with wildlife and fish. Increased use of forests will place added stress on trees and could intensify forest pest problems, especially near population centers.

The growth in demand for recreational activities implies expenditures for equipment, guide services, travel—all of the items necessary to make the experiences enjoyable. Supply–demand imbalances that constrain the growth of recreation will limit both the growth of these expenditures and the growth of local economies dependent on recreation-related industries.

Opportunities—The major ways of increasing supplies include:

—Rehabilitating deteriorating sites and adequately maintaining existing facilities.
—Expanding activities concerned with visitor information services, including field interpretive and educational services that match recreationists with the recreational opportunities in a particular area.
—Improving coordination and encouraging partnerships among private groups, nonprofit organizations, and public agencies so as to deliver recreational opportunities more efficiently.
—Developing stable sources of revenue to cover costs of providing recreational opportunities, for example, user fees for recreational use on private and public lands.
—Constructing additional facilities such as trails, campgrounds, picnic areas, boat ramps, and other sites.
—Improving the coordination and integration of outdoor recreation uses with other uses.
—Improving access to forest and range land and inland water suitable for outdoor recreation, including private lands.

Wildlife and Fish

Implications—Wildlife and fish are critical parts of nature. Society's concerns and values for fish and wildlife are evident in various laws and regulations that have been passed to protect the resource. The social, economic, and environmental implications of increasing demands on the fish and wildlife resource are hard to quantify, however. Employment and income implications have important consequences in fishing communities in areas where other opportunities are limited, such as coastal Alaska.

Rising values for the fisheries resource are also creating investment opportunities in the private sector. For example, aquaculture and commercial fish growing have become important businesses over the past decade.

There are also cultural, societal, psychological, and physiological values associated with the fish and wildlife resource. These range from concerns of Native Americans for subsistence and religious values to the rest and relaxation resulting from experiences with fish and wildlife.

Comparisons of future supplies and demands suggest that recreation centered on fish and wildlife in some areas may become crowded to the point where access to the resource will have to be limited. For example, in some places, lotteries are held to determine who gets the opportunity to hunt big game. Owners of large private parcels increasingly limit public access by charging user fees or restricting their properties to the use of members of hunting or fishing clubs. This is another situation where the market provides investment opportunities for resource owners, but at the margin, some people may be denied recreation opportunities because they cannot or do not choose to pay the access fee. Rising incomes will give consumers more options, however, for choosing among activities.

Future pressures on wildlife and fish habitats are likely to be especially significant for some endangered and threatened species. Any extinction of species diminishes the Nation's natural biological heritage and future options for study and genetic diversity.

Opportunities—Management opportunities for increasing the quantity and/or quality of the resource relate in one way or another to habitat, wildlife and fish populations, users, and planning.

Opportunities for management of habitat include:
—Improving wildlife and fish habitats by increasing food supplies and suitable habitat cover, improving water quality, and increasing the size, diversity, and distribution of habitat areas (fig. 48).

Figure 48—Seeding roadsides and leaving them unmowed over the summer can increase cover suitable for pheasant and other game birds.

—Controlling land and water pollution, especially the use of pesticides, which can adversely affect wildlife and fish species.
—Expanding wetlands nesting habitats through fee purchase of key tracts and easements in the United States and Canada, and preserving and enhancing migration and wintering habitats.
—Increasing efforts to define, protect, improve, and augment critical habitats of endangered and threatened species and the important habitat of other species being adversely affected by changes in management or use.
—Removing barriers to fish migration.

Opportunities for direct management of wildlife and fish populations include:
—Preventing habitat deterioration by control of fish and wildlife populations.
—Reintroduction of species that have been displaced in areas where suitable habitats exist or are developed.
—Increasing the numbers and capabilities of fish hatcheries.
—Controlling or removing pest or competing species.

Opportunities for user and people management include:
—Increasing access to private lands by promoting activities that would assist landowners in establishing wildlife and fish-related businesses.
—Increasing the use of management options that better distribute users to wildlife and fish populations.
—Further educating the public about the role of wildlife and fish management and finding the means of financing it.

Opportunities for planning include:
—Increasing interagency coordination among the many agencies responsible for management of habitat, wildlife and fish populations, and hunting and fishing.
—Integrating more fully wildlife and fish needs in the management of forest and range lands for other renewable resources, especially timber and range forage.
—Continuing, through research, to improve the information base to manage the wildlife and fish resource effectively.

Minerals

Implications—The expected increases in demands for minerals can be met in

three ways: through increasing imports, increasing domestic production, and stepping up the country's efforts in conservation, recycling, and use of renewable resources. In the past, the Nation has responded in all three ways to changes in demands. For example, oil and manganese are imported; the United States is self-sufficient in molybdenum and minerals used for construction; large amounts of lead are recycled. Each response to increased demand has its advantages and disadvantages, and under each, different sectors of the economy and regions of the country are affected in different ways economically, socially, and environmentally. For example, the foreign manipulation of petroleum markets and subsequent high oil prices caused hardship in the Northeastern United States but benefited the U.S. oil industry and oil-producing States.

Increased imports of minerals to meet demands aggravates the Nation's balance-of-payments deficit. Reliance on imports also limits the Nation's options in setting national priorities and goals. If imports reduce prices, they also tend to disrupt local communities through closure of mines. While imports may be beneficial to the United States from the standpoint of reduced environmental impact, imports often originate in developing countries, where environmental controls are lacking. Disruption of the environment is of general concern to the world community of nations.

Increased domestic production of minerals benefits the Nation's balance of payments and in general exerts favorable economic impacts on local communities and on the national economy. Along with such benefits, there are also social, economic, and environmental implications associated with increased mining activity. The severity of potential environmental impact depends on the type of land and the mineral being mined, mining methods, the adequacy of laws and their enforcement, and the policies of the mining company involved. Mining can change the landscape, water quantity and quality, fish and wildlife habitat, air quality, and in some cases the health of workers and people living near the mine.

Conservation, recycling, and substitution of renewable resources for nonrenewable minerals generally have favorable environmental impacts. Though employment opportunities would be reduced in regions where minerals are found, employment opportunities in other parts of the country and other sectors of the economy would increase. Historically, the U.S. populace has not been oriented toward recycling or conservation measures except under very adverse conditions, such as in the gasoline shortages of the 1970's. The use of renewable resources can be expected to increase in situations where economics justify substituting them for nonrenewable resources and where doing so does not adversely affect the typical American lifestyle.

Opportunities—There are a number of opportunities to accommodate the projected increase in the Nation's demands for minerals of all kinds over the next 50 years. They include:
—Increasing domestic production by improving the business climate, encouraging minerals production on private lands, facilitating minerals development on Federal lands, and by improving information on domestic minerals location, quantity, and quality.
—Increasing imports through tax and trade measures and bilateral agreements with foreign nations.
—Extending supplies through more efficient recovery in mining and processing, more efficient use in manufacturing and consumption, and recycling.
—Substituting nonmineral materials for minerals and abundant minerals for scarce ones.
—Improving, through research, the basic information for more effectively mitigating environmental effects of mining (fig. 49).

Figure 49—Research can help managers mitigate the environmental effects of mining.

Resource Interactions

Resource interactions have been the topic of much study and analysis since the passage of the Renewable Resources Planning Act of 1974. Although an obvious result of resource management, resource interactions are difficult to estimate for any large geographic area because they tend to be site specific and complex.

Findings of this Assessment indicate that resource interactions will likely increase in the future as demands grow for all of the outputs of the forest and rangeland resource base. Although many interactions are positive or neutral in net effects, there are some negative ones that can constrain increases in supplies, especially when management of one resource exceeds the limit of tolerance and resilience of another. For example, roads necessary for timber production provide access for recreationists but may increase sedimentation if not properly contained through management practices to reduce or avoid erosion.

Research in the South demonstrates that land use and timber management can alter land cover in ways that change habitats for many wildlife and fish species, water quality, and range forage output. At the present time, these research results are available only for the South, primarily because of lack of data regarding land-base descriptions and projections. This is the first time that changes in the forage, wildlife and fish, and water resources have been quantitatively linked to changes in timber volumes and land areas.

The national forest plans provide another source of information about resource interactions. Analyses of these data indicate that current levels of national forest outputs for timber, range, recreation, water, and wildlife and fish can be produced throughout the next 50 years at current levels of cost, with two exceptions: California, and to a lesser degree, the South. Increases of any of these outputs on national forests in any of the regions over time would require increased investment and operating funds.

The analyses also indicate that if all outputs were to be increased simultaneously to approach Assessment demand projections, water quantity and wildlife habitat would tend to be negatively affected in the northern, eastern, and Rocky Mountain regions. Within the range of alternatives generated in the forest planning effort, it does not appear feasible for the National Forest System to maintain a constant proportion of all demands projected in this Assessment. To meet even part of the increase in demands simultaneously would generate substantial increases in both investments and operating costs. If these funds were to be made available, however, environmental impacts associated with increased outputs could largely be mitigated.

Encouraging Renewable Resource Management in a Market Economy

Just as there are many kinds of management and research opportunities to increase and extend the supply and to increase the quality of nearly all renewable resource products, there are also important obstacles to realization of these opportunities. Some are economic, some relate to lack of information, and some are based on existing policies and legislation. These obstacles must be recognized and managed if a greater proportion of the full potential of the forest and rangeland and inland-waters resources is to be realized.

To bring about changes in the supplies of goods and services, the U.S. economy relies largely on a system of markets and prices. For example, we expect that the market system will bring forth some adjustments in minerals and in management of industry-owned timberland and private rangeland. Also, private-sector landowners may respond to market signals by creating opportunities for some forms of recreation. For some uses of renewable resources, however, the key to increasing supplies sufficiently and maintaining the quality of resource outputs is to facilitate improvements in the workings of markets. Another option is to have public market intervention when the market does not work well, as in the case of market externalities such as water pollution.

There are four major reasons why supplies of some resources are not fully responsive to market forces: (1) management philosophies and priorities for public lands, (2) the broad societal nature of some resource-program outputs, (3) the lack of market prices for some resource products and uses, and (4) inadequate knowledge of resource-production opportunities.

The fish and wildlife resource is an example of why markets and current institutional arrangements do not respond well to changes in demands and supplies. Here as in many other countries, wildlife and fish are considered public property even though it is difficult or impossible to control their movement across property and jurisdictional lines, including international boundaries. Most changes in supplies of fish and wildlife depend upon publicly financed programs. Thus, levels of supplies and supply responses to public demands tend to be based upon political rather than market-driven decisions.

The general lack of market prices for access to and use of fish and wildlife, water, wilderness, and many forms of outdoor recreation opportunities results from the broad societal nature of the benefits. It is also due in part to the mobile nature and public ownership of the resource. Thus far, despite considerable research, it has been difficult to develop market prices for scenic beauty, water quality per se, songbirds, or the enjoyment associated with nature walks (fig. 50).

Figure 50—It has been difficult to develop market prices for nontangibles like the scenic beauty of this view from the Appalachian Trail in Virginia's Blue Ridge Mountains.

Some tangible products of forest and range lands, especially timber and livestock forage, do have established markets and prices. But the market response for these goods (particularly timber) is affected indirectly by inadequate knowledge about the resource-management opportunities and the failure of capital markets to recognize fully the present net value of future resource outputs. Private owners, who control nearly three-quarters of the timberland and about one-half of the rangeland, are greatly affected by these markets.

Various studies have shown that the millions of America's private owners of timberland have widely diverse ownership objectives and attitudes, limited knowledge of existing management opportunities, and varying willingness and capacity to make investments that could increase timber growth. Ownership tenures are typically short, and most owners are in the older age groups. Thus, for timber, where the time between investments and harvest is long, there is the likelihood that direct benefits, such as income from timber sales, will not accrue to many current owners. There is also substantial public ownership of forest and range lands, and management decisions made by public institutions are only indirectly related to changes in market prices.

The same kinds of considerations—different owner characteristics, objectives, and attitudes; lack of knowledge of existing technology; lack of capital; and varying willingness to make changes—also constrain improvements in utilizing timber and timber products.

The factors that affect investments in management and utilization programs also affect investments in research on renewable resources. The broad societal nature of the benefits, the lack of conventional markets and market prices for research knowledge, and the large numbers and characteristics of the owners of forest and range lands effectively cause research in the private sector to be limited to that of a few large industrial ownerships. Even this private-sector investment has declined in recent years. Thus, most of the

research on renewable resources is now, as in the past, carried on by public research agencies and publicly supported educational institutions (fig. 51).

Over time, markets change and have the effect of redefining opportunities. For example, higher prices will signal private landowners to invest more in renewable resources. To be effective, public and private activities that attempt to influence markets in order to capture opportunities will have to be sensitive to changes in markets.

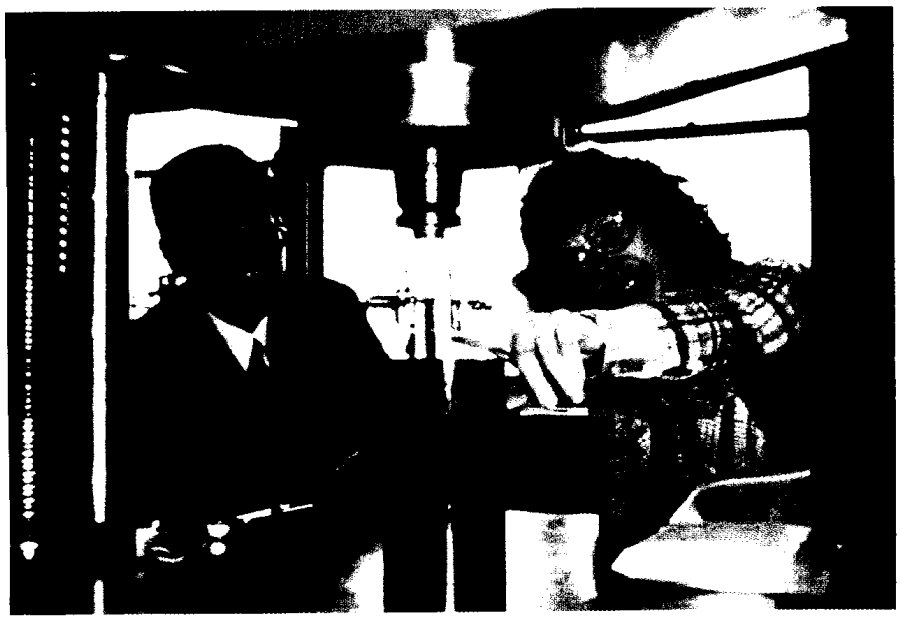


Figure 51—Most of the research on renewable resources is now, as in the past, carried on by public research agencies and publicly supported educational institutions.

Implications of the Assessment for Resource Management

The numerous opportunities to expand renewable resource supplies have implications for both public and private programs and activities that affect resource management. This section of the Assessment presents a general discussion of these implications without reference to laws, regulations, and policies that define responsibilities for action. The implications for Forest Service programs will be developed in the 1990 RPA Program. In general, identification of an opportunity also defines an implication for resource management. Thus, the implications of the Assessment for resource management derive from the opportunities that have been identified.

Renewable resources can be managed in any number of ways so as to change the demand-supply outlook in ways that benefit society. Some management practices yield quick results, and some take years or even decades to achieve the desired change in the outlook. The reason that the Assessment projections are long term—50 years—is to determine the circumstances for market equilibriums likely to evolve from a continuation of trends in resource management and use. These circumstances may then have implications for the 1990 RPA Recommended Program.

We project that future demands for some renewable resource products may be above the levels that would be supplied with projected management, research, and assistance investments. As in the past, demands will equal supplies in the future, however. This implies that for situations where demands are projected to exceed supplies, mechanisms will develop for equilibrating demands and supplies. For example, in the case of timber, it will mean higher prices; for water, it may mean changes in land use; and for

recreation, it may mean higher and wider use of access fees or lower quality recreational experiences if preferred opportunities are not available or affordable. Through appropriate public and private actions, the Nation can make choices about the costs and associated benefits of opportunities to adjust the supplies of resource outputs to meet projected demands at levels desired by society.

Timber

Timber management and utilization decisions can influence the rate of increase in timber prices. One option to keep future timber prices down is to increase timber supplies. This could be achieved by accelerating harvests of softwoods on the national forests in Washington, Oregon, northern California, northern Idaho, and western Montana. Both softwood and hardwood timber supplies can be expanded by increasing harvests on the private timberlands in the South and North, and by improving the utilization of timber and wood resources.

Acceleration of harvests on the national forests would require (1) building roads into old-growth timberlands; (2) protecting the environment and mitigating unacceptable adverse effects on wildlife, outdoor recreation, and other uses of the managed timberlands; and (3) establishing and caring for replacement stands.

Sustained higher harvest levels on private timberlands in the South and North would also benefit from technical assistance and financial incentives to nonindustrial private landowners to assure that productive stands are regenerated and maintained (fig. 52). The improved management would include appropriate control of forest insects and diseases as well.

Figure 52—One intent of education and technical and financial incentives to nonindustrial private landowners is to assure that productive stands are regenerated and maintained.

While improved utilization provides some options, especially in the short run, increased net annual growth offers the only practical means of meeting the longrun projected demands for softwoods and hardwoods at lower prices.

Research can lead to the extending of timber supplies. It can generate major improvements in utilization, primarily by reducing the costs and increasing the efficiency of utilizing currently unused wood materials, of construction and manufacturing, and of the design and maintenance of products and structures.

As they have in the past, forest-products markets will continue to change in the future. Therefore, research emphases will evolve over time. For example, much of the growth in roundwood consumption in the future will be for pulp and other fiber-based products. Research can develop technologies that will enable pulp manufacturers to use all species in the existing timber inventory for pulp manufacture. There are associated implications for the changes in the direction of forest management research as well.

Water

Both water quantity and quality are expected to be important in water-short areas of the West. Restoration and protection of watersheds on the appropriate public lands and cooperative assistance in watershed planning and land treatment measures on private lands can reduce flooding while maintaining water quality. The yield, timing, and quality of waterflows can be improved by research that leads to (1) better methods of managing forest and range lands to stabilize soils and constrain erosion and sedimentation, (2) rehabilitation of mined and other disturbed areas, and (3) minimization of the pollution associated with the use of chemical fertilizers and pesticides.

Continuation of past trends in irrigation will lead to competition for water from instream flows. Drawdown of water for irrigation will adversely affect fish and many forms of wildlife. Research could improve measures of valuation for water, fish, and wildlife so that policymakers can come to reasoned decisions about the allocation of water use in the best interests of society.

Range Forage

Much of the increase in forage needed to meet demands will come from private lands, and these lands will be managed more intensively. Research to improve systems of range management and develop lower cost, more efficient methods of improving ranges can lead to increased forage production on all ownerships.

The primary resource management implication of the range forage assessment is for technical assistance that could lead to the following results on private lands: (1) rehabilitation of range by seeding desirable species and controlling undesirable plants and shrubs, (2) construction of needed livestock control and handling facilities, such as fences (fig. 53), (3)-development of additional water supplies, (4) improvement of grazing systems and livestock management practices, and (5) decreased erosion. Responses of private landowners to markets may lead to some of these results even in the absence of publicly provided assistance.

We project that supplies of range forage from national forests will increase little in the future, and therefore there will not be increases in seasonal supplies of feed for domestic animals. Research could develop feeding systems that take care of increased numbers of animals in traditional ranching areas without reliance on increased seasonal forage from national forests.

Figure 53—Increased fencing is associated with higher productivity of private rangeland.

Outdoor Recreation

The Assessment analyses of outdoor recreation show that demands for most recreation activities are expected to grow, but the rates of growth differ by activity (fig. 54). We project that recreationists' primary future demand will be for opportunities near where they live. Therefore, recreation sites near population centers will receive most of the pressure arising out of these increased demands (fig. 55). The Assessment also shows that demands for some activities, such as dispersed recreation, can be met primarily through changes in management emphasis. Other demands, such as downhill skiing, can be met only through costly investments. Because of differential rates of growth in demand, management activities and investments for recreation must be reviewed and targeted over time to keep them responsive to the needs of the Nation's populace.

To be responsive to the changing demands for the different kinds of

Figure 54—Consumer preferences for recreation change over time. Cross-country skiing is an increasingly popular activity.

Figure 55—Most of the Federal recreation areas are in the West, but most of the people are in the East.

recreation opportunities, we could develop procedures for monitoring to determine the types of activities desired by the public. In the development of this Assessment, we found that standards and definitions for recreational data are not available. Different public agencies have different and sometimes conflicting definitions for the same measure of recreation demand and/or supply. The Department of Agriculture could provide the leadership in developing the needed standards in cooperation with other agencies.

We could also provide more and better visitor information services to encourage dispersal of recreationists' demands and to increase customer satisfaction. This information can direct visitors to underutilized areas and facilities. Closely related to the need for visitor information itself is the opportunity for interagency and private-sector cooperation in providing it. Through cooperative efforts of the various public and private providers, visitors would be able to find at one stop information about all of the recreational facilities in a local area.

The lands near population centers will bear a major share of the expected increases in demand for recreation. Publicly provided facilities and private investments to take advantage of opportunities will undoubtedly be affected by the geographic pattern of growth in demand.

Research designed to develop practical, lower cost ways of constructing, restoring, and maintaining facilities or minimizing the adverse impacts of use can further contribute to meeting the public's demands for outdoor recreation.

Private lands can also provide greatly increased recreation opportunities to the public, especially near population centers. Informing private landowners about the income potential and related social value of their lands for public recreation as well as management strategies and liability risks could result in increased access to private lands for recreation. Research could be developed to describe for State legislatures and other regulatory bodies the deleterious effect that existing liability law has on the use of private lands for recreation.

Multiple-use guidelines would improve coordinated management of both recreation and nonrecreation use of wilderness areas. Preservation of critical wildlife, fish and plant habitats, watershed protection, gene pool preservation, scientific uses, human development and spiritual growth, education, and preservation of representative ecosystems are all uses that would benefit from management direction such as that provided for recreation on public lands.

Wildlife and Fish

Access to private lands will be further restricted in the future, either through outright prohibition or through user fees, thereby shifting demands to public lands. The implication is that on public lands, it will become increasingly important for managers to integrate wildlife and fish objectives fully into management and protection activities for other resources, and especially those for timber, forage, and minerals. Access to public and private lands will also become increasingly important, with user fees probably becoming much more important in determining access.

As land use intensifies on private lands, National Forest System and other public lands will become more important for their unique wildlife and fish habitats. The fact that

approximately 330 threatened and endangered species are found on national forests clearly demonstrates the importance of these habitats.

Minerals

Major opportunities exist to increase minerals production from private forest and range lands. A large proportion of current minerals production now occurs on private land, and there is evidence that major deposits lie beneath private lands in the eastern part of the country. Even if private lands provide the bulk of minerals produced domestically, there is likely to be increased minerals exploration and extraction on Federal lands, including those in the National Forest System. Geologically, the national forests contain some of the host rocks most favorable for minerals deposits, and the forests are currently important sources of molybdenum, gold, lead, silver, copper, and phosphate.

For energy minerals, rising prices are likely to result in increased exploration for and development of oil, gas, coal, and geothermal resources. Especially for metallic minerals, volatile world markets determine prices, and demands for exploration for these minerals on national forests and other lands will be episodic. Where construction minerals such as crushed rock, sand, and gravel exist on national forests near expanding population centers, demand for these minerals will intensify.

In summary, we can expect an increasing interest in minerals of all kinds on National Forest System lands, with associated implications for planning and research on methods of exploring for and extracting minerals with minimum impacts on surface resources and maintenance of environmental quality.

International Cooperation

The United States contains only a small part of the world's forests and rangelands and renewable resources. It depends upon other countries for important shares of its mineral and timber supplies. At the same time, other countries depend upon the United States for supplies of timber products. Some species of wildlife and fish that are commercially or recreationally important spend part of their lives in other countries or international waters. The world's outdoor recreational opportunities and global environment are shared by everyone, and everyone loses or gains as these resources and the environment change. For example, global climate change would affect all people. As a partner in these shared resources, the United States should consider ways to support improved management and use of all forest and range lands and renewable resources and protection for the natural environment. Such support would facilitate sustainable development and trade in renewable resources based on environmentally sound conservation policy.

Resource Protection and Administrative Support Implications for the Forest Service

The expected increases in population and associated economic activity in the United States have implications for resource protection and administrative support on all lands. If renewable resource inventories and supplies increase in response to future demands, there will also be increased demands for the protection of: (1) the soil from erosion and loss of long-term productivity; (2) timber and forage resources from fire, insects, diseases and other pests; and (3) water from nonpoint source pollution.

On National Forest System lands, increased numbers of visitors will expect protection from crime. A crime-related issue that increased significantly in the past decade is the use of National Forest System lands to produce and process marijuana and other controlled substances. In 1986, for example, 800,000 acres were considered unsafe for the public or Forest Service employees to enter. Major efforts have been undertaken to remove this hazard from our national forests.

The decentralized management of the Forest Service and the wide geographic distribution of our 852 administrative units over 46 States and Puerto Rico require the use of more than 21 million square feet of space in approximately 11,200 buildings and support facilities. Maintenance of existing facilities will be a growing challenge, especially for those facilities and natural areas popular with recreationists. Any expansion of resource outputs and use would lead to demands for additional warehouses, offices, laboratories, and associated facilities whose expense must be written off as overhead. Increasingly sophisticated research in the biological sciences will require expensive materials and equipment. The state of the art for information processing will continue to evolve, so our computers and telecommunications equipment will need continual updating.

The Forest Development Road System provides the principal access to National Forest System lands in accordance with decisions reached in the land management planning process. The system serves all resource management activities. Expansion of most resource programs would lead to additional roads and increased maintenance for existing ones.

Policy Considerations for the Forest Service

This 1989 Assessment of the Nation's renewable resources forms the factual foundation for the 1990 RPA Recommended Program for the Forest Service. The RPA Program planning effort, rather than the Assessment, is the proper place to address the recommended Forest Service program. The Assessment, however, is a useful place to point out the types of policy considerations that flow from the Assessment findings and that will be addressed in the Program.

The Assessment projects a future of increased demands for most resources and a considerable capability to increase resource supplies. Many of the resource management and investment opportunities identified in this Assessment can be accomplished within existing laws and existing public policies that apply to the administration of the Forest Service. Some opportunities are beyond existing policies and programs. Other opportunities are more appropriate for the private sector or are responsibilities of State and local governments or are within the program bounds of other public agencies, such as the Soil Conservation Service. Laws and policies relating to renewable resources have evolved over time in response to changes in society's resource demands and changing attitudes toward the management of renewable resources. Forest Service programs have in turn evolved in response to those changes in laws and societal needs. As the projected renewable resource demands unfold in the future and as Forest Service programs continue to evolve to tap the resource supply opportunities more effectively, a number of policy considerations will surface.

Many of these are policy considerations that have arisen in the past, and current answers to them have been developed. Such policy considerations must be revisited in the context of the projected future that the Assessment depicts. Even though the current policy direction may be reaffirmed for the future, to keep the agency's programs vital, management must periodically reassess them in the context of projected resource trends.

There are a number of different ways to formulate the type of policy considerations that flow from the Assessment. Although not exhaustive, the following policy considerations capture many of the most important dimensions of Assessment findings and implications.

What objective should the Forest Service have in the production of resources on nonindustrial private lands?

Private nonindustrial forests cover a greater area than all public and industry-owned forests combined. The Assessment projects that the nonindustrial private lands will supply much of the timber and other forest resources in the future and that the owners of these lands can significantly increase resource supplies. But their ability to do so is limited by market and other barriers, including landowners' potential liability for acts that occur on their property. Only a relatively small proportion of nonindustrial private landowners employ professional forestry assistance. This indicates that many such owners do not use research-based knowledge that is now available to improve the productivity of their woodlands.

Current Forest Service policies aimed at private nonindustrial forests are designed to:
—Provide technical and financial assistance to the States for protecting forests from wildfire, disease, and insects; and
—Support the States in providing technical and financial assistance to landowners, mainly aimed at timber production.

The Assessment identifies the opportunity and demand for increased production of timber from nonindustrial private lands. It also, however, identifies growing demands for other outputs, including various forms of recreation in the Eastern United States. Public forest lands cannot meet all of the increased demands. A key policy to be evaluated is the extent to which the Forest Service, in cooperation with other public agencies, should encourage uses other than timber production on nonindustrial private lands. Existing policies such as fire protection do benefit all uses of the forest and rangeland base, but direct assistance programs often are targeted only at landowners' timber resources.

What balance of multiple-use management will be applied to the national forests?

The Forest Service is required by law to manage the national forests for multiple uses and has done so for decades. There have been conflicts among constituents who favor particular exclusive uses or particular multiple-use balances. Many of these multiple-resource demands can be met through the compatibility possible from multiple-use management.

Lands vary in their productivity for specific renewable resource outputs, and demands are concentrated on lands that have the characteristics desired by users. One view of multiple-use management sees it as providing for

the same general mix of uses across most acres. An alternative view of multiple use encourages managers to concentrate on producing specific outputs from only the lands most capable of such production.

Current Forest Service policy lies between these two interpretations. It provides a resource balance that maximizes net public benefits and responds to public issues and protecting environmental quality. As the Assessment projections of supply and demand come to pass in the future, the particular resource balance that maximizes net public benefits will change over time.

Options for application of multiple-use management to national forests include a resource blend narrower or broader than the current one of providing access to all resources. Under current policy, this choice will be influenced by changes in relative values among resources and in public preferences and issues that influence national forest-based resource planning updates or induce a revision of existing plans. Any change in the resource output mix on national forests would almost certainly lead to changes in the demands placed on private and other public forest lands. Thus, in addition to the question of future balance among the various resources on national forests, the relative capability and productivity of resource use on the national forests and on private and other public lands should be considered comparatively in the development of a national forest program.

Should the Forest Service move to increased reliance on the marketplace for allocation of renewable resources from national forests?

One option for meeting the changing level and composition of resource demands is to institute policy adjustments that would place greater reliance on the marketplace for goods and services from forests and rangelands. For example, this would help ration the use of these lands for recreation and similar uses that now are often free. At issue is the loss of a tradition of open access to public lands for some resources.

How should the relative priorities emphasis of Forest Service research programs be adjusted to respond effectively to the information and technology opportunities associated with increasing resource demands and supply opportunities?

The Assessment identifies many opportunities for research in increasing the quantity and quality of renewable resource outputs. Currently, Forest Service research addresses a very broad array of topics and provides results to meet local and regional scientific needs as well as results related to long-term, multifaceted natural resource issues. In the United States, the Forest Service is uniquely qualified to address a variety of needs because of its national scope, continuity, and multifunctional scientific staff. Any change in the current focus of the Forest Service research program would have significant implications for funding and the role of other natural resource research institutions.

What should the Forest Service do in our long-term resource planning to consider the threat of global climate change?

Global climate change could significantly affect the forests and range forage resources of the United States and have associated impacts on other renewable resources. The Department of Agriculture and the Forest Service are closely monitoring the reports of the carefully documented increase in levels of the "greenhouse" gases—chlorofluorocarbons, carbon dioxide, methane, nitrous oxide, and others in the atmosphere. These gases can contribute to climatic change. Human activities contribute to greater levels of these gases in the atmosphere as well as natural sources. Management efforts such as energy efficiency, emission control, conservation of irrigation water, reforestation, protection of forests from fire, and management of national forests for vigorous growth of young trees can and do contribute to lessening the rate of accumulation of these gases in the atmosphere (fig. 56).

Figure 56—Management of forests for vigorous growth of young trees contributes to lessening the accumulation of greenhouse gases in the atmosphere.

Epilog

The Forest Service is faced with assessing the potential impact of possible future climate changes and differentiating them from the separate impact of local air pollution. Further, since existing forests were produced under different environmental conditions than today's, even without any future climate change, tomorrow's forests could be quite different. Thus, the Forest Service is confronted with great complexity and the challenge of developing appropriate data bases and models. Such models must be based on sound data, much of which is lacking. When they are available, they can provide reliable information for deciding what to do in many different forest ecosystems and locations and under various conditions that involve a wide range of external variables besides the greenhouse gases.

The foregoing and other policy considerations will be reviewed in the determination of a recommended RPA Program.

Renewable natural resources will always be important to the economic welfare and quality of life for the citizens of the United States and the world. The Assessment has pointed out the many opportunities Americans have to use these resources to improve the public's economic welfare and quality of life. The Nation has made a great deal of progress over the past several decades in production of resources and enhancement of productivity. Past performance clearly indicates that U.S. resources are resilient and renewable and responsive to management. Their resilience and renewability account for the management opportunities we have today to increase their products and uses as well as their contribution to the environment.

As our Nation continues to grow in the coming decades, Americans' perspectives on natural resources will change in terms of problems, opportunities, and the appropriate mix of management inputs to manage the country's renewable resources. This is why periodic assessment of the renewable resource situation is so important in providing the factual basis for the 1990 RPA Recommended Program.

Pesticide Precautionary Statement

This publication mentions the use of pesticides in one figure caption. The text does not contain recommendations for their use, nor does it imply that the uses discussed in the figure caption have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

Appendix table 1—Population, gross national product, and disposable personal income in the United States, specified years, 1929-86, with projections to 2040

Year	Population[1]		Gross national product		Disposable personal income		Per capita disposable personal income	
	Millions	*Annual rate of change, percent*	*Billion 1982 dollars*	*Annual rate of change, percent*	*Billion 1982 dollars*	*Annual rate of change, percent*	*1982 dollars*	*Annual rate of change, percent*
1929	121.8	—	709.6	—	498.6	—	4,091	—
1933	125.7	0.8	498.5	-8.4	370.8	-7.3	2,950	-7.8
1940	132.1	.9	772.9	7.9	530.7	6.2	4,017	5.4
1945	139.9	1.1	1,354.8	-1.9	739.5	-1.3	5,285	-2.4
1950	152.3	2.1	1,203.7	8.5	791.8	8.0	5,220	6.2
1955	165.9	1.8	1,494.9	5.6	944.5	5.6	5,714	3.8
1960	180.7	1.6	1,665.3	2.2	1,091.1	2.2	6,036	0.1
1965	194.3	1.3	2,087.6	5.8	1,365.7	5.8	7,027	4.5
1970	205.1	1.2	2,416.2	-0.3	1,668.1	4.3	8,134	3.1
1975	216.0	1.0	2,695.0	-1.3	1,931.7	1.9	8,944	.9
1976	218.0	.9	2,826.7	4.9	2,001.0	3.6	9,175	2.6
1977	220.2	1.0	2,958.6	4.7	2,066.6	3.3	9,381	2.2
1978	222.6	1.1	3,115.2	5.3	2,167.4	4.9	9,735	3.8
1979	225.1	1.1	3,192.4	2.5	2,212.6	2.1	9,829	1.0
1980	227.8	1.2	3,187.1	-.2	2,214.3	0.1	9,722	-1.1
1981	230.1	1.0	3,248.8	1.9	2,248.6	1.5	9,769	.5
1982	232.5	1.0	3,166.0	-2.5	2,261.5	.6	9,725	-.5
1983	234.8	1.0	3,279.1	3.6	2,331.9	3.1	9,930	2.1
1984	237.0	.9	3,501.4	6.8	2,469.8	5.9	10,419	4.9
1985	239.3	1.0	3,618.7	3.4	2,542.8	3.0	10,625	2.0
1986	241.6	1.0	3,721.7	2.8	2,640.9	3.9	10,929	2.9
				Projections				
2000	274.9	.7	5,402	2.8	3,827	2.4	13,920	1.6
2010	294.3	.6	7,031	2.6	4,922	2.3	16,730	1.6
2020	312.1	.5	9,166	2.8	6,136	2.4	19,660	1.8
2030	325.5	.3	11,957	2.7	7,660	2.2	23,530	1.9
2040	333.4	.2	15,627	2.7	9,599	2.3	28,790	2.1

— = not available.

[1] Data for 1929, 1933, and 1940 exclude Alaska and Hawaii. Data for 1929–86 are as of July 1.

Sources: *Historical data:* Council of Economic Advisers. 1987 Economic Report of the President. Washington, DC: U.S. Government Printing Office. *Projections:* The Wharton Econometrics Forecasting Associates group special report to the Forest Service. (Copy on file with the USDA Forest Service, Washington, DC.)

Appendix table 2—Land and water areas in the United States, by region and class of land and water[1]

Class of land and water	Total	North-east	North Central	South-east	South Central	Rocky Mountain	Great Plains	Pacific Coast[2]	Alaska
				1,000 acres					
Land									
Non-Federal									
Rangeland[3]	441,466	16	238	4,192	111,365	168,407	74,080	33,212	49,956
Transition land[4]	35,603	3,601	1,021	989	934	17,876	86	1,167	9,929
Forest land[5]	443,307	78,110	67,686	78,270	105,936	28,624	3,018	39,862	41,801
Other land[6]	689,627	41,083	205,448	52,102	153,808	64,086	110,82	443,697	18,586
Total	1,575,980	122,810	274,392	135,553	372,043	278,987	188,008	117,938	120,272
Federal									
Rangeland	328,887	—	172	197	—	167,411	3,500	34,828	122,779
Forest land	252,394	2,569	9,852	9,054	8,931	90,697	1,211	52,765	77,315
Other land	63,504	1,028	1,802	1,571	4,460	9,812	1,209	2,105	41,517
Total	644,785	3,597	11,826	10,822	13,391	267,920	5,920	89,698	241,611
All land									
Rangeland[3]	770,353	16	410	4,389	111,365	335,818	77,580	68,040	172,735
Transition land	35,603	3,601	1,021	989	934	17,876	86	1,167	9,929
Forest land	695,701	80,679	77,538	87,324	114,867	119,321	4,229	92,627	109,116
Other land	753,131	42,111	207,249	53,673	158,268	73,892	112,033	45,802	60,103
Total land	2,254,788	126,407	286,218	146,375	385,434	546,907	193,928	207,636	361,883
Water									
Inland water									
Large area[7]	51,318	4,422	6,735	7,185	9,182	5,164	2,412	3,309	12,909
Small area[7]	9,863	761	752	1,398	1,960	610	428	504	3,450
Other Water[7]	47,642	6,541	35,879	2,196	1,417	--	--	1,609	--
Total water	108,823	11,724	43,366	10,779	12,559	5,774	2,840	5,422	16,359
Total land and water	2,363,611	138,131	329,584	157,154	397,993	552,681	196,768	213,058	378,242

— = not available.

[1] Data for forest land, rangeland, and other land as of 1982; data on inland water as of 1980; data on other water as of 1970.

[2] Includes Hawaii.

[3] Land on which the climax vegetation (potential natural plant community) is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing and browsing.It includes natural grasslands, savannas, many wetlands, some deserts, tundra, and certain forbs, and shrub communities.It also includes areas seeded to native or adapted introduced species that are managed like native vegetation.

[4] Land that meets the definition of forest land based on cover characteristics but that carries as the predominant vegetation grasses or forage plants used for grazing.The Soil Conservation Service has classified and reported most of these lands as rangeland: the Forest Service has classified and reported these lands as forest land. In most instances these lands are noncommercial timberland ecosystems such as pinyon-juniper, chaparral, and post oak.Transition land is an interim category used in this report to classify part of the area in such ecosystems.Work is underway in the Forest Service and Soil Conservation Service to resolve classification differences and show all such land as rangeland or forest land in future reports.Some of the area in noncommercial timberland ecosystems is classified as forest or rangeland in this report.

[a] Land at least 10 percent stocked by forest trees of any size, or formerly having had such tree cover and not currently developed for nonforest use.The minimum area for classification of forest land is 1 acre and must be at least 100 feet wide.Forest land is distinguished from rangeland in transition vegetation types if the tree canopy cover exceeds 10 percent.Forest lands include cutover areas temporarily unstocked as well as young stands and plantations established for forestry purposes which do not yet have 10 percent crown cover.

[b] Includes crop and pasture land and other land.Cropland is defined as land used for the production of adapted crops for harvest, alone or in rotation with grasses and legumes.Adapted crops include row crops, small grain crops, hay crops, nursery crops, orchard and vineyard crops, and other similar specialty crops. Pasture land is defined as land used primarily for the production of adapted, introduced, or native forage plants for livestock grazing.Pastureland may consist of single species in a pure stand, grass mixture, or a grass-legume mixture. Cultural treatment in the form of fertilization, weed control, reseeding, or renovation is usually a part of pasture management in addition to grazing management.Native pasture is included in pastureland in these land area statistics. Other land is defined as a category of land cover and land use that includes farmsteads, other land in farms, strip mines, quarries, gravel pits, borrow pits, permanent snow and ice, small built-up areas, and all other land that does not fit into any other land cover or land-use category.

[c] Lakes and ponds at least 40 acres in size; waterways 1/8 mile or more in width.

[d] Lakes and ponds between 2 and 40 acres in size; waterways less than 1/8 mile in width.

[e] Includes Atlantic, Pacific, and gulf coastal waters; Chesapeake and Delaware Bays; Long Island and Puget Sounds; New York Harbor; Straits of Juan de Fuca and Georgia; and the Great Lakes.Excludes Alaska and Hawaii.

Sources: Forest land: U.S. Department of Agriculture (USDA), Forest Service. 1977. Forest statistics of the United States, except that forest land ownership in Alaska updated through 1987 by the USDA Forest Service for the Federal and nonfederal ownerships. Rangeland: USDA Forest Service estimates based on data supplied by the USDA Soil Conservation Service; U.S. Department of the Interior, Bureau of Land Management, Bureau of Indian Affairs, and National Park Service; and U.S. Department of Defense. Inland water: USDA Soil Conservation Service (preliminary data).All other land and water: U.S. Department of Commerce, Bureau of the Census. 1970. Area measurement reports, GE-20, No. 1. 22 p.

Appendix table 3—Indexes of softwood timber growth, inventory, and acreage in the United States, by ownership, specified years, 1952–87

(1977 = 100)

Ownership and year	Index of — Growth	Inventory	Acreage	Growth per acre	Growth per inventory
National forest					
1952	67	98	107	63	69
1962	81	103	109	74	79
1970	96	102	107	90	94
1977	100	100	100	100	100
1987	109	90	96	113	121
Other public					
1952	62	98	105	59	67
1962	82	97	100	82	86
1970	94	99	100	94	96
1977	100	100	100	100	100
1987	117	94	91	128	123
Forest industry					
1952	65	104	87	75	63
1962	81	103	89	91	79
1970	91	101	97	94	90
1977	100	100	100	100	100
1987	112	97	102	110	115
Other private					
1952	59	76	106	55	78
1962	74	83	109	67	89
1970	89	92	104	86	97
1977	100	100	100	100	100
1987	93	109	99	94	85
All owners					
1952	62	93	103	60	67
1962	78	97	105	74	80
1970	91	99	103	89	93
1977	100	100	100	100	100
1987	103	97	98	105	106

Appendix table 4—Indexes of hardwood timber growth, inventory, and acreage in the United States, by ownership, specified years, 1952–87

(1977 = 100)

Ownership and year	Index of —				
	Growth	Inventory	Acreage	Growth per acre	Growth per inventory
National forest					
1952	61	64	107	57	96
1962	78	81	109	72	97
1970	88	90	107	82	98
1977	100	100	100	100	100
1987	95	117	96	99	81
Other public					
1952	59	60	105	57	97
1962	76	77	100	76	99
1970	90	89	100	90	101
1977	100	100	100	100	100
1987	116	117	91	127	100
Forest industry					
1952	57	63	87	66	92
1962	69	78	89	77	88
1970	88	84	97	90	98
1977	100	100	100	100	100
1987	95	108	102	93	88
Other private					
1952	69	73	106	65	96
1962	77	82	109	71	94
1970	92	91	104	89	101
1977	100	100	100	100	100
1987	103	118	99	105	88
All owners					
1952	66	70	103	64	96
1962	76	81	105	72	94
1970	91	90	103	88	101
1977	100	100	100	100	100
1987	103	117	98	105	88

Appendix table 5—Net volume of timber on timberland in the United States, by region, class of timber, and softwoods and hardwoods, January 1, 1987

Class of timber	Total	North[1]	South[2]	Rocky Mountain[3]	Pacific Coast[4]
			Billion cubic feet		
Growing stock					
Softwoods	450.9	47.4	103.8	100.3	199.4
Hardwoods	305.1	139.6	134.2	7.7	23.5
Total	755.9	186.9	238.0	108.0	222.9
Live cull trees					
Softwoods	13.0	3.1	2.3	3.8	3.7
Hardwoods	47.0	17.6	25.6	1.7	2.1
Total	60.0	20.7	27.9	5.5	5.8
Sound dead trees					
Softwoods	12.4	0.9	0.7	6.6	4.2
Hardwoods	3.0	1.1	.4	1.3	0.1
Total	15.4	2.0	1.1	7.9	4.3
All timber					
Softwoods	476.3	51.4	106.8	110.7	207.4
Hardwoods	355.0	158.4	160.2	10.8	25.7
Total	831.3	209.8	267.0	121.5	233.1

Note: Data may not add to totals because of rounding.

[1] Includes the Northeast and North Central.

[2] Includes the Southeast and South Central.

[3] Includes the Great Plains.

[4] Includes Alaska and Hawaii.

Appendix table 6—Total freshwater withdrawals in the United States, specified years, 1960-85, by water use and source, with projections of demand to 2040

Water use and source	1960	1965	1970	1975	1980	1985	Projections 2000	2010	2020	2030	2040
					Million gallons per day						
Thermoelectric steam cooling											
Ground water	920	1,100	1,400	1,400	1,600	610	700	700	690	680	680
Surface water	73,100	90,500	118,300	129,600	146,800	129,790	156,700	174,500	192,200	209,900	227,600
Total	74,000	91,600	119,800	131,000	148,400	130,400	157,400	175,200	192,900	210,600	228,300
Irrigation											
Ground water	30,400	41,600	45,250	57,100	61,200	56,300	55,600	58,300	60,900	62,650	64,200
Surface water	54,000	74,400	81,700	85,000	90,400	85,800	86,600	92,900	99,100	104,210	109,100
Wastewater	560	500	370	370	280	450	290	260	200	200	200
Total	4,900	116,500	127,300	142,500	151,900	142,500	142,500	151,500	160,200	167,100	173,400
Municipal central supplies											
Ground water	6,300	8,100	9,500	10,800	11,700	14,600	20,100	24,100	28,200	31,600	33,700
Surface water	14,200	15,700	17,900	18,800	22,300	21,900	30,500	34,600	38,500	41,640	43,500
Total	20,500	23,800	27,400	29,600	34,000	36,500	50,600	58,700	66,700	72,300	77,100
Industrial self-supplies											
Ground water	6,000	6,800	8,000	9,700	10,300	6,100	5,600	6,400	7,340	8,310	9,340
Surface water	27,200	29,700	31,200	28,600	28,700	20,200	21,700	23,600	25,420	27,220	28,960
Wastewater	70	140	150	170	190	150	300	400	420	470	500
Total	33,300	36,600	39,300	38,500	39,200	26,450	27,600	30,400	33,200	36,000	38,800
Domestic self-supplies											
Ground water	1,840	2,200	2,500	2,670	3,260	3,250	4,300	4,800	5,250	5,600	5,800
Surface water	160	120	120	130	180	60	80	60	40	30	30
Total	2,000	2,320	2,620	2,800	3,340	3,320	4,380	4,860	5,290	5,630	5,830
Livestock watering											
Ground water	825	1,000	1,070	1,250	1,200	3,020	1,500	1,600	1,690	1,750	1,780
Surface water	675	740	800	900	970	1,450	1,180	1,260	1,330	1,380	1,410
Total	1,500	1,740	1,870	2,150	2,170	4,470	2,680	2,860	3,020	3,130	3,190
All water use											
Ground water	46,285	60,800	67,720	82,920	89,260	83,880	87,800	95,900	104,070	110,590	115,500
Surface water	169,335	211,160	250,020	263,030	289,350	259,210	296,760	326,920	356,590	384,380	410,600
Wastewater	630	640	520	540	470	600	590	660	620	670	700
Total withdrawals	216,200	272,400	318,300	346,600	379,000	343,700	385,200	423,600	461,300	494,800	526,600

Note: Data may not add to totals because of rounding.

Source: Data for 1960–85 from U.S. Geological Survey circulars except for 1985 data for irrigation. These are from the Soil Conservation Service, modified by additional nonagricultural irrigation use. Projections are Forest Service estimates based upon trends in the historical data.

Appendix table 7—Total freshwater withdrawals in the United States, specified years, 1960-85, by region and water source, with projection of consumption to 2040

Region and water Source	1960	1965	1970	1975	1980	1985	Projections 2000	2010	2020	2030	2040
					Million gallons per day						
North[1]											
Ground water	5,625	7,130	8,750	8,920	9,930	9,395	12,060	13,840	15,670	17,225	18,365
Surface water	70,735	92,000	107,355	106,975	110,050	97,785	117,110	130,450	143,600	156,350	168,450
wastewater	80	125	130	155	190	105	250	310	25	375	415
Total	76,440	99,255	116,235	116,050	120,170	107,285	129,420	144,600	159,595	173,950	187,230
South[2]											
Ground water	15,570	21,820	19,165	23,650	24,040	24,520	25,795	28,280	30,790	32,830	34,390
Surface water	34,635	42,765	57,415	68,265	83,295	70,440	82,360	91,450	100,400	109,050	117,300
Wastewater	30	5	20	65	70	175	100	110	100	105	105
Total	50,235	64,590	76,600	91,980	107,405	95,155	108,255	119,840	131,290	141,985	151,795
Rocky Mountain[3]											
Ground water	12,690	15,920	18,675	27,920	31,140	29,190	27,515	29,220	30,890	32,125	33,120
Surface water	36,420	47,420	52,740	53,380	59,745	57,520	61,475	66,320	71,075	75,100	8,850
Wastewater	90	125	170	155	35	55	70	75	65	60	60
Total	49,200	63,465	71,585	81,454	90,920	86,765	89,060	95,615	102,030	107,285	112,030
Pacific Coast[4]											
Ground water	13,400	15,930	21,130	22,430	24,150	20,790	22,430	24,560	26,720	28,410	29,625
Surface water	27,545	28,975	32,510	34,410	36,260	33,450	35,815	38,700	41,525	43,880	46,000
Wastewater	430	385	200	170	175	260	165	165	135	130	120
Total	41,375	45,290	53,840	57,010	60,585	54,500	58,410	63,425	68,380	72,420	75,745
All regions											
Ground watear	46,285	60,800	67,720	82,920	89,260	83,800	87,800	95,900	104,070	110,590	115,500
Surface water	169,335	211,160	250,020	263,030	289,350	259,210	296,760	326,920	356,590	384,380	410,600
Wastewater	630	640	520	540	470	600	590	660	620	670	700
Total withdrawals	216,200	272,400	318,300	346,600	379,000	343,700	385,200	423,600	461,300	494,800	526,600

Note: Data may not add to totals because of rounding.

[1]Includes the Northeast and North Central.

[2]Includes the Southeast and South Central.

[3]Includes the Great Plains.

[4]Includes Alaska and Hawaii.

Source: Data for 1960-85 from U.S. Geological Survey circulars, except for 1985 data for irrigation. These are from the Soil Conservation Service, modified by additional nonagricultural irrigation use. Projections are Forest Service estimates based upon trends in the historial data.

Appendix table 8—Total freshwater consumption in the United States, specified years, 1960–85, by region and use, with projections of consumption to 2040

Region and water use	1960	1965	1970	1975	1980	1985	2000	Projections 2010	2020	2030	2040
						Million gallons per day					
North[1]											
Domestic self-supplies	427	517	513	356	594	595	482	494	504	511	515
Industrial self-supplies	1,045	1,351	1,187	1,177	1,247	1,656	2,790	3,155	3,523	3,891	4,262
Irrigation	233	398	460	613	1,278	1,187	1,417	1,481	1,543	1,592	1,637
Livestock watering	603	628	614	689	623	650	643	680	711	733	746
Municipal central supplies	1,329	1,735	1,881	1,749	1,615	1,618	2,335	2,575	2,783	2,931	3,016
Thermoelectric steam cooling	53	87	106	630	1,294	2,865	5,457	6,539	7,379	8,483	9,829
Total	3,691	4,717	4,762	5,215	6,651	8,571	13,124	14,924	16,443	18,142	20,005
South[2]											
Domestic self-supplies	519	798	721	661	842	843	732	750	766	777	783
Industrial self-supplies	1,524	1,581	2,220	2,075	2,781	1,702	2,378	2,690	3,003	3,317	3,633
Irrigation	9,143	14,913	12,646	17,564	16,356	14,701	17,550	18,349	19,116	19,717	20,278
Livestock watering	416	472	540	680	769	992	925	977	1,022	1,054	1,073
Municipal central supplies	1,139	1,301	1,612	2,323	2,172	2,176	3,140	3,464	3,742	3,942	4,056
Thermoelectric steam cooling	96	228	568	1,061	1,536	1,089	1,739	2,083	2,351	2,703	3,132
Total	12,837	19,294	18,307	24,364	24,455	21,503	26,464	28,312	29,999	31,509	32,954
Rocky Mountains[3]											
Domestic self-supplies	120	136	161	188	293	253	211	216	221	224	226
Industrial self-supplies	157	248	378	601	625	409	503	569	635	701	768
Irrigation	24,073	30,491	34,755	34,999	36,242	31,689	37,836	39,558	41,212	42,508	43,717
Livestock watering	315	439	476	498	430	524	533	563	589	607	618
Municipal central supplies	495	584	756	857	1,303	1,305	1,883	2,077	2,244	2,364	2,432
Thermoelectric steam cooling	48	83	126	207	369	303	482	578	652	750	869
Total	25,208	31,981	36,651	37,350	39,260	34,494	41,449	43,561	45,553	47,154	48,631
Pacific Coast[4]											
Domestic self-supplies	151	117	261	244	253	253	249	255	261	264	267
Industrial self-supplies	249	181	306	332	364	409	1,044	1,180	1,318	1,456	1,594
Irrigation	18,576	20,095	25,608	26,745	29,243	26,211	30,695	32,091	33,433	34,484	35,465
Livestock watering	103	82	82	84	80	207	211	223	233	240	244
Municipal central supplies	508	1,517	1,675	1,737	2,006	2,010	2,901	3,199	3,457	3,641	3,746
Thermoelectric steam cooling	27	18	24	40	42	96	86	103	117	134	155
Total	19,614	22,010	27,957	29,182	31,987	29,186	35,185	37,052	38,817	40,220	41,472
Total consumption	61,350	78,002	87,677	96,111	102,353	93,755	116,222	123,850	130,812	137,025	143,062

Note: Data may not add to totals because of rounding.

[1] Includes the Northeast and North Central.

[2] Includes the Southeast and South Central.

[3] Includes the Great Plains.

[4] Includes Alaska and Hawaii.

Source: Data for 1960–85 from U.S. Geological Survey circulars. Projections are Forest Service estimates based upon trends in the historical data.

Appendix table 9—Consumption of grazed forages in the United States by type of grazing and livestock and region, on an animal unit-month (AUM) basis, 1985

Type of livestock and region	Total	Deeded non-irrigated		Public grazing		Irrigated grazing		Crop residue	
	1,000 AUM's	*1,000 AUM's*	*Percent*	*1,000 AUM's*	*Percent*	*1,000 AUM's*	*Percent*	*1,000 AUM's*	*Percent*
Beef cattle									
North[1]	70,044.2	66,118.6	94.4	—	—	—	—	3,925.6	5.6
South[2]	181,571.0	167,137.3	92.1	6,603.2	3.6	801.0	0.4	7,029.5	3.9
Rocky Mountain[3]	131,735.0	104,056.0	79.0	15,901.0	12.1	3,892.0	2.9	7,885.6	6.0
Pacific Coast[4]	28,739.0	22,047.0	76.7	1,659.0	5.8	3,864.0	13.4	1,170.0	4.1
Total	412,089.9	359,359.1	87.2	24,162.9	5.9	8,557.3	2.1	20,010.6	4.8
Sheep									
North[1]	3,120.4	2,184.3	70.0	—	—	—	—	936.1	30.0
South[2]	4,041.5	4,041.5	100.0	—	—	—	—	—	—
Rocky Mountain[3]	9,063.0	3,207.0	35.4	4,654.6	51.4	481.6	5.3	719.0	7.9
Pacific Coast[4]	2,848.0	1,308.0	45.9	649.0	22.8	243.8	8.6	646.2	22.7
Total	19,072.9	10,742.2	56.3	5,303.6	27.8	725.4	3.8	2,301.7	12.1

Note: Data may not add to totals because of rounding.

— = not available.

[1] Includes the Northeast and North Central.

[2] Includes the Southeast and South Central.

[3] Includes the Great Plains.

[4] Includes Alaska and Hawaii.

Appendix table 10—Medium-level indexes of future consumption of outdoor recreation trips in the United States, projections to 2040

(1987 = 100)

Activity	Projections				
	2000	2010	2020	2030	2040
Land					
Developed camping	115	130	143	157	167
Picnicking	106	113	119	128	134
Sightseeing	128	143	160	181	203
Family gatherings	124	145	168	192	210
Pleasure driving	126	140	156	175	197
Visiting historic sites	130	147	167	193	220
Attending events	114	126	139	152	162
Visiting museums	119	135	152	171	184
Off-road driving	106	112	118	124	129
Biking	126	149	174	201	220
Running/jogging	137	170	206	243	270
Walking	114	127	141	156	166
Cutting firewood	121	131	143	159	176
Collecting berries	128	143	161	184	208
Visiting prehistoric sites	142	165	191	222	255
Photography	112	123	135	150	160
Day hiking	122	143	164	188	205
Horseback riding	132	158	184	208	226
Nature study	113	125	138	153	163
Backpacking	136	167	202	238	265
Primitive camping	114	127	139	153	162
Wildlife observation	124	145	168	190	207
Water					
Pool swimming	124	143	162	182	196
Sunbathing	116	129	142	154	161
Motorized boating	111	120	129	138	145
Water skiing	115	127	139	151	160
Rafting/tubing	125	156	192	246	287
Canoeing/kayaking	117	132	148	167	180
Other boating/rowing	113	125	138	151	161
Stream/lake swimming	107	113	120	128	133
Snow					
Downhill skiing	164	230	310	399	469
Cross-country skiing	145	193	249	322	378