Chapter 6
The RPA Assessment

RPA requires the Secretary of Agriculture, through the Forest Service, to prepare a Renewable Resource Assessment. RPA specifies the Assessment shall include the following (see appendix for the full text of the Act):

1. an analysis of present and anticipated uses, demand for and supply of the renewable resources, and pertinent supply and demand and price trends, considering the international resource situation;
2. an inventory of present and potential renewable resources, and an evaluation of opportunities for improving their yield of tangible and intangible goods and services, with estimates of investment costs and direct and indirect returns to the Federal Government;
3. a description of Forest Service programs and responsibilities in research, cooperative programs and management of the National Forest System, and their relationship to public and private activities; and
4. a discussion of important policy considerations, laws, regulations, and other factors expected to affect significantly the use, ownership, and management of forests and rangelands.

The Act further directs the Secretary of Agriculture "to make and keep current a comprehensive survey and analysis of the present and prospective conditions of and requirements for the renewable resources of the forest and range lands of the United States . . ." [sec. 3(6)].

This directive calls for information that fits well into the strategic planning process described in chapter 5. The analysis of use, inventory of resources, and survey of conditions describe the current situation, a prerequisite of effective strategic planning. Furthermore, the analysis of trends, evaluation of opportunities, and description of programs is comparable to the WOTS UP analysis (weaknesses, opportunities, threats, and strengths underlying planning) used in strategic planning by businesses. Having such data and analysis does not guarantee effective planning, but lacking it will probably prevent effective planning.

The first RPA Assessment was due on December 31, 1975, with an update due in 1979 and subsequent Assessments due every 10 years after that. In addition, the Forest Service updated the 1979 Assessment in 1984 to contribute to the 1985 RPA Program. Most reviewers commend the Assessment efforts, but note limitations and weaknesses in the process or the documents. For example, the Assessment has been described as "a reasonable benchmark of the status of the Nation's renewable natural resources but which] . . . has failed to provide a complete picture. . . " (58). Some environmental groups disagree with the predictions of shortages for all resources. Further, the Assessment "has become so predictable in its conclusions that anyone who read the last one already knows what the next one will say" (84). Shands (89) describes the 1984 Supplement as "shorter and more focused' than the previous full Assessments, calling it "an excellent document" and praising its treatment of imminent resource shortages.

This chapter examines how well the Assessments meet the legal requirements and strategic planning intent of RPA. The first section describes and evaluates the resource data used in the 1989 Assessment, focusing on the adequacy of the resource inventories in describing the current resource situation. The next section discusses the economic data and analyses that project future threats and opportunities. This is followed by a description of the international resource context. The chapter concludes with an analysis of cooperative assistance and research needs identified in the Assessment, and the agency's strengths and weaknesses for responding to projected threats and opportunities.

RESOURCE DATA

RPA requires information on resource conditions and trends because Congress was concerned that some resources were not being adequately managed and protected. The Multiple-Use Sustained-Yield Act of 1960 directs management of renewable resources at a high level of sustainable output

"without impairment of the productivity of the land." Congress enacted RPA because of concerns that short-range budget decisions were short-changing long-range resource needs. The Assessment was intended, in part, to describe resource conditions and trends periodically so that Congress could know if long-range resource needs were being met and if resource outputs were sustainable.

Determinations of resource supply and sustainable output have generated a considerable amount of controversy (124). In 1979, the Committee of Scientists (21) warned that "In many cases, inventory data are too fragmentary or insufficiently detailed to allow firm judgments in developing management programs of the complexity demanded by RPA/NFMA. In other cases, data on certain organisms, resources, or management effects have simply never been gathered. " Several critics have questioned the validity of the databases used in the Assessment (23, 24, 25, 82). Criticism of data has not only come from outside reviewers but Forest Service personnel as well. A Forest Service review team evaluating the 1979 Assessment found "almost unanimous agreement by respondents that input data was not accurate, data was arbitrarily changed, valid updates to data were not known, and control over data was lost during processing [sic]" (53). In 1980, the Senate Agriculture Subcommittee on Environment, Soil Conservation, and Forestry called for an across-the-board improvement of all databases used to develop the Assessment (64).

The 1989 RPA Assessment (111) is a short, general document supported by several more detailed reports on each of the major resources. In analyzing the more detailed reports on renewable resources it is important to ask how much information is available on resource quality and quantity; what is the quality of the information; and what are the measured outputs of the resource. Resources evaluated include range forage, timber, water, wildlife and fish, and wilderness. Recreation, unlike the other assessment categories, is an activity rather than a renewable resource and requires different kinds of inventory data and management concepts than does planning for renewable resources (21). Thus, while the Forest Service pairs recreation with wilderness in the Assessment, they are treated separately in this report. Similarly, although the Forest Service discusses wildlife and fish in the same report, these two resources are sufficiently different to warrant separate documents. OTA, however, has not separated its discussion of these resources into separate headings because of the limited amount of information on fish resources in the Assessment.

The most useful inventory of a resource would be based on: 1) a data set that provides information on resource quantity, quality, and outputs; and 2) replicable, direct measurements rather than indirect measurements or professional judgment alone. When a direct measure of a resource is not available, a variable measure or an indirect measure must be used to evaluate the quantity and quality of a resource. (See box 6-A for descriptions of types of measures.) For example, direct measurement of wildlife populations is difficult because of their mobility. Variable measures, compiled from a variety of sources, may also pose a problem for some resources because of inconsistent data collection among Federal and State agencies. The next alternative for measuring resource quantity and quality is an indirect measure. For example, the amount of suitable habitat can sometimes be used to derive a wildlife population estimate.

For some resources, the output (e.g., wildlife harvest) is the principal measure of the resource. This measure is important for users and managers, but is usually a poor measure of resource quantity and quality. The assumption behind this measure-that increased output (harvest) reflects greater quantity or higher quality-may not be valid, because outputs can be increased, at least temporarily, by exceeding sustainable use levels. Without more direct measures, trends in the resource base cannot be determined and the sustainability of the output level is questionable.

When logical indirect measures are not available, planners may resort to narrative descriptions of predicted change and professional judgment to estimate resource conditions. For example, planners may report that some area has been placed under improved resource management, implicitly assuming that the resource is improving because of the increased management attention. Furthermore, professional judgments often are not reliable for consistent, replicable data. Narrative descriptions and professional judgments can be useful if they contain specific information or analysis. As with output measures, however, usually little can be determined about the current quantity or quality of a resource, trends in the resource base, or the sustainability of current output levels.

Box 6-A—Resource Data Measures

The purpose of data collection is to provide accurate, replicable information on resource quantity, quality, and outputs. The following categories are useful for evaluating the resource data collected, listed in descending order of desirability:

Direct Measure—Data for assessing a resource based on direct measurements. An example is the number, size, and species of trees in a forest. Data include information from censuses and systematic samples of flora and fauna to assess population trends as accurately and precisely as possible.

Variable Measure—Data for assessing a resource based on estimates. These data may come from a wide variety of sources that have collected data indifferent ways or from a combination of field inventory data mixed with professional judgment. An example is the consolidation of acreage estimates of wetlands in each State.

Indirect Measure—Data for an indirect estimate of a resource, based on a correlated attribute of the resource. An example is the area of vegetative cover types as an indirect measure of area of specific wildlife species habitat.

Output Measure—Data on resource outputs or use often used to supplement other estimates for an indirect measurement of resource quantity and quality. An example is the number of animals harvested as a measure of the size of a wildlife population.

Descriptivel/Professional Judgment-information on resource quality, quantity, or outputs that is not based on systematic data collection. An example is suggesting low population levels for red-cockaded woodpeckers (a federally-listed endangered species) in a forest that has not been censused for woodpeckers.

Recreation

As noted above, recreation stands apart from the assessments of renewable resources because recreation is an activity-comparable to grazing, bird-watching, or timber harvesting-rather than a ***resource, like*** forage, birds, or trees. Quality of the recreational experience varies with individuals and interest groups, and must often be determined by subjective measures, such as personal perceptions. Some recreational activities that are facility-based, such as camping and downhill skiing, have closer parallels with renewable resources because the facilities can be evaluated objectively as a resource rather than subjectively as an activity. Nonetheless, recreation planning often requires different kinds of data than does planning for renewable resources.

The Recreation Assessment (112) divides the discussion of recreational activities into three categories: land, water, and snow and ice. Land recreation activities are described using acres of developed sites, roaded and partially developed areas, and extensive undeveloped areas. Water recreation activities are described using measures for partially developed water resources (acres of national rivers, lakeshores, and seashores) and developed water resources (swimming areas, beaches, boating, marinas, and swimming pools). The land and water recreation sections also include information on the wilderness resource, which is discussed later in this report. Snow and ice recreation activities are described using trails, roads, and cross-country and downhill ski facilities, although snowmobile use is essentially ignored.

All of these measures are either indirect or output measures for the amount of recreation activity available. They are not direct measures because the amount of recreational activity available depends on many variables, some of which cannot be quantified. For example, the Recreation Assessment states recreation 'is limited only by our capacity to invent new ways to have fun" (112). Recreation supplies can be invented, for instance, by converting an empty swimming pool to a skateboarding site or by using cliff edges for hang gliding. Physical measures of the land or water are said to "identify as much about the supply of recreation as the quantity of paints reveals about the supply of art" (112). The Recreation Assessment acknowledges the unique characteristics of recreation and its intangible nature, listing standardized data and improved assessment methods as ways to increase recreation benefits. The 1989 Assessment uses available measures to make generalizations about the status of and future trends in recreation, and identifies potential supply shortfalls that warrant attention.

Range Forage Resources

The quantity and quality of range forage resources are described in terms of area of rangelands, ecological status, and resource value ratings. Outputs for range forage are described using animal unit months (AUMS), defined as the amount of forage

required to sustain one cow plus one calf for one month. The diverse outputs of rangelands are described in the Range Assessment (119), and include forage for domestic and wild herbivores, firewood and specialty wood products, seed sources, habitat for threatened and endangered species, and open space and scenic value. Despite the amount of information provided, the Range Assessment has serious shortcomings as an assessment of the quantity and quality of forage resources.

Rangeland Area and Outputs

The Range Assessment describes in detail the difficulty of quantifying the national production of forage and of linking the area of rangeland and timberland to forage production and consumption (119). Total rangelands are estimated at 770 million acres, or 34 percent of the total land base of the United States.[1] As an indirect measure, these land use data may provide a useful base for working toward forage production estimates, but they are not directly useful for assessing status of range forage resources. Furthermore, the rangeland base is broken down only regionally, and with virtually no landowner information.

The Range Assessment also uses the output measure AUMs to estimate productivity. The conceptual weakness of this measure of resource conditions is compounded by incomplete data on the acres of forests and rangelands that are actually grazed by livestock, and by the near-universal lack of estimates of the acres grazed by wild herbivores (88).

The Nation's forage-producing lands are classified and described using the 34 ecosystems of the Forest and Range Environmental System (104). Ranges of forage production for the 34 ecosystems are provided, along with other output measures (types of plants, large herbivores, and threatened and endangered animals), but no estimates are given for the area occupied by the various ecosystems. A direct measure of the amount of rangeland in each ecosystem is apparently not available, and thus forage production for each ecosystem cannot be determined (88).

Ecological Status and Resource Value Rating

Rangeland inventory techniques have been evolving, and because the changes have not been linked to past efforts, little information is available to assess historical trends in rangeland quality and production. The Forest Service has adopted, and the Bureau of Land Management (BLM) is adopting, a new system to assess forage resources based on: 1) the maintenance of a site's long-term productive potential; and 2) the present level of production relative to the potential production for a specific use, such as livestock grazing or wildlife habitat (80). In this system, forests and rangelands are assessed in terms of ecological status and resource value rating. The categories of ecological status-potential natural community (PNC), late seral, mid seral, and early seral stages—are not equivalent to the Soil Conservation Service's (SCS) range condition categories of excellent, good, fair, and poor (119). The percentage of land moving toward or away from the PNC is shown, implying that this is important. However, the implications of ecological status and trends for the quantity, quality, and output of range forage resources is not discussed.

The resource value rating for range forage is used to assess the usefulness of the vegetation for grazing. The rating hinges on: 1) the adequacy of soil protection, and 2) the acceptability of current species composition and production or their trends. Because the rating is based on adequacy and acceptability, it is probably determined by professional judgment, rather than on field measurements, and thus its replicability is questionable. Furthermore, because the rating is only satisfactory or unsatisfactory, trends in quality for a given area cannot readily be displayed. Therefore, the resource value rating, as currently applied, is an inadequate measure of the quality and quantity of the forage resource.

Despite differences in inventory systems, the Range Assessment gives percentages of rangelands in various condition classes for private rangelands (from SCS) and for Federal rangelands (fromBLM). Without acreage figures to show that field inventories of all rangeland have been completed, it is assumed that the percentages represent a variable measure of rangeland status.

[1] The 1989 RPA Assessment (111) defines rangelands as lands "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."

Timber Resources

The Assessment of the timber resource follows a long series of studies of the Nation's timber supply. The Forest Service provides a chronological list, starting in 1866, of 34 publications and reports considered to be at least partial predecessors of the 1989 Timber Assessment (113).

Data on the status of the timber resource have been collected periodically in each State for decades. The Forest Inventory and Analysis Research Units and Forest Service Regional Timber Management staff, as well as State forestry representatives and other users of the data, design and conduct the inventories. A typical State timber resource report contains data on timberland area,[2] ownership, timber volume by species, stand conditions, timber use, and biomass volume, along with a description of the sampling scheme used to collect the data and estimates of sampling error. Access to the data is provided through published reports, requests for special analysis, and direct computer access to the database (88).

These inventories are generally accepted by the professional natural resource community as state-of-the-art efforts using the latest inventory and computational techniques. Improvements in inventory techniques have been frequent during the long history of periodic inventories and older data are adjusted to maintain continuity and allow the monitoring of trends. Data users are more likely to want more frequent inventories, increased sampling intensity for areas of special concern, and/or additional data collection for resource management concerns other than timber status. Inventory data on timber-related issues, such as old-growth forests and timberland suitability, are rather sparse, limiting the value of the Assessment for addressing some important issues.

The data in the Timber Assessment are an aggregation of the data from the periodic State and national forest inventories. Older inventories were updated to 1986 by adding estimates of growth and deducting estimates of mortality and removals. The timber resource in this Assessment is described using the several direct measures derived from field measurements: acres of timberland; volume of timber; volume lost to mortality; net annual growth; timber removals; and 1986 ratio of growth to removals. Timberland productivity classes, a descriptive scheme of the potential productivity of the land, are also used in the Assessment to describe the timber resource.

Because the status of the timber resource has long been monitored in terms of volume of growing stock, growth, mortality, and removals, predictions of future trends in the Assessment rest on a considerable historical base of information. Most of the uncertainty in predicting timber resource flow has to do with estimates of future demand and removals, although changing conditions that can affect growth rates, such as atmospheric pollution and global warming, make growth predictions less certain than many assume. Clawson (18) has showed that the Forest Service has consistently underestimated future net timber growth (figure 6-l). Nonetheless, data in the Timber Assessment are generally more complete than for the other resources, and the inventories for timber are conducted using sampling designs that produce replicable estimates.

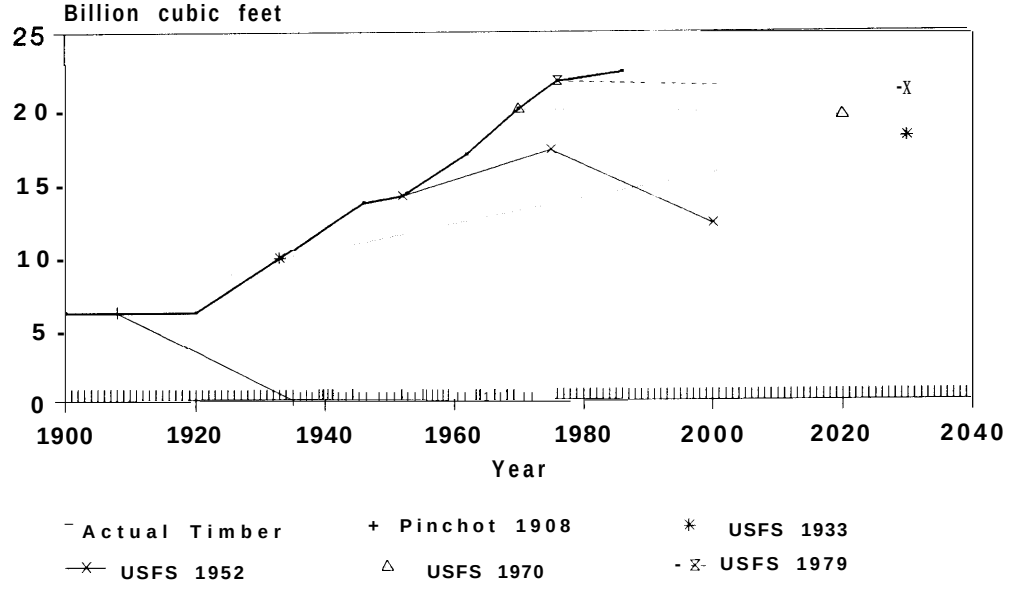
Water Resources

Historically, several Federal agencies have conducted national water assessments, including the U.S. Geological Survey (USGS), the U.S. Environmental Protection Agency (EPA), and the Soil Conservation Service (SCS). The Forest Service used data from all of these sources to prepare the 1989 Assessment of the Nation's water quantity and quality.

The Water Assessment (120) describes the water resource and the anticipated effects of management programs using several measures, including in-stream flows, watershed condition class, and acres of wetlands. These measures calibrate water quantity and quality much better than might be expected for a noncommodity resource. Other terms are used in the Water Assessment, but are only descriptive because they fail to use any units of measurement to evaluate the quantity, quality, or output of the resource. These descriptive terms include enhanced soil productivity, improved timing of runoff, improved riparian areas, installation of watershed improvements to avoid flood damage, and implementing nonpoint-source pollution abatement for silvicultural and range-management activity.

[2]The 1989WAAssessmmt(111) defines timberland as forested land [at least 10 percent covered by trees] "that can grow more than 20 cubic feet of industrial wood per acre per year."

Figure 6-l—Annual Net Timber Growth and Forest Service Projections



SOURCE: M. Clawson, "Forests in the Long Sweep of American History," Science 204:1168-1 174, June 15, 1979; U.S. Department of Agriculture, Forest Service, *An Analysis of the Timber Situation in the United States: 1989-20&Part/: The Current Resource and Use Situation [by* Haynes, R.W.], draft (Washington, DC: U.S. Government Printing Office, 1988).

Instream Flows

Necessary instream flow levels are based on wildlife and fish needs, because "Navigation and recreation activities, such as water skiing and swimming, generally do not suffer. . . over a long-term if low instream flows occur" (120). The flow estimates for each USGS-defined Water Resources Region are based on average precipitation, with deductions for groundwater storage depletion, net reservoir evaporation, and instream flow requirements for maintaining optimal wildlife and fish habitat. Projections show surplus or deficit stream outflow between 1985 and 2040 for two levels of precipitation (average and low) and two levels of fish and wildlife habitat maintenance (optimal and minimal).

The estimates of streamflow are classified as variable measures of water quantity. The concepts and assumptions underlying the estimates are generally accepted by water resource managers. The estimates are replicable, and sufficient for assessing trends. They provide insights as to where current instream flows are inadequate, why deficits exist, and what might be done to improve conditions.

Watershed Condition

The Water Assessment examines water quality in two ways. First, reports from USGS and EPA are synthesized into a general description of how water quality is affected by point and nonpoint sources of pollution. Major pollutants contributing to degradation of the Nation's waters are listed and recent trends described. Particular pollutants posing a problem in specific regions are discussed. Because no units of measurement are used, however, this assessment of water quality is only descriptive and not a measure of the condition of the resource.

Water quality is also assessed by classifying watershed condition. The watershed condition class is determined by the watershed's ability to "sustain water quality, quantity, and timing necessary to support water-dependent ecosystems, instream uses, and downstream withdrawals of water" (120). In addition to land management and land uses affecting water quality and quantity, watershed condition class depends on management of natural and human-made stream channels, associated fauna, and groundwater flows (120).

The Water Assessment describes three watershed condition classes: class I watersheds that represent "an attainable, desirable condition' class II watersheds that require special consideration in resource management; and class III watersheds that require "technologically and economically feasible capital investments to restore watershed conditions. " The status of watersheds that need restoration, but where the investments are not technologically or economically feasible, is unclear from this classification.

Data for determining watershed condition class were developed by sampling watersheds in each Forest Service region. These watersheds were assumed to be representative of all watersheds in the United States, but this assumption has not been tested. The percentage of watersheds in each condition class are then presented by Assessment region (one or more Forest Service regions), but acreage data and landowner information are not reported.

This classification is used as a variable measure to group watersheds with similar needs for improvement. Under this system, the Water Assessment provides useful data: one-fifth of the Nation's watersheds need capital investments and one-half need special management. The Forest Service nonetheless recognizes a need for more data to evaluate watershed improvement needs and for better quality data to improve the reliability of this measure. For example, information on watershed and stream charnel conditions and capabilities is based on inventories collected by several agencies for various ownerships and has not been consolidated, with current data generally covering only a portion of a watershed. Geographic information systems (GIS) may provide a way of consolidating, standardizing, and displaying the data collected by the various levels of government, but until these systems are in widespread use, inventories of watershed condition class on many lands will continue to depend, in part, on professional judgment.

Wetlands

One measure that seems to have sufficient supporting data is acres of wetlands. The Water Assessment reports that an estimated 90 million acres of wetlands are found in the lower 48 States with an additional 200 million acres in Alaska. This variable measure is from the consolidation of estimates from several agencies. General agreement exists on the definition of this resource category and the process of making the estimates seems replicable. A reliable assessment of the number of acres of wetlands is therefore possible, and trends can be monitored. The 1989 Assessment estimates an annual loss of approximately 300,000 acres of wetlands, an improvement over the estimated annual loss of 550,000 acres from the 1950s through the 1970s. Again, however, regional acreage data and landowner information are not reported.

Wildlife and Fish Resources

The Forest Service uses four aspects of wildlife and fish resources to characterize the quantity, quality, and outputs of these resources in the 1989 Wildlife Assessment (121): 1) habitats, 2) population levels, 3) number of users, and 4) harvest levels. Except where harvest levels are used as indirect measures of resource conditions, only measures of habitats and population levels are described in this section, because the other measures do not evaluate the quantity and quality of wildlife and fish resources.

Habitats

National inventories of the amount of suitable habitat available for a single species do not exist, but the Assessment describes and estimates land area that supports a faunal community based on land use and vegetative cover types. Land use types used as indirect measures for wildlife habitats include forestland, rangeland, wetland, water, and agricultural land. The Assessment reviews relevant literature establishing the relationships between faunal populations and land use/vegetative cover types and notes limitations to the use of these relationships in estimating populations or assessing change. Trends inland use and changes in vegetative cover types are discussed for the Nation and for each Assessment region. The use of models to analyze how species respond to changes in forestland characteristics is also discussed and illustrated with a case study (121).

Although land use and land cover patterns provide "a coarse description of wildlife and fish habitats that is appropriate for national and regional evaluations' (121), these indirect measures provide no real opportunity to monitor resource quantity and quality. They do not provide a sufficiently detailed database from which to assess the impact of the planning process on wildlife populations or species-specific habitat requirements.

Population Levels

Estimates are provided for the condition of some species, primarily game animals and threatened and endangered species. Population estimates for small game and furbearers rely primarily on harvest levels which, as output measures, are not very reliable for determining population levels or trends. There are very few population data on nongame species because funding for their collection has never been adequate. The one exception is birds.

Nongame Birds—The U.S. Fish and Wildlife Service (FWS) administers the Breeding Bird Survey to assess population trends of breeding birds in the United States and southern Canada. Data are gathered by volunteers. This survey has critics in the scientific community and its limitations are discussed in the Wildlife Assessment. Nevertheless, the survey is a systematic census of breeding birds serving as a direct measure that is sufficiently reliable to assess population trends.

Migratory Game Birds—The FWS estimates the status of migratory game birds annually. Using a combination of field measurements and professional judgment, population estimates are made for waterfowl (ducks, geese, and swans) and webless migratory game species (such as woodcock and mourning doves). These estimates are reliable for key areas that are monitored closely and are generally sufficient to describe long-term trends.

Big Game Populations—Data on big game populations in the 1989 Assessment are derived from cooperating State wildlife agencies and their associated professional game managers. Because the number of States with data on any one species varies, and because data collection and consolidation are not described, the reliability of these variable measures for the population status of big game is unknown.

Small Game Populations—Population estimates for small game are also compiled from data supplied by cooperating States. Most States use harvest trends (output measures) to evaluate the status of small game, but there is no consistency as to which species are evaluated. Consequently, very few States have substantial information on any one species and the reliability of these population estimates is thus probably low.

Furbearers—Many furbearing species are evasive in nature and consequently difficult to monitor for population data. Although several national summaries reporting furbearer population trends were quoted, this Assessment does not identify survey techniques for the animals discussed nor make clear when harvest levels were used to determine population estimates. The Assessment does correctly point out that harvest may be more a reflection of fur prices than of animal numbers. Thus, when such output measures are used for the population estimates for furbearers, the estimates are weak and their accuracy questionable.

Fish—The 1989 Wildlife Assessment states that, despite the recreational and economic importance of the Nation's fishery resources, there is little information with which to identify or evaluate changes in fish species distribution and abundance in the Nation's fresh waters and estuaries (121). Inventories of fish species are rare. The Assessment did report on the 1982 National Fisheries Survey (128), which tabulated the number of miles of streams in which various species occur. Estimates are not available for fish caught for recreational purposes. Commercial harvest in millions of pounds (an output measure) is reported each year by the National Marine Fisheries Service, but like most other indirect measures of resource status, this estimate is weak and provides little opportunity to monitor the impact of natural resource management activity.

Threatened and Endangered Species—The Assessment presents the number of species currently listed by the U.S. Fish and Wildlife Service as threatened and endangered, and the number found in the national forests and on lands managed by the BLM. It discusses the relationship between population declines and land types, lists the number of approved recovery plans and describes the status of the listing process. There is discussion of some recovering and declining species with population trends given, but in general, no direct or indirect estimates are produced in this section and data regarding individual species are not presented.

Wilderness Resources

Wilderness is combined with recreation in the RPA Assessment, and receives limited attention in several chapters. Measures used to describe wilderness include acres of wilderness/remote backcountry/extensive roadless areas given by region and ownership; miles of wild and scenic rivers by region and ownership; and recreational and non-recreational

uses (in recreation visitor days and percent of areas hosting subsistence, commercial, therapeutic, ecological, and social research values).

Data presented in the Recreation Assessment for evaluating the quantity of the wilderness resource are difficult to evaluate without a detailed description of how the areas were measured. The data on recreational use, as pointed out in the Assessment, have several shortcomings, including inconsistencies in collection methods and irregularity of collection (112). Thus, while trends in wilderness use have been described, the replicability of these data is questionable. The Assessment also points out that because most benefits of wilderness are not as easily measured as those for other renewable resources, many uses of wilderness have not been included in the forest planning process. The Assessment states that 'Interest in the uses and values of wilderness is increasing and improved methods to measure and describe these uses will have to be developed" (112).

The Recreation Assessment lists five actions that might be taken to enhance non-recreation use of wilderness:

1. inventory roadless areas for non-recreation wilderness values and propose areas with high non-recreation values for designation;
2. establish more wilderness and wilderness-like recreation opportunities on non-wilderness public and private land to reduce recreation pressure on sensitive wilderness areas;
3. complete "limits to acceptable change' 'assessments for each national forest wilderness;
4. incorporate protection of non-recreation values into wilderness management plans; and
5. systematically assess threats to wilderness areas (112).

Although the Assessment follows this list with a statement declaring that these actions would provide better information for wilderness managers and result in improved management of wilderness areas for recreation and non-recreation values, no goals or priorities are set to see that these actions are in fact implemented.

One serious shortcoming of the Recreation Assessment is the lack of data on wilderness quality. In 1988 hearings on wilderness management, Forest Service Associate Chief George Leonard acknowledged "a number of problems within wilderness areas, such as soil erosion, stream sedimentation, overgrazing, and insufficient trail maintenance (138). Despite such problems and concerns, apparently no effort has been made to evaluate the current quality or trends in wilderness resources.

ECONOMIC ANALYSIS

RPA indirectly requires the Forest Service to use economic tools in assessing forest and rangeland resources. The Forest Service is specifically directed to analyze current and expected supplies of and demands for renewable resources and to evaluate resource investment opportunities.

Demand and Supply Analysis

The Forest Service assessed current resource uses and projected demand and supply for renewable resources in the supporting Assessments for each of the resources. In two cases, the analysis is based on economic theories and projections are made using econometric models (computer models that make economic projections from certain economic assumptions and data about likely future conditions and responses). For other resources, the analysis is less sophisticated, with demand and supply projected independently, and likely "gaps" identified.

Before discussing the demand and supply analyses in the Assessment, one must consider the role of prices in economics. In a free market, changing prices influence demand and supply, bringing them into a satisfactory balance. If demand exceeds supply at a paticular price, the price would rise, reducing the demand and encouraging increased production and other supply adjustments. Similarly, if prices are expected to rise in the future, producers would be inclined to invest in increased production. The importance of prices in driving private landowner decisions is discussed in the 1989 RPA Assessment (42). However, the concept of using market incentives to harness the creativity and productivity of the private sector is notably lacking (11). Ultimately, market prices *are signals* to consumers and producers.

For goods and services provided free or substantially subsidized, market prices do not provide such signals. There are numerous methods of calculating values of nonpriced or underpriced goods and services (see box 6-B). Regardless of the method used, predicted changes in values should reflect the

Box 6-B—Valuing Nonpriced Goods and Services

Total economic value of nonpriced resources results from both value in use and certain non-use values. Use values include not only today's use, but the value of having the option to use the resource in the future (commonly known as option value). Non-use values include the value of knowing the resource exists as well as the value of preserving the resource for the future; these values are often referred to as existence and bequest values, respectively.

There are two basic approaches to measuring economic value of nonpriced resources. One is based on the financial impacts of current use, usually by measuring either total expenditures or the value added because of those expenditures. Except for evaluating local community impacts, this approach is rarely used, because it doesn't measure the value of the resource. It would be like measuring the value of timber by tabulating how much timber purchasers spent on labor, equipment, gasoline, etc.

The second approach is based on estimated demand for the resource. This approach is generally preferred for its sound theoretical basis, but is difficult to apply, because it requires demand curves. Two methods have been developed for calculating demand curves for recreation resources: the *travel cost* ***method*** and the *contingent valuation method. The* former relies on participation rates, with travel costs as a proxy for the nonexistent market price, and thus measures current use value. The latter uses bidding in an artificially structured market, and therefore can include option, existence, and bequest values. In either case, a demand curve is developed to estimate the quantity demanded at various prices .

Demand curves for nonpriced resources are usually used to calculate ***consumer's surplus.*** Consumer's surplus is the aggregate additional willingness-to-pay for the resource, in excess of current expenditures. It is also described as the possible revenues of a perfectly discriminating monopolist (i.e., one who could charge a different price to each customer). This is a useful measure, but it is not directly comparable to market prices for commodities, since the market price is how much buyers do pay, not how much each would be willing to pay.

The Forest Service has taken nonpriced resource valuation another step in the Draft 1990 RPA Program by estimating the ***market-clearing price,*** the price that would balance demand and supply if the resource were marketed. Theoretically, supply curves would be developed for the resources, and the market-clearing price is the price at which supply and demand are in balance. The Draft 1990 RPA Program discusses developing supply curves from production cost data, but presents no evidence of such with its estimates of market-clearing prices. Thus, although this approach is conceptually strong, it is difficult to evaluate the accuracy of the Forest Service calculations.

same economic picture that price changes indicate for market goods and services. Thus, one would expect values to increase for resources with demand rising faster than supply, and to decline for resources with supply rising faster than demand. In this reamer, current and future values of nonpriced and subsidized goods and services can serve policymakers and government managers in the same manner as price changes can serve consumers and producers.

Econometric Analyses

Econometrics is the application of mathematical and statistical techniques to economic problems. Typically, computer models are used to predict future supplies of and demands for resources, and relevant price trends, considering relevant economic variables, such as demographic trends, technological developments, and the impact of price changes on investments. One difficulty in applying econometric models is posed by the long time horizons for forest management; often, trends must be projected farther into the future than we have history over which to test the models. In addition, occasional social and cultural changes can overwhelm economic analyses. For example, the Great Depression, World War II, and the energy crisis radically affected the U.S. economy, but it would have been difficult to forecast such major changes. Although long-term econometric projections are subject to much uncertainty, the results may be useful for policymakers.

In the 1989 Assessment, the Forest Service used econometric models to examine the land base and the timber resource (11). The land use model projects the amount of land in various categories from 1987 to 2040: Cropland, pasture/rangeland, urban/other, public timberland, industrial timberland, and other private timberland. Except for urban and public lands, land use shifted toward the category with the greatest present net value of current and future returns to landowners. Timber price forecasts from the other econometric model

(described below) were included in determining land use changes, but the feedback loop-of timber management intensity influencing future timber prices—appears to be lacking. Thus, the econometric model for projecting land use patterns has flaws, but the basic approach is consistent with economic theory and seems to fit the intent of RFA.

The future demands, supplies, and prices of timber are projected using the Timber Assessment Market Model—TM (l). TM was originally designed to project softwood lumber and plywood demand and supply regionally, with prices rising (or falling) to dampen demand and enhance supply (or vice versa), as necessary to bring the market into balance. Production was translated into timber demand (adjusted for changing production technologies), with future timber demands and supplies balanced by raising or lowering prices. TAMM has since been revised to include hardwood products, the pulp and paper sector, and Canadian suppliers. However, TAMM is lacking in a few important areas, including market interactions with importers of U.S. wood products, linkage of prices through time (i.e., expected future prices affect today's harvests and thus affect today's prices) and price sensitivity of technological developments. (See box 6-C.) In addition, TAMM is quite sensitive to the many necessary assumptions about future U.S. economic performance, wood use in construction, and the like. Nonetheless, T-provides valuable insights into the workings of timber markets, and thus is useful in examining likely future timber demands, supplies, and prices.

Non-Econometric Analyses

Econometric models are not the only means of analyzing demand, supply, and price trends, although they do provide a replicable means of testing assumptions and assessing the likely effects of decisions. In addition, computer models are probably essential to balance supply and demand trends, and thus to predict prices. Except for certain types of developed recreation, the non-timber resources in the national forests are not priced in a market sense (see box 6-D), and therefore price prediction is not relevant, although future values of the nonpriced or subsidized resource uses should be related to future demand and supply.

For the nonpriced and subsidized resources—recreation, range forage, water, wildlife and fish, and wilderness-the Forest Service has projected demand and supply using its traditional 'gap' model.

Box 6-C—Timber Processing Technology

The Timber Assessment Market Model (TAMM) does not contain an explicit link between timber prices and technology, although research has shown that timber processing efficiency (technology) is sensitive to timber prices (11). Processing technology is ***exogenous*** **to the** model; that is, technology is forecast separately, and the forecast is then assumed in TAMM.

In contrast, the technology forecasts assumed in TAMM do affect future timber prices, but in an unexpected manner. As processing technology improves, timber prices rise, and the faster technology improves, the faster prices rise (43). The explanation behind this relationship is that timber prices are assumed to be a residual value-mill owners will bid as much as they can afford for timber, after paying their labor and capital costs. Improvements in technology either reduce labor costs or reduce the amount of timber (the number of logs) needed to produce the wood products (lumber and plywood). Lower labor costs and/or wood requirements permit the mill owners to bid higher for timber, and thus timber prices will rise. Some of the characteristics of timber and wood product markets suggest that, while timber is the largest cost in lumber and plywood production (19), that the amount paid for the timber is, indeed, a residual, to be paid after other variable and fixed obligations are met. However, some research refutes this assumed relationship (15).

This assumed relationship-technological advance leading to higher timber prices-has important policy implications. Rising prices for resources are normally considered to be a sign of impending shortage, and a condition to be avoided if possible. This is the idea behind RPA--an Assessment of future conditions and a Program that reacts to undesirable future conditions. However, rising timber prices due to improvements in processing technology might actually increase social benefits. If the technological improvement lowers production costs or wood requirements, then product prices and producer profits may remain unchanged, while landowners receive more for their timber. Under such conditions, rising prices would probably be desirable. In fact, one timberland investor observed that rising timber prices are necessary to justify most timberland investments (99). Thus, as a policy goal, the absolute undesirability of rising timber prices may need to be reconsidered.

Box 6-D—Economics of Range Forage

The economics of range forage present an unusual case. Although livestock operations are commercial enterprises, the Forest Service system for allocating grazing permits is not a market system. Permittees must have abase ranch reasonably near the grazing allotment, and allotments are renewed automatically, unless the base ranch is sold or the permittee violates the terms of the permit. In addition, Federal grazing fees are substantially below market prices, as little as one-seventh (14 percent) of the subleasing price on the few BLM leases where subleasing is legal (71). The Forest Service calculated that the fair market rental value of grazing in the western national forests is 2 to 4 times above the current grazing fee (1 16). Thus, livestock grazing on Federal lands clearly does not operate under a market system.

Another problem is the relative lack of information on non-Federal forage supplies. In timber, Federal lands dominate in one of the largest supply regions (the Pacific Northwest), and the Forest Service provided more than 17 percent of softwood timber harvests in 1986 (113). In contrast, livestock grazing on Federal lands accounts for less than 7 percent of the total (1 19). The Forest Service supplies 5 percent or less of livestock grazing in the three largest grazing regions-the South, the North, and the northern Roe@ Mountains. When this situation is combined with the lack of Federal marketing of livestock grazing, it is not surprising that relatively little market supply information on range forage exists.

Further complicating the economics of livestock forage is a more complex demand equation. As with timber, the demand for forage is a secondary demand--consumers want beef, lamb, wool, etc. However, consumers accept a much greater variety of substitutes, U.S. imports come from a wider array of suppliers, and there are more non-land-based technologies (e.g., crop residues, feedlots, etc.) to improve forage supplies (11). Thus, demand projections for range forage are much more complicated than for timber.

The Forest Service did project supply of and demand for range forage in the Range Assessment (119). In contrast to the timber and land base projection models, the models for projecting range forage have not yet been published, and thus their economic foundation cannot be evaluated (1 1). However,Binkley(11) notes that, “prices are not seriously considered as a determinant of either output demand or input supply. ” Thus, the economic logic behind the demand and supply projections appears questionable. Furthermore, the Range Assessment contains no historic or projected prices for livestock products or for forage. Therefore, the Range Assessment appears to be a deficient analysis of livestock forage demand, supply, and price trends.

Under this approach, demand and supply are projected independently, using historic patterns, socioeconomic variables, demographic trends, and other relevant information; however, price or cost data are rarely included. Future demand and supply are then compared, and if demand exceeds supply, a shortage--or gap-exists (or will exist). Gaps are treated much as rising market prices: they are considered undesirable, and policies should be formulated to address this problem. However, potential use of market forces to address supply-demand gaps, and the resulting social and economic implications, have not been considered in the 1989 RPA Assessment (11).

The gap model could provide useful information on demand and supply trends, if the projections are based on sound logic and assumptions. For example, one might expect demand projections to respond to demographic and economic changes, including the impact of changing user costs and increased crowding. Similarly, supply projections should be consistent with general land use decisions, and should reflect anticipated management activities and market responses, such as the development of recreation sites and fee hunting areas. However, the Assessment generally does not include adequate information to determine the adequacy and accuracy of the supply and demand projections for the various resources. In some cases, the projections are inconsistent with other trends. For example, in the next 50 years, the wilderness/roadless area land base is projected to decline by 31 percent, but the supplies of primitive camping and of backpacking are projected to increase by 34 and 98 percent, respectively (112). Similarly, wilderness use is apparently leveling off, but demands for primitive camping and backpacking are projected to increase by 64 and 155 percent, respectively (11). Thus, the demand and supply projections for the nonpriced and subsidized resources appear to be tenuous, at best.

Another potential limitation of the gap model is in the prediction of future values for the resources, which economic theory suggests are related to the projected supplies and demands-the relative scar-

city of the resources. However, most research on nonpriced resource values has focused on estimating current values, a difficult enough task, and no accepted or reliable methods for predicting future values presently exist (12 1). Thus, it is not surprising that none of the resource Assessments, except for timber, contain price or value projections.

Despite the lack of such information in the Assessment, the Forest Service has estimated current and future market-clearing prices and consumer's surplus for the renewable resources of the national forests. 'Appendix F: Resource Pricing and Valuation Guidelines" in the Draft 1990 RPA Program (116) provides a description of the economic concepts employed and then the value estimates by Forest Service region. Overall, the relative size of the Assessment's projected gaps between demand and supply correlates with the 1990 Draft Program's projected change in market-clearing prices. (See table 6-1.) However, there are a number of inconsistencies and problems. For example, the gaps in range forage and in nonconsumptive wildlife use are quite small, yet large increases in market-clearing prices are projected. Future market-clearing price increases for hunting and fishing are also relatively high, when compared with other recreational activities. There were problems in comparing demand/supply gaps with market-clearing price changes for water, because the demand/supply regions do not conform to Forest Service regions. In recreation, there are problems with two of the categories used for projecting market-clearing prices. Hiking/horseback-riding/water travel is an illogical mixture of activities, with large demand/supply gaps for hiking and horseback-riding and small gaps for water travel (canoeing, boating, etc.). The projected increase in market-clearing price is, therefore, probably too high for water travel and too low for hiking and horseback-riding. Winter sports is also a problematic category. Downhill skiing is projected to have excess supply, while the supply of cross-country skiing is projected to meet only 55 percent of the demand. The small increase in market-clearing price is probably an accurate weighted average, but doesn't really apply to either activity. Furthermore, snowmobiling has become an important winter recreational activity, but was apparently excluded from the Recreation Assessment.

Table 6-1—Demand-Supply Gaps and Changes in Market-Clearing Prices

	Demand/ supply gap	Change in M-C price
Recreation;		
Camping/picnicking/swimming . . .	0-1%	4%
Mechanized travel/viewing scenery.	7-26%.	10%
Hiking/horseback riding	27-29%	17%
Water travel	0-6%	
Winter sports:		
Downhill skiing	0%	4%
Cross-country skiing	55%	
Resorts	?	0%
Other activities	0-34%	1470
Livestock forage:	2%	24%
Water:		
Surplus regions	none	0-4%
Shortage regions	under 40%	8-22%
Severe shortage regions	over 90%.	8-22%
Fish and wildlife:		
Hunting	5-16%	10%
Fishing	4-1270	14%
Nonconsumptive use	0%	16%
Wilderness:	22-29%	18%

SOURCES: U.S. Department of Agriculture, Forest Service, *Draft 1990 RPA Program* (Washington, DC: U.S. Government Printing Office, 1989); U.S. Department of Agriculture, Forest Service, *An Analysis of the outdoor Recreation and Wilderness Situation in the United States: 7989-2040,* draft (1988); U.S. Department of Agriculture, Forest Service, *An Analysis of the Range Forage Situation in the United States: 1989-2040 [by* Joyce, L.A.], General Technical Report RM-180 (Ft. Collins, CO: 1989); U.S. Department of Agriculture, Forest Service, *An Analysis of the Water Situation in the United States: 1989-*2040 [by Guldin, R.W.], General Technical Report RM-177 (Ft. Collins, CO: 1989); U.S. Department of Agriculture, Forest Service, *An Analysis of the Wlldlife and Fish Situation in the United States: 1989-2040* [by Flather, C.H. and Hoekstra, T.W.], General Technical Report RM-178 (Ft. Collins, CO: 1989).

Evaluation of Opportunities

In addition to the demand, supply, and price trend analysis, RPA requires an evaluation of opportunities to enhance renewable resource yields, 'together with estimates of investment costs and direct and indirect returns to the Federal Government. " All of the supporting Assessments (except, of course, the Land Assessment) contain sections describing opportunities to improve resource management. However, except for the Timber Assessment, none contain any estimates of investment costs or of direct and indirect returns. Thus, while dozens of opportunities are described, there is virtually no information for evaluating those opportunities.

The Wildlife Assessment does contain some basis for setting priorities. It notes that the first priority is habitat management, since habitat is often the

limiting factor in wildlife and fish management. This is followed by population manipulation, and then user regulation, because appropriate populations must exist before regulating users is relevant. Although this set of priorities does not directly reflect relative economic opportunities, and cost and return information are not presented, it at least sets forth a logical approach to selecting which opportunities to invest in first.

There is some evaluation of investment opportunities for timber (114). Even this evaluation is severely limited, because government and industry lands are excluded. The Forest Service assumed that all economic opportunities would be implemented on industry lands, but this ignores potential limitations on available investment funds and opportunities to increase timber supplies by subsidizing industry timber investments (with direct financial support or through the tax code). Opportunities on government lands are not evaluated, because such decisions "are subject to public policy determinations as much as economic analysis" (114). However, this hampers the ability of policymakers to evaluate the potential of such opportunities, in comparison with timber investment opportunities elsewhere. The evaluation of opportunities on nonindustry private lands is also unnecessarily constrained. There was no evaluation of many areas, because the "stands were judged to be sufficiently productive that no specific treatment was warranted at the time" (114). This standard, which apparently excluded any economic criterion, eliminates many potential opportunities to expand timber supplies. Several types of investments are examined, including three harvest-with-regeneration 'investments," which one might expect to be profitable to the landowner already and not an opportunity to be captured.

INTERNATIONAL CONDITIONS

While RPA directs the Assessment to examine the renewable resources on America's forests and rangelands, it also requires the supply and demand analysis to *consider* international conditions. Global conditions are examined in the Timber, Range, and Wildlife Assessments. Such considerations are probably not relevant for water resources, since water is not (yet) an international commodity. Similarly, foreign visitors account for only a small component of outdoor recreation in the United States, and their characteristics and demands are examined briefly in the Recreation Assessment (112).

International Trade

Chapter 5 of the Timber Assessment describes international trade in wood products. The United States is the world's largest wood importer and second largest exporter (after Canada); Canada is the major U.S. supplier, while the Pacific Rim nations are our major export markets. There is substantial international trade in wood products, primarily among the industrialized nations, with general trends toward freer import markets and more market responsiveness by exporters. Restrictions on log exports from the Philippines, Indonesia, and peninsular Malaysia are noted in the Timber Assessment, but not the widespread trend toward additional export restrictions. (Bans on log exports from Thailand and Brazil and on lumber exports from the Philippines were announced after the draft Timber Assessment was written.) However, the implications of these trends are not discussed.

The Range Assessment contains a brief section on international trade in livestock products. The United States is a net meat importer, but the Assessment doesn't identify the sources of our imports. Depressed international meat prices have apparently led to increased protectionism and export subsidies. However, it is unclear what this means for U.S. consumers or livestock producers, and the implications are not discussed in the Assessment.

Global Resource Concerns

Problems Examined in the Assessment

In the chapter on international trade, the Timber Assessment asserts that, overall, for all regions globally, timber growth exceeds timber harvests. There are localized shortages, especially in the poorest nations, implicitly caused by the demand for fuelwood, and the demand for fuelwood is expected to continue to grow, leading to more common and more severe localized wood shortages.

The other global timber resource concern discussed in the Timber Assessment is atmospheric pollution and acid deposition. This is primarily a problem of the forests in the industrialized world, with the most severe impacts in Eastern Europe, and incipient problems in Western Europe, Scandinavia, and North America. There is, however, no discussion of the implications of either of these conditions

on domestic timber supplies, demands, or prices or on future international trade in wood products.

The Range Assessment observes that the loss of rangelands to encroaching deserts (desertification) is a serious global problem, with losses increasing in area and in intensity. However, the implications for domestic forage resources or for international trade in livestock products are not examined.

International conditions are also mentioned in the Wildlife Assessment. Clearly, migratory birds, and perhaps anadromous fish, can be affected by changing resource situations in other countries. Migratory game birds predominately breed in the United States and Canada, and winter in the United States; since Canadian resource situations are similar to our own, there are probably few significant global problems for migratory game birds. However, many nongame birds (songbirds, etc.) migrate to Central and South America for the winter. Some populations have been declining, allegedly due to Latin American use of organochlorine pesticides (e.g., DDT), loss of wetlands, and tropical deforestation.

Concerns Not Addressed in the Assessment

The discussion of tropical deforestation in the Assessment is totally inadequate. Although tropical deforestation is mentioned as possibly affecting migratory nongame bird populations, effects of protecting tropical forests are not discussed. Tropical timber harvesting and efforts to slow the rate of cutting will influence international trade in wood products, and thus the demands on U.S. timber resources. Similarly, some deforestation in Latin America is to create pasturage to expand beef exports to North America and Europe. Thus, attempts to protect tropical forest resources will affect the demands on U.S. forage resources. Finally, tropical deforestation has been linked with global warming.

Global warming is another major, international concern that can affect renewable resources. Global warming is expected to alter the quantity and timing of precipitation, and thus will affect water resources. These changes, together with increasing temperatures, will affect both flora and fauna. The distributions of tree species will be altered, and could shrink for some important timber species. Endangered species are particularly susceptible to climate changes. While these changes may not be imminent, RPA requires a long-term vision of renewable forest and rangeland resources. Furthermore, the Draft 1990 RPA Program identifies global climate change as 1 of the 15 issues to be addressed. Yet, the 1989 RPA Assessment contains no discussion of global warming.

Finally, in addition to the lack of discussion of the implications of global resource issues, there **is** nothing on the opportunities to influence these trends. There are a variety of possible U.S. actions that could affect these trends, such as expanding technical assistance for sustainable land use practices and increasing financial assistance for efficient use of fuelwood. While an analysis of international opportunities is not a required part of the Assessment, it fits with the intent of the law. Options that could be employed in the United States, such as planting more trees (here as well as abroad) to absorb carbon and thereby slow global warming, would certainly be relevant to a discussion of forest and rangeland resources in the United States.

COOPERATIVE ASSISTANCE

RPA does not specifically require an analysis of cooperative assistance needs in the Assessment. However, because different resource ownerships require different Forest Service responses, it seems appropriate that resource inventories and opportunities should distinguish among landowner categories. Such an analysis is a critical step in strategic planning. The Senate Agriculture Committee stated that the display of lands and resources by public and private ownership and geographic regions was one of the Assessment's most important elements (145). One means of presenting landowner information is by assessing the needs and opportunities for cooperative assistance.

The 1979 RPA Assessment (105) took such an approach. It pointed to a need to increase production and supplies of resources on all forests and rangelands. It also stated that "Substantial increases . . . from [private] ownerships can only be achieved by such measures as cost-sharing programs to help finance management practices, and technical assistance and educational programs to show landowners how to develop and manage forest and range resources' (105). Many of the resource chapters in the 1979 Assessment have a section on specific cooperative assistance actions for increasing resource supplies. For example, the recreation chapter notes the need for cooperative assistance to private

landowners to increase access to private lands for recreation. The timber chapter points to the importance of reducing losses from fire, insects, and disease through strong cooperative protection programs and the wildlife chapter identifies the need for technical assistance and education for landowners on providing access to their lands and on habitat management.

Several of the resource reports supporting the 1989 RPA Assessment distinguish resource ownership by landowner category. Timber resources, for example, are delineated for Forest Service lands, other public lands, forest industry lands, and other private lands. Federal range forage resources and recreational facilities are distinguished from non-Federal resources and facilities. Overall, however, the 1989 Assessment does not clearly define Federal resource responsibilities.

Several findings in the 1989 RPA Assessment are relevant to Forest Service cooperative assistance programs by the Forest Service (116). One is the importance of markets and prices as forces that drive private landowners. Another is the ubiquity of vegetation management as a plausible action to improve future resource conditions and supplies, including water quality and streamflows, range conditions, wildlife habitat, timber supplies, and conditions for recreation. The Assessment notes that management responses to market forces are limited by: 1) management philosophies and priorities for Federal lands (e.g., lack of recreation fees affects private opportunities); 2) the broad societal nature of some outputs of forests and rangelands (e.g., State ownership of wildlife and their migratory nature limit private landowners' ability to capture the benefits of habitat improvements); 3) the lack of market prices for some outputs; and 4) inadequate knowledge of production opportunities, which can lead to failure of markets to respond (116). These limitations broadly define the matters for which cooperative assistance programs could provide solutions (42).

The resource reports supporting the 1989 Assessment provide much more information than the Assessment itself on cooperative assistance. The Recreation Assessment (112) states that increasing opportunities on private lands could help redress the geographic imbalance between Federal recreation sites and the bulk of the population. Barriers to increased use of and access to private lands for recreation by the public include potential liability issues that have inhibited owners from making lands available, and lack of information on the markets for recreation use of their lands. As a result of these kinds of concerns, at least 75 percent of private land is closed to the public for recreation and this proportion is increasing. The Recreation Assessment concludes that programs directed at private lands should focus on keeping land open for recreation by providing information to landowners on management, on ways of limiting liability risks, and on means to capture financial benefits.

The Timber Assessment (114) identifies the increase in projected timber prices as the primary concern of the timber portion of Forest Service programs. Various ways to increase the productivity of forest lands for timber include reducing losses from free, insects, and disease and, most importantly, increasing timber productivity on nonindustry private lands. The Timber Assessment also notes that the greater sustained harvests on nonindustry private lands that would be necessary to slow the expected rate of increase in timber prices "would require expanded public programs,' presumably those aimed at private lands (114).

The Water Assessment (121) notes that lack of knowledge and financial incentives are major obstacles for private landowners in the control of silviculture-related nonpoint-source pollution on private lands. Needed actions for Federal, State, and private lands include assistance in dealing with pollution related to past farming practices, protecting riparian areas, managing vegetation to reduce runoff, and protecting land and vegetation from wild fire. The Wildlife Assessment (122) identifies habitat restoration and improvement and limits on access as two major wildlife issues relevant to private lands. The Assessment notes the importance of cross-boundary planning and coordination for wide-ranging wildlife. A major obstacle to improved vegetation management for wildlife habitats is lack of knowledge by landowners and managers. A trend toward additional fee hunting and access fees for private lands will lead toward improved management for the preferred species, but landowners need technical assistance on vegetation management for wildlife and information on markets (i.e., users and prices).

RESEARCH

RPA does not explicitly require an analysis of forest and rangeland research needs. It does direct the Forest Service to describe its research programs and responsibilities, and their relations to other Forest Service programs, and to private and other public programs. One document supporting the 1989 RPA Assessment, *A Description of Forest Service Programs and Responsibilities (122),* substantially fulfills this requirement.

Nonetheless, an analysis of research needs, resulting from Assessment findings, appears desirable, especially in the context of strategic planning. The 1979 RPA Assessment emphasized the lack of information and the need for more research, stating that "Much can be done to increase and extend supplies of forest and range products by better use of existing technology and by further research to develop new technology" (105). That Assessment noted the need for more information on physical responses to management of wildlife populations and timber growth; on the cost of management practices and prices and uses of forest and rangeland products; and on ways of using land and water to minimize environmental impacts. It also states that there is a need to "explore the economic, social, and environmental implications of a future in which demands for nearly all forest and rangeland products are increasing more rapidly than supplies" (105).

The sections on research opportunities in each chapter of the 1979 RPA Assessment are fairly detailed in their identification of research needs (42). For example, the recreation chapter notes the need for further information on existing and potential recreation resources, trends in participation, and the effects of management. The range chapter identifies needs for ecosystem analysis, range management methods, and multi-resource management of rangelands. The timber chapter focuses on research needed to improve utilization and multi-resource management. The wildlife chapter notes the need for information on the effects of management, minimum habitat conditions to support wildlife populations, and methods to quantify wildlife values.

Despite the serious data limitations described above, the 1989 RPA Assessment raises very few concerns about the adequacy of the information on which its findings are based. And, except for noting the need for appropriate databases and models for evaluating the threat of global climate change, almost no mention is made of research needs that emerged in preparing the 1989 Assessment (42). The accompanying resource reports suggest research needs but contain no estimates of costs and potential benefits which policymakers could use to compare research opportunities. Excluding research needs from the RPA Assessment effectively prevents any discussion of research priorities.

The Recreation Assessment identifies several information needs: standardized information on participation trends, future demands, and available supplies; methods for assessing recreation resources in urban and wild environments; information on how recreation opportunities and uses are related; and ways to estimate and evaluate recreation benefits. The report also identifies the need for research on management of recreation resources, including wilderness and other special areas; on the management of recreation facilities; and on ways to balance the allocation of recreation resources in view of social equity concerns.

The Range Assessment identifies the need for research on vegetation management for multiple-resource uses of rangelands, and on the management of combined livestock and wildlife grazing. This Assessment also notes the need for research on the use of livestock as a management tool in a broad range of ecosystems.

The Timber Assessment identifies research on basic physiological and biological processes of tree growth and timber management, and accelerated technology transfer as having continuing importance. It also notes that utilization research has the greatest potential for curbing the rate of increase in timber prices in the near term. Research in support of management and assistance programs on regenerating timber stands are judged to have the greatest long-term potential for increasing timber growth.

The Water Assessment states that additional information is needed on the cumulative effects of different management activities on water quality (sediment generation and transport) and possible control actions. The Assessment also identifies information needs on instream flows that are required for various uses of forests and rangelands. In a broader context, this Assessment notes that research is needed on the cumulative effects of acid deposition and of chemical buildup in soils.

The Wildlife Assessment notes that obstacles to improving wildlife and fish resources include lack of knowledge on species-habitat relationships, on population inventories, and on public attitudes and wildlife and fish values. The report suggests that monitoring be done to measure the response of wildlife and fish to management and that this information be combined with species-habitat research to learn more about multiple-use management. The report also claims that Forest Service efforts are perceived as being at the forefront of wildlife research and that steps should be taken to assure that this continues.

CONCLUSIONS

The 1989 RPA Assessment is a comprehensive document, produced with substantial efforts by the Forest Service, but one that lacks some of the resource quality and quantity data needed to make well-informed resource management decisions. The data included in the individual Assessments on recreation, range forage, timber, water, wildlife and fish, and wilderness are often incomplete, with measures often relying on surrogates or professional judgments, and with information on resource quality frequently missing.

The Forest Service uses econometric models and the "gap' model to analyze supply and demand for renewable resources. The Assessment generally does not include enough information to evaluate the projection methods and some projections are inconsistent with current trends and with other projections. The required evaluation of opportunities is largely a catalog of possibilities that lacks information on investment costs and on direct and indirect returns to help make informed choices.

The 1989 Assessment considers the international context for domestic resources in brief discussions of international trade and global resource concerns, including demand for fuelwood, atmospheric pollution, and population declines of migratory songbirds. Inadequate attention is given, however, to two major international environmental issues—tropical deforestation and global warming—with important implications for the future of America's renewable resources.

Finally, the 1989 RPA Assessment is not a very useful document for assessing cooperative assistance and research programs. Despite the information in the individual resource Assessments, the 1989 RPA Assessment contains very little on these topics. The 1989 Assessment fails to summarize the needs identified in the individual assessments and does not present cost and benefit information to compare opportunities.