CHAPTER SIX

Implementing the Laws and Policies Governing the National Forests and Grasslands in the Context of Sustainability

The previous chapters have developed a framework for management of the national forests and grasslands to achieve ecological, economic, and social sustainability. In this chapter, we apply the concepts from those chapters in suggesting planning principles for implementing the environmental laws and policies under which the Forest Service operates: the National Forest Management Act, Multiple-Use Sustained-Yield Act, Organic Act, Endangered Species Act, Clean Water Act, Clean Air Act, and related legislation. We use the suite of legislation that influences the management of the national forests and grasslands, rather than focus solely on the National Forest Management Act, in keeping with our overall goal of assisting in the development of an integrated planning process.

We look in depth at four key elements of planning: (1) ecological sustainability, (2) water and watersheds, (3) the suitability of lands for different types of resource management, and (4) the role of timber harvest in achieving sustainability. We choose those four topics for two reasons. First, they are emphasized in much of the legislation at issue, especially the National Forest Management Act. Second, they have been the subject of attention and controversy in land- and resource-management planning.

6A. Ecological Sustainability as the Foundation of National Forest Stewardship

The guiding star for planning is sustainability. Like other overarching national objectives, sustainability is broadly aspirational and can be difficult to define in concrete terms. Yet, especially considering the increased human pressures on the national forests and grasslands, it becomes ever more essential that planning and management begin with a central tenet of sustainability, that our use today does not impair the functioning of ecological processes and the ability of these natural resources to contribute economically and socially in the future.

A suite of laws call for ecological sustainability, often in terms of native-species diversity and ecological processes. The Endangered Species Act calls for federal agencies to undertake all possible means to conserve native species and the ecosystems upon which they depend. The National Forest Management Act calls for maintaining the diversity of plant and animal communities to meet multiple-use objectives, which in the existing regulations implementing the Act have been stated as providing habitat to maintain the viability of vertebrate species, and the protection of streams and watersheds. The Clean Water Act calls for protecting the physical, chemical, and biological integrity of the nation’s waters. The Multiple-Use Sustained-Yield Act calls for ensuring that multiple use and sustained yield do not impair the productivity of the land. The

Clean Air Act calls for protecting the nation's air. Individually and collectively, our environmental laws express a profound commitment to the protection of native species and to our air, water, and soil. While considerable discretion is left in interpreting these laws, their thrust is clear.

As we have found in the Northwest and throughout the country, ignoring the letter and spirit of these laws has, time after time, led to lawsuits that have overturned long-term plans for the national forests and grasslands, frustrating the people who have put so many hours into them. (See Sidebar 6-2.) In addition, the abrupt changes that often follow court decisions can be disconcerting to communities and economies. The Committee feels that it would be better for the Forest Service to recognize its responsibilities for ecological sustainability as part of planning rather than to wait for lawsuits to force the issue.

In addition to the suite of environmental laws calling for protection of ecological systems, scientific results and common sense point to the necessity of protecting these systems so they continue providing benefits to society. Lessons from across the National Forest System suggest that the conservation of ecological systems cannot be ignored. As an example, concerns about the effect that declining water clarity will have on tourism in Lake Tahoe have led to an intensive and expensive effort to reverse this trend. More generally, the cost of replacing the watersheds that supply the municipal water for many communities has caused increased protection of these lands. Once ecological systems are pushed to the edge, the costs of recovery can be astronomical, and the ability to apply adaptive management is significantly compromised.

The Committee recommends that ecological sustainability provide a foundation upon which the management for national forests and grasslands can contribute to economic and social sustainability. This finding does not mean that the Forest Service is expected to maximize the protection of plant and animal species and environmental protection to the exclusion of other human values and uses. Rather, it means that planning for the multiple use and sustained yield of the resources of national forests and grasslands should operate within a baseline level of ensuring the sustainability of ecological systems and native species. Such use would avoid impairing the functioning of ecological processes and the ability of these natural resources to contribute economically and socially in the future.

Setting ecological sustainability as a key goal acknowledges that ecological systems provide many outputs that humans require to sustain themselves as living, biological organisms. That is, human health and the integrity of ecological systems are inseparable objectives. Humans are "a part of" not "apart from" their environment. Choices in management still exist, and the level of risk to take is a policy choice. Further, the human values, needs, uses, and ecological condition of each locality will change with time. Policy and management must evolve according to natural dynamics and disturbances as well as social events, economic change, and political values. Nonetheless, it is clear that ecological sustainability lays a necessary foundation for national forests and grasslands to contribute to the economic and social components of sustainability, making contributions to strong, productive economies and creating opportunities for enduring human communities.

The Committee believes that conserving habitat for native species and the processes of ecological systems remains the surest path to maintaining ecological sustainability. We suggest the use of two general approaches in tandem to conserve these key elements of sustainability.

First, we suggest a scientific assessment of the characteristic composition, structure, and processes of the ecosystems. This assessment should provide an understanding of the "ecological integrity" of the planning area.

Ecosystems with integrity maintain their characteristic species diversity and ecological processes, such as productivity, soil fertility, and rates of biogeochemical cycling. Because ecosystems are dynamic and variable, the concept of the "historic range of variability" is used to characterize the variation and distribution of ecological conditions occurring in the past. This concept allows one to compare the ecological conditions that will be created under proposed management scenarios to past conditions. The more the prospective conditions differ from the conditions during recent millennia, the greater the expected risk to native species, their habitats, and the long-term stability of ecological processes.

Second, we suggest focusing on the viability of native species themselves. However, monitoring the status of all species and assessing their viability is impossible from a practical standpoint. Thus, it is necessary to focus on a subset of species called "focal species." The key characteristic of a focal species is that its abundance, distribution, health, and activity over time and space are indicative of the functioning of the larger ecological system. In monitoring, the habitat needs of the focal species are analyzed, and projections are made of the habitat that will be needed for the species to be considered "viable," having self-sustaining populations well distributed throughout the species range. Self-sustaining populations, in turn, can be defined as those that have sufficient abundance and diversity to display the array of life-history strategies and forms that will provide for their persistence and adaptability in the planning area over time. The habitat that will be created under any management scenario is compared to the habitat needed for the viability of each selected focal species. The less adequate the habitat for each species, the greater the risk to native species and ecological processes. Therefore, the Committee suggests a three-pronged strategy: (1) focusing on a set of selected "focal" species and their habitat needs, (2) maintaining conditions necessary for ecological integrity, and (3) monitoring the effectiveness of this approach in conserving native species and ecological processes.

In many cases, national forests and grasslands by themselves are unable to conserve native species and ecological processes. As noted earlier, other landowners and agencies often control key elements of the habitats and ecological systems. Thus, in some cases, the national forests and grasslands can contribute to, but not ensure, the achievement of ecological sustainability.

It is important to note that this approach is similar to the existing regulations implementing the National Forest Management Act. These 1982 regulations have an extensive section on "Management Requirements" that calls for *provi*sion of adequate habitat to maintain viable populations of existing native and desired nonnative vertebrate species; protection of soils, streams and watersheds; and many other conservation measures. These requirements were intended to provide a policy framework for sustaining ecological systems within which decisions could be made. In its details of implementation, however, the approach proposed by the Committee for assessing ecological sustainability differs from the existing one, reflecting more than 15 years of experience since those regulations were written. Conserving habitat for native species remains central to ecological sustainability while broadening the focus from vertebrates to all native species. At the same time, the Committee recognizes that ensuring the viability of all native species, through analysis of individual species, is an impossible task.

To ensure the development of scientifically credible conservation strategies, the Committee recommends a process that includes (1) scientific involvement in the selection of focal species, in the development of measures of species viability and ecological integrity, and in the definition of key elements of conservation strategies; (2) independent

6-1. Public Participation in Forest Planning in the Absence of Scientifically Credible Conservation Strategies: An Exercise in Futility

In the 1980s, Region 6 of the Forest Service undertook a massive public-involvement effort as part of the development of land and resource plans under NFMA. Most of the effort was done in a traditional way in which the Forest Service asked the public to react to alternative management plans for each National Forest presented in a draft NEPA statement. Generally, one of the alternatives was proposed as the preferred alternative.

And react the public did. Thousands of people met with the Forest Service and each other to give a reaction to the proposed plan and alternatives to it. Lobbying and letter writing were the order of the day; a national forest that did not get at least 10,000 comment letters and comments felt neglected. Consensus groups were set up on numerous national forests to try and reach some agreement on a plan for the forest. The State of Oregon began an unprecedented effort to develop a state alternative for each national forest in Oregon through the work of state agencies and through the holding of town meetings throughout the state. In total, hundreds of thousands of hours were spent responding to the proposed plans by people in the Northwest and across the nation.

Unfortunately, the massive effort went for naught because the plans were built on an unsound foundation. To protect species and ecosystems, planners on the national forests and grasslands had developed a set of "minimum management requirements" that set limits on resource development, primarily timber harvest. By and large, scientists were not directly involved in developing these requirements although the planners attempted to use whatever scientific literature was available. Upon challenge and review, the strategies to protect species and ecosystems were found to be inadequate and to lack scientific credibility. As this foundation disintegrated, the plans that had been built on them also collapsed.

The planning process in Region 6 gave the illusion of choices that did not really exist under the laws and policies then in effect for the protection of species and ecosystems. Once science teams were empowered to develop scientifically credible strategies for ecological sustainability, a new foundation for planning emerged that strengthened protection for species and ecosystems, dramatically reduced the potential for timber harvest, and withstood court challenge. In retrospect, the public debate about which management alternative in the EIS would best serve the public interest was largely a waste of time and the most profoundly disillusioning event to occur in that region. In sum, effective public participation depends on the assembing of a scientifically credible foundation of ecological sustainability before management plans to meet public needs can be developed.

6-2. Coarse- and Fine-Filter Approaches to Habitat Assessment in the Southern Region

Coarse and fine filters are currently being used by National Forest System managers to address issues of biological diversity and species viability. As an example, the Southern Region defined their "coarse filter" with elements characterizing the composition and structure of the landscape, with no specific reference to species requirements or habitat associations. The status and trends of the terrestrial coarse-filter elements were assessed for the total Southern Appalachian Assessment area by ecological section, by ownership, and by state. These elements will be used to develop desired future conditions. Some of the elements used to characterize future conditions include broad forest classes, forest successional classes, and rare, native-plant communities.

A fine-filter approach will also be used to identify individual species for emphasis in the Southern Appalachian forest plans. Candidate species include federally listed threatened and endangered species, range-wide viability-concern species, and sensitive species. Habitat relationships will be developed for these species from the existing species-habitat-association database, followed by an external scientific review. Habitat relationships are used to organize the list of species into functional groups according to broad habitat associations. These habitat associations, along with individual species, will be the focus in assessing the adequacy of planning to meet species viability requirements.

scientific review of proposed conservation strategies before plans are published; (3) scientific involvement in designing monitoring protocols and adaptive management; and (4) a national scientific committee to advise the Chief of the Forest Service on scientific issues in assessment and planning.

The Committee recognizes that its role is not to dictate specific management approaches for the Forest Service but to provide advice that the Secretary and Chief may act on as they deem appropriate. Nonetheless, the Committee recognizes that such concepts as focal species, ecological integrity, and the use of scientific information may involve technical issues and that the Committee thus has an obligation to the Secretary and the Chief to provide some insight on how this framework for ecological sustainability might be converted from concept to application. Therefore, while our approach has not been field-tested, the Committee has drafted the following regulatory language, that, we believe, provides a useful approach to this issue.

Committee's Proposed Regulation on Ecological Sustainability

36 CFR Sec. 219. Ecological Sustainability.

A. Goals. Nature provides many goods, services, and values to humans. These ecological benefits occur as two, major, interdependent forms: the variety of native plants and animals and the products of ecological systems, such as clean water, air, and fertile soil.

The most fundamental goal of the National Forest System is to maintain and restore ecological sustainability, the long-term maintenance of the diversity of native plant and animal communities and the productive capacity of ecological systems. Ecological sustainability is the foundation of national forest stewardship and makes it possible for the national forests and grasslands to provide a wide variety of benefits to present and future generations.

B. Diversity. Ecosystems are inherently dynamic; changes regularly result from natural events, such as floods, fires, or insect outbreaks. Human intervention, such as through forest cutting and water diversions, is often substantial. Thus, because species must have the capability and opportunity to respond adaptively to changes in their environment, species diversity and ecological processes can only be sustained if the essential elements of the natural dynamics of ecosystems are recognized and accommodated when human intervention occurs. Planners and managers must apply the best available scientific information and analysis so that the diversity and adaptive capability of ecosystems will be maintained and restored.

1. Levels of diversity. Ecological diversity must be considered at three hierarchical levels: ecosystems, species, and genes, all of which are necessary parts of a strategy to sustain species values and ecological goods and services. Ecosystem diversity, including landscape diversity, is the coarsest level of resolution in this hierarchy. Ecosystems are physical environments and the associated communities of interacting plants and animals. Ecosystem diversity can be described by the variety of components, structures, and processes within an ecosystem and the variety among ecosystem types and functions across broad areas, such as watersheds, landscapes, and regions. Ecosystem diversity provides essential elements for sustaining individual species and the productive capacity of ecosystems. Species diversity refers to variation in the number and relative abundance of species (including subspecies and distinct populations) within a given area. To maintain species diversity, individual species must have the capability and opportunity to respond adaptively to their environment. Genetic diversity, the finest level of resolution in this hierarchy, refers to the degree of variation in heritable characteristics (including life histories) within and among individual organisms and populations.

2. Use of surrogate approaches. Ecological diversity is expressed at a variety of spatial and temporal scales. Explicitly describing and managing all elements of diversity and their interconnections within a single assessment or planning effort is beyond the capacity of the agency. Thus, planners must identify surrogate approaches that rely on a subset of ecological measurements that are sensitive to management and indicative of overall diversity. Although all three levels of diversity are essential to providing ecological sustainability, the most developed scientific knowledge and assessment strategies relevant to broad-scale resource management occur at the ecosystem (especially landscape scales) and species levels. Accordingly, this section primarily addresses ecosystem and species diversity.

C. Ecosystem Diversity. The first step in providing for ecological sustainability is to sustain the variety and functions of ecosystems across multiple spatial scales, from microsites to large landscapes, to maintain the diversity of native plant and animal communities and the productive capacity of ecological systems.

1. Management standards: ecological integrity. The decisions of resource managers must be based upon the best available scientific information and analysis to provide for conditions that support ecological integrity sufficient to meet the goals of this section. The ecological integrity of an ecosystem can be defined as the completeness of the composition, structure, and processes that are charac-

teristic of the native states of that system. Ecosystems with high ecological integrity continue to express the evolutionary and biogeographic processes that gave rise to the current biota; have a species composition, diversity, and functional organization expected from natural habitats of the region; and are resilient to environmental change and disturbance occurring within their natural range of variability. As part of this analysis, planning must address needs for variation in frequencies and intensities of fire and in-stream flows of water, and, as appropriate, establish standards for fire regimes and for quantity and quality of water needed to meet aquatic goals. Ecological integrity should be analyzed at appropriate spatial and temporal scales and consider the cumulative effects of human and natural disturbances.

2. Assessment and planning. Measures of ecosystem integrity shall be developed in regional assessments based on scientific principles and knowledge of local conditions. As national forests and grasslands may comprise only a portion of the landscape under consideration, coordination with other landowners and institutions concerning probable future conditions is critical. Planning documents must explicitly set forth the constraints and opportunities for sustaining ecological systems presented by jurisdictional patterns and varying land-management objectives. In general, in assessing and planning for ecosystem integrity, the planning process must address the larger physical landscape (its historical legacy, its current condition, its biological potential, and its expected changes over successional time) both within and beyond the national forests and grasslands.

3. Validation. The assumption that coarse-filter elements can serve as a basis of sustaining native species diversity shall be validated through monitoring and research. The best available scientific information and analysis shall be used to assess this assumption in a timely manner. If this assumption is invalid, then additional coarse-filter elements will be required, or modification of the coarse-filter approach will be needed, and appropriate management action shall be taken to meet the goals of this section.

D. Species Diversity. A second step in providing for ecological sustainability is to sustain the diversity of native plant and animal communities through maintaining and restoring the viability of the species that comprise them. The goal of this section is to provide the ecological conditions needed to protect and, as necessary, restore the viability of native species.

1. Focal species. The primary obligation in the selection of focal species is to provide for the diversity of native species. However, since it is not feasible to assess the viability of all species, this section will employ focal species to provide for plant and animal diversity. The status of a single species, or group of species, such as a functional guild of species, can convey information about the status of the larger ecological system in which it resides or about the integrity of specific habitat or ecosystem processes. Regional assessments shall select an appropriate number of focal species that represent the range of environments within the planning area, serve an umbrella function in terms of encompassing habitats needed for many other species, play key roles in maintaining community structure or processes, and are sensitive to the changes likely to occur.

2. Management standards: species viability. The decisions of resource managers must be based upon the best available scientific information and analysis to provide ecological conditions needed to protect and, as necessary, restore the viability of focal species and of threatened, endangered, and sensitive species.* A viable species is defined as consisting of self-sustaining populations that are well distributed throughout the species's range. Self-sustaining populations are those that are sufficiently abundant and have sufficient diversity to display the array of life-history

strategies and forms that will provide for their persistence and adaptability in the planning area over time.

3. Validation. The assumption that focal species are providing reliable information about the status and trend of species not being directly monitored shall be validated through monitoring and research. The best available scientific information and analysis shall be used to assess this assumption in a timely fashion. If this assumption is invalidated for a given focal species, then such focal species shall be augmented or replaced by species that better meet the criteria, and appropriate management action shall be taken to meet the goals of this section.

E. Implementation. The determinations required regarding ecosystem integrity and species viability shall be made at the appropriate planning level. Decisions at each level must be consistent with such determinations. For example, viability determinations for wide-ranging species are best made at the regional scale. Planners and managers must then demonstrate consistency with this determination in all subsequent decisions made at finer scales of planning, including the project level.

F. Monitoring. Effective monitoring is a critical aspect of achieving ecological sustainability. Monitoring, which must be an ongoing process, provides a better understanding of how to sustain ecosystems and serves as an "early warning system" to detect declines in ecosystem integrity and species viability before irreversible loss has occurred. The monitoring program must select indicators of ecosystem integrity and species viability, develop methods for measuring such indicators, designate critical indicator values that would trigger changes in management practices, obtain data to determine whether such critical values are being approached, and interpret those data in relation to past and potential management decisions. If analysis and assessment concludes that some critical values are being approached, then the appropriate plan must be reevaluated to determine whether amendments are necessary to comply with the provisions of this section.

G. Development of Viability Assessment Methods and Conservation Strategies. Regional assessments shall develop methods for assessing ecosystem diversity and species diversity, including methods for assessing ecological integrity and the viability of focal, threatened, endangered, and sensitive species, and shall apply them to estimate the likely condition of ecosystems and species. These assessments shall also propose strategies for use in testing the effectiveness of plans in conserving ecosystem diversity and species diversity.

H. Evaluation of Plans. The following evaluations shall occur during planning: (1) an evaluation of the plan's capability to provide for the ecological conditions necessary to support ecosystem diversity and species diversity and (2) an independent review, before publication of the plans, by Forest Service and other scientists of the effectiveness of the plan in meeting the goals of this section. The results from this work shall be made available to the public.

* NOTE: Sensitive species should be defined in the definitions section of the planning regulations (219.2). This definition will read as follows: Sensitive Species. Those species identified as sensitive under the Forest Service's sensitive-species program, currently set out in the Forest Service Manual, Chapter 2670.

6B. Water and Watersheds

Because watersheds are typically embedded within broad biophysical regions, their individual characteristics, functions, and processes have an important role in the maintenance of biodiversity and ecological integrity. While watersheds are simply geographic areas, the degree to which ecosystem functions and processes operate within them provides an important perspective regarding their overall "integrity" (i.e., the quality or state of being unimpaired, sound). At a variety of landscape scales, human uses, either individually or collectively, have influenced the character and integrity of many national forests and grasslands. As a result, there is an increasing need to protect watersheds in which modifications have been minimal and integrity remains relatively intact. Such key watersheds can provide important refugia to species and can provide important references for demonstrating how relatively intact systems operate. The identification of key watersheds should thus be a high priority in any planning effort.

A loss or degradation of watershed integrity can occur in many ways: a loss or reduction in specific species or their abundance; a change in the timing, amount, or quality of ecosystem outputs; a change in the physical structure of the stream; or some combination of these and other factors. Historically, many human uses have occurred on national forests and grasslands, and many of these have contributed to altering watershed integrity, both locally and at landscape scales. For example, loss of watershed integrity might be represented by a reduction in beaver populations, alteration in the abundance and distribution of wild ungulates, a change in fire regimes, extensive use of short-rotation and even-aged silvicultural systems, modification of streamflow and sediment regimes, introduction of nonnative plant and animal species, season-long grazing, high-density recreation use, private land uses associated with adjacent landowners (particularly where mixed ownership patterns prevail), and others. Because restoration of impacted watersheds is generally considered to be more difficult than maintaining intact systems, planners and managers must continually strive to prevent and minimize the occurrence of significant impacts to national forest and grassland ecosystems.

The Legal Mandate to Conserve Watersheds

Watershed protection has always been a central theme in national forest law and policy. When Congress authorized the president to establish forest reserves in the 1891 Creative Act, the overwhelming reason was to meet the request of municipalities and irrigation districts for watershed protection. In the 1897 Organic Act, the first listed purpose of the forest reserves was "securing favorable conditions of water flows." Timber production was the other announced purpose, but logging proponents regularly assured Congress that watershed functions would not be compromised. The Weeks Act of 1911 was also a watershed-protection statute. The Multiple-Use Sustained-Yield Act of 1960 lists watershed purposes as one of the multiple uses and, taking the long view, provides for "the maintenance in perpetuity of a high-level of regular or periodic output" of the multiple uses "without impairment of the productivity of the land." While the NFMA of 1976 indicates timber, range, and other resources were important multiple uses of National Forest System lands, Congress nevertheless emphasized the importance of long-term sustainability:

> Sec. 2. (6) the Forest Service ... has both a responsibility and an opportunity to be a leader in assuring that the Nation maintains a natural resource conservation posture that will meet the requirements of our people in perpetuity.

The NFMA calls for consideration and protection of water courses and watersheds in a number of places. First, the NFMA identifies water as one of the multiple uses. Second, it has specific provisions about protection of water courses and watersheds when timber harvest is considered:

> (6) (g) (3) (D) insure timber will be harvested from National Forest System lands only where— (i) soil, slope, or other watershed

conditions will not be irreversibly damaged; ... (iii) protection is provided for streams, streambanks, shorelines, lakes, wetlands, or other bodies of water from detrimental changes in water temperatures, blockages of water courses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fire habitat.

(6) (g) (3) (D) insure that clearcutting, seed tree cutting, shelterwood cutting, and other cuts designed to regenerate an evenaged stand of timber will be used as a cutting method on National Forest System lands only where— ... (v) such cuts are carried out in a manner consistent with the protection of soil, watershed, fish, wildlife, recreation, and esthetic resources, and the regeneration of the timber resource.

Other federal legislation, such as the Clean Water Act (CWA) (1972 and as amended 1987) also mandate the conservation of water resources. The overall purpose of the CWA is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." To accomplish this, individual states are responsible for regulating both point and nonpoint sources of pollution by designating beneficial uses for each body of water, by defining criteria necessary to ensure these uses are met, and by implementing an antidegradation policy, which requires, at a minimum, water quality to be maintained and protected. As a component of the antidegradation policy of the CWA, high-quality waters, which represent "an outstanding national resource," such as waters of national and state parks, of wildlife refuges, and of exceptional recreational or ecological significance, should be designated and afforded a high level of protection. Waters of many national forests clearly meet these criteria.

In addition, the Federal Power Act requires the Federal Energy Regulatory Commission (FERC) to consider the protection of fish, wildlife, recreation, and watershed values in the relicensing of federal dams. This authority could have important implications for the protection of water resources and associated beneficial uses as hundreds, perhaps thousands, of nonfederal dams come up for licensing in the next few decades. (See Sidebar 6-3.)

Watershed Integrity and Restoration

Where watershed conditions, functions, or processes on national forests and grasslands have been significantly altered by human activities, the restoration of those conditions, functions, and processes should assume a high priority. From an aquatic perspective, the National Research Council (1992) defined restoration as representing

> "re-establishment of pre-disturbance aquatic functions and related physical, chemical, and biological characteristics; ... it is a holistic process not achieved through the isolated manipulation of individual elements."

"Disturbance" in this context refers to the intensive land use that has often occurred in the past 50 to 150 years in the west and much longer in the east. From a larger watershed or ecosystem perspective, restoration should also include the conditions, functions, and processes of riparian and terrestrial ecosystems. The definition of restoration by the National Research Council is similar in intent to the definition of ecological integrity given in Sect. 6A: "The ecological integrity of an ecosystem can be defined as the completeness of the composition, structure, and processes that are characteristic of the native states of that system. Ecosystems with high ecological integrity continue to express the evolutionary and biogeographic processes that gave rise to the current biota, have a species composition, diversity, and functional organization expected from natural habitats of the region, and are resilient to environmental change and disturbance occurring within their natural range of variability."

Restoration of watersheds and their ecosystems can often represent a major scientific and management challenge. Forest and range systems are complex (have many components and processes) and are adaptive (conditions and the biota may respond over time to changing environmental conditions and human uses). In addition, forest responses to environmental conditions and human uses are often nonlinear, demonstrating threshold behaviors (e.g., antagonisms and synergisms are common). While "restoration science" is currently developing a better understanding of factors affecting the trajectories of recovering ecosystems, managers have few models of restoration success to emulate in their planning efforts. Nevertheless, some restoration principles are beginning to emerge:

1) The historical range of natural variability of ecosystem conditions and processes at watershed and bioregional scales needs to be considered and understood as a context within which to consider planning decisions across a variety of spatial scales.

2) An important component of ecological systems is that they have developed in conjunction with, and in response to, disturbance regimes (e.g., varying hydrologic patterns at landscape and micrometeorologic scales, fires, insects, and diseases). Thus, where such regimes have been significantly altered, their reestablishment will generally be a high priority.

3) Because vegetation is a key component of natural ecosystems and often experiences the effects of land-use activities (e.g., grazing, timber harvest, and fire-control policies), the ecological role of plant species and communities must be understood relative to terrestrial, riparian, and aquatic systems. Although some of this information is available in the scientific literature, it will almost always be incomplete at some level, or it may not be fully applicable to specific watershed conditions. Thus, local "reference sites" or demonstration areas of functionally intact plant communities need to be identified, protected, and used to gain local understanding and experience of related functions and processes.

4) The history of resource development and land-use patterns associated with national forests and grasslands must be understood within watersheds and across bioregions. This information may be critical not only for understanding the present status and trends of various resources but also for identifying potential reasons for existing conditions. Because many watershed effects have occurred prior to the current generation of resource managers, understanding historical trends in resource conditions often provides important insights for developing restoration strategies and plans.

Because of the numerous local and landscape-scale modifications to vegetation, to soil characteristics, to disturbance regimes, and to the distribution and abundance of terrestrial and aquatic species that have occurred on many national forests and grasslands as a result of human uses, there is increasing recognition in the scientific community of the need to protect watersheds, particularly those portions of watersheds that currently remain in good ecological condition. In other situations where resource degradation has occurred, the restoration of watershed processes and functions is a high priority. Although restoration can take a number of pathways, two general approaches are commonly recognized: passive and active. As an example of the passive approach, many areas are capable of ecological recovery simply by stopping or removing the human perturbations that originally contributed to degradation. In such situations, the natural-disturbance regimes are likely still operating, and the biota are sufficiently resilient to recover, despite the effects of previous management practices and the occurrence of natural disturbances. This approach to restoration is considered to be "passive" and may be the most effective approach for wide number of situations. In other instances, degradation may have been so extensive that more-direct intervention is required before restoration can occur. This approach might include such practices as stand-density reductions before the reintroduction of fire, removal of an exotic species that competes with native species, reintroduction of a locally extirpated species, deconstruction of highly erosive roads, and others. This more proactive approach represents "active" restoration. However, in both situations the general improvement of ecological functions and related physical, chemical, and biological characteristics is the goal.

Key Elements in a Strategy for Conserving and Restoring Watersheds

To conserve and restore watersheds, we suggest a six-part strategy:

1) *Provide conditions for the viability of native riparian and aquatic species.* The status of native riparian and aquatic species is typically an important indicator of watershed condition. Thus, it is important that native riparian and aquatic species be included as candidate focal species in the analysis, as discussed in Sect. 6A , to provide for the ecological conditions needed to conserve native species. In particular, threatened, endangered, and sensitive riparian and aquatic species should receive extensive consideration in the analysis. The needs of these species should represent a driving force in developing goals and standards for areas near streams and in estimating the overall ecological conditions of watersheds.

2) *Maintain and restore watershed integrity.* Watershed integrity is the expression of ecological integrity at the scale of a watershed. Based on the definition of ecological integrity in Sect. 6A, watersheds with high integrity continue to express the historic and biogeographic processes that gave rise to the current biota; have a species composition, diversity, and functional organization expected from natural habitats of the region; and are resilient to environmental change and disturbance occurring within their natural range of variability. In the discussion above, we defined restoration as the reestablishment of functions and related physical, chemical, and biological characteristics. While the wording is somewhat different for these two definitions, both have a similar intent. Controlling, modifying, and, in some instances, eliminating land-use disturbances that adversely affect watersheds are important components of maintaining and restoring watershed integrity.

The maintenance of flow regimes is of fundamental importance to sustaining riparian and aquatic systems. The protection and long-term maintenance of flow regimes in many areas will likely require the Forest Service, as a high priority, to pursue the development and attainment of in-stream flow claims and to follow through on its legal mandate to set conditions for the relicensing of nonfederal dams for flow regimes and fish and wildlife. For degraded watersheds, improving their integrity will require the reestablishment of aquatic functions and related physical, chemical, and biological characteristics to within the historical range of natural variability. Again, as indicated by the National Research Council (1992), restoration is a holistic process not achieved through the isolated manipulation of individual elements.

3) *Recognize watersheds in assessment and planning.* Assessment and planning efforts directed at conserving and restoring watershed integrity can generally be most effective when watersheds are used as the organizing concept for analysis. The cumulative effects of historical and ongoing management practices upon various environmental measures (e.g., erosion

and sediment production, riparian habitat, water quality, and aquatic species) often become manifest in a watershed context. Thus, Forest Service efforts directed at ecosystem protection and restoration should consider watersheds as their fundamental landscape unit, to the extent practical, in both assessment and planning.

4) *Develop an overall strategy for setting priorities for restoration and use.* A common saying among the watershed community is to "save the best, restore the rest." From an ecological, cultural, political, and economic perspective, it is almost always easier to protect intact and functioning ecosystems than it is to restore degraded ones. Thus, it is important that assessments classify watersheds as to their current ecological condition and integrity. Planning should then use this information in deciding where protection is warranted and where land-use management and restoration activities should occur.

Generally, management should be cautious in taking risks in watersheds in good condition; there is too much at stake. Sometimes, minimal standards for watershed condition are used to set limits on activities, allowing for the deterioration of watersheds with high integrity, as all watersheds approach a common level. In general, such an approach should be avoided: management in different watersheds should reflect the values of concern and the characteristics and conditions of the watershed itself. Where watershed conditions have diverged significantly from the historical range of natural variability, opportunities for restoration should be considered in planning efforts. In these situations, land managers may want to assume a risk of short-term ecological impacts to attain long-term restoration goals.

At both the site-specific and aggregate scales, it is important to limit the adverse effects of land-use disturbances, particularly those that are unrepresentative of the natural disturbance regimes or that have significant unintended consequences to species, productivity, water quality, and other watershed conditions. At the same time, it is important to encourage land uses that emulate natural-disturbance regimes. In this manner, and over the long term, undesirable cumulative effects of land use can be controlled and minimized at both site-specific and watershed scales.

5) *Energize the people of the watershed to help.* Most watersheds of any size contain a mixture of federal and nonfederal lands. Often, national forests cover the upper watershed and private landowners hold the rest. Or national forests might cover the entire watershed except those lands adjacent to rivers and major streams. Collaborative stewardship by all the landowners, along with state and local governments and the public, will be needed for successful conservation and restoration of these watersheds. Watershed councils can often motivate and direct crucial voluntary conservation efforts.

6) *Monitor watershed condition over time as part of adaptive management.* Restoration efforts need to be monitored as part of the adaptive-management approach to natural resources. Such efforts, which may ultimately succeed or fail, should be tracked and reported in an open manner. Monitoring is of fundamental importance for learning about the effects of various management practices because it provides the linkage between the original management decisions and the consequences of those decisions. Because not all attributes of a particular watershed or plan can be tracked in any given monitoring program, monitoring efforts need to be directed at selected components, those that provide immediate feedback to land-use managers and the public about the ecological integrity of the watershed.

6-3. The Importance of FERC Relicensing to Fish and Wildlife and Watersheds

The Federal Power Act (FPA) regulates most hydroelectric development, covering all nonfederal hydropower projects on navigable waters of the United States, on federal lands, and on nonnavigable waters subject to Commerce Claims jurisdiction. The FPA was enacted in 1920 and amended several times since then. The latest amendments, embodied in the Electric Consumers Protection Act of 1986, are intended to strengthen the FPA's protection of nonpower values though giving more authority to the Federal Energy Regulatory Commission (FERC), the independent federal agency responsible for implementing the FPA, to adequately safeguard fish, wildlife, water quality, and other public uses of the nation's waters.

The FPA authorizes FERC to issue hydropower licenses for up to 50 years if the license is deemed to be in the public interest. In determining whether licensing a project would be in the public interest, FERC must examine all relevant issues and must give consideration to both power and nonpower values of the resource. Nonpower values include "the protection, mitigation of damage to, and enhancement of fish and wildlife (including related spawning grounds and habitat), the protection of recreational opportunities, and the preservation of other aspects of environmental quality" 16 USC 803(a). The public interest involved is the same, regardless of whether the application is for a license to construct a project or a license to operate an existing project. Moreover, the FPA mandates license terms that provide "adequate and equitable" protection, mitigation, and enhancement measures for fish and wildlife and their habitat 16 USC 803 (j).

Hydropower development and relicensing proposals on federal reserved lands (e.g., national forests) are subject to two additional requirements. First, FERC cannot license a project that would be inconsistent with the purpose of the national forests. Second, the federal land management agency in charge of the reservation can prescribe mandatory license conditions deemed necessary to protect and carry out the purpose of the reservation (16 USC 797 (e)). A federal agency's conditioning authority, however, cannot be exercised arbitrarily; it must be reasonably related to the protection of the reservation.

6C. Identifying the Suitability of Lands for Different Types of Resource Management

The National Forest Management Act, Sect. 6 (g) states that guidelines are to be developed that "... require identification of the suitability of lands for resource management." The classification of lands as to their suitability for different kinds of resource management should be made during planning for large landscapes. Land classifications are often needed to support decisions at various levels and can be incorporated into the land- and resource-management plan. Furthermore, the identification of lands not suited for timber production should be a subset of the identification of the suitability of lands for different types of resource management.

The planning process should classify (zone) lands by suitable types of resource management: habitat preservation, water-quality management, timber production, range management, and recreation. Some lands might be classified as suitable for all types of management; others might only be suitable for one type. Site-specific analysis might be necessary to refine the estimates of where activities could actually occur and the form they could take.

The most complicated portion of this analysis addresses resource management involving timber harvest and timber production, where timber production is defined as a long-term commitment to produce commercial-timber volume. NFMA states "Sec. 6 (k) In developing land management plans pursuant to this Act, the Secretary shall identify lands within the management area which are not suited for timber production, considering physical, economic, and other pertinent factors to the extent feasible, as determined by the Secretary, and shall assure that, except for salvage sales or sales necessitated to protect other multiple-use values, no timber harvesting shall occur on these lands for a period of 10 years."

Under this clause, timber harvest can occur for the "protection of other multiple-use values," even where the forest is not suitable for timber production. Thus, lands suitable for resource management involving timber harvest need two subcategories: (1) where timber harvest is prohibited and (2) where timber harvest is permitted. When timber harvest is permitted, however, it might be either (1) for protection of other multiple-use values, even though timber production is not a goal, or (2) for timber production as one of several goals.

Given this complexity, it is not surprising that identifying the lands " not suited for timber production considering physical, economic, and other pertinent factors to the extent feasible..." has perplexed analysts since the passage of the NFMA. However, the criterion of economic efficiency broadly defined should eliminate many of these conflicts. For example, lands should be viewed as unsuited for timber production if the costs of regeneration, including using a reasonable discount rate, cannot be covered by the benefits (returns) from the future timber sales. In this case, these lands should not be allocated to timber production; such an allocation would be inconsistent with efficient attainment of long-term sustainability. Timber harvest should occur on these lands only to "protect other multiple-use values." Lands may also be unsuitable because of environmental damages associated with the harvest (e.g., serious erosion or water-quality deterioration) that exceed any surplus of harvest revenues over harvest costs. Similarly, economic criteria suggest that below-cost timber sales do not pass the efficiency test and therefore should not be undertaken unless justified by the achievement of some other end of sufficient value to justify the revenue losses. For example, if the below-cost activity generated substantial values in turkey browse to compensate for the losses, the activity would be meet the efficiency criteria. The careful use of economic criteria should eliminate many of the questionable practices of the past. We do believe these problems are solvable by appropriate analysis of revenues and costs. Furthermore, such problems can be avoided by using the scientifically credible, participatory planning process that is recommended in the report and by striving to attain the overarching goal of sustainability.

6D. The Role of Timber Harvest in Achieving Sustainability

In many situations, silvicultural practices can be used to help achieve the desired future condition of forests and can enhance both stand- and landscape-level goals for ecological, economic, and social sustainability. Silviculture is the process whereby humans tend, harvest, and reestablish forest stands and landscapes. Silvicultural practices, such as timber harvest and prescribed burning, can be used to help meet stand-specific objectives for species composition and forest structure as well as landscape-level objectives for abundance, size, shape, and pattern of patches of different stand conditions. Many stand and landscape objectives can be expressed in terms of these variables; they should be the focus of regulations that give silvicultural instructions for land and resource planning.

Silvicultural Aspects of the National Forest Management Act

The National Forest Management Act (NFMA) was most prescriptive in its sections on silvicultural practices within forested landscapes. This prescriptiveness becomes especially evident in a comparison of the detailed instruction in the section quoted below and the broad language on biological diversity within the Act. Yet whatever regulations are written for the national forests and grasslands, it is important that they allow flexibility in designing methods and systems to create and maintain the species composition, stand structure, and processes that are the foundation of ecological sustainability and that, in turn, sustain healthy economies and human communities. The Committee believes that NFMA provides adequate flexibility for the conditions of today and, we hope, of tomorrow.

In the discussion below, the need is emphasized for regional assessment to provide information on the characteristics of stands and landscapes that historically occurred in the different forest types (such as ponderosa pine or mixed conifer forests) and landscape units (such as mountain ranges, watersheds, or the range of some species). This information would then be used to guide and limit the silvicultural approaches to achieving stand and landscape objectives, including the selection of silvicultural systems and restocking standards.

Silviculture

When managing for ecological, economic, and social sustainability, silvicultural practices should strive to emulate the effects of natural disturbance processes, such as fire, wind, insects, and disease, on the forest. This approach applies at both the stand and landscape levels and addresses both the temporal (recurrance interval) and spatial (extent) components of natural disturbances. In forests managed for timber production, regeneration harvest methods (clearcut, shelterwood, and selection) can simulate natural landscape-level (coarse-scale) disturbances that have periodically reinitiated succession. These methods represent a gradient of disturbance intensities from the high-intensity disturbance of clearcutting to the moderate-disturbance of selection harvest. Silvicultural systems, such as even-aged, two-aged, and uneven-aged, that are achieved and maintained through various silvicultural activities, such as thinning, can mimic the structural conditions produced by different types and intensities of stand-level (fine-scale) natural disturbances.

In general, silvicultural systems were originally designed to achieve natural regeneration after harvest because the technology for planting stock (seedlings) had not yet been developed. The Committee suggests that, for reasons of genetic diversity, natural regeneration and the systems that provide it be considered specifically in the regulatory process.

> 6(g)(3)(D) … permit increases in harvest levels based on intensified management practices … [the "allowable-cut effect"]

From a silvicultural perspective, the linkage between intensified management practices and increases in harvest levels is certainly understandable. Intensified management often means increased growth, which, in turn, translates into increased harvest levels under an even-flow (or nondeclining-yield) constraint. The reality, however, is that the increased timber yield implied in this provision has not always materialized in the past, and it is questionable whether it will be a primary focus of future investment on much of the National Forest System lands.

Allowable sale quantities (ASQs) for many forest plans were derived from stand-level growth-and-yield estimates based on assumptions of intensive silvicultural practices (e.g., precommercial thinning, commercial thinnings, and fertilization). The stand-level projections were generally reasonable if intensive silvicultural practices had actually been used; in many cases, however, they had not been implemented at the scales envisioned in the plans. For this and other reasons, the projected ASQs for many planning areas have proven overly optimistic. If estimates of future timber yields are to be part of planning analysis, they should be based on realistic land-use allocations as well as realistic assumptions concerning investment in silvicultural practices. Put another way, a silviculture system designed to capture the potential timber productivity of a site is simply a theoretical exercise if there is little likelihood of its implementation.

> 6 (g) (3) (E) … insure that timber will be harvested from National Forest System lands only where … (ii) there is assurance that such lands can be adequately restocked within five years after harvest.

In this context, "harvest" applies only to "regeneration methods," such as clearcutting, selection, or the initial cut to establish a shelterwood or seed-tree system, that are intended to precede the establishment of a new stand. We presume that it does not refer to thinning, sanitation, or other harvests not intended to regenerate a new stand. We believe that the intent of this provision is to minimize situations in which combinations of difficult sites and inappropriate silvicultural methods result in regeneration failures. There are still, for example, many acres of poorly stocked spruce-fir clearcuts in the Central Rockies dating from the 1960s.

Two major questions immediately surface in interpreting this provision:

> When does the five-year clock begin when the overstory is removed in a sequence of harvests?
>
> Does the clause require that the sites in question "will be" restocked within five

years or that they "could be" restocked within that period?

We recommend that "... adequately restocked within five years after harvest" should correspond to the period following cutting (e.g., five years after clearcutting, five years after a seed-tree cutting, five years after a cutting to establish a shelterwood, and five years after selection cutting). An alternative, and the current regulation, would be to start the five-year clock at the final harvest, regardless of the silvicultural system used. Although this alternative works for clearcuts, it makes no sense for other even-aged harvest methods, such as shelterwood or seed tree. With these methods, some trees are left on the site to provide shelter for seedlings and/or seed for natural regeneration. The final harvest, in which the remaining large trees are cut, is not intended to occur until the new seedlings are well established and regeneration is deemed successful, at which point, no clock is necessary. For these methods, then, the biological clock should begin with the initial cut, not the final harvest.

The Committee further recommends that the clause should be interpreted as "could be" adequately restocked rather than "will be" adequately restocked, within constraints discussed below. The reasoning is that, under ecosystem management, it will be important to consider natural regeneration for the maintenance of genetic diversity. Interpreting the clause to mean that sites "will be" restocked within five years of harvest, rather than "could be" restocked, could have a chilling effect on the willingness of managers to give natural regeneration a chance.

Consider, for example, shelterwoods on which natural regeneration of trees has a very high probability of success and the trees themselves are considered valuable for maintaining genetic diversity. If the parent trees on the site are not expected to produce good seed crops for several years, artificial regeneration (planting seedlings) may be necessary to ensure that the site is replanted within five years. Artificial regeneration could become the norm and perhaps even the default, possibly resulting in a loss of genetic diversity and adaptive potential.

This situation may occur even after natural disturbance, such as a fire, because regeneration on such sites takes more that five years on the average. The question has important implications in areas ranging from economics to conservation biology. In some cases, policies designed to address regeneration delays have produced high-yield stands with little or no range in age and little species diversity. Therefore, we make the following recommendation:

1) Any proposal for harvest should be based on the objectives for the stand and broader landscape and on an assessment of appropriate regeneration methods for each combination of major forest type and landscape unit within each major region. (See the discussion concerning 6 (g) (3) (F) and 6 (g) (3) (F) (iv) below.) As a starting point in the analysis, the regional assessment would highlight the potential for successful regeneration in the major forest types and conditions likely to be encountered in the region. Through this process, the assessment would rule out forest types and/or landscape conditions in which it had not been shown, through experience or research, that it was possible with established techniques to restock an area within five years after harvest. This analysis, would serve as a first step in addressing lands "marginal" for restocking within five years.

2) An assessment of the potential for artificial and natural regeneration should accompany each silvicultural prescription associated with a proposed regeneration harvest. These harvests can be considered only if the site can be adequately restocked within five years.

3) In the silvicultural prescription, the basis for a conclusion that the site can be successfully restocked within five years would

be presented. Potential evidence for this conclusion could include successful regeneration within five years on similar sites based on research findings or past experience. This process will serve as a second screen in eliminating lands marginal for restocking.

4) Natural regeneration would be permitted, even if it took more than five years, if conditions were being created through regeneration harvest that would allow the stand to reestablish naturally as has occurred throughout history in that type and condition of forest and if this method would meet stand and landscape goals. Permanent openings many be created for wildlife-habitat improvement, vistas, recreational uses, and similar practices, but, for the purposes of this section, successful natural regeneration of the stand is the goal.

5) Any determination of an allowable sale quantity must include realistic calculations of the likely time until the stand is restocked, given the likely future method of harvest.

6) A priority of the technical and scientific review of assessments, strategic plans, and project implementation (discussed elsewhere in this report) will be to examine the analysis and rationales underlying regeneration guidance and decisions.

7) Regional guidelines should be developed covering the characteristics of natural regeneration in different forest types. These guides will define adequate restocking within the guidelines of regulations under 6(G)(3)(E).

> 6 (g) (3) (F) ... ensure that clearcutting, seed-tree cutting, shelterwood cutting, and other cuts designed to regenerate an even-aged stand of timber will be used as a cutting method on the National Forest System lands only where: (i) for clearcutting, it has been determined to be the optimum method, and for other such cuts it is determined to be appropriate, to meet the objectives and requirements of the relevant management plan.

With respect to clearcutting, the intent of this clause seems fairly obvious: clearcutting should be used only where it can be demonstrated to be the best method for meeting the objectives for the stand and landscape; it certainly should not be the default method that it had become in the 1960s. For many species and ecosystems, a convincing argument can be made for the "optimality" of clearcutting. Such an argument could, in principle, be made for most species that regenerate in essentially even-aged stands (e.g., red alder in the Pacific Northwest, lodgepole pine in the Rockies, and aspen in the Lake States) after natural, catastrophic, stand-replacing disturbances. It should be noted, though, that characteristics (size, shape, frequency, and pattern) of openings caused by these natural catastrophic stand-replacing disturbances vary considerably among different tree species.

While clearcutting may be an obvious choice for the regeneration of such pioneering species, clearcutting is not the only way that they can be regenerated and managed. Suitable conditions for regeneration can almost always be created with a range of alternative reproduction methods (e.g., clearcutting with reserve trees, a shelterwood, and even large-group selection).

An additional requirement is that cuts designed to regenerate an even-aged stand of timber are to be used only when they, and presumably the even-aged stand structures that result, meet explicit objectives of the plan. This requirement provides a great deal of latitude, but seems to suggest that even-aged stand management should not be the default method and that alternatives should be seriously considered. It is important to note that the requirement to explore alternatives to even-aged stand management is not a requirement to adopt classic uneven-aged management. Arguably, there is not a requirement to consider classic uneven-aged management. Nontraditional reserve-tree silvicultural systems can be used to create and maintain a broad range of stand structures that fall between the extremes of classic even-aged and uneven-aged silviculture. The choice of an appropriate regeneration method and silvicultural system needs to be made within the context of the ecology of the species involved and the management objectives at both the stand and landscape scale. These evaluations should draw upon the regional analysis of appropriate regeneration methods and patch characteristics. (See discussion concerning 6 (g) (3) (F) (iv) below.)

At times, there have been attempts to list the situations under which clearcutting will be considered. Such an approach is fraught with difficulties because of the impossibility of predicting all the different situations that might occur. With such a list, forest managers would be forced to fit any of the circumstances under which they would like to consider clearcutting into some category on the list, whether it really fit or not, which would lead to the inevitable claims of deception and fraud. The Committee believes that cases where managers would like to use clearcutting should be clearly justified as the best regeneration method for that situation and that each case should be judged by that criterion.

> 6(G)3(F)(iii) … cut blocks, patches, or strips are shaped and blended to the extent practicable with the natural terrain;

In general, there are abundant patch cuts where such blending with the natural terrain has not been done and others where it has been done quite well. The shaping of cut blocks has a critical visual impact and greatly influences the social acceptability of clearcutting. Straight lines are sometimes unavoidable, but we recommend that the intent of the law, even with the proviso “to the extent practicable,” be reemphasized in the new regulations.

> 6 (g) (3) (F) (iv) … according to geographic areas, forest types, or other suitable classifications the maximum size limits for areas to be cut in one harvest operation … .

At the time NFMA was passed, there was concern and controversy over the large clearcut squares that were appearing on the national forests. Much of this concern was from a visual perspective. This clause was one attempt in NFMA to address the clearcutting issue and its unsightly effects. Setting upper limits on clearcuts and other even-aged methods seemed a useful way to address the problem at the time. In the context of ecosystem management, though, the limits can result in detrimental, unintended effects.

General implementation of this provision could be a prescription for fragmentation of the forest into patterns that have not been experienced historically though natural-disturbance regimes. As forest managers have become interested in management (and silviculture) reflecting natural-disturbance regimes, it has become less certain that simply restricting the size of the patch created by even-aged harvest is the best approach for determining the size of disturbance created through harvest. To emulate natural disturbances, it may be important to set minimum sizes as well as maximums and to have objectives for the overall pattern of disturbance on the broader landscape.

Analysis of the historical characteristics of disturbances should be undertaken in regional assessments for each major forest type and landscape unit within the region. The assessment should consider the types of silvicultural systems potentially useful in the recreation of these disturbance characteristics. Out of this analysis should come minimum and maximum sizes of disturbances in different forest types and landscapes and also information on the historical frequency, intensity, and pattern of disturbances.

Timber Removals, Sustained Yield, and the Desired Future Condition

The National Forests Management Act specifies limitations on timber removals as follows:

Sec. 11 Limitations on Timber Removal—

> (a) The Secretary of Agriculture shall limit the sale of timber from each national forest to a quantity equal to or less than a quantity which can be removed on such a forest annually in perpetuity on a sustained yield basis; Provided, that in order to meet overall multiple-use objectives, the Secretary may establish an allowable sale quantity for any decade which departs from the projected long-term average sale quantity that would otherwise be established; Provided further, that any such planned departure must be consistent with the multiple-use management objectives of the land management plan.
>
> (b) Nothing in subsection (a) of this section shall prohibit the Secretary from salvage or sanitation harvesting of timber stands which are substantially damaged by fire, windthrow, or other catastrophe, or which are in imminent danger from insect or disease attack. The Secretary may either substitute such timber for timber that would otherwise be sold under the plan or, if not feasible, sell such timber over and above plan volume.

During the 1980s, this "sustained-yield" clause received considerable attention as one of the major considerations in land and resource planning. As an example, the primary function of FORPLAN, the primary analysis tool used by the Forest Service in planning, was to calculate harvest levels that met the provisions of this clause. With the broadened definition of sustainability advocated in this report, the use and function of this clause may change somewhat, but the national forests will still need to demonstrate compliance with it in land and resource planning.

It is highly likely that Congress expected that a significant majority of timber removals from the national forests would fall under the timber-removal restrictions of Sec. 11a, since that was the case during the period in which the law was created. In recent years, though, timber harvest volume on the national forests has come from lands on which timber removal is a byproduct of achieving other goals or from salvage. It can be argued that Sec. 11a applies most directly to green volume on lands where timber production is a goal. Unless timber production is a goal, it is difficult to calculate the long-term sustained yield essential to operating the provisions of Sec. 11a. Also, salvage volume is inherently unpredictable. In writing regulations to implement this provision, the Forest Service will need to clearly distinguish those categories of timber harvest to which Sec. 11a applies.

The National Forest Management Act limits timber removals to be "a quantity equal to or less than a quantity that can be removed on such a forest annually in perpetuity on a sustained yield basis" given certain provisions. The need for predictable, sustainable timber-harvest levels changes over time. In the past, this sustained-yield provision was seen as an all-purpose safeguard of sustainability. The restriction on timber harvest to the level that could be sustained in perpetuity would ensure that the forest was not plundered. An even flow of timber was seen as ensuring economic and social sustainability through contributing to community stability. In recent years, though, the identification of sustainability with sustained yield has wavered. The difficulty of producing an even-flow harvest level through time arises from several sources, including the inherently dynamic nature of ecological systems. Of course, it is this inherently dynamic situation that will make management for a "desired future condition" also difficult to predict or achieve with precision. Such inescapable uncertainty has lessened the capability of sustained-yield management to contribute to “community stability.” Also, questions have been raised as to whether community stability is the appropriate goal.

Still, there is the desire for predictability in timber-harvest levels. Without some notion of the magnitude of likely offerings, it is improbable that investment will occur in wood-processing facilities. Ultimately, national forests may be faced with a situation in which the operators needed to undertake desired stand treatments are not available. Just as the timber industry in many parts of the country requires outputs from the national forests, the national forests need a functional timber industry to help achieve long-term goals for these lands. In addition, communities planning for their future would like to have some confidence in the amount of timber that will be coming off nearby national forests.

Thus, the more that timber harvest contributes to long-term sustainability, the more predictable timber outputs will be. To the degree that timber harvest works against sustainability (ecological, economic, or social), it will be unpredictable and difficult to achieve. Proposals to harvest old-growth trees where they are relatively scarce will almost always meet with resistance. Proposals to temporarily raise timber harvests above sustainable levels to address employment problems generally meet with public dismay in the last planning process. On the other hand, thinning understories to reduce fuel and produce commercial volume can meet with acceptance and approval.

Under the Committee’s recommendations, forest management actions in the future would be guided by a comparison of the existing condition to the desired future condition. Where timber harvest is scheduled, these actions should be stated as a prescription that focuses first on the actions needed to achieve the desired structure and composition. The volume taken is the result of applying the prescription. While aggregating the expected volume will also be useful, and may be one of the goals of the prescription, planning, budgeting, and monitoring should focus first on the kinds and amounts of expected actions and the conditions they produce.

Past planning, which often focused on timber harvest and the allowable harvest, tended to polarize people and groups. Planning that focuses on desired future conditions and outcomes and the activities to achieve them, on the other hand, gives the Forest Service its best chance to unify people on the management of the national forests and grasslands.

Budgeting by amount and type of actions needed, rather than volume harvested, will ensure that the needed treatments occur. Currently, the understandable tendency is to tackle the easy treatments to get the stated volume; accountability by type of treatment will help reduce that.

The expected outcomes following a specific management action should guide the design of the monitoring program. The degree to which outcomes correspond to expectation will provide a key piece of information about progress toward the desired future condition. This information provided by monitoring should be gathered on an annual basis from the projects that have occurred.

Large landscape plans should provide an estimate of desired conditions and a schedule of management actions to achieve them, including timber harvest, that then serve as reference points for the achievement of the restoration-plan goals.

In large-landscape plans, a schedule of forest-management actions needed to reach the desired conditions should be estimated along with the conditions expected to be achieved through time. The correspondence of expected management actions and conditions through time with actual management actions and conditions should be a critical measure of achievement of forest-plan goals. Measurement of plan performance would be accomplished through (1) comparing, on an annual, basis, expected treatments with actual treatments and (2) comparing, every 5 to 10 years, expected conditions with those that occur. Either of those measures might have three possible outcomes: (1) concluding that management actions are moving the landscape towards the desired future conditions; (2) concluding that the treatments need to be adjusted to achieve this condition; or (3) reevaluating the desirability of the future conditions that have been identified as the goal.