paradigm shift. New forestry provided some new tools to assist our management. The New Perspectives program expanded our thinking beyond just forestry to include all our goods and services in the multiple-use charter. In so doing, New Perspectives allowed us to reach for new goals and to look for new and better ways to do business. New Perspectives principles began to guide the management and research activities necessary to achieve the 1990 RPA program. The next logical step was the development and formal designation of ecosystem management as a key management philosophy.

Ecosystem management means using an ecological approach to achieve the multiple-use management of national forests and grasslands by blending the needs of people and environmental values in such a way that these lands represent diverse, healthy, productive, and sustainable ecosystems. Make no mistake—people are part of the ecosystem and must be factored into the equation of management. As the USFS implements ecosystem management, we aim to accomplish many goals. Our management practices will be ecologically possible, economically feasible, and socially desirable. These three ingredients are all essential, and each forms a leg of a triangle that is not complete without the others (Figure 1).

The USFS will take care of the land by restoring and sustaining the integrity of its soils, air, waters, biological diversity, and ecological processes. Within the sustainable capacity of the land, we intend to meet the needs of people who depend on natural resources for food, fuel, shelter, livelihood, and inspirational experiences. Within the sustainable capacity of the land, we also intend to assist with improving the well-being of communities, regions, and the nation through diverse, cost-effective, and environmentally sensitive production, use, and conservation of natural resources. We seek balance and harmony between people and the land with equity between interests, across regions, and through generations, meeting this generation's resource needs while maintaining options for future generations to also meet their needs.

Admittedly, this is a tall order and one which can only happen with effective citizen participation. Ecosystem management will succeed when the proponents and adver-

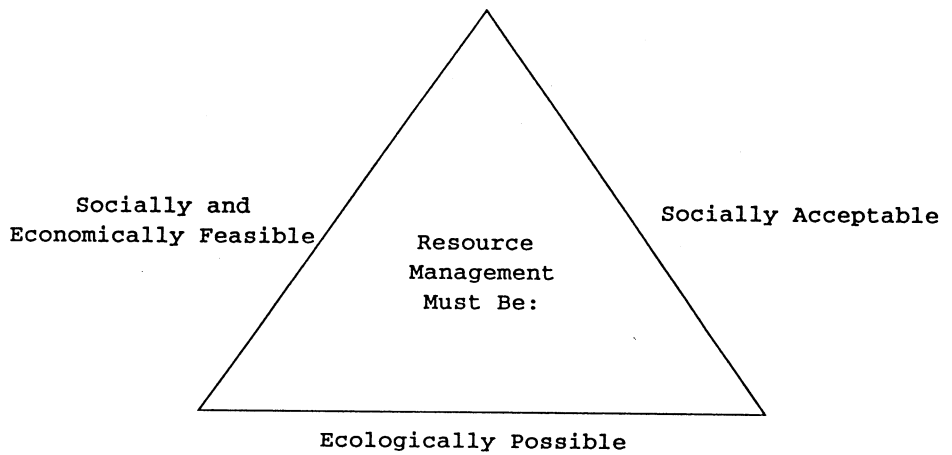

Figure 1. Three essential ingredients.

saries of options truly become decision-makers–recapturing the essence of democracy. Responsibility for the stability and success of the chosen solution will be shifted to those who affect and will be affected by its outcome.

Is the public willing to accept this new role? We think so. The increase in volume of appeals to decisions made on every imaginable management or preservation action indicate not only a willingness of interest groups and individuals to get involved in decision-making; it signals that society is no longer willing to abdicate their decisions on natural resource use to scientists and public land managers. Admittedly, providing background, science, assistance, and facilitation to diverse groups of citizens and coaxing them into making and taking responsibility for decisions is a departure from business as usual in the federal government. But it is not as much a departure in the USFS as might be expected.

The process of public involvement in developing Forest Land Management Plans introduced the agency to techniques for acquiring information from external sources in ways that could be used in decision-making. New skills and expertise were infused into the agency that more fully represented the cultural diversity of the country as well as the diverse range of public opinions and values. For example, the ranks of "ologists" (wildlife biologists, ecologists, archaeologists, geologists, etc.) swelled in unprecedented fashion to bring new dimensions to the decision-making arena. Volunteers became welcome members of the team to help care for the land and serve people. The introduction of Challenge Cost Share Authority in 1986 opened the door to shared decisions and shared power with outside groups, as long as projects were within the parameters of existing Forest Plans. More and more, National Forests have informally begun to work with external parties to plan, as well as accomplish, objectives. It is reasonable to assume that the USFS is well-positioned to depend less on procedures and bureaucracy and more upon relationships and cooperation to accomplish a sustainable flow of public values.

LAND MANAGEMENT, ECOSYSTEM STYLE

There are at least four critical actions that we believe are needed to make ecosystem management work. These include: (1) completing inventories and assessments, (2) identifying the range of natural variability for ecosystem types, (3) gaining a better appreciation of scale, and (4) empowering an ecologically literate society.

Assessments and Inventories

The inventory and assessment of social values, ecological factors and social and economic conditions are essential in defining desired future conditions for each Forest Plan at both the programmatic-forest level and the management-area level. In essence, they help define the space within which decisions about management can be made and implemented. They become the basis on which interested publics, working with the USFS, build and carry out management direction. They are the common ground between interest groups. They are the shared understanding of what is ecologically sustainable, socially acceptable, and economically feasible (Figure 2).

The **Social Values Assessment** helps define people's wants and needs, ranging from desire to use public lands to facilitate employment and income or lifestyles, like ranching, to the use of public lands for spiritual enrichment or recreation, to the desire to protect lands from all human activities and maintan them as vestiges of wilderness. It helps quantify and qualify various

social values of the forest components so decisions can be made with a better understanding of the effects they will have on the owners of the National Forests, the people of the United States.

are performing. Such things as employment, income, and tax revenues help us assess economic diversity and dependency of communities. The assessments address community infrastructure needs such as schools,

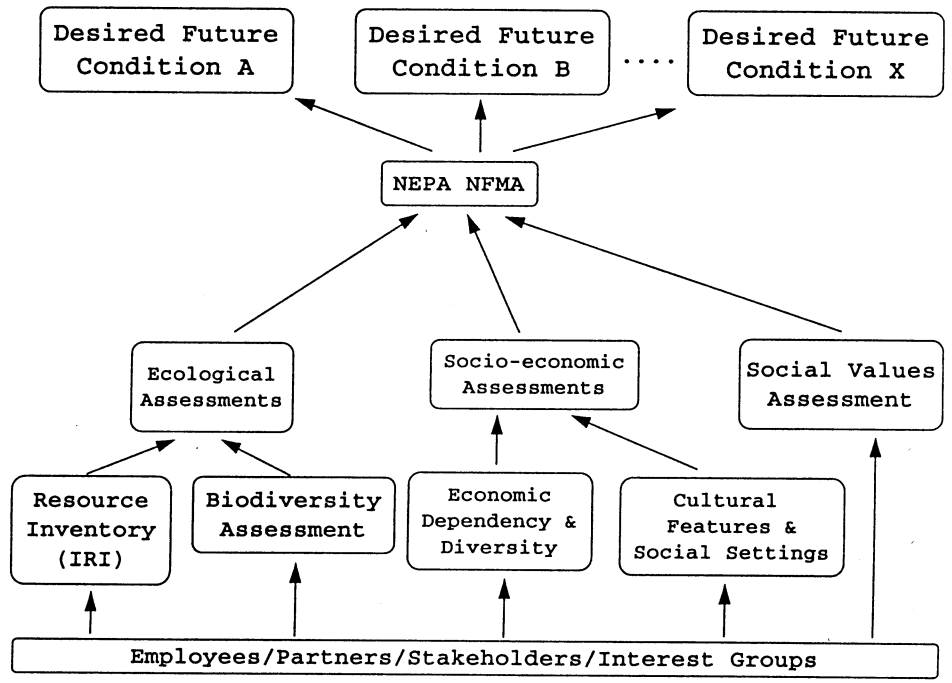

Figure 2. Ecosystem Management.

The **Social/Economic Assessments** consist of two parts: Economic Dependency and Diversity and Cultural Features and Social Settings Inventories.

The economic assessments tell us what products, services and amenities we can acquire from the land on a sustainable basis and within the framework of a community-based land ethic. Products can be commodity, cultural, aesthetic, or spiritual in nature as long as they have economic value—provide jobs and income to the surrounding area. They also tell us what socio-economic systems are in place and how they

hospitals, housing, transportation and law enforcement needs.

The social assessments also rely on inventories of cultural features and social settings.

Cultural Features Unit

- Roads
- Trails
- Recreation Facilities
- Buildings
- Communities, etc.
- Polygons, Lines, and Points

Social Settings Unit

- Recreation Opportunity Spectrum
- Visual Quality
- Polygons

Most of this information is currently available or is easily obtainable. Its purpose is to clearly define the present extent of human influence on the physical and biological components of the ecosystem.

The **Ecological Assessments** consist of two parts: Integrated Resource Inventory, and Biological Diversity Assessment. This information is critical, for it provides the means to create ecological literacy and understanding, both internally and with individuals and groups who wish to participate in decision-making.

The Integrated Resource Inventory (IRI) is an effort to prepare our basic resource information for entry into a Geographic Information System (GIS). The end product is reliable, integrated resource information that is consistent across the Region and understood by everyone. The Rocky Mountain Region's basic resource information will consist of three themes:

Common Water Unit

- Watershed Boundaries
- Stream Network
- Ponds, Lakes, and Reservoirs
- Polygons, Lines, and Points

Common Land Unit

- Landscape
- Potential Natural Vegetation
- Soils
- Polygons

Common Vegetation Unit

- Existing Vegetation—Trees, Shrubs, Forbs, Grasses/Sedges, Cropland, and Barrenland
- Polygons

The initial IRI efforts are focused on developing three distinct, integrated maps containing polygons, lines, and points that represent basic resource information. A fourth IRI layer, that contains point information for all sample plots associated with any of the three Common Unit layers, will be needed.

Concern for biological diversity is changing how we do business. The Biological Diversity Assessment provides baseline information about some of the components of biological diversity. It provides a framework for looking at the range of natural variability, threatened, endangered, or sensitive (TES) species, special communities or features, and different scales of time and space.

Sustainability and the Range of Natural Variability

As we develop management plans, we need to understand how the ecosystems we manage have functioned over time and across large landscapes. This understanding, which comes from a "range of natural variability assessment," provides a context for management and a set of lessons from nature that we can use to design management activities. This understanding also provides a context for discussing the concept of ecological sustainability.

Ecological processes and conditions of habitat that existed for the last several thousand years are those that supported native biological diversity. Biological diversity provides the machinery that makes ecosystems work. The recent explosion in human population has produced increasing alteration of the Earth's ecosystems. As ecological conditions across landscapes change from those that existed for centuries or thousands of years, chances increase that some vital element or process will cease to exist. Highly altered ecosystems may continue to be productive with continuous subsidies of energy and materials. In addition, the time span over which we can be sure they will be productive is often shortened in proportion to the degree of alteration.

Alteration may change the capability of the ecosystem to photosynthesize, cycle nutrients, and maintain other basic processes. A

corn field, for example, may be highly productive with subsidies of fertilizers, water, tillage, and pest control. A forested landscape in the Rocky Mountains managed for old-growth forests may require fire, insect and disease suppression. A similar area managed for a natural mix of seral stages may require the use of prescribed fire. The probability of long-term ecological sustainability increases as the ecosystem retains the machinery provided by biological diversity and natural processes. We use the metaphor "saving all the pieces" to describe our attempt to retain biological diversity and manage for ecological sustainability (Figure 3).

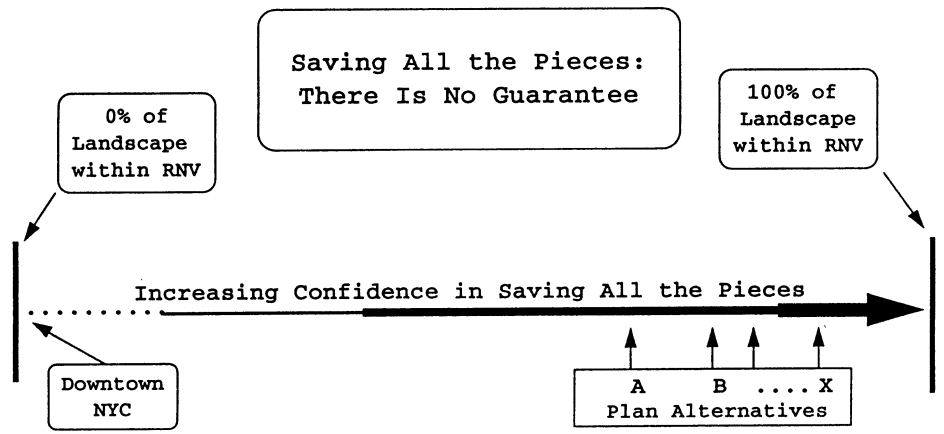

Figure 3. Saving all the pieces.

There is no single point along the continuum from slightly to highly altered ecosystems where we can say that some condition "is" or "is not" sustainable. However, there are at least two vital signs that signal declining sustainability: loss of species and loss of inherent site capability (due to accelerated erosion, for example). The former will usually occur before the latter. If species loss has occurred, or conditions otherwise dictate, management practices must focus on individual "featured" species, habitat, and people management. Not only is featured species management generally expensive, it frequently generates conflicting results for different species.

Where possible, conservation of biological diversity in the Rocky Mountain Region will result from management that approaches ecological processes and habitat conditions discovered during a range of natural variability assessment. Management practices will be distributed over space and time to achieve a broad range of conditions. The appropriate mix of featured species and landscape habitat management must be designed for each individual ecosystem. While a combination of these two approaches will often be appropriate, we will emphasize management that emulates natural conditions wherever possible. This is not to say that we will manage for natural conditions. We must continue to operate as a multiple-use agency, but will use our understanding of natural processes to do so in an ecologically sustainable fashion.

The goal of USFS stewardship is to understand and retain natural processes, thereby increasing the chances of long-term sustainability,

while providing for multiple uses. The range of natural variability assessment is our tool for understanding these processes.

The range of natural variability assessment must be a useful description of the composition, structure, and function of ecosystems over space and time. Over long periods of time (thousands of years), climatic variation has caused major shifts in the kinds of ecosystems present in landscapes and the disturbance regimes that affect them. From a pragmatic point of view, assessment of the range of natural variability is difficult beyond the normal life-spans of most tree species and is more difficult in grass- or shrub-dominated ecosystems. The time span for assessment could be broken into three parts, reflecting periods of accelerated change: 1) the period of reduced fire frequency since effective fire suppression began (usually early 20th century), 2) the period of increased fire associated with the mining, railroading, and timbering activities of early European settlement (generally 1840 to the start of fire suppression period), and 3) the background period before European settlement. This separation pulls out the different major recent shifts in disturbance regimes and may be appropriate for much of the Rocky Mountain Region.

Composition can be assessed for each ecosystem type by developing a list of species by seral stage or aquatic habitat type under natural conditions. This information can come from the scientific literature (where relevant to the ecosystem), inventories in representative and relatively undisturbed areas (integrated resource inventories, stand exams, reforestation exams, range exams, etc.), and professional management experience. In addition to a list of species, each species should be categorized by its dominance or abundance in each seral stage. Lists and abundances at the broad landscape scale will most often not be all-inclusive.

Structure assessment at the stand level describes the typical sizes of plants, their spacing, and the amounts and kinds of dead material (e.g., downed logs and snags) for each seral stage under natural conditions. For aquatic ecosystems, the structure of riparian vegetation, amounts and sizes of large organic debris, and physical form of stream channels, lake margins, etc. are analogous features.

A description of the structure or pattern of stands across large landscapes is also important. Pattern assessment at the broad landscape scale consists of qualitative or quantitative descriptions of the sizes, shapes, and landscape position of vegetation patches generated by stand replacement disturbance and physical site conditions. Indices of edge and fragmentation calculated for existing conditions or proposed activities are only meaningful when compared with habitat conditions described by assessments of the range of natural variability.

Pattern in time should also be described. The frequency and intensity of disturbances (fire, insect/disease, flood, etc.) has a major impact on the abundance of different seral stages or aquatic habitat conditions across a landscape. It is more important, at the large landscape scale, to answer the question "Were the stands in this ecosystem reset by disturbance once in 300 years or every hundred years or less?" rather than the question "Is the natural fire rotation in this ecosystem 250 or 300 years?"

Scale

Analysis at large landscape scales provides a context for project analysis. For example, it is difficult to estimate the effects of proposed actions on a sensitive species unless you know the distribution and popu-

lation status of the species across a larger landscape. The range of natural variability for a watershed or planning area in which proposed actions will occur might be appreciably different from the general range of natural variability for a whole ecosystem type across a larger landscape. Analysis at larger scales should include two focuses: the distributions and populations of TES species or special features (such as unusual, unique plant communities, wetlands, bogs, etc.) and the range of natural variability in terrestrial and aquatic ecosystems.

We need to more clearly understand the scales appropriate to describe ecological processes. Our knowledge of scales, from the universe to the particle world, traverses forty-two orders of magnitude, yet only about seven orders of magnitude (the organism to the biosphere) cover the Earth and those things we can view directly. We can observe and plan management at any scale we choose, but we must be knowledgeable of the processes that we can expect to observe at a particular scale in order for that scale to have utility. A rigorous analysis of sustainability requires us to "think big." It is not until we approach at least the ecosystem level or, more often than not, the landscape level, that we are thinking big enough.

Empowering an Ecologically Literate Society

One of the greatest challenges facing all land management agencies is to work with people who have great passion for the resource but who may have little understanding of ecology and the natural world. As the population of this country shifts to urban areas and is influenced more by slick promotional campaigns from various interest groups and less by experience and observation, reaching an informed consensus about the desired condition of the resource is increasingly difficult. The multiple-use management mission of the USFS is a given, but the emphasis given each of the uses shifts with public opinion and values—whether or not they are informed opinions and values. Historically, public agencies have tried to convert the public to agency values rather than incorporate new values into management practices. That era is ending. We run the risk, now, of trying to be all things to all people without adequately educating ourselves and our publics about the trade-offs that must be made, one way or the other.

As the USFS begins the job of ecosystem management, from developing the inventories, to identifying the range of natural variability, to looking at different scales, we need to recognize that we are developing tools for a public process. These are only aids to help all of us decide what management activities should occur on the public estate. In the past, we have assumed that the public would accept some form of active management. We can no longer make that assumption. The people of this nation are often not convinced that management is necessary to provide the goods, services, and values they demand. Many people do not consider humans to be intrinsically part of the Earth's ecosystems. It is imperative that our environmental education efforts include the concepts that humans are part of ecosystems and that management to deliver agreed-upon goods, services, and values is often necessary. We must also recognize that production of goods, services, and values on the National Forests must be in the context of long-term sustainability.

A CHANGING U. S. FOREST SERVICE

There are many opportunities and challenges ahead. It is not realistic to think we can get the job done with the same USFS organiza-

tion, people, and skills that existed even five years ago. We are moving toward a more multi-cultural and diverse organization. Our employees will have different experiences and insights that will help us solve problems. We value diversity in the workplace as much as we do in the forest and range lands.

Nor can the job be done without the advantage of expanding technology to more effectively process, display, and use information. We will do Integrated Resource Inventories. We will use Geographic Information Systems.

We will continue to hire people with diverse skills. We will continue to look for more cost-effective ways of doing business. Partnerships with other agencies and the private sector will be a way of life. Ecosystem management will be an integral part of Forest Plan revisions and implementation. Local communities must be involved with National Forests to assure sustainable local economies. With help from both our partners and critics, we intend to generate predictable, sustainable products, services and values within the framework of sustainable ecosystems.

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