CHAPTER 3.0 ECOSYSTEM MANAGEMENT

This chapter begins by relating the evolution of ecosystem management through its roots in stewardship of the land, ecology, conservation biology, landscape ecology, adaptive management, and environmental planning based on a review of the relevant literature. Ecosystem management is then described along four dominant themes: ecosystem integrity, time and spatial scales, environmental planning and management, and human health and welfare. The chapter next presents strategies for improved ecosystem management implementation.

Before proceeding further, this chapter interjects a historical perspective of ecosystem management's progressive evolution within the U.S. Forest Service—sustained yield *to* multiple use *to* "New Perspectives" *to* ecosystem management. This section has been included here because I thought it was important for the reader to understand the Forest Service's interpretation and incorporation of ecosystem management principles within the context of the general discussion of ecosystem management's evolution as described in the previous sections.

Chapter 3.0 then synthesizes the discussion of ecosystem management into a list of "ideal" ecosystem management criteria. The chapter concludes with a set of ecosystem management goals developed from the list of ecosystem management criteria. The goals, in turn, were used to formulate the ecosystem management questions for the case study evaluations (Chapters 4.0 and 5.0).

3.1 Evolution of Ecosystem Management

If we seek insight into what might be involved in actually implementing an ecosystem approach to management, Flader (1994:18) suggests that "we might recall Leopold's insistence on setting specific standards of conservation for each area through careful observation, historical study, and scientific research and then monitoring and evaluating the effect on the forest." Keiter (1990) postulated that ecosystem management is closely linked to modern conservation biology theories. Ecosystem management principles, according to Golley (1994), must be formulated based on the integration of landscape ecology and environmental management. And, Slocombe (1993:289) has argued that "ecosystem approaches" to environmental planning "may provide a more transdisciplinary route to successful integration of environment and development."

Ecosystem management did not develop in a vacuum, nor can it be considered a totally new and unique concept. Ecosystem management can be viewed as evolving through the integration of various existing and newly developed disciplines within the sciences, planning, and management. The following sections trace the evolutionary "roots" of ecosystem management.

3.1.1 Stewardship of the Land

Two advocates of land preservation and stewardship that set the stage for ecosystem management were John Muir and Aldo Leopold. John Muir was a leading proponent of the protection and preservation of wild nature. Muir based his case for preservation on several grounds: the benefits of forest cover for protecting soils and regulating water flows; the restorative powers of "a little pure wilderness"; and a sense of intrinsic beauty and value of all things within "the one great unit of creation" (Muir as cited in Nash 1989:41). In 1878 John Muir wrote, "When we try to pick out anything by itself, we find it hitched to everything else in the Universe."

Aldo Leopold through the development of his "land ethic," stressed the need to combine conservative use and preservation based on an appreciation of ecological health and diversity, and the integrity, stability, and beauty of the biotic community.

> The land ethic . . . enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land . . . . A land ethic of course cannot prevent the alteration, management, and use of these "resources," but it does affirm their right to continued existence, and, at least in spots, their continued existence in a natural state. In short, a land ethic changes the role of *Homo sapiens* from conqueror of the land community, to plain member and citizen of it. [Leopold 1949:204]

Dale Robertson, former Forest Service Chief, identified Leopold's "land ethic" as the basis of the ecosystem management philosophy for forest and grasslands management by striving for "balance, equity, and harmony between people and land" (USFS 1992:2). Bengston (1994:517) has proposed that the philosophical base of ecosystem management is a "Leopoldian environmental ethic." Flader (1994) has cited Leopold's conservation standards as the foundation for developing an ecosystem management approach. Gobster (1995) has written that the ideals about an ecological aesthetic—the basis for an ecosystem management approach—come largely from essays by Leopold, culminating in his *A Sand County Almanac* (1949). Knight (1996) concluded that the concept of ecosystem management is not new, but a half-century old. "It was developed by Aldo Leopold and was called the 'land ethic'" (Knight 1996:472).

3.1.2 Ecology

According to McIntosh (1985), all definitions of ecology agree that ecology studies the interrelationships of organisms and their environment. A prevailing theory of ecology is general systems theory (Allen and Hoekstra 1992). General systems theory "is a holistic scientific theory and philosophy of the hierarchical order of nature as open systems with increasing complexity and organization and with living systems and ecological systems as their special biosystem subsets" (Naveh and Lieberman 1994:26). The concept of "ecosystem" applies across hierarchical levels of organization and may span a large range of spatial and temporal scales (King 1993).

As defined by Allen and Hoekstra (1992:44), "the functional ecosystem is the conception where biota are explicitly linked to the abiotic world of their surroundings." The internal dynamics of an ecosystem—involving the flow of energy, the recycling of materials, the organization of food-webs, and so on—have been much studied and are fairly well understood (Odum 1986). In contrast, what Odum (1986) called the "external dynamics of an ecosystem" have been widely neglected. Because ecosystems are open systems, consideration of both the "input environment" and the "output environment" is critical. "These environments are coupled with, and essential for, the ecosystem to function and maintain itself" (Odum 1986:4).

The application of ecology and its approaches to organisms, including humans, and the environment have lagged behind the thoughts and actions of various environmental and conservation groups concerned with humans and their environment (McIntosh 1985). In 1971, L.K. Caldwell (1971:665) commented that, "The subversive potential of ecology had been unperceived even by ecologists, this nascent science having been focused largely upon manageable microproblems from which the human animal was usually excluded."

Odum (1986:2) offered three reasons why "applied" scientists have been so slow to apply ecosystem theories to practical problems:

1. Reliance on the "quick-fix" that works very well in the short-term of political and economic worlds. But when numbers of small "quick-fix" are made independently, the central problem is not properly addressed; decisions at a higher hierarchical level, that would benefit the whole, are accordingly not made.

2. Science has become so strongly reductionist with increasing specializations; emphasis on smaller and smaller units down to the molecular level and a preoccupation with laboratory studies.

3. The mistaken notion that 'the whole' is nothing more than the sum of its parts.

Because of the force of human interventions, a new definition of ecosystem that included social, economic, and political implications was slowly realized by ecologists such as Odum (1986) and Forman and Godron (1986). Odum (1986:10) stated that "a holistic or holoeconomic approach is especially important in assessing land use. Only in this manner can non-market life-support goods and services of natural environments be properly valued and effectively preserved." Thus, ecosystem management, which is based on ecological principles, evolved to inform decisionmakers about ecosystem potentials and consequences of choices (Salwasser 1994).

3.1.3 Conservation Biology

The field of conservation biology developed in response to the biodiversity crisis (Soule 1985; Noss 1991; Salwasser 1991; Franklin 1993; Meffe and Carroll 1994). It differs from traditional sciences in that it involves many disciplines. Meffe and Carroll (1994:559) defined conservation biology as, "An integrative approach to the protection and management of biodiversity that uses appropriate principles and experiences from basic biological fields . . ." Conservation biology applies the principles of ecology, biogeography, population genetics, economics, sociology, anthropology, philosophy, and other theoretically based disciplines for the maintenance of biological diversity (Meffe and Carroll 1994). Conservation biology recognizes that intact and functioning ecosystems are important life-support systems and are critical to our continued survival and well-being (Odum 1986).

According to Soule and Simberloff (1986), Clark and Zaunbrecher (1987), Agee and Johnson (1988), Grumbine (1988, 1990), Noss (1990, 1991), Salwasser (1991), Franklin (1992), and Knight and George (1995), the traditional "one species at-a-time" and "community-level" strategies for recovery and rehabilitation of threatened or endangered species needed to be amended with landscape-level strategies that recognize ecosystem patterns and processes. Grumbine (1990) discussed a "greater ecosystem concept," which is an integrated system of large nature reserves that involve human occupancy and use. Knight and George (1995) described a landscape approach that relies on the principles of landscape ecology and which manipulates habitats and landscapes to influence groups of species collectively in the desired direction. In practice, from 1972 to 1993 in Pacific Northwest forest management, the species conservation issue evolved from protecting a single species, to protecting several species simultaneously within a single ecosystem, to considering the effects of broad-scale management plans on all species associated with old-growth or late-successional forests (FEMAT 1993).

Within the greater ecosystem concept, goals for the conservation of biodiversity are blended with other goals for land use (Salwasser 1991). This ecological concept also requires cooperation and coordination among federal, state, and private landowners (Grumbine 1990). [It is here that competing equities are balanced and conflicts managed effectively.] As postulated by Salwasser (1991:248), "The future for endangered species, as for all of life's variety, will be determined by how quickly and how well we learn to integrate goals for a rich biotic future with our growing need for resources for subsistence, commerce, recreation, and spiritual renewal."

3.1.4 Landscape Ecology

Landscape ecology is a branch of modern ecology that deals with the interrelationship between man and his open and built-up landscapes (Naveh and Lieberman 1994). For the first time, the human environment is integrated with ecological systems analyses. Forman and Godron (1986:595) have defined landscape ecology as "the study of the structure, function, and change in a heterogeneous land area composed of interacting systems." According to Wiens (1992), landscape ecology is less concerned with theory and hypothesis-testing and more with problems addressing habitat fragmentation, reserve design, biological diversity, resource management, and sustainable development.

The application of landscape ecology recognizes that "holistic and transdisciplinary approaches are called for in the implementation of landscape evaluation, planning, design, management, conservation, and reclamation" (Naveh and Lieberman 1994:109). Golley and Bellot (1991) noted that landscape ecology provides planners and decisionmakers with information that depicts the structure of the physical and biological environment at various scales and describes dynamic processes in time and space. An understanding of ecosystem structure and processes allows for informed planning, policymaking, and resource management, and for predicting the consequences of proposed actions—ecosystem management. In Golley's (1994:39) view, ecosystem management provides an effective method for integrating "information on the capacity of natural and managed systems to provide services, resist and recover from disturbance, and sustain function over space and time scales appropriate to social and political needs."

While the conceptual basis of landscape ecology was being developed, tools were also evolving that would take landscape ecology beyond the conceptual stage. Tools include remote sensing (Quattrocki and Pelletier 1991; Lachowski et al. 1994), geographic information systems (GIS) (Johnson 1990; Coulson et al. 1991; Baker and Cai 1992; Loh and Rykiel 1992; Kienast 1993; Scott et al. 1993; Ball 1994; Lachowski et al. 1994), ecological landscape modeling (King 1991; Rossi et al. 1992; Cantwell and Forman 1993; Turner et al. 1993; Ball 1994; Sample 1994), and expert systems (Coulson et al. 1991; Loh and Rykiel 1992). These new tools have facilitated the acceptance of "holistic landscape ecology" by planners, managers, and policymakers (Naveh and Lieberman 1994).

3.1.5 Adaptive Management

An ecosystem perspective on sustainable resources management has the capability to produce a new model for developing the scientific basis of conservation: "interdisciplinary teams of researchers working hand-in-hand with managers, educators, and citizens to address both short- and long-term dynamics in the many dimensions of relationships between people and the land"

(Salwasser and Pfister 1994:159). The working principles for such a model, known collectively as adaptive management, have been evolving for nearly 20 years (Holling 1978, Walters 1986).

Adaptive management, as defined by Carl Walters (1986:8), is an approach that "begins with the central tenet that management involves a continual learning process that cannot conveniently be separated into functions like 'research' and 'ongoing regulatory activities,' and probably never converges to a state of blissful equilibrium involving full knowledge and optimum productivity." It is implicit that every managed resource system is unique, "with at least some quantitative characteristics that cannot be inferred from experience with other (replicate) cases" (Walters 1986:7).

C.S. Holling (1978:20) offered the following recommendations for adaptive management for making environmental assessments:

- Environmental dimensions should be introduced at the very beginning of the development, or policy design process, and should be integrated as equal partners with economic and social considerations, so that the design can benefit from, and even enhance, natural forces.

- During the design phase, there should be periods of intense focused innovation involving significant outside constituencies, followed by periods of stable consolidation.

- Information should be increased on unknown or partially known social, economic, and environmental effects.

- Some of the experiments designed to produce information should be designed into the actual management activities.

- Monitoring and remedial mechanisms should be an integral part of the design.

- There should be a careful analysis of the economic trade-offs between structures and policies that presume that the unexpected can be designed out, and less capital-expense mechanisms that monitor and ameliorate the unexpected.

3.1.6 Environmental Planning

In recent decades, in response to increased demands placed on and degradation of natural resources, environmental planning has emerged to protect and enhance the environment. As early as 1974, Twiss argued that environmental issues must be related to planning efforts. Briassoulis (1989) discussed the varied theoretical orientations and practices of environmental planning. Environmental problems, as metaproblems, explain why "pure" approaches to environmental planning are not suitable; elements of pure approaches combined provide a planning approach that responds to the complexity of environmental problems (Briassoulis 1989). Armitage (1995) determined that sustainable environmental planning and management would require the effective integration of ecological, socioeconomic, and institutional elements.

Several ecosystem-based frameworks have been devised within the broader category of environmental planning and management. They include:

- Ecosystem approach to planning (Slocombe 1993; Cortner and Moote 1994)—an ecosystem approach (1) seeks to produce understanding of the structure, function, and interactions of a system and its environment; (2) is explicitly holistic, transdisciplinary; (3) defines ecosystems naturally, and includes people within them; and (4) integrates study, analysis, and planning.

- Holistic resource management model (Savory 1988)—holistic management applies to situations that are by definition unique; it undertakes to manage innumerable variables simultaneously without artificially limiting any of them, but it can only do so successfully on the basis of knowledge about those variables.

- Integrated environmental management (Mitchell 1986; Cairns 1991; Cairns et al. 1994; Lemons and Malone 1994; Born and Sonzogni 1995)—Integrated environmental management is a comprehensive philosophy and methodology to reduce uncertainties inherent in traditional environmental impact statements (EISs) and environmental assessments (EAs); integrated environmental management has been proposed as a set of coordinated proactive or preventative measures that maintain the environment in good condition for a variety of long-term or sustainable uses; the concept embodies systematic, integrated, and interdisciplinary studies.

- Integrative methodological framework (Armitage 1995)—the model provides the basis for an analysis of the ecological information related to the environmental management unit, thus identifying the appropriate resource management actions and practices and ensuring the centrality of ecological elements.

According to Slocombe (1993), ecosystem approaches to planning, such as ecosystem management, may provide a more transdisciplinary route to the successful integration of the environment, planning, and development. Cortner and Moote (1994:169) postulated that any new environmental planning paradigm "will reflect the evolving concepts of ecosystem management and collaborative decisionmaking." Cortner and Moote (1994) have proposed new national-level legislation for the incorporation of ecosystem-level management, where NEPA and the Endangered Species Act, could serve as templates for such an "integrated ecosystem management act."

Ecosystem management represents a fundamental change away from fragmented, incremental planning and management approaches to holistic, comprehensive, and interdisciplinary land and resource management. As discussed here, the change to ecosystem management has been based largely on evolutionary processes within ethics, the sciences, policy and decisionmaking processes, and technology. Lubchenco (1994:33) has asserted that the concept of ecosystem management has also been driven by "the evolving understanding of the substantial, detrimental impact of humans on the very ecological systems upon which they depend, by political and legal conflicts which have arisen from past management failures, and by the desires of people throughout the world to improve their condition without destroying the options for their children."

3.2 Description of Ecosystem Management

From the preceding discussion, it is evident that the linkages among the concepts of stewardship of the land, ecology, conservation biology, landscape ecology, adaptive management, and environmental planning are strong. It is equally evident that all have contributed to the development of ecosystem management. Nevertheless, ecosystem management has not been uniformly defined or consistently applied by federal or state management agencies. Consensus is developing within the scientific literature with regard to operational definitions and for establishing a conceptual or theoretical base for ecosystem management.

In 1994, Edward Grumbine published a seminal article in *Conservation Biology*, entitled, "What is Ecosystem Management?" The article traced the historic development of ecosystem management and summarized the dominant themes developed from an extensive literature review (Grumbine 1994). For this research, I also made an extensive review of the literature. As evident below, much has been published on ecosystem management since Grumbine's article appeared in March 1994.

3.2.1 Ecosystem Management Themes

From my review of the relevant literature, four broad ecosystem management categories or themes emerged: (1) ecosystem integrity; (2) time and spatial scales; (3) environmental planning and management; and (4) human health and welfare. The following sections are presented accordingly.

3.2.1.1 Ecosystem Integrity

Biological Diversity—Ecosystem integrity has been defined by the Greater Yellowstone Coordinating Committee (1990), Grumbine (1994), Kaufmann et al. (1994), Maser (1994), Salwasser et al. (1995), U.S. House of Representatives, Committee on Natural Resources (1994), and Wood (1994) as protecting total native diversity (species, populations, ecosystems) and the ecological patterns and processes that maintain that diversity. The maintenance of biological diversity[1] is an integral component of ecosystem management as "biological diversity is central to the productivity and sustainability of the earth's ecosystems" (Christensen et al. 1996:671). Grumbine (1988, 1994) and Salwasser et al.'s (1995) definition of ecosystem integrity stressed the importance of maintaining evolutionary processes and viable populations of native species in situ. While, Goldstein (1992), Kaufmann et al. (1994), and the U.S. House of Representatives, Committee on Natural Resources (1994) emphasized the importance of maintaining natural or ecosystem processes with respect to protecting ecosystem integrity.

Ecosystem Patterns/Ecological Processes—Using an ecosystem management approach for maintaining ecosystem integrity requires scientists, planners, and managers to work with nature (Salwasser et al. 1995), or to manage based on the mechanisms of ecosystems or ecological principles (Gordon 1994; Grumbine 1994; Maser 1994; Morrison 1994). Ecological patterns and diversity should be studied in terms of the processes and constraints generating them (Bourgeron and Jensen (1994). Maser (1994) and Christensen et al. (1996) go further in suggesting that scientists, planners, and managers need to develop an understanding of the effects that disturbance, succession, evolution, and natural selection have on the mechanisms of change within ecosystems. Therefore, it is apparent that all known components of the system are to be considered when decisions and management actions are made (Gordon 1994; Maser 1994; Salwasser 1994). According to Salwasser et al. (1993), it is the different biological and physical capabilities of ecosystems that should dictate what is possible with regard to management options.

Sustainability—To maintain ecosystem integrity, it is also crucial that ecosystems and ecosystem processes be sustained for the long term (Goldstein 1992; Bourgeron and Jensen 1994; Gordon 1994; Grumbine 1994; Kaufmann et al. 1994; Salwasser 1994; Wood 1994). According to Christensen et al. (1996:668), sustainability is the central goal or value of ecosystem management. The authors were not only concerned about long-term sustainability, but also intergenerational sustainability as a precondition for management rather than an afterthought (Christensen et al. 1996). Salwasser et al. (1993), Kaufmann et al. (1994), Sample (1994), and Wood (1994) have argued that the net cumulative effect of human influences on the environment is negative and that ascribing to an ecosystem management perspective would no longer allow

[1] Biological diversity is the variety of life and its processes, including the variety of living organisms and the genetic differences among them, as well as all the variety of habitats, communities, ecosystems, and landscapes in which they occur (Christensen et al. 1996:671).

human influences to degrade ecosystem processes. Not only is ecosystem diversity, health and productivity to be maintained, it is to be restored in previously degraded areas (Quigley and McDonald 1993; Golley 1994; Kaufmann et al. 1994; Salwasser 1994; USDOI, BLM 1994).

3.2.1.2 Time and Spatial Scales

Hierarchical Context—Ecosystem management operates within a hierarchical context that recognizes a wide range of spatial and temporal scales. The behavior of ecosystem processes "at any given location is very much affected by the status and behavior of the systems or landscapes that surround them" (Christensen et al. 1996:669). The primary consequence of this hierarchical context is that any management decisions will affect several scales of ecological organization (higher and lower levels) (Bourgeron and Jensen 1994). Therefore, in ecosystem management, ecosystem patterns and processes need to be studied at varied geographic and time scales or within "ecological time frames" (Salwasser et al. 1993; Bourgeron and Jensen 1994; Maser 1994; Salwasser and Pfister 1994; U.S. House of Representatives, Committee on Natural Resources 1994; Reichman and Pulliam 1996).

A hierarchical context is used to ensure the persistence or sustainability of ecological patterns at all relevant scales (Salwasser et al. 1993; Bourgeron and Jensen 1994; Grumbine 1994). Ways to maintain ecosystem patterns and processes at all appropriate scales include: (1) defining the historic range of natural variability across a range of spatial-temporal scales (Bourgeron and Jensen 1994); (2) defining ecological boundaries at appropriate scales that are compatible with natural processes, i.e., across whole landscapes, watersheds, or regions (Quigley and McDonald 1993); and (3) completing ecosystem-level characterizations through appropriate mapping and analyses (Joyce and Knight 1992; Bourgeron and Jensen 1994; Gordon 1994; Grumbine 1994; Maser 1994; Sample 1994; U.S. House of Representatives, Committee on Natural Resources 1994).

Planning Within Ecological Boundaries—It is important to recognize that management activities are occurring within an ever changing landscape (Joyce and Knight 1992; Bourgeron and Jensen 1994; Maser 1994). Therefore, it becomes important to manage or plan over periods of time long enough to maintain the evolutionary potential of species and ecosystems (Grumbine 1994). Kaufmann et al. (1994) recognized, within the context of ecosystem management, that the potential exists for all biotic and abiotic elements to be present with sufficient redundancy across the landscape. To optimize this potential, scientists, planners, and managers need to identify and analyze the full impact, both cumulatively and geographically, of management proposals on existing resources and ecosystem patterns and processes (Keiter 1990; Joyce and Knight 1992; Bourgeron and Jensen 1994; Sample 1994). Within this context, Grumbine (1994) concluded that ecosystem boundaries should have priority over political boundaries. Therefore, Maser (1994:307) has noted that management activities must also be able to incorporate change in societal processes, "in our understanding of natural and social phenomena, and in the capacity of a system to produce that which society desires."

3.2.1.3 Environmental Planning and Management

Interdisciplinary Planning—An ecosystem perspective expands the focus of land management and resource conservation to whole landscapes rather than selected portions or processes (Salwasser and Pfister 1994). Therefore, ecosystem management necessitates the incorporation of a broad, cooperative, and integrated approach to policy formulation, planning, and management (Gilbert 1988; USDOI, BLM 1994). Policymaking, planning, and management by interdisciplinary or transdisciplinary teams of researchers, managers, educators, and citizens (Salwasser and Pfister 1994) is such an integrated approach. Roe (1996) argued that interdisciplinarity does not mean that all disciplines within an interdisciplinary team are equal and that the make-up of the team and the relative roles of each member are dependent on the nature of the ecosystem(s) to be managed. For federal, state and local organizations to incorporate ecosystem management into their planning, management, and policymaking, changes in the structural makeup of the organizations or changes in operating procedures may be necessary (Grumbine 1988, 1994; Quigley McDonald 1993; Cortner and Moote 1994; Morrissey 1996; Thomas 1996).

There is consensus in the literature that cooperation secured in accord with ecosystem patterns and processes among the various disciplines within local, state and federal agencies, organizations, private for-profit firms, and the public is essential if ecosystem management is to succeed (Greater Yellowstone Coordinating Committee 1990; Grumbine 1988, 1994; Keiter 1990; Quigley and McDonald 1993; Maser 1994; USDOI, BLM 1994; U.S. House of Representatives, Committee on Natural Resources 1994; Wood 1994). This can be accomplished through cooperative institutional arrangements and effective partnerships among private, local, state, tribal, and federal interests (Maser 1994; Sample 1994; U.S. House of Representatives, Committee on Natural Resources 1994); the coordination of goals, plans, and analyses among agencies and organizations (USDOI, BLM 1994; Wood 1994); and the formulation of joint strategies for the conservation of shared resources among private organizations and local, state and federal agencies (Greater Yellowstone Coordinating Committee 1990; Salwasser et al. 1995).

Public Involvement—Public involvement is an integral component of ecosystem management. Christensen et al. (1996:670) contended that ecosystem management must acknowledge the role of humans, "not only as the cause of the most significant challenges to sustainability, but as integral ecosystem components who must be engaged to achieve sustainable management goals." According to Grumbine (1988), USDOI, BLM (1994), Salwasser et al. (1995), and Shindler et al. (1996), the public should be directly involved in the planning and decisionmaking process as "an informed citizenry is essential to publicly made resource decisions" (Shindler et al. 1996:7). At a minimum public involvement occurs through communications, but ideally public involvement includes effective partnerships with the public and all stakeholders, and facilitates collective decisionmaking or consensus building in reaching management decisions (Quigley and McDonald 1993; Maser 1994; U.S. House of Representatives, Committee on Natural Resources 1994; McLain and Lee 1996). Brown and Peterson (1993) proposed "citizen juries," where impartial members would become fully informed of the issues and attempt to reach consensus. Christensen et al. (1996:760) concluded that, "identifying and engaging stakeholders in the development of management plans is a key ecosystem management strategy."

Scientific Basis for Planning—The effects of planning and management decisions on ecosystems cannot be predicted unless the structure of the ecosystem is understood (Levine 1991; Christensen et al. 1996). Ecosystem management therefore necessitates the development of a strong scientific basis for management decisions (Quigley and McDonald 1993; Golley 1994; Grumbine 1994; Lucier 1994; Maser 1994; Morrison 1994; Salwasser and Pfister 1994; U.S. House of Representative, Committee on Natural Resources 1994; Wood 1994; Burroughs and Clark 1995; Christensen et al. 1996; Reichman and Pulliam et al. 1996). Stanford and Poole (1996) proposed beginning the decisionmaking process by reviewing and synthesizing existing information so as to form a consolidated base of empirical information at the beginning of the planning process. One way to accomplish this is to promote stronger teamwork among scientists and managers (Golley 1994; Grumbine 1994; Wood 1994). Effective teamwork provides the applicable information and technology needed for informing management decisions (Golley 1994). Grossarth and Nygren (1994) emphasized the importance of using established scientific methods to estimate the effects of management practices on ecosystems. Another proposed way to ensure that the best available scientific information is used as the cornerstone for resource allocations and other land management decisions (USDOI, BLM 1994) is to place emphasis on goals that are clear, concise, informed and integrated with ecosystem patterns and processes (Bourgeron and Jensen 1994; Grossarth and Nygren 1994; Maser 1994). According to Christensen et al. (1996), ecosystem management should be rooted in the best current models of ecosystem function. However, there is consensus that the most appropriate way to integrate scientific research and management is to incorporate scientific information at the policy level (Goldstein 1992; Grumbine 1994; Maser 1994; Yaffee 1994; Christensen et al. 1996).

Adaptive Management—Adaptability and accountability are key elements of ecosystem management (Grumbine 1994; Christensen et al. 1996; Holling 1996). Ecosystem management must be an experimental and adaptive process because of the uncertainties of science and limited databases and because ecosystems are dynamic, and therefore, have the potential for multiple futures (Everett et al. 1994; Grumbine 1994; Maser 1994; Yaffee 1994; Holling 1996; McLain and Lee 1996; Ringold et al. 1996). There are also uncertainties concerning social values and needs and the processes that shape them (Everett et al. 1994; Holling 1996).

Ecosystem management should be driven by explicit goals in terms of specific desired future outcomes and desired future behaviors for the ecosystem components and processes necessary for sustainability (Grumbine 1994; Christensen et al. 1996). These specific desired outcomes and desired future behaviors need to be stated in terms that can be measured, monitored, and evaluated (Joyce and Knight 1992; Quigley and McDonald 1993; Everett et al. 1994; Grumbine 1994; Maser 1994; Salwasser and Pfister 1994; U.S. House of Representatives, Committee on Natural Resources 1994; Yaffee 1994; Holling 1996). Adaptive management ascribes to the development of site-specific monitoring and evaluation schemes (Quigley and McDonald 1993; Grossarth and Nygren 1994; Morrison 1994) vs. standardized monitoring and evaluation programs. Monitoring of multiple attributes at all appropriate ecological scales provides a basis for assessing ecosystem changes over time (Joyce and Knight 1992; Bourgeron and Jensen 1994; Grossarth and Nygren 1994; Grumbine 1994; Maser 1994). Thus adaptive management becomes the mechanism for integrating research and monitoring (Quigley and McDonald 1993). Ringold et al. (1996) has suggested that it is appropriate to consider the monitoring plan itself as an incremental adaptive plan. The authors proposed that this "concept be embodied in the term 'adaptive monitoring design'" (Ringold et al. 1996:745).

Education/Information Exchange—Most of the ecosystem management literature specified the need to develop educational programs and to provide better mechanisms for informational exchange. According to Stanford and Poole (1996), an informed public is a requisite for sustaining regional ecosystem processes. "The limited public understanding of how science is done, much less the nuances of specific scientific issues, present special challenges within ecosystem management" (Christensen et al. 1996:682). Educational programs should be developed by federal agencies not only for within agency use, but also for state and local governments, organizations and the general public (Greater Yellowstone Coordinating Committee 1990; Goldstein 1992; Wood 1994; Christensen et al. 1996). Educational programs may be in the form of conservation education and interpretation programs (Salwasser et al. 1995), programs that promote awareness and understanding of ecosystem processes (Jensen and Everett 1994), or published and distributed materials on the nature of ecosystems (Greater Yellowstone Coordinating Committee 1990; Joyce and Knight 1992; Gordon 1994; Grossarth and Nygren 1994; Maser 1994; Wood 1994).

For ecosystem management to be effective, it is necessary to improve applied knowledge of specific processes and interactions responsible for system activities and outcomes continually (Maser 1994) and to augment regularly existing databases (Grumbine 1994). It may be necessary to develop new methods to facilitate technology transfer, training, and education (Goldstein 1992; Quigley and McDonald 1993; Maser 1994). Methods include the integration of data and tools that cut across traditional functional disciplines (Goldstein 1992; Quigley and McDonald 1993) and the development of information management schemes (Quigley and McDonald 1993).

3.2.1.4 Human Health and Welfare

Role of Humans—Every ecosystem connects to and interacts with human values, uses, institutions, and other social structures (Kaufmann et al. 1994; Salwasser et al. 1994). Therefore, to be effective, ecosystem management must operate with people in mind and accommodate human use and occupancy (Grumbine 1994; Kaufmann et al. 1994; Salwasser 1994; Salwasser and Pfister 1994). The desires and requirements of people who will be affected by management decisions must be determined and incorporated into the planning and decisionmaking process (Jensen and Everett 1994; Maser 1994). Holling (1996) posited that incentives may be necessary for economic and private interests to maintain ecosystem resilience.

An ecosystem management perspective necessitates determining future management aims based on the appropriate integration of historic, ecological, economic and social considerations (Quigley and McDonald 1993; Grossarth and Nygren 1994; Jensen and Everett 1994; Maser 1994; USDOI, BLM 1994). This is accomplished through developing an understanding that ecosystems and society are inexorably linked and that the relationship among them is always changing (Maser 1994; Salwasser and Pfister 1994), and recognizing the importance of social and economic viability within functioning ecosystems (Jensen and Everett 1994; Maser 1994; Sample 1994; U.S. House of Representatives, Committee on Natural Resources 1994). In this light, ecosystem managers should also (1) develop an understanding of social and cultural attitudes (Maser 1994), (2) recognize that goals are set and evolve via social, cultural, economic and political processes (Maser 1994; Shepard 1994; Haeuber and Franklin 1996), (3) account for aesthetic concerns and amenities (Keiter 1990; Grumbine 1994), and (4) incorporate a strong environmental ethic (Goldstein 1992).

> Human health and welfare are embraced by ecosystem management, since protecting natural processes can ensure a lasting supply of material things that people value, and people are a long-standing and integral part of the ecological landscape. The key is to respect ecological limits, and adapt consumptive activities to harmonize with natural processes. [Goldstein 1992:296]

3.2.2 Ecosystem Management Defined

Over the last 10 to 15 years, many definitions and descriptions of ecosystem management have appeared in the literature. Table 3.1 presents a synopsis of ecosystem management definitions from the more recent literature. There is much consistency within these definitions. First, all definitions specify, either explicitly or inferentially, and in varying degrees, the integration of ecological, economic, and social factors. Everett et al. (1994:8) presented ecosystem management as "the optimum integration of societal values and expectations, ecological potentials, and economic plus technological considerations." Salwasser and Pfister (1994:154)

Table 3.1. Definitions of Ecosystem Management.

Ecosystem management focuses on inputs, interactions, and processes, as well as on uses or outputs. Ecosystem management is a tool to achieve sustainability. *—Gordon 1993:241-242*

Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term. *— Grumbine 1994:31*

Ecosystem management is the optimum integration of societal values and expectations, ecological potentials, and economic plus technological considerations. The philosophy of ecosystem management is to sustain the patterns and processes of ecosystems for the benefit of future generations, while providing goods and services for each generation. *—Everett et al. 1994:7-8*

Ecosystem management implies a process . . . . humans cannot avoid decisions about natural resources, and . . . those decisions should be supported with knowledge of the physical, biological, and social relationships that define ecosystems. *¾ Lucier 1994:21*

Ecosystem management is a system of making, implementing, and evaluating decisions based on the ecosystem approach, which recognizes that ecosystems and society are inexorably linked and always changing. *— Maser 1994:307*

Ecosystem management emphasizes the integration of ecological, social, and economic factors at different temporal and spatial scales to maintain a diversity of life forms, ecological processes, and human cultures. *— Salwasser and Pfister 1994:151*

Ecosystem management represents shifts in the way we do business, indeed in the way we view and interpret society. . . . Ecosystem management is not a static program with a beginning and ending date, but rather involves concepts and principles that evolve and adapt along with changes in science, economics, and demographics. *— Staebler 1994:5*

Ecosystem management is generally viewed as management that promotes ecological, economic, and social sustainability. *— U.S. House of Representatives, Committee on Natural Resources 1994:xi*

Ecosystem management is the integration of ecological, economic, and social principles to manage biological and physical systems in the manner that safeguards the ecological sustainability, natural diversity, and productivity of the landscape. *— Wood 1994:9*

Ecosystem management is a concept of natural resources management wherein National Forest activities are considered within the context of economic, ecological, and social interactions within a defined area or region over both the short- and long-term. *— USFS 1995:18920*

Ecosystem management is management driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure and function. *—Christensen et al. (Ecological Society of America Committee on the Scientific Basis for Ecosystem Management) 1996:665* likewise espoused an integrative approach: "The goals for ecosystem management come from the ecological capabilities of the land together with legal mandates and public needs and aspirations."

Second, the primary goals of ecosystem management, although expressed in varying terminology, are likewise similar in intent—protecting native ecosystem integrity (Grumbine 1994); protecting natural resources (Lucier 1994; USFS 1995); maintaining diversity of life forms, ecological processes, and human cultures (Salwasser and Pfister 1994); promoting ecological, economic and social sustainability (U.S. House of Representatives, Committee on Natural Resources 1994); safeguarding ecological sustainability, natural diversity and productivity of the land (Wood 1994); and sustaining ecosystem composition, structure and function (Everett et al. 1994; Christensen et al. 1996).

A third characteristic in common with all the definitions is that ecosystem management is considered a planning and management *process (*Salwasser and Pfister 1994), or *system* (Maser 1994), or *tool* (Gordon 1993). It is not a goal to be attained (Salwasser and Pfister 1994), nor is it a static program (Staebler 1994). Ecosystem management is a *means* to a goal or set of goals (Salwasser and Pfister 1994) and it is at the same time *driven* by these explicit goal(s) (Christensen et al. 1996). There is also general agreement in the literature that it is each agency's (local, state and federal) responsibility, individually and cooperatively, to translate and integrate the goals and concepts of ecosystem management into agency goals, policy, protocols, and decisionmaking processes (Grumbine 1994; Christensen et al. 1996).

Fourth, most definitions acknowledged the changing or evolving nature of ecosystems over time and space (Salwasser and Pfister 1994), the linkage between humans and nature is also continually changing (Maser 1994; Staebler 1994), and uncertainties inherent to science (Grumbine 1994; Holling 1996). Consequently, "adaptability," or adaptive management, is intrinsic to the concept of ecosystem management. Accordingly, Holling (1996:735) proposed that ecosystem management based policies be "designed as hypotheses and management implemented as experiments to test those hypotheses."

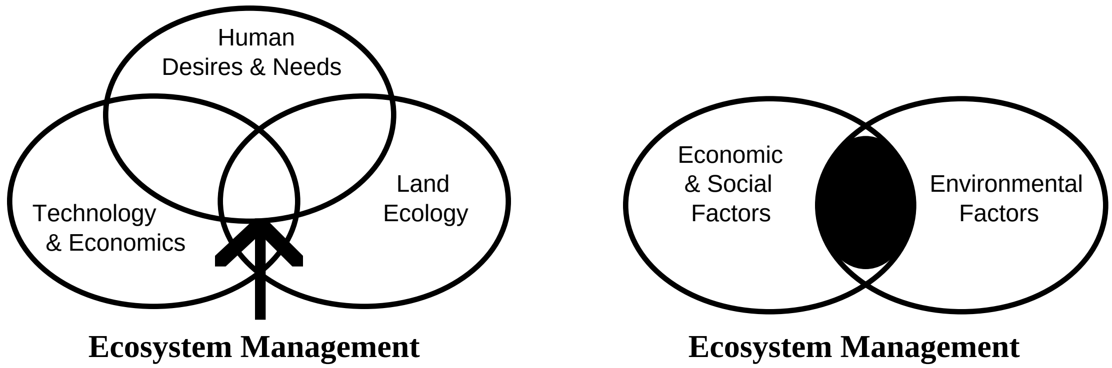
There is one major difference among the definitions—the role of humans. Salwasser (1994:10) argued that "ecosystem management is more about people than anything else. . . . to succeed in a world full of people, ecosystem management must meet human needs for livelihood while tempering human pressures on the land; living lighter on the land is the key." Everett et al. (1994) echoed this position—for ecosystem management to work, constant interaction with people is required as it is human values and public expectations that shape the goals of ecosystem management. Therefore, the greatest challenge for ecosystem managers, according to these authors, is to ensure that human values are compatible with the ecological potential of the landscape.

Grumbine (1994), on the other hand, found in his extensive literature survey that there was general agreement among scientists that the maintenance of ecosystem integrity should take precedence over any other management goal, including human needs and expectations. It was evident, however, that there was not uniform agreement on what constitutes "ecosystem integrity." The sentiment toward maintenance of ecosystem integrity, however defined, according to Grumbine (1994:32), "may be due partially to the fact that, given the rate and scale of environmental deterioration along with our profound scientific ignorance of ecological patterns and processes, we are in no position to make judgments about what ecosystem elements to favor in our management efforts." Elevating ecosystem integrity above other management goals can also be viewed as a "proactive process" rather than a "reactive response" as maintained by Grumbine. I use the term "proactive process" in the sense that an evolving transformation, or paradigm shift, as discussed in Section 3.1 of this chapter, has occurred within the sciences, environmental policy and planning, and technological fields over the past 25 years toward an ecological or ecosystems perspective.

After a thorough synthesis and assessment of the literature and the development of my own position on ecosystem management, I offer the following definition:

> **Ecosystem management is an integrative, interdisciplinary, and adaptive approach to policymaking, planning, and management, at all levels, that is grounded on the best available scientific information, recognizes the uncertainties of science and the dynamic nature of ecosystems, and acknowledges that humans and ecosystems are inexorably linked. The primary goal of ecosystem management is to sustain and/or restore ecosystem integrity, which includes biological diversity and the ecological patterns and processes that support that diversity at all spatial and temporal scales.**

While several of the ecosystem management definitions (Everett et al. 1994; Salwasser and Pfister 1994; USFS 1995) integrated ecological, economic, and social factors as though they were equal (see Figure 3.1A), Grumbine (1994) and others contended that ecosystem integrity, or the ecological factors of the triad, take precedence over economic and social factors. I propose that economic and social factors be combined and then equated (as a unit) to ecological factors as depicted in Figure 3.1B. In other words, a symbiotic-type relationship between economic/social factors and environmental factors should be advanced vs. the traditional view that economic and social considerations are incongruous with environmental constraints. Without productive and sustainable ecosystems, we cannot meet societal needs or economic expectations in any form over the long term.



A. Economic, Ecological and Social Triad
[From Everett et al. 1994]

B. Symbiotic Relationship

Figure 3.1. Frameworks for Ecosystem Management.

To confront this challenge, it is essential that ecosystem management include a strong educational component. Grumbine (1994), Salwasser (1994), Yaffee (1996), and others concurred that it would probably require a restructuring of how we make decisions at all levels of government before ecosystem management can optimally function. According to Salwasser and Pfister (1994) and Everett et al. (1994), the greatest challenge for ecosystem management is to ensure that human values and expectations are compatible with ecosystem processes and operate within ecological constraints. This compatability can only transpire through education.

To support my definition of ecosystem management, I developed a set of 10 clear goals, based in large part on my review of the literature, for achieving the overall goal of ecosystem management—to sustain and/or restore ecosystem integrity.

1. Maintain ecosystem integrity—protect total native diversity and ecological patterns and processes.

2. Manage based on natural processes—manage with regard to ecosystem constraints and ecological principles.

3. Sustain ecosystems for the long-term—maintain and/or restore ecosystem diversity, health, and productivity.

4. Manage within the context of an ecological hierarchical organization—study ecosystem patterns and processes at varied geographic and time scales or within ecological time frames; give priority to ecosystem boundaries over political boundaries.

5. Develop and adopt an interdisciplinary approach—manage using interdisciplinary teams of researchers, managers, educators, and citizens.

6. Facilitate public involvement—directly involve the public in the decisionmaking process; encourage collective decisionmaking or consensus building.

7. Integrate scientific research, policy, and management—develop a strong scientific basis for management decisions; promote stronger teamwork among scientists, managers, and policymakers.

8. Incorporate adaptive management procedures—develop site-specific monitoring and evaluation schemes to assess ecosystem changes over time.

9. Develop educational programs and provide for informational exchange—promote awareness and understanding of ecosystem processes and constraints; facilitate the transfer of information within and across disciplines and agencies.

10. Accommodate human use and occupancy—operate with people in mind; determine and incorporate human desires and requirements in the planning and decisionmaking process.

3.2.3 Strategies for Improved Ecosystem Management Implementation

The following section summarizes the results of three research efforts that have assessed ecosystem management implementation efforts through surveys and interviews with project participants and case study evaluations.

Vice President Gore's 1993 National Performance Review called for federal agencies to adopt "a proactive approach to ensuring a sustainable economy and a sustainable environment through ecosystem management" (Interagency Ecosystem Management Task Force 1995). Consequently, the Interagency Ecosystem Management Task Force was established to carry out this mandate. The Task Force formed a working group to conduct case studies, to learn about ecosystem efforts to date, to identify barriers to implementation, and to identify ways the federal government could assist in overcoming those barriers (Interagency Ecosystem Management Task

Force 1995). Table 3.2 presents the Task Force's 31 recommendations for promoting ecosystem management.

Kennedy and Quigley (1994) interviewed the staffs and studied the Oregon and Washington National Forests' organization and operation methods. Based on the Forest Service's 1994 adoption of an ecosystem management approach, the authors proposed that the following should be implemented by the agency as first steps to develop a sustained ecosystem model:

1. Employee Classification and Training: Develop interdisciplinary classifications and training that transcend traditional range, recreation, or hydrology functional boundaries; a general series of courses should be taken covering socioeconomics, planning and management, and ecosystems in a broad, integrated ecosystem management manner; develop ecosystem management certification.

2. Planning Systems: Shift RPA and forest planning from out-put driven to a desired sustainable ecosystem model; design National Forest planning units on landscape ecosystem criteria and reference such units to political and administrative parameters and trends; develop desired future conditions for landscape-scale ecosystems as the initial, pivotal planning activity; estimate National Forest output capability from a bottom-up approach.

   Budgeting: Reconsider the FORPLAN model, out-put targeted budget system for modeling and budgeting that enhances ecosystem management values and goals; shift from line-item budget to end-state system of achieving and maintaining desired conditions of ecosystems, user systems, or output systems; increase sensitivity of budgets and acceptability to a 10-year timeframe and ecosystem adaptation and change; allow 10 percent of budget to be used for innovative, experimental options without traditional sanctions for failure or inefficiency.

3. Reward System: Shift from output-oriented reward system to one that creates and enhances diverse, adaptable, and sustainable ecosystems, organizational cultures, and output and user services; the system should accommodate risk-taking, entrepreneurship, and team processes.

Table 3.2. Interagency Ecosystem Management Task Force Recommendations for an Ecosystem Management Approach.

1. Regional interagency collaboration: regular and systematic exchanges of information about plans, priorities, and problems to eliminate inefficiencies and duplication of effort; strengthens executive-level support for interagency activities of field personnel.

2. Joint planning and decisionmaking structures: develop joint decisionmaking structures among governmental agencies, private organizations, and the public.

3. Management commitment: put ecosystem approach on a par with other approaches to implementing agency programs.

4. Decentralization of management: focus on providing guidance and resources needed to sustain on-the-ground efforts.

5. Administrative boundaries: determine opportunities for adjustments, land exchanges, and reciprocal management agreements that eliminate inefficiencies and inconsistencies; develop coordination mechanisms to ensure that an ecosystem approach can be effectively applied across administrative boundaries.

6. Shared vision: develop a shared vision among federal agencies and state, tribal, and local governments, and private stakeholders.

7. Federal Advisory Committee Act (FACA) procedures: attempt to create flexible Act procedures.

8. Advisory committees under FACA: make extensive use of advisory committees.

9. Private landowners: federal agencies should offer technical assistance to private landowners involved in ecosystem management efforts.

10. Support for existing grass-roots efforts.

11. Public access to information: increase access to biological, social, and economic information and data associated with ecosystems; develop a communication plan.

12. Training in community relations: train agency staff in public involvement techniques.

13. Interagency teams: develop an integrated and comprehensive communications strategy for the ecosystem; this action would decrease duplication and increase the mix of skills available.

14. Regional planning under NEPA: develop regional ecosystem plans to coordinate their review activities under NEPA; these plans would provide a framework for evaluating the environmental status quo and the combined cumulative impacts of individual projects; would also allow for identification of appropriate opportunities to maintain sustainable ecosystems in a cost-effective and coordinated manner.

Table 3.2. Interagency Ecosystem Management Task Force Recommendations for an Ecosystem Management Approach (continued).

15. Public involvement programs: assess the successes and shortcomings of public involvement efforts; develop mechanisms to strengthen existing programs; the public should be involved in this process.

16. Coordinated ecosystem budgets: coordinate ecosystem budgets to parallel their cooperative program activities.

17. Budget structure: work with the Office of Management and Budget and Congress to revise budget structures and organizations where needed.

18. Budget planning procedures: identify mechanisms to increase participation by field-level managers in the budget process; ensure that budgets reflect long-term ecosystem needs; and ensure that budget procedures reflect ecosystem approach as a new way of meeting existing responsibilities, rather than as a new set of program responsibilities.

19. Exchange of human and financial resources: use short-term personnel exchanges to increase flexibility for dealing with new problems, obtaining needed skills as ecosystem requirements change, and as a way of infusing new ideas.

20. Fund-pooling arrangements: in large, complex ecosystem efforts, seek legislative authority for the pooling of resources.

21. Regional science planning bodies: establish or support regional science planning bodies to assess current state of knowledge, identify major gaps, and allocate responsibilities consistent with agency expertise, resources, and mandates.

22. Translating science into everyday language: ensure that research results are produced in a form that can be understood and used by managers and the public.

23. Standards for ecosystem studies: develop protocols for ecological indicators for monitoring, techniques for restoring damaged ecosystems, and models to link management activities.

24. Exempting peer review from FACA: provide specific exemptions for scientific panels used by agencies to obtain advice and recommendations.

25. Monitoring of all ecosystem efforts: provide coordinated monitoring and evaluation programs among all agencies.

26. Federal research budgets: design budgets should be described in terms of major thrusts rather than specific projects at specific research centers.

27. Data ownership: provide training for communication and information sharing, and on the nature, handling, and limitations of combining data from multiple sources.

Table 3.2. Interagency Ecosystem Management Task Force Recommendations for an Ecosystem Management Approach (continued).

28. Collaborative regional data management efforts: share and transfer data through electronic format; develop data-sharing systems; obtain and enter data and information into systems; develop standards and protocols for data collection, management, and transfer.

29. Common monitoring and evaluation standards: develop common monitoring and evaluation standards.

30. Management structures: assess current statutes, regulations, and management structure to determine whether they provide sufficient incentives, authority, and responsibility to undertake adaptive management.

31. Long-term funding for monitoring and research: commit adequate resources to secure the necessary long-term monitoring and research programs necessary for adaptive management.

[Adapted from: Interagency Ecosystem Management Task Force 1995]

In Yaffee et al. (1996) and Yaffee (1996), a team of research assistants studied 77 ecosystem management-based projects in all states by surveying and interviewing project participants. Participants included government agencies, nonprofits, for-profit corporations, and Indian tribes. The team found that these projects were primarily initiated by federal and state agencies and The Nature Conservancy. The projects covered a wide-range of strategies including (in order of prevalence): research, stakeholder involvement, mitigation, land protection, public education, and outreach. From the data collected, Yaffee (1996) assessed what has worked vs. what hasn't work. A summary of his assessment follows (Yaffee 1996:725-726):

- Use collaborative decisionmaking approaches: respondents talked about the need to involve the public effectively more than any other topic; collaborative decisionmaking means developing problem solving approaches that are interagency, multi-party, and interdisciplinary.

- Develop information and information networks: scientific uncertainty was identified as one of the top four obstacles to site-level progress; therefore, gather new information; build better mechanisms for sharing that information; develop more effective networks to facilitate the shared use of knowledge; telecommunications technology, GIS, and improved human interaction.

- Mobilize organizational change and innovation: there are problems with agency cultures and procedures; agency leaders need to find ways to reward creativity, innovation and risk-taking for behaviors that may conflict with agency norms and traditions; need to promote trans-boundary interactions between different disciplines and subunits, and between their agencies and other public and private organizations.

- Educate and be educated: ecosystem management requires increased understanding and modified attitudes of both the general public and key stakeholders; the use of collaborative decisionmaking processes can help by building understanding and a sense of ownership, but more fundamental education is needed; education and outreach are needed to build public understanding, but also to expand the awareness of managers, scientists, and policymakers.

- Empower individuals: having dedicated individuals who make things happen is as important as having formal policies and programs.

3.3 Ecosystem Management in the U.S. Forest Service

3.3.1 Background

Foresters have historically managed ecosystems for certain desired uses and conditions. For example, one traditional goal of management has been to produce and sustain the yields of selected products, such as wood or wood fiber. Management to maximize or optimize a single or selected few products of ecosystems has usually involved simplifying the system, for example, clearcutting followed by planting desired tree species and reducing competing vegetation (Salwasser et al. 1993).

An ecosystem perspective on forest policy choices has been evolving over the last decade. An ecosystem perspective is more holistic than historic forestry practices in that it adds a focus on the “relationships between various forest conditions, natural events and processes, various human uses of forests, and the different and changing values of forests to people at multiple geographic scales over time” (Salwasser et al. 1993:47). An ecosystem perspective includes attention to selected resources and their related economic and social systems (Salwasser et al. 1993).

Staebler (1994) and others consider ecosystem management as a logical step in the progression of the practice of forestry through “sustained yield,” “multiple use,” and “New Perspectives,” while others believe that a management paradigm shift has occurred within the Forest Service (e.g., Kennedy and Quigley 1994). Salwasser (1992a) has asserted that the Forest Service's new policy of ecosystem management was stimulated by the early results of “New Perspectives.” Interdisciplinary research efforts among wildlife biologists, fisheries specialists, ecosystem ecologists, and foresters have also played a pivotal role in the transformation from sustained yield management to sustainable ecosystem management (Swanson and Berg 1991). Additionally, changes in public attitudes have focused attention on natural resource issues and led the forestry profession to reexamine its traditions (Lucier 1994:21). Whether or not a paradigm shift has occurred, many changes in values and management practices have occurred over the last decades. Table 3.3 presents Kennedy and Quigley’s comparison of Forest Service images, values and management paradigms in the 1950s and then again in the 1990s.

3.3.1.1 Sustained Yield and Multiple Use

The Forest Service has a Congressional mandate under the Organic Act of 1897, the Multiple-Use and Sustained-Yield Act of 1960 (MUSYA), and the National Forest Management Act of 1976 (NFMA) to manage lands and resources entrusted to its care. MUSYA defined sustained yield as:

Table 3.3. Forest Service Images, Values, and Management Paradigm Shifts: 1950 vs. 1990.

1950s	1990s
Forest Service Mottoes	
"Land of many uses," timber primary use.	"Caring for the land and serving people."
Focus on "outputs."	Sustainable and healthy ecosystems.
Intensive timber harvesting.	Multiple social values.
Facilitator with technology.	Questioning dominance of technology.
Management Models	
Intensive forest management paradigm.	Search for new management paradigms.
Focus on maximizing outputs and efficiency.	Focus on health, diversity, sustainability.
Forest Service Role Models	
Era of great men and benign professional aristocrats.	Era of interdisciplinary teams, team leader, public partnerships.
Action and achievement oriented.	Specialized expert; power sharing.
Dominant Models/Metaphors	
Simple, compartmentalized machine model.	Complex, inclusive, interrelated models.
Simple, homogenous, well-managed forests.	Respect for diversity, uniqueness of land.
Fascination with machine model plantations.	"New Perspectives" to ecosystem management.
Dominant Forest Service Values	
Action, can-do, development oriented.	Can't do, shouldn't do; think, plan, seek consensus.
Must dominate and control forests.	Codependency and mutuality w/nature.
Loyalty to the agency.	Loyalty split between agency and land.
Space Focus	
Forest lands or research project.	Broad, inclusive landscape; ecosystem scale.
Local/regional focus.	Regional, national, global thinking.
Time Focus	
Annual target accomplishments.	Long-term desired future conditions.
Short-run economic/project efficiency.	Decadal focus needed.
Patron Saints	
Gifford Pinchot.	Aldo Leopold.
St. George the Dragon-Killer.	St. Francis of Assisi.

[Adapted from: Kennedy and Quigley 1994]

> . . . the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land.

Historically, sustained yield has been applied primarily to timber. Gifford Pinchot wanted to show that timberlands could be managed profitably for continuous production—demonstrating that cut-and-run practices of the timber industry were unnecessary (Wolf 1989).

The sustained yield paradigm that dominated much of this century was based on several key assumptions (Mladenoff and Pastor 1993:158):

- Potential forest productivity is constant.

- Utilization predictions can be based on managing the forest in a specific state to bring actual production up to potential.

- The observed state can be maintained indefinitely through management, without negative effects.

The concept of multiple use has encompassed two distinct views for managing outputs and uses: joint production and patchwork of dominant uses (U.S. Congress, Office of Technology Assessment 1992). Joint production recognizes that forests and rangelands are ecosystems that can provide more than one output, e.g., forests or rangelands provide wildlife habitat, yield water, can be used for recreation, and produce timber and forage for livestock. "Under a patchwork of dominant uses, lands are divided into management units, and each unit is managed to produce more (or higher quality) of the dominant use(s) or output(s) while maintaining environmental and resource quality standards" (U.S. Congress, Office of Technology Assessment 1992:43). According to Hardt (1994:351), the multiple use concept has evolved over the years in two significant ways:

- The concept of multiple use has come to encompass a broader range of human needs, including a healthful environment, recreation, spiritual sustenance, and aesthetic quality, as well as traditional commodity needs.

- Federal land management policy has begun to incorporate an ecological perspective; the law now requires a comprehensive, integrated approach to managing federal natural resources and the protection of certain federal land values unrelated to commodity uses.

NFMA established a complex series of procedural and substantive requirements for developing the long-term Land and Resource Management Plans (Forest Plans). The Act enlarged the focus of and more fully delineated the principles of multiple use and sustained yield, and, consequently, offered additional guidance to the agency on forest planning. NFMA serves three basic functions (U.S. Congress, Office of Technology Assessment 1992:63):

1. It directs the agency to prepare long-term integrated forest plans for each national forest;

2. It requires regulations establishing substantive standards and guidelines for timber management and for the protection of water and other renewable resources; and

3. It expressly provides for active public involvement in the planning process.

In 1980, the Forest Service developed regulations to guide the agency in carrying out the requirements of NFMA. The regulations were rescinded in 1981 and revised regulations were adopted in 1983. As early as 1988, Keiter recognized that the revised 1983 regulations promulgated under the NFMA endorsed the concept of ecosystem management (Keiter 1988). Section 36 CFR 219.1(3) reflects a serious commitment to ecological principles; Section 36 CFR 219.27(5) discusses the importance of plant and animal species diversity; and Section 36 CFR 219.19 discusses the preservation of fish and wildlife habitat (Keiter 1988; Jones et al. 1995).

3.3.1.2 New Perspectives

In March 1990, Dale Robertson, then Chief of the U.S. Forest Service, decided that changes were needed in Forest Service procedures for approaching management of the land and its resources. New policies were needed to guide the agency toward new ways of dealing with people and the land. Robertson announced that the Forest Service would be incorporating “New Perspectives” into its planning and management efforts. He described “New Perspectives” as a different way of thinking about managing the national forests and national grasslands, emphasizing ecological principles, to sustain their many values and uses (Robertson 1991). According to Kessler et al. (1992:221), “‘New Perspectives’ embraces a land stewardship philosophy that seeks balance in the protection of natural environments while using them to provide products and services needed by people.”

Brooks and Grant (1992:3-6) listed six reasons that led up to the Forest Service’s implementation of “New Perspectives”:

1. Effect of pattern—the recognition that certain types of problems were not being addressed by segmented, pattern-insensitive approaches to forest management.

2. Ecosystem complexity—increased recognition by forest ecologists of the complex web of interactions in forests and the importance of biological and physical diversity in maintaining healthy forest ecosystems.

3. New technology—recent developments in computer-based technologies suitable for handling multiple-resource problems over large areas and long time scales.

4. Social and political influences—prolonged and acrimonious public debate among forest users.

5. Agency climate—changes within federal land-management agencies.

6. The role of science—the emerging role of scientists is primarily in identifying uncertainties and in pointing out the complexities of systems to managers.

Integration was the fundamental principle of "New Perspectives" that provided the "creative tendons necessary to bridge the gap between research, management, and education" (Jones 1993:10). According to Salwasser (1992a:469), there were five primary goals for "New Perspectives":

1. To learn how to better sustain diverse and productive ecological systems at multiple geographic scales for a richer variety of current and future benefits and uses.

2. To integrate better the different aspects of land and resources management.

3. To improve the effectiveness of public participation in resource decisionmaking.

4. To continue building partnerships between forest managers and forest users.

5. To strengthen teamwork between researcher and resource managers in carrying out adaptive land and resource management.

Approximately six to eight months after the Forest Service Chief launched "New Perspectives," the scope of the project had gone from "a moderate extension of New Forestry to a wide-open look at ecosystem management to sustain the widest array of values and uses possible" (Salwasser 1992b:3).

3.3.2 Ecosystem Management

In the Summer of 1992, Dale Robertson, then Chief of the U.S. Forest Service, announced in a policy letter, the agency's intent to develop ecosystem management as "a strategic approach for sustaining desired conditions of ecosystem diversity, productivity, and resilience for the multiple uses and values of national forests and grasslands" (Salwasser and Pfister 1994:151). The Forest

Service's new policy of ecosystem management was stimulated by the early results of "New Perspectives" (Salwasser 1992a:469).

According to Robertson (USFS 1992), "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 national forests and grasslands represent diverse, healthy, productive, and sustainable ecosystems." Jack Ward Thomas (1996:703), who succeeded Robertson as Chief of the U.S. Forest Service, has suggested that ecosystem management is "a concept of management that is more inclusive of the variables that impinge on management, occurring at larger scales, and over more extended time horizons than has been common in the past." It is a holistic approach to natural resource management (Thomas 1996). Robertson (USFS 1992) proposed four principles of ecosystem management for the Forest Service:

1. Take care of the land by protecting or restoring the integrity of its soils, air, waters, biological diversity, and ecological processes.

2. Take care of people and their cultural diversity by meeting the basic needs of people and communities who depend on the land for food, fuel, shelter, livelihood, and spiritual renewal.

3. Use resources wisely and efficiently to improve the economic prosperity of communities, regions, and nations through cost-effective and environmentally sensitive production of natural resources such as wood fiber, water, minerals, energy, forage for domestic animals, and recreation opportunities.

4. Strive for balance, equity, and harmony between people and land across interests, across regions, and across generations by meeting this generation's resource needs while maintaining options for future generations to also meet their needs.

Ecosystem management is to be the means the Forest Service uses to meet the goals specified in laws, regulations, forest plans, and project decision documents. As forest plans need to be amended or revised, they are to reflect ecosystem management policy (USFS 1992). Ecosystem management, as viewed by the Forest Service, is an evolving concept which will require periodic adaptation and refinement along with changes in science, economics, and demographics (Staebler 1994). According to Mangold (1995:28), "the agency is working to institutionalize the broader concepts involved in sustainable development with a goal of all programs working toward creating sustainable ecosystems and vital communities." Ecosystem management activities are to become the means of achieving the goal of sustainable forest management

(Mangold 1995). In Thomas' (1996:703) view, "the protection and restoration of ecosystems is the means to assure that multiple uses can continue to be provided."

Under ecosystem management, areas of the National Forest System that are designated for production of wood, energy, minerals, water, and recreation, will have stronger environmental protection measures (Salwasser et al. 1993). Even intensively managed lands will feature protection of riparian areas, within-stand species diversity, habitat for early successional wildlife, and outdoor recreation (Salwasser et al. 1993). A provision was adopted to reduce clearcutting on the National Forest System lands by as much as 70 percent, and to make greater use of individual tree selection, group selection, green tree retention, shelterwood, seed tree, and other regeneration cutting methods (USFS 1992: Attachment 2).

To facilitate the incorporation of ecosystem management into Forest Service planning and management procedures, former Forest Service Chief Robertson prepared working guidelines to accompany his policy letter on ecosystem management (USFS 1992: Attachment 1):

1. Focus on desired present and future conditions of the land and its human communities.

2. Integrate thinking and actions at multiple spatial and temporal scales.

3. Be especially careful in sensitive areas.

4. Employ the ecological capabilities and processes of the land.

5. Get people involved in planning and carrying out project work. Develop conservation partnerships.

6. Involve scientists through adaptive management. Monitor, research, interpret, and adapt.

7. Integrate resource management for operational efficiency. Integrate resources, integrate actions across geographic scales, and build a community of interests.

Since 1992, the Forest Service has actively promoted implementation of ecosystem management principles through its existing legal requirements, which include NEPA procedures and the preparation of Forest Plans. The spotted owl controversy in the Pacific Northwest has become a focal point for exploring ways to implement the principles of ecosystem management. The validity of an ecosystem approach was recently upheld when the Record of Decision (ROD) for the Range of the Northern Spotted Owl was sustained from programmatic challenge [*SAS v. Lyons*, No. C92-479WD (W.D. WA, Dec. 21, 1994)]. Further, the Forest Service was one of the key players in the preparation of *Vision for the Future: a Framework for Coordination in the*

Greater Yellowstone Area (Greater Yellowstone Coordinating Committee 1990). The *Vision* process offered general principles intended to guide future management decisions within the Greater Yellowstone Ecosystem and was an attempt to conceptualize the principles of ecosystem management (Freemuth and Cawley 1993).

In a 1993 memorandum, "Ecosystem Management Questions and Answers," the Forest Service, responded to a question of how ecosystem management differed from what has already been mandated under the NFMA and MUSYA. The Forest Service stated that ecosystem management does not change NFMA. "Ecosystem management is a refinement of the approaches we have employed to meet NFMA, NEPA, and other requirements. It provides a new synthesis of our legal mandates, and includes policy, principles and guidelines that allow us to more effectively respond to those mandates" (USFS 1993b:7). Furthermore,

> Traditional multiple use management sought to sustain selected forest uses and product flows. Ecosystem management seeks to sustain not only resource uses and products, but also the health, beauty, adaptability, and long-term productivity of ecological systems. In concept and practice, ecosystem management is a more complex approach than traditional multiple-use management. [USFS 1993b:7]

3.3.3 The 1995 Proposed Rule

Irrespective of NFMA regulations that implicitly endorse ecosystem management, the adoption of "New Perspectives," and legal mandates under the Endangered Species Act of 1973, as amended, ecosystem management, as policy, has no legal basis within the Forest Service or any other federal agency. Therefore, in an effort to give ecosystem management legal and substantive support, in April 1995, then Forest Service Chief, Jack Ward Thomas, published a proposed rule, as an amendment to NFMA, to guide land and resource management planning under the framework of ecosystem management. The proposed rule was the culmination of a systematic and comprehensive review of forest planning rules and processes that was begun in 1992 (*Federal Register*, 60(71) April 13, 1995:18886-18932). Basic conclusions underling the proposal were:

- Many recommendations of the Critique of Land Management Planning can and should be adopted by revising the planning rule.
  - Simplify, clarify, and shorten the planning process.
  - Carify the decisionmaking framework.
  - Provide for an incremental approach to revising forest plans.

- While NFMA has some limitations, it remains basically sound.

- Many opportunities exist to streamline the existing regulatory text.

- The solution to some problems with the planning process are not within the scope of the planning regulation.

- Principles of ecosystem management need to be reflected in the planning regulation.

The four-fold purpose of the proposed rule would (1) describe the agency's framework for National Forest System resource decisionmaking; (2) incorporate principles of ecosystem management; (3) establish requirements for the implementation, monitoring, evaluation, amendment, and revision of forest plans; and (4) articulate the relationship between resource decisionmaking and compliance with NEPA (*Federal Register* 1995:18890). The primary outcomes expected from the proposed rule are given below (*Federal Register* 1995:18889):

- Forest plans and forest planning prodecures that are simpler, more understandable, and less costly.

- Stronger relationships with the public and other government entities.

- The incorporation of ecosystem management principles into forest planning.

- Clarification of the nature of forest plan decisions and their relationsh to other planning and decisionmaking processes.

Comments concerning the proposed rule were received until August 17, 1995. Since that time, the Forest Service Ecosystem Management Team has reviewed the comments, and is currently revising the rule and going through the clearance process within the agency; no date has been projected for when the rule will be enacted (what effect the recent change in Forest Chiefs will have on the proposed rule is not known) (Sue Cummings, Ecosystem Management Team, USDA Forest Service, Washington, DC, personal communication, March 6, 1997).

3.4 Ecosystem Management Criteria, Goals and Questions

This section synthesizes the principles of ecosystem management as discerned from the literature review into a list of "ideal" ecosystem management criteria from which 10 ecosystem management goals were derived. The goals, in turn, were used to formulate the questions for the case study evaluations of the George Washington and Francis Marion National Forests.

3.4.1 Ecosystem Management Criteria and Goals

For this research, I surveyed the scientific literature and published proceedings through October 1996 to determine where consensus exists with regard to defining ecosystem management and establishing its theoretical basis. Overall, there was much consistency in the literature from author to author with regard to ecosystem management concepts, goals, and methodologies, with one major exception—the role of humans (see Section 3.2.2).

As discussed in Section 3.2.1, four broad categories or themes emerged from my evaluation of the literature—ecosystem integrity, time and spatial scales, environmental planning and management, and human health and welfare. The themes were derived through a synthesis of an extensive list of ecosystem management criteria. The list of ecosystem management criteria was then synthesized and analyzed further, resulting in 10 ecosystem management goals. Table 3.4 lists the 10 ecosystem management goals. Appendix B lists the ecosystem management goals along with the specific criteria that led to the formulation of each of the goals. The literature sources for each of the criteria are also included for reference.

Table 3.4. The Goals of Ecosystem Management.

1. Maintain ecosystem integrity.
2. Manage based on natural processes.
3. Sustain ecosystems for the long-term.
4. Manage within the context of an ecological hierarchical organization.
5. Develop and adopt an interdisciplinary approach.
6. Facilitate public involvement.
7. Integrate scientific research, policy, and management.
8. Incorporate adaptive management procedures.
9. Develop educational programs and provide for informational exchange.
10. Accommodate human use and occupancy.

3.4.2 Ecosystem Management Questions

A suite of ecosystem management questions was developed to evaluate the two sets of Forest Service EISs and their accompanying Forest Plans. The purpose of the evaluation is to ascertain how and to what extent ecosystem management has been incorporated into the Forest Service EIS process and, by implication, what effect this has had on overall Forest Service planning practices.

Evaluation questions were formulated from the ecosystem management goals. The ecosystem management questions and range of possible responses are given in Table 3.5. Each ecosystem management question not only incorporates the specific objectives of each goal, but each question also attempts to capture the broader, holistic intent of ecosystem management. This is illustrated through the matrix presented in Table 3.6. The matrix shows the integrated relationship of the 11 ecosystem management questions to the ecosystem management criteria.

From a practical perspective, it was imperative that the question responses be discernible through an examination of the EIS and Forest Plan documents. From an evaluation perspective, the 11 ecosystem management questions were formulated for their ability to contribute to the defined "ideal" set of ecosystem management criteria. Therefore, the range of responses for each question was designed to ascertain this "ideal." In order to estimate the relative differences among the range of responses for each ecosystem management question, a measurable criterion indicator was devised to depict the differences between the "ideal" and "real" elements for each criterion type. The criterion indicators were assessed relative to one another using a heuristic scale (adapted from Kennedy 1992):

- Does not satisfy the criterion.
- Partially satisfies the criterion.
- Satisfies the criterion ("ideal" element).

Table 3.5 includes the range of responses for each of the ecosystem management questions based on the heuristic scale described above. Several of the questions (Questions 2, 6, 8, and 11) have a fourth possible response to either the low or mid-range response ("does not satisfy the criterion" or "partially satisfies the criterion"). This additional response was necessary because of the specific nature of the EISs evaluated.

Table 3.5. Ecosystem Management Questions and Range of Responses Based on Ecosystem Management Goals and Criteria.

1. Did the agency propose management procedures to maintain viable populations of native species in situ? If so, how?
   - no procedures proposed.
   - management procedures primarily focused on game species such as deer, bear, wild turkey, and endangered species.
   - agency proposed management procedures to maintain viable populations of native species in situ through preservation and enhancement of multiple habitat types and sizes.

2. Was it evident that the agency acknowledged ecological patterns and diversity in terms of the processes and constraints generating them?
   - minimal or no evidence.
   - agency demonstrated some understanding of ecological patterns and diversity; however, this understanding did not effect the management decisionmaking process.
   - agency demonstrated some understanding of ecological patterns and diversity; this limited understanding was reflected in the decisionmaking process.
   - agency demonstrated understanding of ecological patterns and diversity in terms of the processes and constraints generating them; management decisions reflected this understanding.

3. What level of measures were proposed to sustain ecosystem diversity, health, and productivity?
   - minimal or very narrowly focused measures proposed.
   - importance of sustainability discussed, but no management measures were proposed.
   - specific measures proposed to sustain ecosystem diversity, health, and productivity, e.g., mandated BMPs, environmental restrictions on pesticides, etc.

4. Were ecosystem patterns and processes studied at different geographic and time scales?
   - management decisions were only concerned with the prescribed management time-frame within defined forest system boundaries.
   - acknowledged ecosystem patterns and processes at different scales, but management decisions only affected prescribed time-frame within defined forest system boundaries.
   - the historic range of ecosystem patterns and processes were defined across a range of spatial and temporal scales; the agency developed effective partnerships with other federal agencies, state and local agencies, and private landowners.

5. How were management boundaries delineated?
   - only used political boundaries; no or limited discussion beyond political boundaries.
   - acknowledged ecosystem concepts, but only looked at selected parts of ecosystems.
   - defined ecological boundaries at appropriate scales; managed within and across whole landscapes, watersheds, regions, etc.

Table 3.5. Ecosystem Management Questions and Range of Responses Based on Ecosystem Management Goals and Criteria (continued).

6. To what extent was a broad, integrative, interdisciplinary approach used?
    - project completed entirely using in-house personnel from the same disciplinary background.
    - project completed using an in-house, interdisciplinary team; other agencies or specialists consulted only on a needs basis (e.g., permit required).
    - interdisciplinary committee, composed of representatives of other federal agencies, state and local agencies, and the public, was formed at the onset of this project.
    - involved ongoing interdisciplinary committee that included representatives of other federal agencies, state and local agencies, and the public in policymaking and planning processes.

7. How was the public involved in the planning and decisionmaking process?
    - not at all; framing goals were left to the "experts."
    - input through informal meetings, open-houses, letters, and/or public hearings.
    - meaningful stakeholder and public involvement generated to facilitate collective decisionmaking.

8. How were results of recent scientific research and technology integrated into management and policy decisionmaking?
    - had no influence on final outcome.
    - recent scientific research and technology considered in decisionmaking, but many "trade-offs" were made to accomplish social and economic goals that were contrary to scientific information.
    - recent scientific research and technology considered in decisionmaking; some "trade-offs" were made to accomplish social and economic goals; the "trade-offs" were determined not to be contrary to the precepts of ecosystem management.
    - best available scientific information was cornerstone for resource allocations and management decisions; scientific database increased as a result of this planning process.

9. Were adaptive management techniques (e.g., monitoring, evaluation) integrated into planning and management?
    - not at all.
    - followed standardized monitoring and evaluation procedures.
    - used adaptive management by monitoring and evaluating multiple attributes at all appropriate ecological scales; monitoring and evaluation outcomes to influence future planning and management decisions.

10. How were educational programs integrated into the decisionmaking process?
    - no or minimal educational programs developed.
    - in-house educational workshops or short courses held for agency personnel to prepare them for the decisionmaking process.
    - educational workshops or short courses held for agency personnel, representatives from other federal agencies, state and local agencies, and the public.

Table 3.5. Ecosystem Management Questions and Range of Responses Based on Ecosystem Management Goals and Criteria (continued).

11. Did the agency evaluate and set priorities based on societal demands within the constraints of ecosystem patterns and processes?
    - agency did not evaluate or set priorities based on societal demands; ecosystem patterns and processes were disregarded.
    - agency evaluated and set priorities based on societal demands; ecosystem patterns and processes were generally disregarded.
    - agency evaluated and set priorities based on societal demands; ecosystem patterns and processes were given some consideration.
    - agency evaluated and set priorities based on societal demands within the constraints of ecosystem patterns and processes.