An Ecosystem Management Process for the Thunder Basin

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Natural resource managers face many new and difficult challenges today. Among these is the recognition that management objectives must incorporate the conservation of biological diversity. This recognition has made managers aware that they need to plan across larger landscapes than they typically have in the past. These larger landscapes are usually of mixed ownership, and successful management will require the cooperation of private, state, and federal land owners/managers.

Locally-led collaborative efforts that address local issues but that also incorporate state and national objectives offer a feasible way of addressing management across mixed ownership landscapes. Collaborative planning brings with it the necessity to manage for multiple objectives in order to address the various perspectives and issues that collaborative groups usually represent. It requires integrating the ecological, economic, and social objectives for a given landscape. It also means that to be most effective, planning should integrate the various natural resource disciplines such as wildlife, fisheries, forestry, and range conservation, so that one plan can include all of these disciplines rather than having four or more separate plans that don't necessarily work or link together.

All of these factors require natural resource managers to operate in new ways. A solution to these challenges is the application of ecosystem management as an overriding framework for natural resource planning.

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What is ecosystem management? It can be simply defined as an approach to natural resource management that strives to integrate ecological, social, and economic objectives (Kaufmann et al. 1994). The key to this definition lies in the further definition of the objectives to be integrated (Haufler 2000). Ecological objectives of ecosystem management typically include maintaining or enhancing biological diversity and ecosystem integrity (Grumbine 1994, Kaufmann et al. 1994). Biological diversity has been defined as the variety of life and life processes and typically includes the organizational levels of landscape, ecosystem or community, species, and genetic (Keystone Center 1991). Ecosystem integrity addresses processes that are important for ecosystems to function in a defined and predictable manner (Haufler 2000) and it recognizes temporal dynamics of ecosystems as critical considerations for ecosystem management. Ecosystem management recognizes the need to address these complex ecological objectives, but to do so while also integrating economic and social objectives. Economic objectives include maintaining or enhancing natural resource-based economies, especially those that strongly influence local communities. Social objectives include maintaining or enhancing abilities to meet cultural, aesthetic, recreational, spiritual, and other societal demands.

Effective ecosystem management is that which does the best job of integrating the ecological, economic, and social objectives. In other words, ecosystem management isn't about giving lip service to one or two of the objectives while primarily focusing on a third, but rather striving to provide the attainment of all three objectives within the same planning landscape. A need for successful ecosystem management is the identification of an approach for addressing the ecological objectives that also allows for the integration of

the economic and social objectives. Many efforts of collaborative or agency groups that have attempted to apply ecosystem management have been conducted without an articulated approach that identifies how the ecological objectives are to be met. Such efforts rarely produce an integrated plan because the process lacks a clear understanding of how the ecological objectives are to be met, and consequently, the economic and social objectives are constantly questioned. Only with an identified and agreed upon approach to addressing the ecological objectives can the true integration of the economic and social objectives be achieved.

Haufler (1999a,b, 2000) discussed various approaches that have been proposed for addressing the ecological objectives of maintaining and enhancing biodiversity and ecosystem integrity. This is what the use of the term ecological objectives will refer to in this paper. While recognizing that most land management plans may incorporate aspects of various approaches, Haufler (2000) identified a coarse filter (Noss 1987, Hunter 1990) approach that also links with a species assessment as being effective for meeting ecological objectives. This approach further allows the integration of economic and social objectives. A coarse filter approach provides for an appropriate mix of ecosystems to address the ecological objectives (Hunter 1990, Haufler et al. 1996,1999), while the species assessment serves as a check on the effectiveness of the coarse filter as well as to address needs of species that may not respond to the coarse-filter approach alone. Haufler (1999 a,b) discussed why this particular approach was preferred for ecosystem management, as it has a strong scientific foundation for meeting the ecological objectives while also accommodating the integration of the economic and social objectives.

An Ecosystem Management Process

Accomplishing ecosystem management can be divided into several phases in a coordinated process. The phases are: 1) to conduct an assessment of ecological, economic, and social conditions, 2) to develop an ecosystem management plan that identifies desired conditions, as well as any associated species strategies, 3) to implement the plan and develop any appropriate conservation agreements, and 4) to conduct monitoring and adjust the plan as necessary. Haufler et al. (1996, 1999) described a process for ecosystem management that follows these four phases, but further identified 10 steps that use a coarse-filter approach with a species assessment to address the ecological objectives and allow the integration of the economic and social objectives. The first step in the process is the delineation of the planning landscape of interest. For example, the Thunder Basin Grasslands Prairie Ecosystem Association has identified a planning landscape in eastern Wyoming for their goal of producing an ecosystem management plan (Fig. 1). The process (Haufler et al. 1996) then follows a series of steps (Fig. 2) that together complete the four phases of ecosystem management identified above.

Ecosystem Management Assessment

The first phase of an ecosystem management process is the assessment of the ecological, economic, and social conditions of the delineated planning landscape. For the economic objectives, the various natural resource based economies need to be identified and described in terms of their resource base, their level of production, and their impacts on local jobs and economics. For renewable resources, an evaluation of sustainable use is usually desirable. Assessment of social objectives includes the current uses and interests

in the planning landscape in terms of recreational activities, aesthetics, and other public demands. These objectives need to include not only the desires and needs of the local population, but also broader state interests in state-owned lands, and national interests in Federal-owned lands. Some of the social and economic interests overlap, as recreation is a primary driver of the tourism industry, while the coal industry may generate sightseeing opportunities.

Assessment of the ecological objectives using a coarse-filter approach is a relatively new method of landscape assessment. The objective of the coarse-filter approach is to identify the mix of ecosystems that if represented within the landscape will adequately provide for the ecological objectives. Identifying and delineating these ecosystems requires that they be classified, as the landscape needs to be mapped and mapping requires a classification of similar areas. Numerous classification systems have been developed. Haufler et al. (1996, 1999) advocated the selection of a classification that allows for identification and delineation of both the complexity of ecological sites in terms of abiotic factors within the landscape as well as the temporal or successional response of ecosystems occurring across similar sites to historical disturbances. Haufler et al. (1996) further suggested the use of a tool termed the ecosystem diversity matrix that provides the ability to describe ecological sites as well as the successional trajectories of ecosystems occurring on each type of site as a response to historical disturbances. A hypothesized example of an ecosystem diversity matrix for grass and shrub ecosystems of the Thunder Basin planning landscape is shown in Figure 3. This coarse filter can be displayed using the ecosystem diversity matrix. Each cell of the matrix, represents an ecosystem that occurred under historical disturbance regimes, and the entire matrix

should represent the mix of ecosystems that occurred. If each cell or ecosystem is sufficiently represented within the landscape, then the habitat requirements of species as well as ecosystem integrity will be provided. Haufler (1999a, b, 2000) termed this specific coarse-filter approach as the historical range of variability-based approach. It has as a basis that the ecological objectives of ecosystem management can be met with adequate representation of ecosystems, not necessarily a return to historical levels of ecosystems, and that this representation allows for substantial levels of economic and social activities within the landscape.

Additional steps in the ecological assessment characterize the landscape under existing conditions, and compare these conditions to the planning landscape under historical disturbance regimes. The process described by Haufler et al. (1996, 1999) suggests that the ecological objectives of ecosystem management can best be met by adequately representing the mix of ecosystems that occurred under historical disturbance regimes. The hypothesized ecosystem diversity matrix (Fig. 3) provides an example of how the historical mix of ecosystems can be classified. For each type of ecological site, historical disturbance regimes can be described and quantified. This is generally accomplished by modeling the primary disturbance regimes, such as fire, for the hypothesized grass/shrub ecosystem diversity matrix. The historical disturbance modeling will provide an estimate of the range in amounts of each successional stage that was estimated to have occurred within the landscape over a designated time period, such as several hundred years. This is the historical range of variability in landscape composition under historical disturbance regimes. The amounts of these different

ecosystems that occurred historically can then be compared to the amounts present today to provide a quantification of their representation under existing conditions.

A final step in the ecological assessment is to determine which, if any, species need individual attention or planning. Species included in this category would be those exhibiting low or declining populations that are not limited by habitat availability. Species with low or declining populations that are limited by habitat losses or fragmentation should have their habitat needs met by the coarse-filter approach. A select number of these species can be furthered evaluated to confirm that the coarse filter is providing suitable habitat, as discussed by Haufler et al. (1996). Species of concern not limited by habitat availability may instead be limited by factors such as direct mortality from humans, pesticides or other pollutants, competition with exotic species, or mortality from exotic diseases. For these species, the coarse-filter approach is unlikely to solve non-habitat related mortality or population constraints, and other measures may be required. Therefore, species of concern that are not habitat limited within the planning landscape need to be identified and individually assessed as to their limiting factors.

Ecosystem Management Plan

The assessment phase should provide the information base for making planning decisions. It should provide a good understanding of the natural resource-based economics of the planning landscape, the social demands on the landscape, and the types and complexity of ecosystems and species of concern that address the ecological objectives of the landscape. With this information, an ecosystem management plan can be developed. This plan involves first identifying ecological sustainability requirements for the landscape- the needed conditions to address the ecological objectives. This

determination sets bounds for the economic and social objectives. Social objectives may include a desire for additional amounts of natural conditions or species populations, but this needs to be distinguished from what is needed to address the ecological objectives. In other words, if the needs for biological diversity and ecosystem integrity are sufficiently provided in the plan, then additional social desires for wilderness designations, for example, should be considered social desires and not as part of the definition of ecological sustainability that defines the ecological objectives.

Defining the amount of representation needed for each ecosystem to meet the ecological objectives under a coarse-filter approach should be based on a scientific understanding of the likelihood of the persistence of species and ecosystem integrity. However, the amount or level of needed representation is also a societal decision based on acceptable levels of risk. Science should provide information on the probabilities of risk under different levels of representation, and managers need to work with collaborative groups to define what is an acceptable probability of risk. Failure to address this difficult question will leave most collaborative efforts in an ineffective state, where no decisions about acceptable economic or social activities can be made because a definition of what is needed to address the ecological objectives is lacking.

Thus, a critical step in an ecosystem management plan is the determination of an adequate amount of representation of the mix of ecosystems that occurred historically. In addition, those species limited by factors other than habitat availability will usually require preparation of a species conservation strategy. Such a strategy should indicate what levels of populations and control of mortality factors are needed to maintain the population within the planning landscape. For example, in eastern Wyoming, the black-

tailed prairie dog (Cynomys ludovicianus) is not limited by habitat, but rather by the levels and distribution of its population that is tolerable to other human activities. A conservation strategy for this species would specify how large a population, and what sizes and arrangements of prairie dog colonies would be needed to assure the persistence of this species in the planning landscape.

Adequate ecological representation along with any required species conservation strategies address the ecological objectives. With these needs identified, the economic and social objectives can then be defined and integrated. Amounts of different ecosystems desired to meet the various ecological, economic, and social objectives within the landscape as well as their associated management practices can be identified. Certain amounts of each type of ecosystem can be designated with a priority use, such as maintaining a specific ecological condition, or providing for a certain level of economic or social use. This does not assume that economic, social, and ecological objectives are each met separately on different areas of the landscape. Rather, the ability of areas to contribute to all three objectives needs to be considered. Certain areas will have a priority for an ecological, economic, or social purpose, but the ability of the area to not only meet that priority use but to contribute to other objectives should also be determined. For example, certain levels of grazing may be compatible with representation of an area for ecological objectives.

The ecosystem management plan should produce a document of desired future conditions for the landscape. This should specify the amounts and types of ecosystems needed to address the ecological objectives. It should include the desired distribution and populations of species for which conservation strategies were deemed necessary. It

should identify amounts of economic activities that can be conducted within the landscape consistent with ecological sustainability. And, it should discuss the desired levels of social needs that are also consistent with the ecological and economic objectives. There will undoubtedly be differing views on the desired conditions, but through the assessment and discussions of desired conditions that integrate ecological, economic, and social objectives, workable solutions that incorporate the needs of all participants can be identified. While not an easy task, and while not providing all of what each collaborator may like to have in a plan, this process provides the best way of producing a plan that will provide for long term needs, produce the best integration of objectives, and provide consistency for management activities.

Plan Implementation

The ecosystem management plan describes the desired conditions for the landscape, but does not specify exactly where or how these conditions are to be provided. The plan should indicate what are compatible uses of specific ecosystems and what uses compromise the attainment of other objectives. Implementation specifies the activities, management actions, and locations that will produce the desired conditions. It involves a collaborative effort where each landowner or agency identifies conditions that each is able and willing to provide. A first priority is to identify how representation of the coarse filter will be provided over time. The ecosystem management plan will specify amounts, sizes, and distributional considerations of each ecosystem that need to be present within the landscape at all times for the ecological objectives to be met. In addition, any species needs not addressed by the provision of habitat in the coarse filter would be identified in the plan. The distribution of ecological sites within the landscape determines which lands

have the capability of providing specific ecosystems. With this information, activities on public lands can be reviewed to determine the extent that their management actions will address the ecological objectives. Shortfalls in desired amounts or distributions of the mix of ecosystems on the public lands may need to be provided on private lands if the desired conditions are to be met. Incentive programs can help increase the feasibility of contributions from private lands towards the ecological objectives.

Implementation may involve landowners and agencies entering into various types of agreements. Agreements with land management agencies can help coordinate needed conditions across property lines. In addition, for species of concern, candidate conservation agreements, safe harbor agreements, and habitat conservation plans can be used to provide long term assurances and consistency both for the desired ecological conditions as well as the planned activities of landowners.

Monitoring and Adjustment

Ecosystem management should not be viewed simply as a one time or periodic planning activity. Rather, an ecosystem management plan should be viewed as a dynamic effort, that may need to be adjusted as new information and data become available. The collaborative process that developed the ecosystem management plan identified what was perceived at that point in time to be workable solutions for the integration of ecological, economic, and social objectives. The implementation phase strives to establish and maintain the desired conditions within the landscape. However, many projections of conditions may have been made based on incomplete information. The actual responses to management activities and actions needs to be monitored to determine if desired conditions are obtainable as outlined in the plan. Where predicted

outcomes of the plan are found to be in error, adjustments may be needed. When such adjustments are needed, it should be the goal to honor the intent of the original collaborative plan in terms of workable solutions to complex issues.

Monitoring should be included as part of the ecosystem management plan, and incorporated directly into the implementation phase. Monitoring should focus on the components of the plan with the greatest potential impacts on desired outcomes as well as on parts of the plan that had the weakest information at the time of planning. Some deviations from projected conditions should be expected, and minor deviations should not result in review or adjustment to the plan. The plan for monitoring should identify various trigger points that are levels of deviation from plan projections that the collaborative group agrees are large enough to warrant a review or adjustment in the plan. While not all possible trigger points can be identified in the planning process, enough diverse examples should be addressed in the plan to provide a basis for identifying additional trigger points when deviations from the projected plan are encountered.

In this way, the ecosystem management plan should be a living document that provides directions for landscape conditions on an on-going basis. The plan should be deemed acceptable unless actual conditions deviate from the projected conditions by more than an acceptable amount. The collaborative group should discuss a process for plan review and possible revision based on potential changes in the objectives over time. This might involve revisiting the objectives agreed upon in the plan at a specified future date, and determining how changes to the plan might be conducted.

Thus, monitoring serves the purpose of identifying if the plan is proceeding as projected, and identifies deviations in projected conditions that are severe enough to

require review or alteration of the plan. In these instances, the objectives of the plan should remain the same, and the intent of the collaborative agreement honored in revisions. A second type of review of the plan would be an agreed upon process to occur at specified times or conditions that would reopen the discussion of objectives and collaborative solutions.

Summary

Natural resource management has become increasingly complex as expanding demands for natural resources, recreational opportunities, and other societal objectives have challenged the maintenance and enhancement of biological diversity and ecosystem integrity. Ecosystem management offers a means of addressing such challenges. Ecosystem management involves a planning and land management implementation process that integrates ecological, economic, and social objectives across large, mixed ownership landscapes. Ecosystem management involves four parts to its application. An ecological assessment provides information on the status of ecological, economic, and social conditions within the landscape. The ecosystem management plan identifies the desired conditions of the landscape and where these conditions differ from existing conditions. The plan defines the conditions required to meet the ecological objectives, which set the sideboards for ecological sustainability for the economic and social objectives. Implementation of the plan identifies specific management practices and locations to maintain or obtain the desired conditions. Implementation involves development of cooperative agreements between and among landowners and agencies, and is enhanced by the incorporation of voluntary incentive programs. Monitoring assesses if the projected outcomes of the plan were accurate, and identifies when

deviations from expected plan outcomes are sufficiently large to warrant plan adjustments. When such adjustments are needed, they should strive to honor the intent of the desired conditions as determined by the collaborative group. In this way, ecosystem management is an on-going process that provides consistency as long as the information for planning is sufficiently accurate to produce projected results. The plan may be followed indefinitely, requiring adjustments only when projected conditions are not obtained as expected, but still focusing on the objectives and solutions identified by the collaborative group. The plan may be revisited at set times to reassess the objectives and collaborative solutions.

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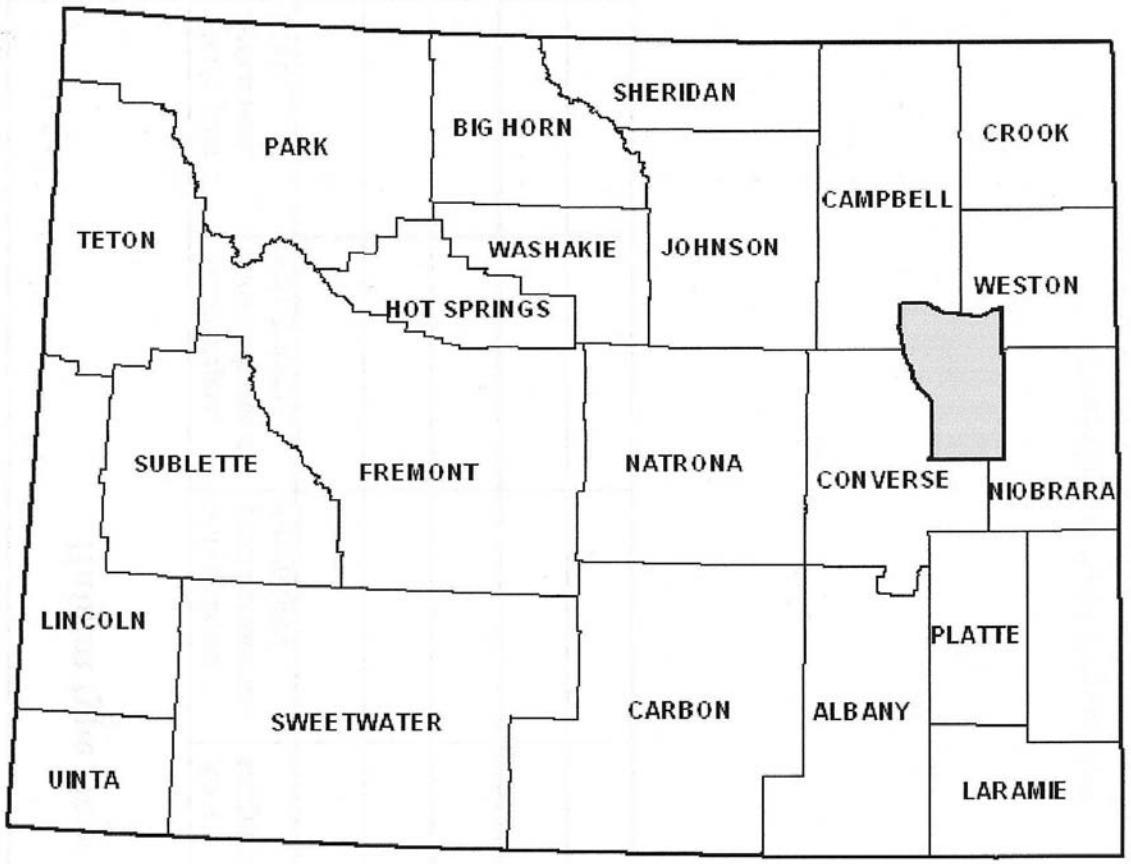

Figure 1. Map of planning landscape delineated by the Thunder Basin Grasslands Prairie Ecosystem Association for the development of an ecosystem management plan.

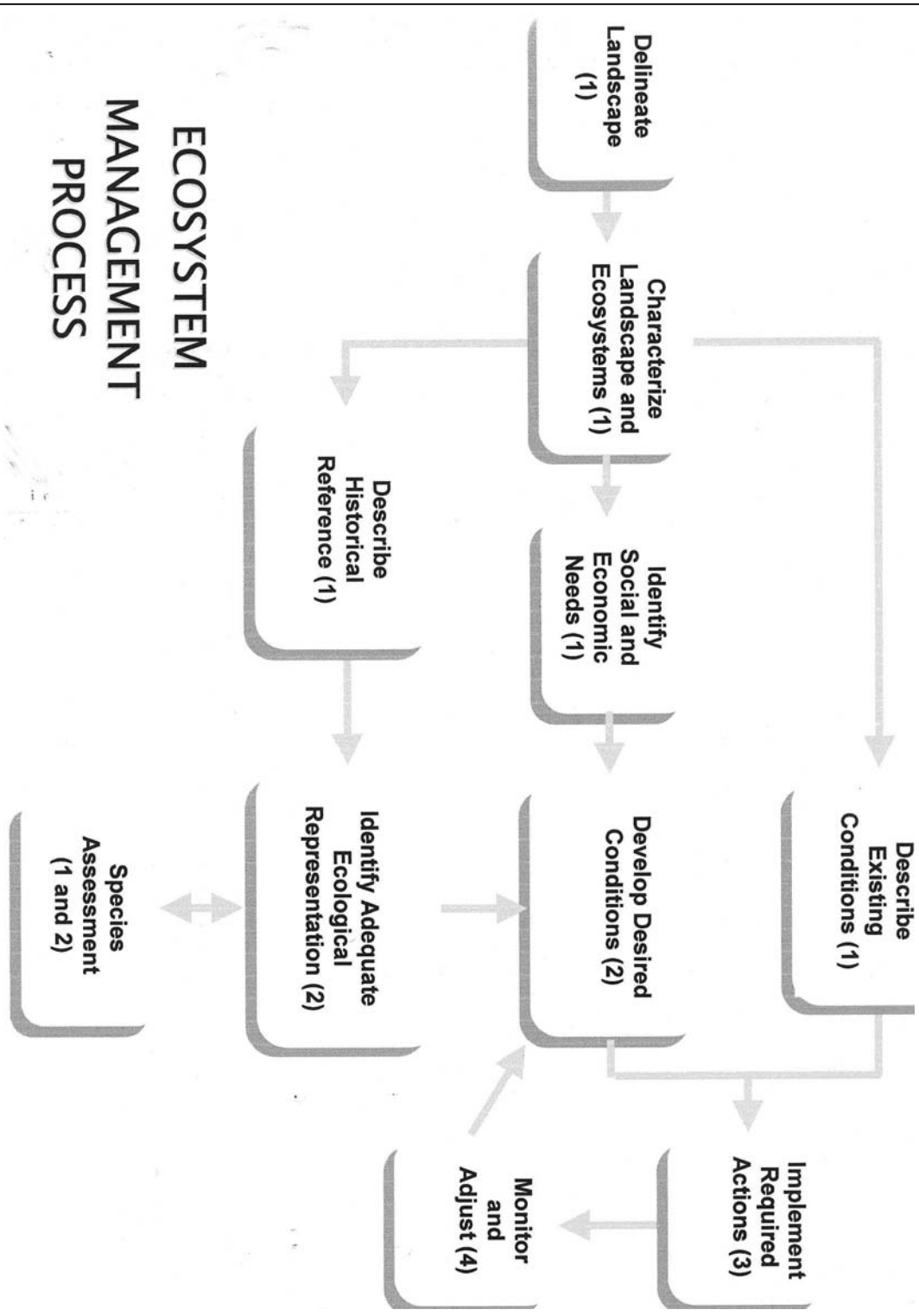

Figure 2. A process for ecosystem management, after Haufler et al. (1996). The steps labeled "1" comprise the ecological assessment, steps labeled "2" comprise the development of the ecosystem management plan, the step labeled "3" comprises the implementation of the plan, and the step labeled "4" comprises monitoring and adjustment.

Successional Stage	Habitat type class					
	Shrub, poor herbaceous, xeric	Shrub-steppe, good herbaceous, well drained	Shrub-steppe, good herbaceous, mineralized	Xeric sodgrass	Xeric bunchgrass	Mesic herbaceous
Early grass/forb						
Late grass/forb						
Early shrub						
Mid shrub						
Late shrub						

Figure 3. An hypothesized example of an ecosystem diversity matrix for terrestrial grass and shrub ecosystems of the Thunder Basin planning landscape.