DEVELOPING ECOLOGICAL GUIDELINES FOR MANAGEMENT AND RESTORATION OF WESTERN JUNIPER WOODLANDS[1]

Lee E. Eddleman

SUMMARY

It is suggested that the development of ecological guidelines for management and restoration of western juniper woodlands begins with clear comprehensive statements, preferably written, of desired future conditions (goals and objectives), followed by statements delineating the ways and degrees in which the present situation is lacking (problem statement). The next step suggested is an analysis of the resources available on the site including trees, understory plants and soils. This is followed by an analysis of how the site presently functions, with particular emphasis on aspects of the site that control key processes such as erosion and infiltration as well as plant reproduction, establishment, growth and succession. Finally, it is suggested that an analysis of site linkage to the surrounding landscape be made so that there is sense of the degree to which, the site influences or depends upon the surrounding landscape. From these statements and analyses actions can be designed that will facilitate those processes needed to reach desired future conditions.

INTRODUCTION

Attempts to develop site specific ecological guidelines for the management and restoration of western juniper woodlands are always underlain by a variety of assumptions. These assumptions may be derived from expectations, desires, and objectives that are unrealistic in terms of either the supporting science or the available resources. Assumptions are likely based on social values, understanding of ecological theories, and interpretation of ecological data, each of which need to be kept as distinct as possible (Scarnecchia 1995, Tausch 1996). We do not have comprehensive, whole system, ecological research data available on our arid lands. Therefore the land manager is faced with the formidable task of formulating suitable assumptions, developing reasonable objectives, and applying guidelines in an appropriate manner from shifting societal values, not so succinct and frequently conflicting ecological theories, less than adequate research data, as well as from observations and experience.

However, ecological principles and guidelines applicable to the management and restoration of woodlands can be found in, or can be derived from, a variety of comprehensive publications on range management, grazing management, rangeland improvement, and game range improvement. More specifically, Evans (1988) considered many ecological relations in

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developing strategies for management of pinyon-juniper woodlands for a variety of products and values.

Ecological guidelines must contain both mid-scale site qualities and broad-scale landscape qualities. When guidelines are developed for an ecological site (U. S. Department of Agriculture 1997) mid-scale, it is assumed that this site is unique within itself , however in addition it should be considered equally unique in its connectivity to surrounding sites within a landscape, broad-scale. Connectivity has been defined as the "degree to which patches of a given type are joined by corridors into a lattice of nodes and links" (Wiens et al. 1993). In woodlands connectivity could be considered as the degree to which a site is functional linked to other sites or landscape units of the system. At a very basic level each site functions either as a source of materials, functions to transport materials, or it functions in storage of landscape materials. The linkage is both spatial and temporal and operates through input, transfer, and output mechanisms of resource materials such as water, sediment, nutrients, energy, flora and fauna, etc. (Schlesinger et al. 1990, Tongway 1990, Wilcox and Breshears 1995).

Establishment of guidelines for management and restoration of western juniper woodlands implies that standards exist and that we are capable of directing or redirecting ecological processes to attain those standards. Nevertheless, setting ecological standards is a distinctly human process and is therefore an arbitrary value judgment that shifts with changing personal and societal values. We would like to think that western juniper woodlands have their own inherent ecological standards, and at certain temporal-spatial scales perhaps they do. Words such as "natural" and "healthy" pervade the literature, and our concept of these words, as applied to a particular area, provides the driving force for the establishment of arbitrary, not scientific, standards. However, Lawton (1997) has pointed out that "ecosystems change continuously at all time-scales". Standards and guidelines developed around concepts of sustainability should be called into question and carefully evaluated, particularly as to their spatial-temporal scale. Recognition of change and the processes associated with change should allow us to better derive our area goals, objectives, and standards more realistically focusing on trajectories and functional standards (Lawton 1997, Miller and Wigand 1994, Tausch 1996,).

When we select key functional attributes they should be the internal attributes of the ecosystem that control rate and magnitude of those processes that can lead to degradation, or vice-versa to desired conditions on the site in question. Functional attributes may be difficult to measure but several surface structural components have been found to be useful indicators of site function (de Soyza and others 1997). Approaches suggested by the Committee on Rangeland Classification (National Research Council 1994) are a good step toward the application of functional ecology to determination and management of rangeland health and are applicable to western juniper woodlands.

Development of ecological guidelines is at least a four-step process. The first step is the development of a set of goals and objectives. Secondly, a set of problem statements needs to be developed. This should be followed by a structural and functional analysis of the land area under consideration for treatment. Finally, a functional analysis relating the area under consideration to the landscape as a whole is needed. These are not new concepts but serve rather as a reminder since logical systematic approaches are needed to avoid pitfalls.

GOALS AND OBJECTIVES

(what the desired future conditions are)

Clear, concise goals and broad objectives are required at the outset of any management or restoration action. Establishment of goals and objectives requires that the desired pattern and process have been determined at both the site level and landscape-level for the land area under consideration for management change or restorative action. Examples of questions that need to be asked and answered include those below:

- What are the desired short-term and long-term ecological goals?
- What are the objectives and what is the spatial-temporal framework for measurement? (Literally, how many units per unit of space per unit of time must be specified)
- How do the objectives for the land area under consideration fit within the goals for the landscape as a whole?
- What are the assumptions that underlie each objective? (Why have I selected this objective and what gives credence to it?)

Unless considerable thought is put into making sure these questions have been answered, conflicts and cross-purposes may not be identified and the reality of success may be illusive. Ecological goals for woodlands should include components of sustainability and productivity as well as components of conservation of natural abiotic and biotic resources. Goals and objectives must be definable and achievable and the latter must be measurable. They should provide a clear statement of the desired direction of change, if any, for soils, plants and animals, and identify desired future woodland conditions. The degree of success should be measurable on both temporal and spatial scales. Knowing the degree to which one's assumptions rely on social values, ecological theory, ecological data, and observation and experience will help adjust confidence in reaching the goals and objectives.

PROBLEM STATEMENT

(what is wrong)

The next step in the process is to state precisely and clearly the apparent ecological problem(s) as it exists on the land area under consideration. This statement should be as comprehensive as possible and based on field observation and as much site-specific and local information as is available. It should identify those structural components that control rates and amounts of change and those processes that appear associated with degradation or with barriers to the achievement of future desired conditions. Degradation as used in this paper is the degree to which pattern and process have been altered and the land area under consideration rendered less favorable for the desired plant community or communities identified in the goals and

objectives (modified from Tongway 1990). Some examples of questions from which a problem statement can be developed follow.

- What is there too much of or too little of? Why?
- What is wrong with the pattern? Why?
- What direction are things going or what processes are dominating the target site? Why?
- What are the underlying assumptions of each statement? (If a statement is made that there is approximately two times more bare ground than there should be, what assumptions have been brought to the statement formulation? Some examples could be: bare ground has a negative connotation, local observations suggest it, experience from similar sites suggests it, concepts and ecological theories favor it, interpretation of research data and established guidelines support it.

SITE ANALYSIS

(the resource materials present to work with)

Kind of Woodland - An inventory and analysis of the temporal and spatial nature of the woodland on the land area under consideration is needed since the kind of woodland presently on the land area determines to a large degree the management and restoration practices to be applied. Examples of questions that need to be asked and answered include those below.

- What is the age class structure of the trees? Are woodlands old, new or developing?
- What is the size class-spatial structure of the trees? Are woodland stands open or closed?
- What degradation processes are apparent, if any?

Old woodlands have a variable number of very old trees present and the land area appears to have been in woodland for several hundreds of years. Pattern of plants, soils and animals, and processes, both biotic and abiotic, may appear spatially and temporally controlled by the tree component of the woodland when the stands are closed. The tree component may appear to be stable; however, in the last century degradation in these woodlands may be ongoing at several scales.

New woodlands are those that have largely developed this century and there is no indication they were present previously. These woodlands contain mature trees; the larger individuals may have recently begun to slow down their growth rates but mortality factors are not strongly in evidence. Patterns and processes in these communities may be largely under the control of the woodland tree component. Degradation processes, if present, are likely multi-factored and complex.

Developing woodlands should be identified. These are areas that are being newly invaded by trees, but have not as yet reached the stage where internal patterns and processes are controlled or driven by the tree component.

Understory Vegetation - The composition and density of understory vegetation components must be determined on each functional unit within the land area under consideration in order to predict rates and amounts of transition in pattern and process toward the desired state. Examples of questions that need to be asked and answered include those below.

- Which species and functional groups of understory plants are present and which ones are absent?
- Is the apparent vigor or health of the shrub species sufficient to maintain them in the community or has a threshold been crossed and extinction expected?
- Given the density of long-lived herbaceous and shrub species, how will they respond to disturbance factors, both natural and man caused?
- What are the assumptions made in answering each question?

Functional Attributes - The local land area under consideration may be made up of one to several ecological sites, or one to several distinct functional landscape units. The area of interest must be delineated to assess functional attributes. Example questions that need to be asked and answered at both the mid-scale and broad-scale include those below.

- What ecological sites and functional landscape units are present?
- What structural factors currently dominate and control on-site pattern and process, and how do they do so?
- What causal factors led to current site conditions?
- What is the degree of degradation?
- What ecological thresholds currently restrict transitions to goal oriented ecological conditions?
- What assumptions were made in answering each question?

Thinking in spatial-temporal scales will greatly aid in understanding how an area functions. Spatially scaled functional units suggested by Wilcox and Breshears (1995) or those suggested by Anderson and Hodgkinson (1997) are very useful. Temporally scaled functions should at least include key seasonal aspects of moisture input as well as plant growth, reproduction, and establishment.

Basic processes of concern are those associated with the hydrologic cycle, nutrient cycle, and energy flow. Also of primary concern are successional processes in the functional groups of plants and processes associated with functional structures for animal habitat (National Research Council 1994, U. S. Department of Agriculture 1997).

Identification of the causal factors of degradation to pattern and process on a particular land area is complex. Additionally, degradation of one area may be caused by treatments on other areas. Such a relationship is particularly evident in riparian systems (Briggs 1996), but is also true for most upland systems. The degree to which certain ecological structures function as thresholds restricting transition to desired future conditions must be assessed (Laycock 1991, Reitkerk and van de Koppel 1997, Reitkerk et al. 1997, Tausch et al. 1995, Westoby et al. 1989). The degree of tree dominance, present and potential dominance of invasive alien plant species,

lack of plant species, and individuals of particular species to respond, shallow soils, clayey or sandy textured soils, slopes receiving direct solar radiation at key seasons, surface soil loss, high surface water runoff, and intense spring frost action constitute some of the thresholds needing evaluation in western juniper woodlands. Threshold assessment provides the basis for determining treatment type and treatment magnitude, management changes and additions or deletions of organism and abiotic materials.

LANDSCAPE LEVEL ANALYSIS

(how the area is connected to the landscape)

A complete spatially temporally scaled landscape-level analysis relative to the land area or target site in question is necessary to assure selection of the right treatment area and right treatment and to prevent negative reactions on and off-site. Example questions that need to be asked and answered include those below.

- How does the landscape function as a whole?
- What are the links (connectivity) from the target site to adjacent and removed sites and functional units in the landscape?
- As to the natural resources of the landscape, which areas are source-areas, which areas are transport areas, and which areas are storage areas that intercept or accumulate resource materials?
- How does the particular site or land area under consideration fit functionally into the landscape?
- What reasons are there to believe that the area under consideration should function differently than it does?
- What are the assumptions made to support the conclusions?

Consideration of management units and treatment areas in isolation is not acceptable. It may be the case for a particular area of land that initial floristics and relay floristics are mechanisms determining composition of plant species over particular time scales. However, each area is linked to other areas in terms of a variety of critical resources that may strongly influence plant densities, vigor and energy values as well as rates and magnitude of processes.

In landscape analysis, emphasis may need to be placed on water flow, paying particular attention to the physical and biological structures that control and dominate the water cycle. Of critical concern is the ecological function of each land management area, ecological site, and functional unit for which restoration treatments are proposed. The degree of movement and accumulation of critical resources is hypothesized to be the principle mechanism controlling threshold levels of response in arid and semi-arid systems (Anderson and Hodgkinson 1997, Burke et al. 1995, Reitkerk et al. 1997, Tongway 1990, Ludwig et al. 1998).

MANAGEMENT AND RESTORATION ACTIONS

Following the structural and functional assessment of ecological factors, scaled from the functional unit up to the landscape, the problem statement needs to be revisited and revised. Once this process is complete, site-specific action guidelines of what, when, where, and how can be addressed. Common actions considered in the management and restoration of western juniper woodlands, such as burning, mechanical removal, seeding, and grazing should draw their ecological guidelines from a complete set of goals, objectives, and land analysis.

For example, questions as to grazing by domestic livestock can be answered only by asking if grazing will function to meet goals and objectives for the target site given the present structural and functional conditions of the resources of that site and influential off-site areas. More specifically, consideration of fall grazing requires that the prescription meet short-term and long-term goals and objectives, and that appropriate structural and functional resources in time and space are available to do so. For instance, fall grazing may be acceptable when the focus is on water capture and storage during the growing season, however, when capture and storage of winter and early spring moisture inputs are considered, fall grazing may become unacceptable.

Consideration as to grazing rest time after additions of species by seeding should be guided by goals, objectives, and land analysis. Future conditions, desired direction, rate of change, and site function should play a major role in the determination of what, when, where, and how grazing is to be used.

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