

SUSTAINABLE RESTORATION

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Sustainable restoration as it applies to rangeland ecosystems is a difficult subject to deal with. This difficulty has less to do with achievement through the application of basic concepts and sound ecological principles, as it has to do with communication problems through indiscriminate word usage, failure to recognize the underlying assumptions (or lack of them), and expectations formed out of perceptions and desires.

One basic assumption is that rangeland ecosystems are in need of improvement and require some decision making as to the processes needed to restore them to some desired state. It is also assumed that there is a need for human intervention, at some point and to some degree of intensity, in the physical-chemical-biological make-up of the system in order to move it toward the desired state of "restored". Both additions and deletions (removal) of physical structures, chemicals, and organisms are considered part of such intervention.

If the restored community or ecosystem is sustainable it generally implies that it can maintain itself at that level without outside intervention to prop it back up. Ewel (1987) defined sustainability as the capability of the restored community to perpetuate itself without outside subsidy. Although certain types of agriculture would have difficulty meeting Ewel's definition, this kind of sustainability has been the goal in range management for many years. "Restored" is used in the definition since many plant communities that we consider degraded have the capability of sustaining themselves for long periods of time. In general, a restored rangeland ecosystem that is capable of sustaining itself will be characterized by an increasing resistance to invasion by weedy plants, productivity in balance with available resources, retention of nutrients, water and energy, and complex biological interactions above- and below-ground as well as through the seasons.

Managers of natural resource lands find the word "sustainable" fraught with problems. Firstly, what are the time and space dimensions or characteristics of sustainability for restored rangeland ecosystems? And secondly what constitutes movement away from or lack of sustainability?

With regard to the first problem we have the question of: sustainable for how long? We need to remember that all communities and ecosystems are dynamic and that change is inevitable. Nevertheless, a manager needs to resolve the time frame issue. Probably one- to a few decades is a reasonable time frame for arid and semi-arid rangelands as it would cover much (but certainly not all) of the expected environmental variation.

The space dimension is equally difficult since each plant-animal community in an ecosystem is inter-linked. For example sustainable restoration of a moist swale area in an arid ecosystem would be linked to various parts (or functional units) of the upland through inputs of water, minerals, organics and sediment. Generally tablelands at the top are source areas for water and some nutrients. Steeper slopes are flow-through areas. South slopes supply inorganic nutrients and sediment while north slopes supply organic matter, nutrients, and sustained subsurface water flow. Toe slopes, if present, are accumulation areas that act as buffers to these materials being flushed out of the system. Instead they release water, minerals, organic matter and sediment at a sustained-moderated rate into moist areas and to downstream riparian areas.

The point of this is that restoration practices focused on the moist bottom alone will not be sustainable.

Each landscape unit in a watershed has a vital role to play in the sustainable restoration of other landscape units. A landscape unit may or may not be equivalent to an ecological site, rather it is a functional concept that helps us to understand, and through management promote, proper ecosystem operation. Others consider these to be functional landscape cells (see Tongway 1994). The functional approach of landscape units is closely paralleled by the current worldwide effort in ecology to classify plants into functional groups (i.e., annual-perennial, woody-herbaceous, evergreen-deciduous, fibrous root- tap root, etc.). The *Journal of Vegetation Science* (Vol. 7, 1996) is devoted to the advances and utility of functional plant types in understanding ecosystem operation.

In addition to unit specific physical and chemical processes, biota likewise selectively use specific landscape units and deposit nutrients and seed in other units. A point here is that poorly located fence lines create problems with sustainability of restoration.

As to the second problem, monitoring changing system conditions is a necessity. An understanding of plant, soil and environment interactions, as well as succession, competition, and population dynamics of plants is very helpful. Currently developing concepts of thresholds in rangeland health are particularly useful (National Research Council 1994, Laycock 1991) "Restoration", as it applies to rangeland ecosystems would seem to be a simple concept. However, this word is used in many ways and against a backdrop of expectations. The National Academy of Sciences (1974) adopted definitions for restoration, reclamation, and rehabilitation as they applied to drastically disturbed lands (e. g., surface coal mines).

"Restoration" – means the return to exact pre-disturbance physical-chemical-biological conditions.

"Reclamation" – means the site is returned to a condition habitable by organisms in approximately the same composition and density as existed previous to disturbance.

"Rehabilitation" – means returning the site to a structural configuration and productivity level conforming to a previously developed use plan.

Restoration relies on two underlying assumptions. The first is that we already know or can determine pre-disturbance conditions and the second is that we can return the ecosystem to those conditions. From an ecological perspective, return to exact pre-disturbance conditions is not a possibility. We always lack the necessary pre-disturbance documentation. Our pre-disturbance data are usually point-data (taken at point in time such as mid-summer etc. in one or perhaps a few years) and are usually inclusive of a limited number of ecosystem values. Range and variation in all ecosystem values, such as structural configuration, operational or functional attributes and processes of materials movement around the system, in response to daily, seasonal, or yearly environmental changes are needed but seldom if ever available. Even where ranges and variations in ecosystem values are known for a particular part of or site within an ecosystem, only a limited understanding of the interaction with or connectivity to other parts of that ecosystem will be available for our use. Finally, even if we are satisfied with our understanding of pre-disturbance conditions, how do we duplicate the pre-disturbance ranges and variations in environmental factors, such as precipitation and temperature in time and space, under which those communities developed?

Reclamation relies on the first assumption of restoration as well as an assumption that we are capable of returning the ecosystem to a functional state approximating pre-disturbance conditions. To satisfy the latter we focus our efforts on establishment of above- and below-ground structures, usually plants, similar to pre-disturbance or desired conditions and then assume that these structures will result in similar processes. Actually the literature indicates a close linkage exists between the structural patterns produced by plants and the kinds, amounts and rates of processes.

Rehabilitation relies on the underlying assumption that a pre-planned structure and productivity for the site is achievable following disturbance. Perhaps the Berkley Pit in Butte, Montana and the smelter influenced area with its slag and heavy metals concentration near Anaconda, Montana appropriately fit the concept of rehabilitation.

The usage of the word restoration today more nearly approximates the 1974 National Academy of Sciences definition of reclamation than that of restoration. Philosophically, it may be that many people are more comfortable with the word restoration due to its god-like connotations. On the other hand, when restoration is used relative to specified ecosystem values for which we have some type of database (e. g., restoration of native bunchgrasses or restoration of soil water infiltration capacity) we approach usage in a proper way.

An appropriate example is the present effort in restoring rangelands to a sustainable level of health. The approach taken relies more on the general ecosystem attributes of structure, function and process in time and space, rather than the exactness of each and every physical-chemical-biological component and therefore is a logical step in the right direction. Not only because the approach gives present land managers reasonable latitude in the decision-making process, but because it also provides for the best on-site resource retention. Future generations of land managers have the opportunity to take restoration to the next level.

Successful approaches to sustainable restoration of rangeland health are dependent on an understanding and an incorporation of the functional links of the ecosystem into the restoration process. Individual units of the landscape within the watershed are linked or connected to each other through physical, chemical, or biological processes. This linkage may be strong or it may be weak but it will be present and the sustainability of restoration will be dependent on understanding the direct and indirect strengths of these linkages. Therefore achieving sustainable restoration necessitates that certain steps be followed. Those listed below may not be entirely new (Vallentine 1989, Briggs 1996) but need to be reiterated.

- 1- A whole watershed (landscape) level evaluation of conditions is needed to understand the condition of each and every landscape unit. Decline in conditions is more properly understood and restoration is best treated in a whole watershed context.
- 2- An assessment is needed as to the degree and nature of the decline in condition of each landscape unit. At present our best reference for this assessment are the standards developed for each ecological site by the Natural Resources Conservation Service. This assessment provides practical direction for intervention. Assessment must include vegetation and soil surface conditions at a minimum.
- 3- An assessment is needed as to the cause of the decline in conditions. Where land management practices have led to the decline, strategies need to be developed that will alleviate or remove the causal factors of that decline. Where livestock grazing is concerned, analysis of animal numbers distribution in time and space is a must if their

role in ecosystem decline is to be correctly determined. It must also be kept in mind that environmental factors beyond human control may have led to the decline in condition. Consideration should be given to climate change and particularly to sequences of precipitation and temperature extremes that send plant communities off on new trajectories.

- 4- Always include watershed-level management strategies as a priority in restoration practices for a landscape unit or site.
- 5- In general sustainable restoration is more easily achieved by starting with the upper elevation first order watersheds and moving successively to lower elevation portions of the system. In this regard, fences, with their separation of ownership and management approach, may dictate strategies which are less than desirable.
- 6- Where conditions warrant the addition of plant materials (seeding, plugs, tublings, cuttings etc.) the first consideration is that species chosen fall within the proper functional groups for each landscape unit. At first glance this is simply matching the plant to the environment, but where sustainable restoration is desired those species selected must re-establish into the future those processes expected on each and every landscape unit, including the dynamic process of plant community change (succession).

In the restoration of rangeland health, consideration should be given to native species but that consideration should be secondary to proper ecosystem function. The point here is to select proper functional groups of plant species to achieve restoration of the desired ecosystem values. There is bound to be disagreement on this issue but the multitude of species involved and the lack of seed resources create roadblocks to their use. In the extreme, Linhart (1995) suggests that "native" means that the seed source be from the same slope, aspect, soils, and not more than 300 feet from the planting site. The underlying assumption is that the genetics of a remnant population, if indeed there is one, more nearly approximates that of the pre-disturbance population than that of a less disturbed population some distance away. Such an assumption should be seriously questioned.

- 7- Establish a monitoring program that measures the ecosystem values being restored. If the desired value is litter, estimate the percent of the surface covered by litter. If the desired value is some minimal bare ground, estimate the amount of it relative to other components of the system. If the desired value is erect deep rooted, perennial bunchgrasses, count the adults and seedlings on a specified area, say 10 sq. ft., and estimate the square feet of surface they cover. If the desired value is precipitation infiltration, measure depth of water penetration into the soil after a storm which has been preceded by a dry period and do so on a variety of landscape units. The point is to make measurements simple, direct, and repeatable and accompany the measurements with photographs.

In summary, sustainable restoration is dependent on a whole-watershed approach where considerable thought is put into the interaction of various landscape units in the watershed. Most importantly, there is no substitute for looking and thinking followed by asking questions. Finally

sustainable restoration must include monitoring, followed by adjustment, adaptation, and change in management strategies if it is to be successful over the long-term.

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