Range Sites

Are they the appropriate spatial unit for measuring and managing rangelands?

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Plant communities—and plant populations that comprise them—represent the fundamental spatial unit at which most information is gathered for inventory, monitoring and, ultimately, decision-making on rangelands (see SRM 1995).

Although different agencies may use different terminology, the plant community is the focal point for describing sites. Plant community concepts underlying site descriptions have been around for more than a century, but their formalization and institutionalization occurred during the late 40's and early 50's.

The range site was the on-the-ground implementation of concepts derived from Clementsian plant ecology. The plant community and the populations and processes within it were the basis for the range condition concept and its application to determine the status of rangelands.

Ultimately, the implementation of management practices was based on managing plant community processes. These ideas and protocols were the bases for rangeland inventory and management during the last half-century. Even though the theoretical basis for describing temporal dynamics has recently shifted from a climax approach to one based on non-equilibrium dynamics and range sites have become ecological sites, plant community attributes and dynamics still dictate site delineation and description.

Through a half-century of research and management and an improved ability to handle large amounts of quantitative information, we have gained an increased knowledge of the importance of spatial scale in describing and managing ecological processes.

In addition, changing expectations of rangeland ecosystem services and heightened interest on the part of the general public in rangelands dictate that we rethink how we organize and disseminate information. In this article, we examine developments in several disciplines representing the most common rangeland values (grazing, watershed, wildlife, recreation) to test whether sites (representing plant community concepts) are an appropriate tool for collecting and organizing information on rangelands. Our objectives are to:

1. Review some emerging principles and applications in the spatial analysis of rangelands,
2. Illustrate how some important goods and services of rangeland ecosystems are the result of the way different organisms and processes integrate resources across a variety of spatial scales, and
3. Describe how information to make decisions and communicate the status of rangelands can be organized to better serve a variety of decision makers.

Managing Livestock

In developing grazing management plans for livestock, a critical step is to estimate carrying capacity and then set stocking rates, integrating both animal performance and vegetation management objectives. The challenge is to set the spatial scale small enough to identify areas with unique production or ecological properties and large enough for cost-effective implementation of decisions. We examine two perspectives: one in which ad-

Northern Great Basin Experimental Range photo illustrating the variability and connectivity of habitat and productivity within a single management unit.

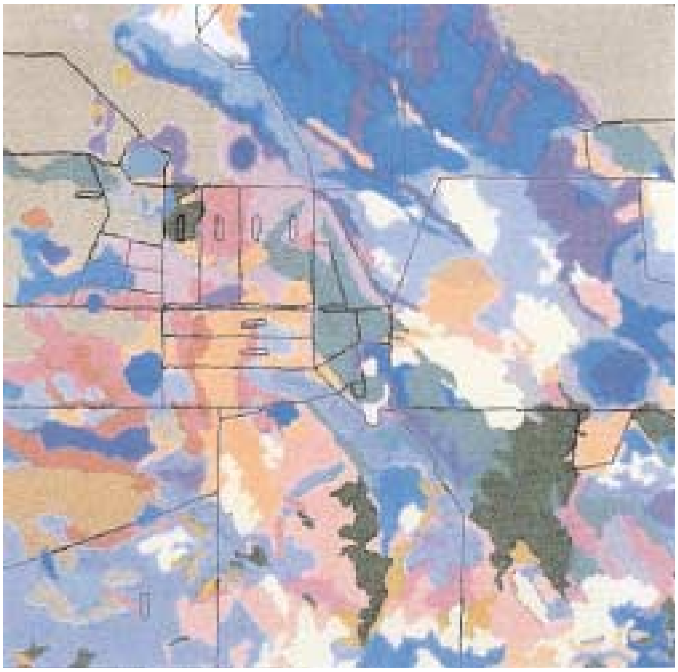

Figure 1. ***Soil map units for the Northern Great Basin Experimental Range, 40 miles west of Burns Oregon. The total area is 16 000 acres. Fifty-four soil map units were identified on the range.***

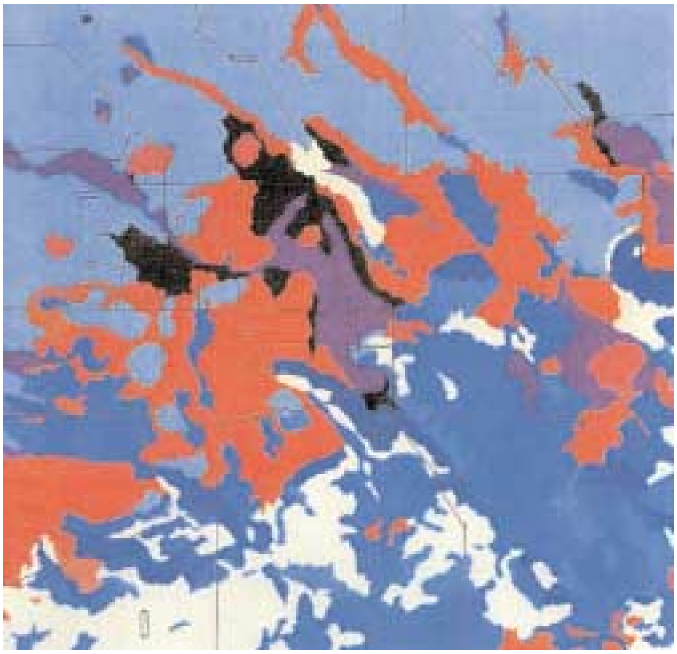

Figure 2. ***The extent and distribution of range sites on the Northern Great Basin Experimental Range. Ten range sites were identified from the soils data.***

vanced analytical tools are employed in a research capacity; the other from the perspective of a practicing rancher.

On the sagebrush/bunchgrass rangeland of the 16,000 ac Northern Great Basin (NGB) Experimental Range near Burns, Oregon, a detailed soil survey was used as the basis for estimating carrying capacity by management unit (pasture) and the information managed and manipulated using Grazing Lands Application software.

Fifty-four soil map units were identified (Fig. 1) with even small (160 ac) pastures containing at least 4 to 5 soil map units. Estimating forage production for 54 different map units was unreasonably time consuming and involved much repetition, so the soil map units were aggregated into the 10 existing NRCS range sites for analysis (Fig. 2). Several pastures were dominated by one range site, but about two-thirds of the land area was a mix of sites and estimating forage production (and carrying capacity) was still too tedious, even for a research unit, considering the contribution to making critical grazing decisions.

With a combination of standing crop measurements, existing forage production data, and "expert" opinion, the ten range sites were further aggregated into four distinct forage production groups (Fig. 3). One large (~4000ac) pasture contained all four production groups, but generally one or two production groups dominated any given pasture.

This approach allows for retention of basic information (soil map units and range sites) in case it is needed in the future, while still providing reasonably scaled management delineations. With spreadsheet-type software it is easy to combine units, and if necessary, recombine according to different criteria (production, seasonality, dominant species etc) if the original decisions

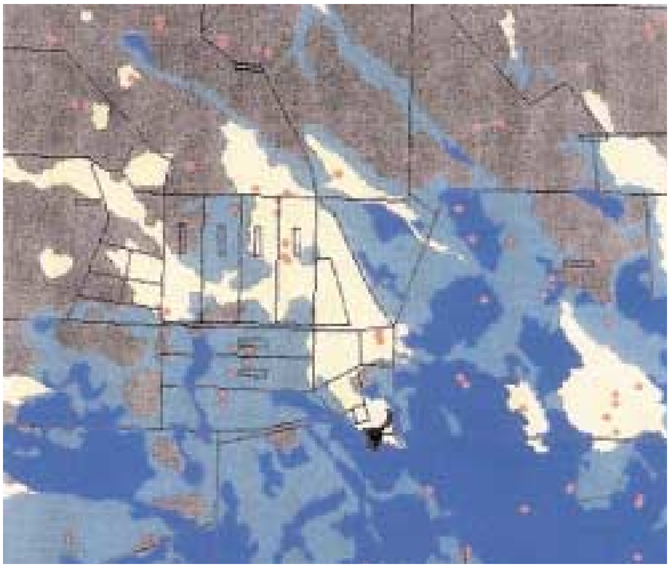

Figure 3. ***Aggregation of range sites into four production groups based on current standing crop, historical data, and expert opinion.***

prove unworkable. The appropriate number of spatial units that best meets management needs will vary depending on intensity of use and land management goals.

From a rancher's perspective, does having range site information, such as productivity and species composition, improve the quality of large-scale decisions made by ranchers? In the example above, the range site information was important, but had limited value in developing a grazing management plan even when high tech tools were available.

Ranchers must make many decisions without the aid of sophisticated tools, using a qualitative, expert appraisal of the lay of the land beyond the community scale: A fence down a ridge to separate two drainages; a seeding on ground gentle enough to till; a water development located at the junction of several pastures; a riparian fence protects a river while continuing to allow a meadow to be hayed. All of these activities require a wide variety of information rather than just descriptions at one spatial scale.

Northern Great Basin Experimental Range photo illustrating the importance of spatial position on the process of shrub increase as invasive plants move from higher elevation rocky outcrops onto lowlands.

However, range site information can facilitate an understanding and be used to create a database of the capability of rangeland. As management units become increasingly smaller in response to development, a thorough description of soil/vegetation dynamics within a site in addition to a quantitative description of the relationships among sites is a critical component in making timely planning, implementation and monitoring decisions for managing domestic livestock.

Managing Watersheds

Infiltration rate, soil water storage capacity, rain use efficiency and precipitation characteristics are hydrologic attributes vital to ecosystem structure and function. Understanding how land use and management impact these attributes can be used as criteria for assessing sustainability and providing management guidance to a wide variety of land managers.

The watershed is an effective natural scale of spatial resolution for assessing progress toward both ecological and economic objectives. Drainage patterns form the framework for energy and nutrient movement within a watershed as well as providing the delivery system of materials and information into larger spatial units.

These flow patterns also provide the context for a more complete socioeconomic accounting of the serial benefits and costs of investments in rangeland management. Examples of watershed management projects from several continents illustrate how varying the spatial scale for assessing management technologies can be influenced dramatically, depending on what ecosystem service(s) are most important and who is making the decision.

For instance, examples from Niger and Honduras show that upland restoration techniques (reestablishing cover) may not be justified if the sole criterion is increased net primary productivity at the site level. However, if the criteria included enhanced hydrologic function at the watershed level, then the application of restoration technologies on upland sites that enhance infiltration rate and soil water storage become integral to project success.

Hydrologic function at the watershed level ($>10^2$ sq mi) is an emergent property and cannot be predicted using solely plant community scale information. Information at the plant community scale must be integrated using both conceptual and mathematical approaches that focus not only on the properties of individual sites, but also on how interactions between and among sites contribute to larger-scale outputs.

Distribution of public resources might also change depending on how the goals and objectives are defined and pursued. The manipulation of shrub density via chemical and mechanical techniques has long been a staple of rangeland management in the semi-arid western U.S where the majority of precipitation falls in small events. The distribution of financial and technical resources has been based on assumptions that both local site productivity and watershed scale hydrologic function would be enhanced simultaneously.

However, economic and ecological analyses suggests that increased water yield at the watershed level would be better accomplished by allocating resources preferentially to riparian sites, while efforts to enhance forage production would be achieved more efficiently by targeting resources to upland sites. Riparian sites had more influence on water delivery than did upland sites where water savings achieved through decreases in shrub density were captured on site by grasses and were not delivered to collection points.

Clearly, the objectives of managing the hydrologic cycle, whether at the watershed scale (water yield) or the community scale (forage production), may change the allocation of both public and private resources.

Managing Habitat

The attributes humans perceive and use to categorize wildlife habitat are the result of interactions that occur at spatial scales both larger and smaller than the site level. Individuals and populations contribute to site level properties, while site level outputs contribute to landscape and larger properties.

Humans selected sites as a management focus largely as a result of our body size, how we perceive and use our environment, and our capacity to organize information. Other organisms are likely to interpret the same information in vastly different ways. Swainson's hawks, for example, annually migrate from the pampas of Argentina to central and western North America. At a much different scale, meadow voles live their lives in areas defined by a measure of square feet. The characteristics that are important in their habitat selection and use may not coincide with the human-perceived concept of ecological sites.

Changing expectations of rangeland ecosystem services and heightened interest on the part of the general public in rangelands dictate that we reevaluate how we organize and disseminate information.

The perceived boundaries of a particular site are based on an animal's integration of habitat attributes and internal driving forces. The characteristics of habitat (e.g., forage, water, or cover) are therefore completely dependent on the animal's ability to see, feel, and remember and current internal needs (e.g., hunger, thirst, predator avoidance, thermoregulation, or social interaction). Features of a particular ecological site may, never the less, have substantial impact on animal species and animal communities.

Individual animals, animal populations, or communities of interacting animal species are rarely limited to single sites. Additionally, biotic and abiotic factors affecting individual animals, populations or communities are not limited to site boundaries. For example, a loamy ecological site dominated by black grama and bush muhly in the northern Chihuahuan Desert adjacent to a housing development provides a different set of habitat constraints then a similar site adjacent to a black grama-bush muhly site with lesser degrees of human influence.

While attributes of human development provide opportunities for some species it provides barriers to others. Feral dogs and cats, roads, introduced plants, increased water availability, and increased perches for avian predators differentially affect the habitat quality for animals that inhabit adjacent lands. As a result there is a shift in the community toward species better adapted to human dominated landscapes.

Similarly, a range site adjacent to or including seasonal water will present different attributes to potential users compared to sites having the same vegetation adjacent to either perennial water or no surface water. Effective management requires concepts and techniques that take into account a species' life history, population genetics and interactions with other species in addition to site-specific information.

Making and Implementing Policy

While the debate over issues of spatial scale in range management has focused mainly on the biophysical aspects of rangelands, it can also be applied to socioeconomic questions. Because humans influence rangelands (and are influenced by them) at various spatial scales, human/rangeland interactions must be assessed and managed at multiple scales.

The smallest scales of human/rangeland interactions, those measured most appropriately at the site level, consists of actions by and/or effects upon humans acting within rangeland systems. Humans can act upon rangelands through: direct management actions intended to regulate livestock grazing, wildlife, or recreation; disturbance behaviors such as off-trail ATV riding; or land type conversions that occur as a result of direct action (new subdivisions) or inaction (failure to control weeds).

Meanwhile rangelands affect humans at these smaller scales by providing scenery, wildlife habitat, food, water, fiber, and forage. Often these interactions are reciprocal, since range management can change how rangelands affect humans; e.g., if fire management influences scenic quality or grazing practices affect fish habitat.

Interactions also occur at larger scales involving actions of humans from outside rangeland systems, whether in small rural communities or society as a whole. These actions may include: changes in range policy at local, regional, or national levels; changes in land-use allocation (e.g., local bans on motorized vehicles, eliminating grazing from a new national park); or economic forces that change the demand for rangeland outputs. Conversely, range ecosystems can affect humans outside those systems through non-anthropogenic events such as fires, floods, insect/disease infestations, weed invasions, or changes in wildlife abundance and distribution.

A good example is the Grand Staircase-Escalante National Monument, designated by President Clinton in

1996 over the protests of Utah citizens and politicians. The initial action was taken to achieve a national political advantage by wooing environmental interests outside Utah, and also to achieve conservation benefits by halting a proposed coal mine. The immediate impacts (loss of potential mining jobs, uncertainty about future grazing, expansion of the tourist economy) were almost entirely local. Paradoxically, designating a new national monument also created an instant national constituency for a hitherto unknown place, so that the scale at which humans were affected by subsequent action was greatly expanded.

The BLM recognized this, and its comprehensive planning effort involved the public at multiple scales from the smallest nearby communities to cities on both coasts. This laudable effort was expensive, and so may not be repeated in subsequent planning, leading to new discrepancies of scale. For example, backcountry recreationists from distant urban areas often say their experiences are negatively affected by livestock grazing, yet grazing decisions typically occur at local scales.

Alternatively, proposed restrictions on off-highway vehicle use were intended to protect national conservation goals but have mainly affected local users who, seeking to resolve the scale discrepancy, have turned to national advocacy groups for help, leading to intensified conflict.

We cannot eliminate scale discrepancies entirely. In the case of private lands, rights of small property holders must be respected, while on federal lands we will always have cases where national political interests override local concerns. However, we can identify means for reducing the frequency of such discrepancies.

One such improvement is to expand social and economic monitoring at appropriate scales. Monitoring must occur not only when needed to predict impacts of proposed changes in policy and management, but beforehand, if managers are to know the appropriate scales for effective public involvement or impact assessment. This does not mean decisions cannot favor interests at one scale over those at another, only that managers should know the scale of impacts so they may be adequately considered.

Working Toward A Better Future

The goal of this article is not to propose a new system of inventorying, measuring and managing rangelands, but to examine our current approaches and stimulate thinking and discussion about how we as a profession can be more effective in communicating with the public and how we can better organize our body of knowledge, ultimately leading to better decisions.

Different ecosystem services provided by rangelands such as water, recreation, habitat, open space and forage production can be analyzed using plant community scale information. However, for each rangeland value, there is convincing evidence that the accurate prediction of outputs of these important rangeland services cannot be accomplished using linear combinations of site scale information. Understanding critical relationships and interactions among natural and management stresses and disturbances can only be understood using a multi-scale approach.

Plant community scale descriptions, whether they take the form of the traditional range site or the new ecological site, will continue to be an indispensable component in the responsible analysis and management of rangelands. However, plant community scale information is inadequate if we expect to meet the needs of an ever- expanding clientele and an ever-increasing complexity of ecological, economic, social and political framework in which decisions are made.

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