Sheep Grazing and Riparian and Watershed Management

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Summary

A critical measure of grazing management success is the functional capacity of rangeland watersheds and riparian ecosystems. Legal mandates for water quality, the increasing demand for water and the importance of riparian areas for recreation, fish and wildlife habitat and their contribution to biodiversity will place increasing emphasis on riparian and watershed management. It is clear that overgrazing and poorly timed grazing by any livestock species can be detrimental to riparian and watershed resources. However, the literature generally suggests that low to moderate sheep grazing levels at optimum times for the vegetation community are not detrimental. Based on reviews of research and anecdotal experiences, recommended management practices for various sheep grazing systems are suggested.

Introduction

Opportunities exist for bringing rangeland management into better balance for optimum sustainability, biodiversity and productivity. A critical measure of grazing management success is the functional capacity of rangeland watersheds and riparian ecosystems. Legal mandates for water quality continue to increase, with emphasis on non-point source pollution. Further, in most arid and semi-arid regions, water quantity is becoming increasingly critical due to population pressures and increased demands for other uses. This paper reviews our understanding of optimum sheep production systems for riparian areas and watersheds valued for the quality of their aquatic and terrestrial ecosystems and their ability to deliver appropriate amounts of high quality water.

The land manager must meet several goals. The protection or restoration and sustainability of the ecosystem is fundamental. For a grazing enterprise to be sustainable, animal production criteria must also be understood and met. The needs of the animal and wildlife and the costs of meeting these needs are critical to sustainable animal production systems. Grazing generally reduces plant cover and may increase soil compaction. Grazing will consume fuels and may either negatively or positively affect individual plants and shift plant species composition. The need, therefore, is to identify appropriate grazing management practices that minimize disturbance and enhance ecosystem functions, fish and wildlife populations and other resource values while economically harvesting nutritious forage. To recognize opportunities for optimal watershed and livestock management, both the land and the animal must be understood in relation to management goals and options.

Watershed management is primarily a function of vegetation and water management. Livestock can be effectively used for vegetation management. The goal for vegetation management is a combination of healthy plants, desired plant communities and the desired mixes of plant communities across a landscape.

Watershed Function

The function of a watershed is the capture, storage and release of water (Bedell, 1991). Water infiltration into soil is the primary means of capture and provides the greatest retention time. Once stored in soil, water becomes available for plant growth and for soil organisms that drive nutrient cycles. Water exerts greater influence on plant distribution and productivity than any other environmental factor. The more water that is captured and stored within the root zone, the more opportunity for vegetation production on-site and downslope. Further, vegetation significantly influences soil's inherent capacity for infiltration and storage. Vegetation also plays a role in the timing of water runoff by providing temporary detention storage sites on

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or within plants and plant litter. Any mechanism that slows runoff will diminish flood peaks and may extend periods of increased flow.

In most flood or runoff events, only part of the watershed contributes water to stream flow. The variable source area, described by Dunne (1978), within or near streams or ephemeral channels is most likely to contribute the first and most runoff. Although previously stored moisture in these areas may cause them to dispense water more quickly, their location where water collects and capacity for water retention creates the conditions necessary for wetlands or riparian vegetation. The vegetation in turn is instrumental in trapping sediment and forming flood plains with gentler slopes and deeper soils. These conditions dampen the flood peaks of large runoff events, thus making these near-channel areas a high priority for watershed management.

Once water collects in channels, vegetation further restricts water flow by providing roughness that decreases water velocity. Riparian vegetation, especially root material, can greatly enhance streambank integrity by binding soil particles against the forces of bank erosion (Smith, 1976; Kamyab, 1991; Kleinfelder et al., 1992). These effects combine to help maintain channel form and floodplain. On meandering streams, these vegetation effects also maintain channel pattern and a gentle gradient that further ensure that the stream will flood onto a flood plain. Well-vegetated flood plains reduce water velocity, trap soils and nutrients and increase infiltration.

Gifford (1984) identified cover as the key parameter influencing runoff or sediment yield. Vegetation and litter absorb the energy of raindrops, thus reducing the energy available to initiate soil erosion. Vegetation and litter reduce erosion from surface runoff by increasing water infiltration, absorbing raindrop energy, slowing overland flow, providing surfaces for temporary water storage and by binding together soil particles and aggregates.

Geographic variation in precipitation and soils leads to natural variation in plant type, plant cover and, thus, in erosion (Thurow, 1991). Some regions produce so much vegetation that, unless disturbed, erosion is rare. Conversely, sparsely vegetated desert areas are largely incapable of retarding erosion. The watersheds with greatest potential for management are those with sufficient vegetation that can be managed to maintain or enhance plant cover, which includes most semi-arid rangeland.

In addition to vegetation and cover, other factors can enhance or retard infiltration and soil erosion. Potential negative effects of livestock include overgrazing and trampling which causes soil compaction and the formation of trails. Roads are renowned for their potential to interrupt and concentrate water flow, increase sediment supply, accelerate runoff and potentially alter stream morphology.

The successional stage of plant communities has often been correlated with infiltration (Gifford, 1984). However, successional stage probably accompanies various soil and soil surface characteristics and the infiltration response may not reflect simply species composition. For at least some range sites, there may be a negative watershed response from woody plant communities where natural fire cycles have been disrupted, such as those dominated by western juniper, *Juniperus occidentalis* (Buckhouse and Gaither, 1982). For any watershed, disturbance will largely determine erosion response to rainfall, and the most recent disturbance is likely to dominate (Gifford and Hawkins, 1978). However, some disturbances even as dramatic as prescribed fire may be useful at times if they lead to improved vegetation for watershed protection (Buckhouse, 1985; Taylor, 1994).

Streams or Riparian Areas

Just as upland range sites vary in their potential to produce vegetation or watershed functions, so do streams and their associated floodplains and riparian zones. Much effort has been devoted in recent years to riparian and wetland classification (Cowardin et al., 1979; Winward and Padgett, 1987; Swanson, 1988; Platts, 1991). Most classification systems use a relationship between geomorphology, including soils and hydrology, and a site's potential to grow plants. Stream types differ in reaction to land management, dependence on vegetation for channel stability and potential to provide fish habitat, clean water and other resource values. Stream types differ on the basis of active channel braiding, entrenchment, width-to-depth ratio, sinuosity, substrate and gradient. Stream type and ungulate bank damage are each correlated with many aquatic habitat condition and stream stability variables including riparian vegetation (Manning and Padgett, 1992; Myers and Swanson, 1992). Some streams or stream reaches are relatively stable and, when disturbed, will return to pre-disturbance condition rather quickly, while others may be disturbed enough to exceed a geomorphic threshold (Schumm, 1977). Streams may progress through a predictable series of geomorphic stages and may become more unstable before attaining the capacity to stabilize (Van Havern and Jackson, 1986; Swanson, 1989). Riparian managers must consider a stream's potential to change and respond to management in order to set achievable and measurable objectives.

Riparian objectives most often focus on vegetation. Woody plants are valued for shade, structural and habitat diversity, for coarse woody debris or root wads that form certain fish habitats (McCain et al., 1990) and because they may be part of the natural stream and riparian ecosystem. Herbaceous plants also influence channel morphology and provide habitat for numerous species. Narrower streams, less variable water temperature and decreased sedimentation of spawning beds are the most common fish-related stream objectives for riparian grazing management. Managers should minimize direct effects on stream morphology such as bank trampling and contamination. Properly managed riparian areas can provide forage for domestic livestock and, at the same time, provide esthetically pleasing recreation areas, critical wildlife and fisheries habitat and water resources that are plentiful and clean.

Factors Influencing Sheep Grazing

The voluntary intake of forage by sheep may be affected by pregnancy status, age, body condition, hunger or satiety and the amount and type of forage available. Grazing selectivity may also be influenced by ambient temperature, slope and elevation, distance from water and trails, experience with the range, season of grazing and the extent to which animals are controlled during grazing. Only those factors affecting voluntary intake that directly impact on riparian and watershed management are discussed in this review.

Spatial, Temporal and Management Factors

Sheep are diurnal grazers, with normal grazing early in the morning and in the afternoon towards dusk (Arnold, 1981). Grazing periods tend to be longer when available forage is low and shorter during the summer. Night grazing is normally a minimum, but tends to increase during periods of higher ambient temperatures and/or when available forage is limited. Night penning may interfere with normal grazing times, thus influencing the amount of time spent grazing during the normal grazing periods. Sheep spend up to one-half of their time resting and include time for watering, trailing and cud-chewing during their non-grazing periods.

Sheep tend to prefer upland grazing sites and are less intimidated by steeper slopes than cattle. Sheep do not prefer wet or marshy grazing areas. They are reluctant to penetrate dense vegetation higher than their line of vision, which may result in "spot grazing" in areas with excess forage production. Sheep tend to graze into the wind, but will graze away from the wind in colder climates with higher wind velocity (Griffith, 1967). Location of preferred plant communities, as well as elevation and slope, influence sheep grazing site selection. Distance to water can be important on arid ranges during high ambient temperature periods (Cook, 1966).

One factor of practical importance is animal experience on the available range. Inexperienced animals may exhibit depressed intakes of as high as 50% for as long as 10 months (Arnold, 1975). Many range operators have experienced this problem, especially where available grasses, forbs and shrubs are quite different from the animals' previous experience. Ranchers believe inexperienced animals are more likely to graze unfamiliar toxic plants. Adding inexperienced animals to flocks of experienced animals is helpful.

Grazing Management System

A critical factor influencing sheep grazing of available forage is the sheep management system. Basically, three grazing management systems are used in the U.S. Sheep are required to graze under herder supervision on western public rangelands. Approximately 40% of U.S. sheep are grazed under herded systems, which may be the most intensively controlled grazing system ever devised by man. The second major grazing system may be defined as fenced pastures in semi-arid rangelands, with no supervision of sheep within pastures. Another 40% of U.S. sheep are grazed in this system in Texas and the Southwest, the Northern Great Plains and on private lands in the western states. The remaining 20%, largely in the midwest and east, are managed under various systems of intensive pasture grazing, often associated with integrated crop-livestock production systems. Ely (1994) discussed the more intensive systems under sustainable agricultural systems approaches.

Herded grazing management may be defined as an intensive and opportunistic grazing system, often resulting in rangeland receiving its annual grazing in one day with 364 days of rest, which is just about as intensive as grazing can get. Herded production systems are opportunistic in that the sheep are moved seasonally to rangelands that may optimally be grazed in the spring, summer, fall or winter for animal and/or vegetation response. Most production systems were initially designed to optimize animal response rather than for vegetation management. Variations in herded systems range from operations in Nevada that never leave public lands to Idaho producers that ship pregnant ewes to southern California and Arizona for winter lambing on crop aftermath, usually alfalfa, then ship the ewes and lambs back to rangelands grazing in the spring. Early lambing in northern climates usually requires shed lambing, which is normally timed so that lambs are ready to turn out on spring grazing with their mothers at two to three weeks of age. A growing number of range operators are spring lambing later in the season on range or pasture.

Fenced pasture or rangeland grazing systems, primarily on private lands, are generally without supervision of the sheep. Ranchers will handle the sheep only two to four times per year and when rotating pastures. A large portion of these range operations include co-species grazing of cattle and sheep, with goats included in many Southwest range operations. Where habitat is favorable, deer and other wildlife species may be economically important for private range operators. Because sheep are selective grazers, it would seem likely that they would perform better when allowed to graze without control than when herded. Walker and Glimp (unpublished data) confirmed this in three years of studies at the U.S. Sheep Experiment Station. Ewes and lambs grazing in fenced pastures on mixed sagebrush-grass-forb range had heavier ewe and lamb weights at weaning than those grazing under herded management.

Watershed Grazing Management

As stated previously, good watershed management is largely a function of good vegetation management. The negative impacts of grazing are a combination of trampling and vegetation removal. Blackburn

(1984), in a comprehensive review of the impacts of grazing on watershed management, states that the literature is full of references that document the negative effects of overgrazing on soil hydrology and erosion. Blackburn (1984) summarized the negative effects of heavy grazing and the resulting loss of vegetative cover as: 1) increasing the impact of raindrops, 2) decreased soil organic matter and aggregates, 3) increased surface crusts and 4) ultimately increased erosion. He states, however, that existing studies generally show no hydrologic advantage of zero or light grazing levels over moderate grazing levels.

The studies reviewed by Blackburn (1984) and Gifford (1984) indicate that heavily grazed shrub-dominant ranges generally have lower water infiltration rates and higher erosion levels than moderately grazed mixed shrub-grass and perennial grass dominant ranges. Pearse and Wooley (1936) found greater water infiltration rates on plots with fibrous-rooted plants than plots with tap-rooted plants. Perennial bunchgrasses with fibrous roots tend to encourage greater infiltration and reduced erosion over shallow-rooted annual grasses (Packer, 1951; Dadkhah and Gifford, 1980). Studies in Montana (Vogel and Van Dyne, 1966) and Utah (Ruyle and Bowns, 1986) indicate that long-term sheep grazing at moderate levels increases perennial grasses and reduces forbs and shrubs in the vegetation mix. These studies when combined indirectly suggest that properly managed sheep grazing may create a vegetation mix that could improve soil hydrology and reduce erosion.

Low to moderate grazing intensities that utilize less than 60% of available forage are likely to encourage better sheep grazing distribution and decrease reliance on riparian areas that may be in the pasture (Blackburn, 1984). Vogel and Van Dyne (1966) found that neither total cover nor total herbage yield differed greatly on areas that were moderately grazed by sheep as compared to those deferred from grazing for four years. One concern might be the preference of sheep for grazing on upland sites with greater slope, which could increase erosion potential. Wilcox and Wood (1988) compared infiltration rates and sediment production on sites varying from steep (less than 50%) to moderate (greater than 10%) slopes with ungrazed and moderately grazed with sheep sites on semi-arid rangelands in New Mexico. Infiltration rates were lower and sediment rates were higher on the steeper slopes and grazed sites, although the differences due to moderate sheep grazing were not large enough to cause serious concern. Steeper slopes were not more hydrologically sensitive to moderate grazing than moderate slopes. They also noted that the differences in infiltration and sediment production due to moderate sheep grazing were much lower than those reported for moderate cattle grazing on similar sites (Gamagoun et al., 1984; Weltz and Wood, 1986).

There is no grazing system that is universally optimum for both vegetation management and sheep performance. Rotational grazing systems that provide strategic rest or deferment periods combined with moderate stocking rates are credited with range improvements in recent history (May and Davis, 1982; Blackburn, 1984; Platts, 1990). Two accepted rotational grazing systems are the Merrill three herd/four pasture system developed by Leo Merrill at the Texas Agricultural Experiment Station near Sonora, TX, and four- to five-pasture rest-rotation systems that provide a full-season rest during the rotation. The Merrill system uses four pastures for four seasons and only three grazing flocks or herds. Over a four-year cycle, each pasture will receive a seasonal rest in each of the four seasons. This system is most widely recommended and used on Southwestern rangelands that generally have longer growing seasons and less predictable rainfall. In the more arid western states with shorter growing seasons, rest-rotation grazing systems that provide a full-season rest on a rotational basis appear to be the most widely recommended. Rest-rotation systems with sheep that combine both full-season rest and seasonal use rotation in the grazed pastures are considered most desirable for riparian and watershed management (Platts, 1990).

Research at the U.S. Sheep Experiment Station (Laycock, 1967) documented the consequences of heavy sheep grazing during the spring growing season on sagebrush-grass ranges. Grasses and forbs virtually disappeared with heavy spring grazing, while heavy fall grazing increased grasses and forbs and reduced shrub density. If trail routes and grazing periods cannot be seasonally adjusted, grazing pressure in the growing season should not result in more than 40% to 50% utilization of the preferred plant species. One approach to improving grazing distribution and more uniform vegetation use is co-species grazing of cattle and sheep, which is discussed in detail by Walker (1994). This system is widely used in the Southwest and should receive increased attention by land managers in the western U.S.

A rotational grazing system widely promoted over the last 15 years in the Southwest and West is short duration grazing (SDG) or the Savory grazing method (SGM; Savory, 1978, 1983; Savory and Parsons, 1980). A large number of pastures are used with livestock concentrated on one pasture for a short period followed by a longer intermittent rest period. Proponents of this method have claimed that the SGM increases plant vigor, reduces selective grazing and, with intense trampling activity, improves seedling establishment, enhances rainfall infiltration and reduces erosion. A series of research studies by Texas A&M University scientists clearly do not support the claimed hydrologic benefits (Wood and Blackburn, 1981; McCalla et al., 1984; Warren et al., 1986abc). These studies consistently reported reduced water infiltration and increased sedimentation with SGM tactics.

Where herded sheep grazing systems are used, herders should move their camps frequently to minimize grazing pressure in areas around campsites. Bedding grounds should be moved daily, which would increase benefits to soil fertility. Failure to move bedding grounds frequently can result in plant damage and soil nutrient overload from feces and urine. Movement of sheep to and from bedding grounds and water sites should be as random as possible to avoid trail development and vegetation damage. One of the common mistakes of herders during grazing periods is to exercise too much control over flock distribution. The authors have observed flocks of up to 1,000 ewes plus their lambs grazing in areas of 10 to 15 acres. This clearly increases potential for overgrazing and the majority of the sheep will not be able to selectively graze. A good herder should plan where the sheep should go during the grazing period, see that they are moving in that direction and then leave them alone to spread out and selectively graze. A herder that knows how to manage sheep during grazing can add five pounds or more to weaning weights and will graze rangelands closer to the desired vegetation level in the process.

Riparian Grazing Management

Riparian grazing, particularly by cattle, has often been critically discussed (Platts, 1991). Riparian areas may account for as high as 80% of cattle grazing time, yet not cover more than 2% of the rangeland and produce only 15% to 20% of the total available forage (Reid and Pickford, 1946; Roath and Krueger, 1982). The major advantage of herded sheep grazing is that the herder can control the amount of time spent grazing riparian areas. This is made easier by the preference of sheep for grazing upland and drier areas (Cook, 1966; Arnold, 1981). Platts (1982) reported that properly managed herded sheep grazing will have little impact on riparian streams and critical habitat vegetation. May and Davis (1982) stated that sheep generally exert a minimum influence on riparian and aquatic areas and that herding to direct sheep away from stream side areas once desirable forage use is achieved is the most effective grazing system. Platts (1990, 1991) rated a wide range of livestock riparian grazing systems with respect to their impact on streambank stability and brushy species condition, based on research results and experiences. He rated herded sheep grazing and rest-rotation with seasonal preference to avoid riparian problem times as the most desirable livestock riparian grazing systems and second in preference only to non-use. Both May and Davis (1982) and Platts (1982) suggested that areas where the riparian zones have been overgrazed by cattle may need to be switched to sheep use. Although not published, the U.S. Sheep Experiment Station has shared a U.S. Forest Service summer grazing allotment with cattle (approximately one year sheep, three years cattle in a four-unit rotation). The riparian vegetation in this allotment is generally very healthy, especially for the first one to two years after sheep grazing.

Timing and intensity of grazing are critical to riparian areas. The preferred grazing periods are late season and dormancy (Platts, 1990); however, grazing should not be at levels that are competitive with wildlife that depend on riparian habitats for winter range. Prolonged or repetitious grazing of riparian areas during the growing season should be avoided and growing season use should be restricted to light to moderate use. Hayes (1978) suggests that vegetation use in riparian areas should be less than 60%. Platts (1982) stated that rest-rotation grazing strategies are preferred with vegetation use in the range of 25 to 50% and that stream bank and vegetation damage are likely when utilization exceeds 65%. Research has generally supported grazing strategies that allow re-growth.

A major concern with herded sheep grazing is over-use of riparian areas by herders for camp sites and bedding grounds, or when riparian areas are used for excessive periods as holding areas on trails (May and Davis, 1982; Platts, 1982). Herders would generally have to force sheep to remain on riparian areas because they prefer upland and drier sites. An exception would be during hot summer weather when the only shade may be along streams. Another exception may be late in the growing season when woody riparian plants may be the most palatable available vegetation. Herders must avoid continued use of the same areas for resting or grazing.

With fenced pasture grazing, probably the most critical factors are time of grazing, suitable stocking rate or grazing intensity, many watering sites rather than one location along a stream and adequate shade away from riparian areas. Although sheep prefer upland and drier grazing sites, sheep will graze where necessary to meet their nutrient needs. This includes riparian areas. Providing alternate water, salt and shade away from riparian areas will likely decrease riparian disturbance. If riparian vegetation damage is occurring, particularly in fragile ecosystems, fenced riparian pastures may be needed to control riparian grazing (Platts, 1990).

Water Quality

Kaufmann and Krueger (1984) reviewed the literature on the effects of livestock grazing on instream ecology and water quality. Livestock grazing at moderate to heavy stocking rates can reduce streambank vegetation which may result in increased water temperature and stream sediment loads. Both of these problems may reduce salmonid fish populations (Platts, 1990).

Buckhouse and Gifford (1976) summarized results from other studies that fecal coliform, streptococci and other pathogens from livestock and wildlife can contaminate streams. Their own research concluded that this was not likely to be a problem on arid rangelands of moderate slope and remote from live streams. Other studies reporting fecal bacterial contamination of streams (Darling and Coltharp, 1978; Skinner et al., 1974; Tiedemann et al., 1988) found contamination to be highest during the grazing season with heavy grazing along riparian areas and during heavy runoff periods from snow melt or rainfall. Tiedemann et al. (1988) reported that controlled livestock grazing with light to moderate vegetation use resulted in lower fecal coliform water contamination than uncontrolled grazing. Blackburn (1984) concluded from his review of the literature that moderate vegetation use and adequate ground cover will likely prevent significant fecal contamination from rangelands.

The general conclusion that light to moderate grazing is preferred for watersheds and water quality is clearly supported by the literature. Sheep preference for upland grazing sites is clearly a positive factor. The highest potential for abuse with sheep is poor selection of and failure to rotate bed grounds. Sheep will concentrate urine and feces at bed grounds, which should not be located near streams. Moving bedding grounds daily maximizes soil fertility benefits, minimizes vegetation damage and reduces the potential for contamination of streams.

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