Water Quality: The Rangeland Component

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Rangelands can be a major component in many watersheds, and proper grazing management is essential in minimizing runoff into the watershed. Lowering the runoff potential from rangelands will improve the water quality of the watershed.

The Bowman-Haley watershed in North Dakota is an example of a watershed that contains a high percentage of rangeland. This watershed consists of 316,800 acres of land situated in southwestern North Dakota. Over 175,000 acres (55.3 percent) are native rangeland with another 46,000 acres (14.5 percent) tamegrass pasture and hayland. Improving grazing management techniques must be emphasized if water quality is to be improved in this or any other watershed in North Dakota.

Many acres of the rangeland is currently overgrazed and over-utilized, which has promoted a deterioration in range condition. Researchers studying rangeland hydrology show that as range condition decreases, rainwater and snowmelt infiltration decreases and runoff increases. High runoff causes a shortage of moisture needed for plant development, increases soil erosion and moves sediment into water resources. Plant growth must be increased to slow down runoff and increase infiltration by improving the soil structure.

Sediment in water has been recognized as a pollutant in the same content as industrial waste, sewage effluents, and other forms of pollution. Range management that controls erosion and sediment movement will help us reach water quality goals.

Researchers have found that achieving ground cover of 60 percent or greater is recommended to keep surface runoff less than 5 percent, if rainfall was 2.5 inches for one hour. Ground cover of 35 to 40 percent will allow about 15 percent runoff at the same rainfall rate. A minimum of 30 percent ground cover at all times is recommended. With proper grazing this goal is attainable.

Research shows that proper grazing (50 to 60 percent utilization of aboveground biomass) will allow sufficient plant growth for adequate ground cover. Many researchers have shown that stocking rate seems to be a consistently more important influence on infiltration rate and bulk density than the type of grazing system. Well managed grazing, stocked at proper rates, resulted in little to no increase in erosion compared to no grazing. However, a marked increase in erosion will occur under heavy grazing.

There are several natural and introduced factors, including grazing, that influence erosion. Observed changes in erosion (variance) between different locations can help determine which factors affect erosion the most. Those factors that create the greatest variance are the most important.

Grazing and its attendant effects on depletion of plant cover and litter and trampling of the soil was the most important factor contributing to erosion and sediment build-up (Table 1). Plant cover can be restored by implementing range and livestock management improvements, especially on areas highly susceptible to erosion. All practices designed to control erosion will potentially reduce sedimentation.

Table 1. Variance in erosion associated with the following seven factors expressed in percent (Renner, 1936. USDA Tech. Bull. 528:32).

Gradient	2.9
Rodent infestation	4.9
Plant density	6.8
Aspect	10.6
Soil condition	12.8
Plant type	13.4
Past grazing as expressed by accessibility of range to livestock	15.3

Proper Grazing Management

Utilization

A common rule for proper grazing use is "take half - leave half" or 50 percent utilization. Proper grazing is defined as the degree of use that will maintain or improve range condition.

Before a grazing management system can be designed to improve range health, range condition must be assessed. Range condition is determined through careful observation and some special techniques. Cages that prevent grazing are often used to compare grazed and ungrazed range to determine levels of use. Small cages (18 inches by 36 inches) are adequate to allow visual comparisons between grazed and ungrazed range.

Degree of use can then be estimated (Figure 1, 2, 3, 4, and 5).

Taylor and Lacey (Monitoring Montana Rangelands, Ext. Bull. 369, 1987) developed these five figures and indicate in Figure 1 an illustration of a 25 percent use (by weight) for a bunchgrass. Figures 2-5 illustrate percentage weights of various grass species as utilized at different stubble heights. Remember, proper use is 50 percent (take half - leave half).

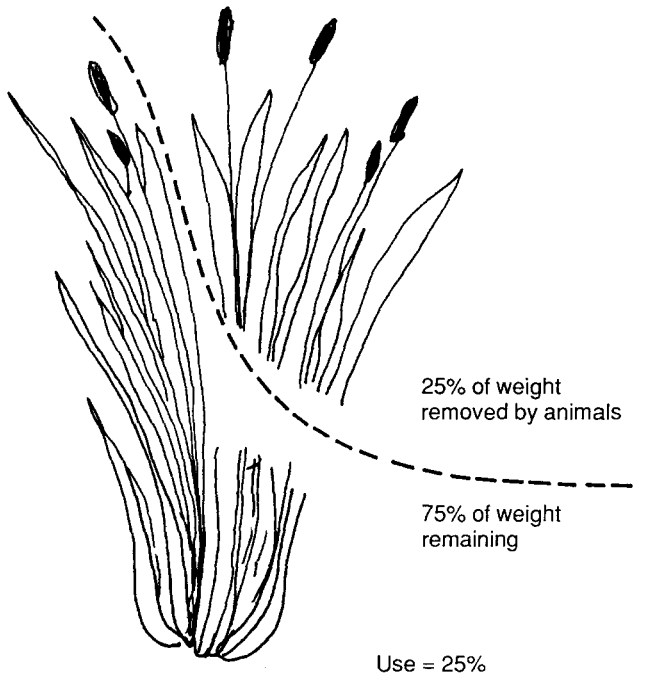

Figure 1. Forage use of a bunchgrass.

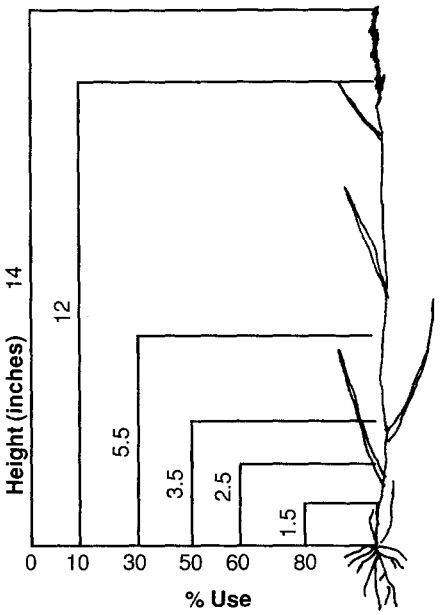

Figure 2. Percentage weight of western wheatgrass utilized at different stubble heights.

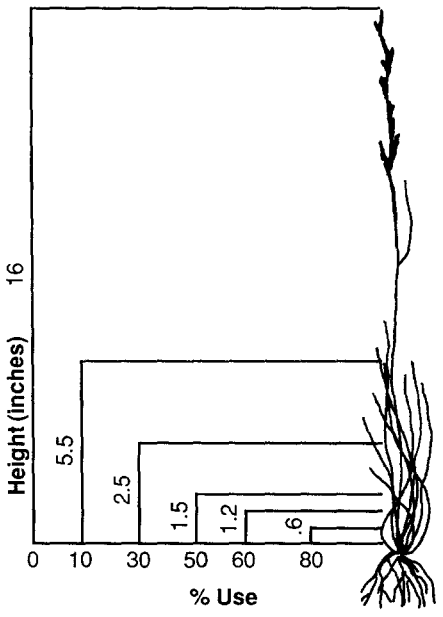

Figure 3. Percent of Idaho fescue utilized at different stubble heights.

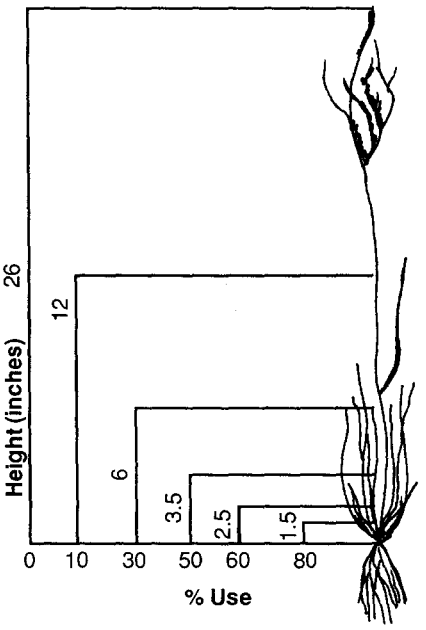

Figure 4. Percentage weight of needle-and-thread grass utilized at different stubble heights.

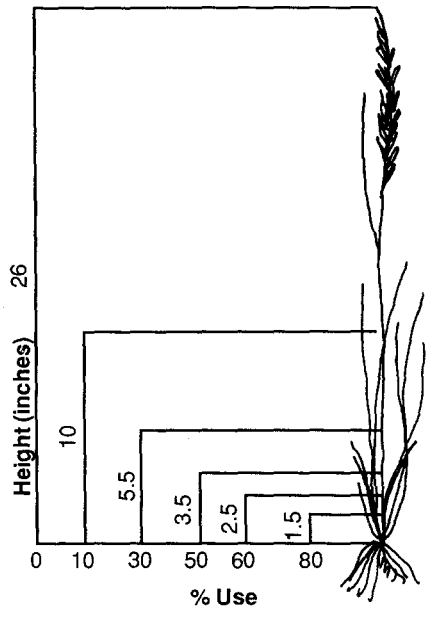

Figure 5. Percentage weight of green needlegrass utilized at different stubble heights.

Timing of Grazing

One of the most important techniques in range management is proper timing of grazing. Native rangeland in North Dakota should be grazed no earlier than June 1, with the exception of the southeastern region where about May 20 is recommended. April and May are critical growth months for the cool-season grasses, late May and June critical periods for warm-season grasses. Plants are most sensitive to grazing during this time period. Most plant species defoliated or grazed in April and May rely on stored nutrients from the roots to provide regrowth. Nutrient reserves are then depleted and cannot be replenished adequately due to loss of leaf area needed to perform photosynthesis. Forage production is reduced (Table 2).

Crested Wheatgrass - Smooth Bromegrass and Timing

Pastures or range dominated by crested wheatgrass or smooth bromegrass should be grazed separately. Crested wheatgrass and smooth bromegrass are introduced cool-season grasses that begin growth earlier than the native grass species. Early grazing, beginning the end of April to early May, is recommended. These introduced grasses can maintain a heavier stocking rate than native rangeland, about 1.0 animal units/acre/month (ex. one cow/calf pair per acre or five sheep per acre) in southwestern North Dakota to around 2.5 animal units/acre/month in eastern North Dakota if fertilized annually. Mature crested wheatgrass becomes extremely rank and is seldom grazed after July 1. Mature crested wheatgrass is best harvested for hay to eliminate old plants from inhibiting grazing the following spring.

Table 2. Percent of potential forage production compared by start of grazing date on seasonlong treatments (Rogler et al., 1962, ND Agri. Exp. Sta. Bull. 439 and Campbell, 1952, J. Range Manage. 5:252-258)

Starting date of grazing season	May 1	May 15	June 1	June 15	July 1	July 15	Aug 1
Mandan, N.D.							
Percent of Max. Total	24	43	57	67	92	100	87
Percent Lost	76	57	43	33	8	0	-13
Canada							
Percent of Max. Total		55		88	93	100	82
Percent Lost		45		12	7	0	-18

Carrying Capacity and Stocking Rates

Determinating carrying capacity of the rangeland and current stocking rate is necessary for proper grazing management. Carrying capacity can be calculated using the Soil Conservation Service (1984) technical guidelines.

Recommended carrying capacity or stocking rate is equivalent to the forage demand on a unit of land over time. A change in one or both of two factors, 1) amount of land grazed and 2) time of grazing season, will change the carrying capacity of the range resource.

The stocking rate of the present livestock herd can be determined by multiplying the number of animals times their animal unit equivalent (AUE) (Table 3). Then multiply the number of AUEs times the number of months desired for grazing. The resulting number is the animal unit months (AUMs) of forage needed to support the herd. Refer back to the carrying capacity (AUMs of forage produced on your range resource), determined earlier from the SCS Technical Guidelines. The stocking rate should be close to the carrying capacity for the most efficient use of the resource.

Table 3. Animal unit equivalents[a]

Animal	AU Equivalent
Cattle	
Mature 1,000 lb cow with or without calf	1.00
Mature 1,100 lb cow with or without calf	1.07
Mature 1,200 lb cow with or without calf	1.13
Mature 1,300 lb cow with or without calf	1.19
Steers and heifers (2 yrs and over)	1.00
Calves (over 3 months)	0.30
Weaned calves to yearling	0.60
Yearling cattle	0.75
Dairy cattle	1.30
Mature bulls	1.30
Sheep	
Mature ewes with or without lambs	0.20
Weaned lambs to yearling	0.12
Mature rams	0.25
Goats	
Mature does with or without kids	0.17
Weaned kid to yearling	0.10
Mature bucks	0.22
Wether	0.16
Others	
Deer	0.17
Mature buffalo	1.00
Mature horses	1.50

[a] 1.0 animal unit is based on 26 lbs/day consumption of dry matter.

Proper range management may involve increasing or decreasing stocking rates, or keeping stocking rates the same. The producer can either adjust animal numbers, length of time animals are pastured, or number of acres being grazed.

Range Improvement Practices

Range improvements are special treatments, developments, and structures used to improve forage production and resource, or to facilitate use by grazing animals. Water developments, fencing, burning, mowing, and salt and mineral placement can be used to control livestock distribution. More uniform distribution of livestock will improve forage efficiency and reduce damage from overgrazing on areas of livestock concentration.

Planning is the key to successful range improvement practices. The planning process should include a range situation map showing the producer's fences, water, natural barriers, range sites, and range condition. Based on the map, problems and solution can be assessed. An overall plan can then be developed that includes possible range improvements and changes in livestock management.

Grazing Systems

A grazing system is a management plan intended to provide a more uniform and proper use of forage resource. Maintenance or improvement of the rangelands to provide a high level of animal production is the major objective.

In North Dakota, native and tamegrass pastures are grazed under several different grazing treatments (Table 4). Grazing systems must be adapted for individual farms or ranches. Systems are developed to suit each particular set of circumstances. Consideration must be given to availability of water in each pasture, the type of livestock operation, kind and type of forage available for grazing, number, size and/or carrying capacity of different pasture units available, and relative location of pastures for easy movement of livestock between pastures.

Continuous grazing is the most common grazing method used in North Dakota. It consists of unrestricted livestock access to any part of the range during the entire grazing season. Livestock utilize the most desirable forage first with seasonlong grazing. Livestock distribution is very poor, especially in larger pastures. Severe overgrazing occurs where cattle congregate, leaving other areas under-utilized. Maintenance of long-term productivity can only be maintained by moderate levels of stocking under continuous grazing.

Rotation grazing systems are usually designed to give most attention to certain key plant species. A proper system allows range plants to recover from the shock of close cropping by livestock. Time is required for plants to regain their vigor through build-up of carbohydrate reserves. Rest after intense grazing is provided by moving livestock among two or more pastures on a scheduled basis. A pasture may be alternately grazed and rested several times during a grazing season.

However, longer rotations may be on a basis of rotating the deferred pasture or the rested pasture among months, or even years.

Specialized grazing management plans, once in operation, often permit increased stocking rates, thus increasing livestock production per acre. Depending on the degree of intensification of grazing management, observations indicate stocking rate increases of 15 to 25 percent are possible when compared to normal stocking for properly managed continuous grazing on native rangelands. If stocking rates are excessive before implementing a grazing system plan, a reduction in animal numbers should be made until forage production and plant vigor are improved.

The range should be stocked to get full use of the total available herbage in grazed units during the grazing season under a good rotation system. This means 50 to 60 percent utilization would be desired. Heavier grazing (60 percent utilization) can be tolerated under a good grazing system, because it is not sustained for long periods.

Any amount of rotation is better than none at all. When designing a rotation system, start with water development and availability, then construct the fencing design. The

Table 4. Grazing treatments used in North Dakota based on grassland or forage type.

Grazing Treatments	Grassland or forage type		
	Native	Tame	Native & Tame
Continuous grazing	x	x	
Rest-rotation	x		
Deferred-rotation	x		
Switchback-rotation	x		
Twice-over rotation	x		
Short-duration	x		
Complementary			x

simplest grazing system is two pasture **switchback grazing**. It involves rotating livestock back and forth between two pastures every two to three weeks.

Rest-rotation grazing systems in North Dakota are designed to include four pastures. Three are grazed, leaving one idle each year. The first pasture is grazed in the spring, second in the summer, and third in the fall. The starting pasture is alternated every year.

Deferred rotation grazing allows discontinuation of grazing on different parts of the range in succeeding years. This allows each grazed part to rest during the succeeding growing season. Traditionally, deferred rotation grazing generally implies no grazing until seed is mature on one unit during the first growing season, or on another unit during the second year, and so on in rotation. A pasture grazed early in the growing season but left ungrazed during rapid growth and flowering of key plant species would not be a deferred pasture.

The **twice-over rotation grazing system** is a variation of deferred-rotation grazing. This system rotates the livestock faster, resulting in more acceptable forage for livestock throughout the grazing season. During the first grazing cycle, cool-season grasses and sedges are utilized before they become too mature and unpalatable. High quality vegetative regrowth forage is available during the second grazing cycle. Three to five pastures are commonly used in this system.

Twice-over rotation grazing allows for a long period of rest between rotations. Only one pasture is grazed during the critical period in plant development, when carbohydrate root reserves are being used for spring growth. The grazing sequence will alternate from year to year.

Short-duration grazing, also known as rapid-rotation and time-controlled grazing, is a rotation system using multiple pastures and usually one livestock herd. It involves a large herd combined with many small pastures, resulting in a high stocking density (animals/area). The system is usually designed with eight or more cells. Grazing period is short, usually seven days or less, to eliminate grazing of new plant regrowth. The rest period, generally 30 days or more, allows regrowth to recover for grazing prior to maturity.

Number of grazing cycles obtained during the grazing season depends on stocking rate and forage regrowth potential. Four to five cycles should be obtained if properly stocked. This grazing method should not be implemented unless grass and herd management practices are at a high skill level.

Complementary grazing uses domesticated grass, legumes, and annual crop pastures to add to or "complement" native range pastures. Crested wheatgrass and smooth bromegrass are often used for spring grazing, and altai wildrye and Russian wildrye can be used for fall and early winter grazing. Crested wheatgrass and smooth bromegrass have the following advantages:

1) they begin growth earlier in the spring;
2) they produce more early season forage;
3) they can be grazed earlier; and
4) fewer acres are required per animal unit compared to native grasslands.

Seeded grasses used in spring can provide excellent grazing for 45 days or longer.

Water Development

Water development may allow increased stocking rates by lengthening the season of use, spreading moisture usage more evenly over the range, or opening up more range to grazing. Stocking rates must also be evaluated in terms of adequate drinking water for livestock. Maximum livestock gains can be obtained only when both forage and water needs are met.

Rolling topography contains many draws and ravines with opportunities for water development. Waterways are often dammed with spillway dams that create small reservoirs. They function as both water holes and sediment traps. These small reservoirs are either permanent or temporary.

Dugouts are also commonly developed to hold water for livestock consumption. Dugouts are developed by digging a large depression in a low-lying area that normally collects runoff water from adjacent slopes. Low areas that often hold water in spring or have a water table close to the surface provide good locations for dugout development.

Water development on rangeland may also include techniques in waterspreading. Waterspreading is a practice of diverting runoff water from stream channels or courses and distributing it over flood plains or lower lying prairie. The velocity of water is slowed and the water allowed to infiltrate into the soil, filtering out sediments. Increased forage production and reduced channel erosion is the result. Water may also be spread via a single furrow or ditch leading from a channel or complex system at dikes and dams.

Piping is another common water development technique. Piping water from one place to another is a common practice in western North Dakota. This technique involves developing a pipeline that begins at a current water supply and ends at a destination where water is needed.

Other Range Improvement Practices

Range improvement practices that are direct means of developing and improving range forage resources include:

1) control of undesirable range plants;
2) applying fertilizer;
3) grass interseeding and reseeding; and
4) runoff control, i.e contour furrowing.

Runoff control — Contour furrows and pitting on rangelands are used to control moderate amounts of runoff and improve infiltration for increased forage production. These are best used on moderate to nearly level slopes and on fine-textured soils. Pitting equipment has been used on rangelands to form small pits that can store 1/3 to 2/3 inch of water. The water is then available for vegetative growth. Deferment from grazing for one year is recommended.

Control weeds and woody plants — Gumweed, fringed sage, leafy spurge, thistles, buckbrush, and sagebrush are moisture and nutrient competitors. They can be controlled by mowing, burning and applying herbicides. Brush management should take into account the benefits of brush for late-season forage and wildlife cover.

Reseeding — Complete tillage and reseeding to native or introduced grasses can be used to restore previously cultivated lands, areas disturbed by mining, or overgrazed lands that are irreversibly damaged. Reseeding can eliminate undesirable plants and improve productivity. Deferment of grazing for two or more growing seasons is recommended for full establishment of native grass seeded area. Grazing deferment for one or more growing seasons is recommended when a full establishment of crested wheatgrass and smooth bromegrass seeded areas are conducted.

Interseeding — Seeding into an established vegetation cover can improve rangeland lacking high-producing desirable plants. Decreaser plant species and legumes can be planted in furrows that are accessible to interseeding by specific drill equipment. Deferment from grazing for one growing season is recommended.

Fertilizer— Increased use of fertilizers is part of a trend toward more intensive management of soil and forage resources. Nitrogen is the most commonly used fertilizer on native rangelands and introduced perennial domestic (tame) grass pastures (ex. bromegrass and crested wheatgrass pastures). Increased herbage production and plant palatabilty have been observed in fertilized pastures. Studies at the Dickinson and Central Grasslands Research Centers have shown economic benefits from fertilization of domestic grass pastures even during drought years. However, fertilization of native range has yet to show economic benefits when warm-season grasses dominate the plant community. In fact, fertilizing native rangeland in consecutive years causes an unbalanced combination of warm- and cool-season grasses.

Summary

Proper rangeland management is an important step in the improvement of water quality in rangeland dominated areas. Rangelands that are in good condition and maintaining 50 percent of the aboveground cover by weight will have little to no runoff, protecting water quality. Maintaining proper use (50 percent utilization) and incorporating a grazing management plan that maximizes the range resource will provide the most benefit to the land owner and improved water quality for drinking and aquatic life.

A solid grazing management plan should include the elimination of early grazing of native rangelands, removing no more than 50 percent of the aboveground herbage by weight, and improving livestock distribution through the use of a grazing system. Water quality will be protected and maximizing the use of the forage resource achieved.

Other NDSU Extension Service publications of interest relating to rangeland management and grazing systems:

R207	Renovation of Rangeland and Grassland Pastures
R750	Range Condition...A Guide to Grazing Management
R580	Range Site Identification
R741	North Dakota Grasses and Sedges
R778	Interseeding Native Pasture
R559	Grazing Systems
R1006	Design and Characteristics of the Twice-over Rotation Grazing System
ES	Report No. 1 Implementing and Evaluating Short-duration Grazing Systems

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