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RangeDetect Series

Grazing and Browsing: How Plants are Affected

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Grazing can have a neutral, positive or negative effect on rangeland plants, depending on how it is managed. Land owners and managers can better protect rangeland plants, and, in turn, other rangeland resources, if they understand:

- The effects of grazing and browsing (eating the leaves and young twigs of trees and shrubs) on individual plants and plant populations.
- The indicators that show which plants are in danger of overuse by grazing and browsing animals.
- The grazing management practices that help preserve the rangeland resource.

Understanding these factors and knowing the available management options allows landowners and managers to make better decisions about which actions are best for a particular site and when to take action. Timely action can preserve the long-term health of the rangeland as well as the viability of livestock and wildlife operations.

Interactions between range plants and range animals

Rangelands are ecosystems that have adapted to withstand such disturbances as drought, flood, fire, and grazing. All disturbances affect plants to some extent, either directly or indirectly, depending on the timing, intensity, and frequency of the disturbance. Generally, the more diverse the vegetation, the better rangeland can withstand disturbance.

Rangeland plants provide nutrients—proteins, starches and sugars—to grazing and browsing livestock and wildlife. These nutrients, or plant foods, are produced by photosynthesis. Because photosynthesis occurs only in green plant tissue and mostly in the leaves, a plant becomes less able to produce food, at least temporarily, when its leaves are removed (defoliation) by grazing and browsing animals.

Products of photosynthesis are just as important to plants as they are to animals. Like all other living things, plants need food to survive and grow. The food that plants make for themselves through photosynthesis is used for major plant functions such as surviving dormancy, growing new roots, growing new leaves in the spring, and replacing leaves lost to grazing or browsing.

Most native rangelands evolved under grazing. Therefore, rangeland plants have developed the ability to withstand a certain level of grazing or browsing. Although grazing animals do disturb rangeland, research has shown that rangelands gain few benefits when livestock are totally excluded for long periods.

What happens to a plant after grazing or browsing?

Grazing affects not just the leaves, but also other parts and functions of plants, including the root system, food production after defoliation, and the destination of food products within the plant after defoliation.

Food reserves and the root system

When a plant's leaves are removed, its roots are also affected. Excessive defoliation makes the root system smaller.

Removal of too many leaves has a profound effect on the root system (Figure 1). Research on grasses has demonstrated that when 80 percent of the leaf is removed, the roots stop growing for 12 days. When 90 percent of the leaf is removed, the roots stop growing for 18 days. Root growth drops by half when 60 percent of leaf is removed.

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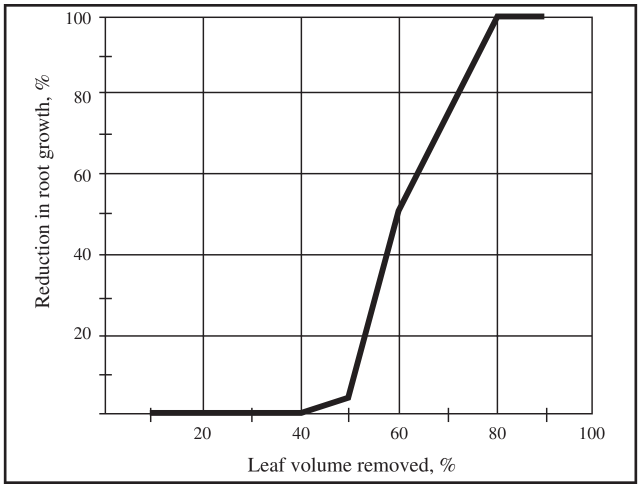

Figure 1. The effect of leaf removal on the root growth of a grass. With 80 percent leaf removal, roots stopped growing for 12 days; with 90 percent removal, root growth stopped for 18 days.

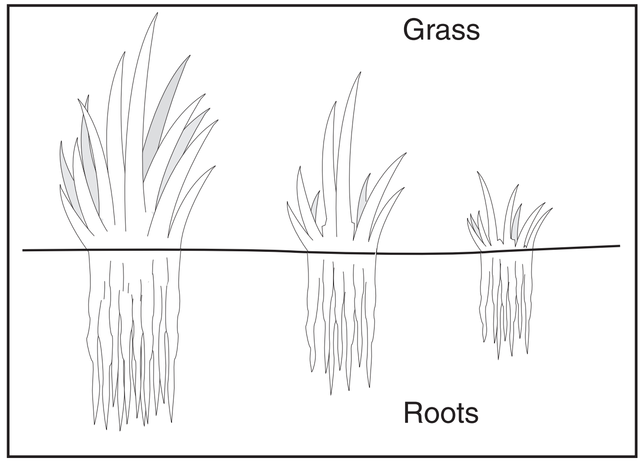

Figure 2. Heavy, frequent defoliation stops root growth and reduces the size of the root system. It reduces the plant's ability to absorb water and other nutrients, thus making the plant less drought resistant and less able to manufacture food.

As root growth is reduced or stopped, root volume decreases (Figure 2). Plants with smaller roots have less access to water and other nutrients in the soil needed to manufacture food. A smaller root system also makes plants less drought resistant.

Early research demonstrated that roots lose stored foods after defoliation. These observations led to the conclusion that the roots and crown of grasses were major sources of food for the initiation of growth after defoliation.

However, recent information indicates that, at least in grasses, stored foods are not as important in initiating this growth. Although food reserves decline in grass roots after defoliation, these reserves do not appear to be sent to the food-producing parts of the plant.

Recent research indicates that this decline in food stored in grass roots after defoliation results from a combination of:

- Remaining leaves sending less of the food they manufacture to the roots, and
- Roots themselves using the root food reserves.

In addition, studies involving grass crowns have shown that this part of the plant stores only about a 3-day supply of food reserves. This finding indicates that this part of the plant does not supply enough food to promote significant growth after defoliation.

If roots do not contribute stored food to promote growth after defoliation, where does the plant get this food?

Food production after defoliation

Grazing and browsing decrease, at least temporarily, a plant's food production by reducing the amount of green plant material available to produce food. Other factors affecting food production after grazing or browsing include the amount, kind, and age of plant material (leaf, sheath, stem) remaining on the plant.

For example, grass leaf blades, whether mature or young, often produce food at a higher rate than leaf sheaths (the leaf base enveloping the stem) or stems. In addition, young leaves produce food at higher rates than older leaves. Therefore, the more leaf material left after grazing, the faster grasses recover from grazing.

In many plant species, including some grasses, the leaves on grazed or browsed plants produce food at higher rates than leaves of the same age on plants that have not been grazed or browsed. In plants where it occurs, this process happens over several days in leaves remaining on a grazed or browsed plant and in new leaves developing after grazing or browsing. This process is one way that some plants partially cope with grazing or browsing.

Destination of food products after defoliation

Plants use the foods they produce for growth and maintenance. Any excess food is sent from the food-producing plant parts to other parts both above and below ground, where it is stored.

Once a plant has been defoliated, it may change the destination of its food products. The destination of that food varies with plant species. In some species, more food is sent to growing shoots and less to roots. This process occurs for a few days until the food-producing tissues can be reestablished. In some grass species, more food products may even be sent to the more active food-producing leaf blades rather than to less active leaf sheaths.

A plant's ability to send food products to new shoots after defoliation can help it quickly reestablish its food-producing parts. Plant species that have this ability are better able to tolerate grazing.

In investigations of grazing tolerance, researchers compared two western grass species that had different levels of grazing tolerance. They found that after defoliation, the grazing-tolerant species sent more food products to new leaves and fewer products to the roots. In contrast, the grazing intolerant species sent large amounts of food products to the root system. This finding helps explain why some grasses are better able to resist grazing.

How do plants cope with grazing and browsing?

The ability of plants to survive grazing or browsing is called grazing or browsing resistance. The most grazing-resistant plants are grasses, followed by forbs (herbaceous plants other than grass), deciduous shrubs and trees, and evergreen shrubs and trees.

When a grass seedling develops, it produces a primary tiller, or shoot. This primary tiller has both a main growing point and secondary growing points located at or below ground level.

Additional tillers can develop from secondary growing points at the base of a tiller. Tillers can also develop from buds at the nodes of stolons (above-ground lateral stems, such as in buffalograss) or rhizomes (below-ground lateral stems, such as in Johnsongrass) of grasses with these structures.

Cool-season grasses begin growth in the fall, maintain some live basal leaves through winter, and continue growth in the spring. Tillers produced in the fall are exposed to cold and can produce seedheads in spring. Tillers initiated in the spring usually do not produce seedheads.

In comparison, warm-season grasses produce new tillers in late summer and early fall. Although these young tillers die back when exposed to frost, their buds will produce new tillers the following spring.

Tillers of most grasses live only 1 to 2 years. Individual leaves usually live less than a year and most only a few months.

A plant can produce leaves only at an intact growing point. As long as that growing point is close to the ground, it is protected from being eaten (Figure 3). At some point, most grasses elevate at least some of their growing points to produce tillers, or shoots, that have seedheads.

Tillers stop producing new leaves when a seedhead develops from the growing point or when the growing point is eaten. Plants then must depend on other tillers to continue producing new leaves or wait until basal buds produce new tillers.

Excessive grazing of a grass plant when its growing points are elevated reduces new leaf production, and therefore, the ability of the plant to produce food and tolerate grazing. Destruction of the growing point also prevents seed production and production of new seedlings. Grasses should be rested from grazing periodically to allow them to produce leaf material to feed the plant and to allow seed production.

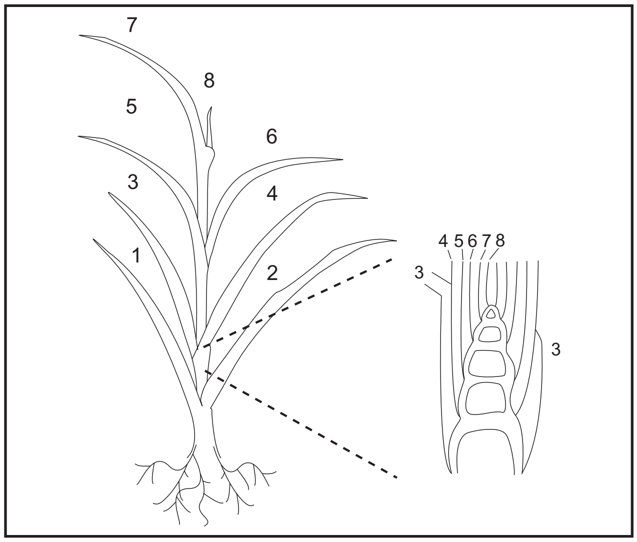

Figure 3. This illustration represents a grass tiller (or shoot) and its main growing point. On the left are the grass tiller and eight leaves, numbered 1 to 8. On the right is an enlargement of the area near the base of this tiller where the main growing point is located. All the leaves shown have developed from this growing point. As long as the growing point is close to the ground as shown here, it is safe from being eaten and can continue to produce leaves for the life of the tiller (1 to 2 years).

Timing of growing point elevation varies among grass species (Table 1). For example, growing points of buffalograss and other sod-forming grasses remain close to the ground, giving these grasses high grazing resistance.

Little bluestem and sideoats grama keep their growing points close to the ground until just before seedheads emerge. Although this strategy protects growing points from being eaten for a longer period, these two grasses produce many tillers with seedheads, which means that many growing points are exposed. The combined effect of delayed elevation and the production of many tillers with seedheads gives these two grasses moderate grazing resistance.

Yellow indiangrass and switchgrass elevate their growing points above ground level soon after growth begins. This early elevation results in low grazing resistance.

Grasses with low (yellow indiangrass and switchgrass) to moderate (little bluestem and sideoats grama) grazing resistance require more care in grazing management. This care can be accomplished in several ways.

One way to manage these low- to moderate-grazing-resistant grasses is to lower grazing pressure by stocking fewer animals to allow some plants to escape grazing.

Table 1. Examples of growing point elevation and grazing resistance for some common range grasses.

Grass Species	Growing Point Elevation/Reproductive Tiller Ratio	Grazing Resistance
Buffalograss	Remain close to ground	High
Little bluestem	Elevation late w/ large number reproductive tillers	Moderate
Sideoats grama	Elevation late w/ large number reproductive tillers	Moderate
Switchgrass	Elevation early	Low
Yellow indiangrass	Elevation early	Low
Johnsongrass	High proportion of reproductive tillers	Low

Another method is to make sure that pastures with these grasses are rested from grazing every 3 or 4 years during the growing season to allow the plants to produce seed.

Still another method that has been used successfully is intensive-early stocking. With this approach, grazing animals are stocked at higher than normal numbers for the first part of the growing season and then removed from pastures for the rest of the growing season. This approach has typically been used with stocker (young steer and heifer) operations.

Johnsongrass is an interesting contradiction. Because it produces strong rhizomes (underground stems), it should be resistant to grazing. However, Johnsongrass also produces a high proportion of reproductive stems, which cancels the advantage of rhizome production and results in lower grazing resistance.

The growing points of forbs, like those of grasses, remain close to the ground early in the growing season. Forb species that elevate growing points early are less resistant to grazing.

For woody plants, growing points are elevated above ground and, therefore, are easily accessible to browsing animals. If these growing points are removed, lateral buds are stimulated to sprout and produce leaves. However, woody plants replace leaves relatively slowly.

Grazing avoidance and grazing tolerance

Grazing resistance can be divided into avoidance and tolerance (Figure 4). Grazing avoidance mechanisms decrease the chance that a plant will be grazed or browsed. Grazing tolerance mechanisms promote growth after grazing or browsing.

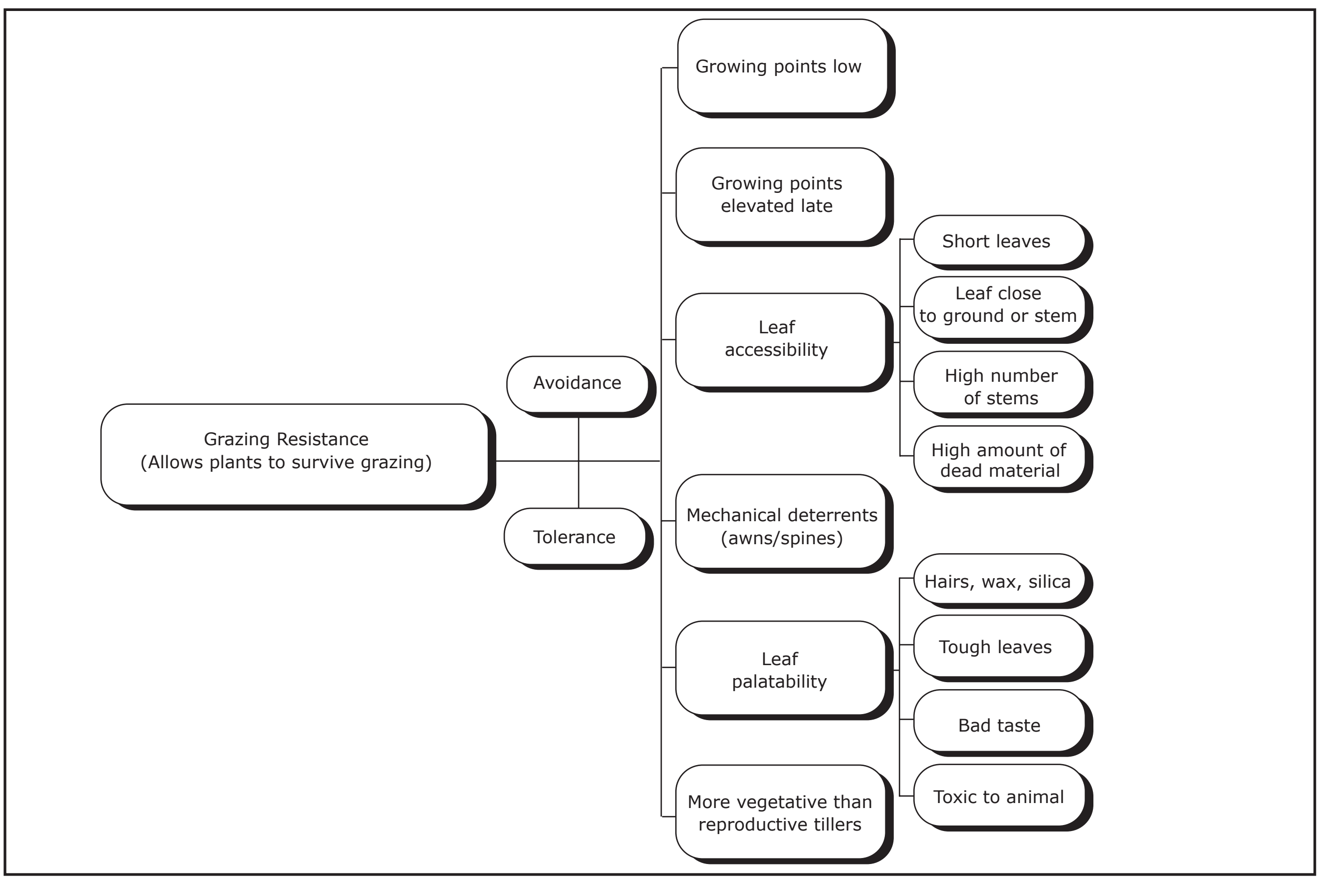

Figure 4. Examples of plant grazing-resistance mechanisms.

Grazing resistance factors can be related to plant anatomy, plant chemistry or plant physiology:

- Anatomical features that help plants resist being grazed include leaf accessibility (leaf angle, leaf length), awns or spines, leaf hair and/or wax, tough leaves, grass species with more vegetative stems (fewer growing points exposed) than reproductive stems, and the ability to replace leaves, which depends on growing points.
- Chemical factors of grazing resistance include those compounds that make plants taste bad, toxic, or hard to digest.
- Physiological factors include sending new food products to new leaves, water-use efficiency, and root growth and function.

Competition and grazing

Competition from neighboring plants for soil nutrients and water affects plant response to defoliation. Studies have shown that when competition is reduced, leaf growth in defoliated plants can be similar to that in nondefoliated plants. Competition can be reduced by 1) lowering grazing pressure by stocking fewer animals and 2) resting plants from grazing.

If competition is not reduced, new leaf growth may not occur because of a lack of available nutrients to grow new leaves. Therefore, plants that are grazed severely while neighboring plants are not grazed or grazed less severely are at a competitive disadvantage.

Do plants benefit from grazing?

It is not clear if plants benefit from being grazed. Certain species may benefit from grazing but not necessarily from being grazed. For example, plants may benefit indirectly from removal of competition or from the creation of a favorable environment for seed germination or directly from removal of self-shading or removal of inactive leaves.

Some grazed plants experience compensatory photosynthesis (food production). However, this response does not mean that the plants benefit from being grazed, only that they have ways to cope with grazing.

Browse management considerations

Browsing animals such as goats and deer prefer certain browse species. Preferred species vary with natural regions (such as the Edwards Plateau, Rio Grande Plain, Trans Pecos, etc.) of Texas. However, Texas kidneywood and Texas or Spanish oak are examples of highly preferred species; live oak represents a moderately preferred species; and ashe juniper (blueberry cedar) and mesquite are examples of low-preference species.

Without proper management, the more desirable browse species can disappear because of these preferences, while less desirable or undesirable species become more abundant. From a livestock perspective, proper management involves controlling browsing livestock numbers and controlling access to browse plants to provide rest from browsing. From a wildlife standpoint, proper management involves harvesting animals when wildlife census numbers and browse use signs indicate a danger to the browse resource.

Just as with grasses, browse species can be managed to promote and maintain key species, that is, the preferred plants that make up a significant part of the production of browse available for animals to eat. This task is accomplished by controlling animal numbers and providing rest from browsing.

How to determine if the range is being overused

Managers can use browse indicators to help make management decisions about the browse resource. These indicators include degree of use, hedging, and the presence or absence of seedlings.

Degree of use is the amount of the current season's growth that has been removed by browsing animals. It is best observed at the end of the growing season in late fall for deciduous plants and late winter for evergreens. When determining degree of use, consider only current season growth by comparing browsed twigs with unbrowsed twigs.

Browse use can be divided into three levels of current season growth removal: light use is marked by less than 40 percent removal; moderate use ranges from 40 to 65 percent removal; and heavy use is more than 65 percent removal.

Moderate use on key browse species is the correct management goal. When use approaches the upper limit of moderate use for key species, browsing pressure should be reduced by 1) resting areas from browsing livestock use or reducing livestock numbers and/or 2) reducing wildlife numbers.

Hedging is a plant response to browsing marked by twigs that have many lateral branches. A moderate degree of hedging is acceptable (Figure 5) because it keeps browse material within easy reach of animals and stimulates leaf and twig growth.

However, excessive hedging produces short twigs with smaller than normal leaves and twigs. Eventually, entire plants can die from excessive hedging.

Another indicator of excess browsing pressure is the hedging of low-preference plants such as agarita (Figure 6). When animals consume plants they do not normally eat, it usually means that not enough of their preferred food is available.

Figure 5. A moderate degree of hedging as shown on this Texas kidneywood plant, a highly desirable browse species, is acceptable.

Figure 6. The hedging on agarita, a low-preference browse plant, indicates excessive use.

To provide forage, browse plants must be within reach of browsing animals (Figure 7). As hedging increases, the lower branches disappear and a browse line develops. A browse line is the height on trees or shrubs below which there is little or no browse and above which browse cannot be reached by animals.

Areas where trees or shrubs have a highly developed browse line have a park-like appearance. In the early development of a browse line, light begins to show through the lower vegetation. With continued browsing pressure, a distinct browse line develops (Figure 8). Development of browse lines on low-preference plants such as ashe juniper (blueberry cedar) also indicates excessive use of the range (Figure 9).

Figure 7. The absence of a browse line on desirable woody species indicates that forage is accessible to animals and that the number of animals is probably in balance with the supply of browse.

Figure 8. A prominent browse line on moderately preferred browse species such as live oak is an indication of past overuse.

Figure 9. A prominent browse line on ashe juniper (blueberry cedar), a low-preference plant, is an indication of severe overuse of the browse resource.

The height of browse lines depends on browsing animal species. For example, white-tailed deer usually browse to about 3 to 4 feet, goats to about 4 to 5 feet, and exotic wildlife species to 6 feet and more.

To keep woody plant populations healthy, plants must be allowed to reproduce. Therefore, the presence of seedlings of desirable browse plants is another indicator that managers can use to check for range overuse.

Management considerations

Regardless of whether a ranch's production goal is livestock or wildlife, plants feed these animals and protect the soil from erosion. A good steward should aim to conserve the soil and plant resources so that animals are produced in a way that can be sustained over time.

To influence the effect of grazing disturbances on range plants, managers can control three factors of grazing or browsing:

- Intensity refers to the amount of grass or browse that is eaten. It is the most important factor because it affects the amount of leaf available for food production as well as the amount of root system in grasses and the production of seed.
- Timing of grazing affects plants more severely at certain stages of their development. The most critical grazing period is usually from flowering to seed production. Although the least critical period is dormancy, leaving plant residue is important even during dormancy. Research and demonstration work have shown that removing high quantities of forage during dormancy is almost as detrimental to plant productivity as during active growth periods.
- Frequency refers to how often plants are grazed or browsed. Animals tend to come back to the same plants to graze or browse during a growing season. If a plant is repeatedly defoliated, it can be weakened and may die.

To manage grazing and browsing and protect the range resources, managers should:

- Observe the status of and changes in grasses, forbs, and woody species as well as in livestock or wildlife. Make adjustments when either the range plants or animals show signs that the range is being overused.
- Rest grasses periodically, but not at the same time every year. Grasses differ as to when growing points are elevated, making it difficult to find one optimum rest period for all species.
- Leave enough residual forage ungrazed to keep plants healthy and to capture rainfall. The best way to prevent excess rainfall runoff is to maintain adequate ground cover. When the range has enough plant material to promote water infiltration into the soil, less rainfall is required to produce forage.
- Note when the more palatable key species start to show overuse. Grazing and browsing animals are selective: They graze or browse the most palatable forage species first and often. If the more palatable species are overused and disappear, the plant species that survive will be those that can best resist grazing. Animals often avoid eating plants that are abundant but not palatable; instead, they spend time and energy searching for plants that are more palatable but scarce. Therefore, overuse of more-palatable species can reduce animal performance.
- Adjust livestock and wildlife browsing by reducing animal numbers and/or resting pastures when you notice more than moderate use or excessive hedging on desirable brush plants and before the development of browse lines.

For more information

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