R1707 (Reviewed June 2022)

Ranchers Guide to Grassland Management IV

NDSU EXTENSION

USDA United States Department of Agriculture

Contents

Introduction

This guide is intended to serve as a quick reference for ranchers looking for information on grazing management. As such, it does not attempt to cover any single topic in great depth. Instead, it provides general information on a variety of subjects related to range, pasture and hay land management. References for other sources of information are provided should the reader wish to research the topic in greater depth.

The basic outline for this handbook was developed by a small group of ranchers consisting of Larry Woodbury, Keith Bartholomay, Darell Evanson and Lynn Wolf. They provided the authors with ideas and guidelines in producing a user-friendly guide containing topical information they felt their fellow ranchers would find useful. The authors thank Stan Boltz, Miranda Meehan, Mark Hayek, Don Kirby, Jay Mar, Merlyn Lepp, Darell Evanson, David Lautt, Gary Moran, Myron Senechal, Keith Bartholomay, and Todd Hagel for review and constructive criticism.

The authors also would thank Miranda Meehan and Craig Brumbaugh for their assistance in writing the Riparian Grazing Management section.

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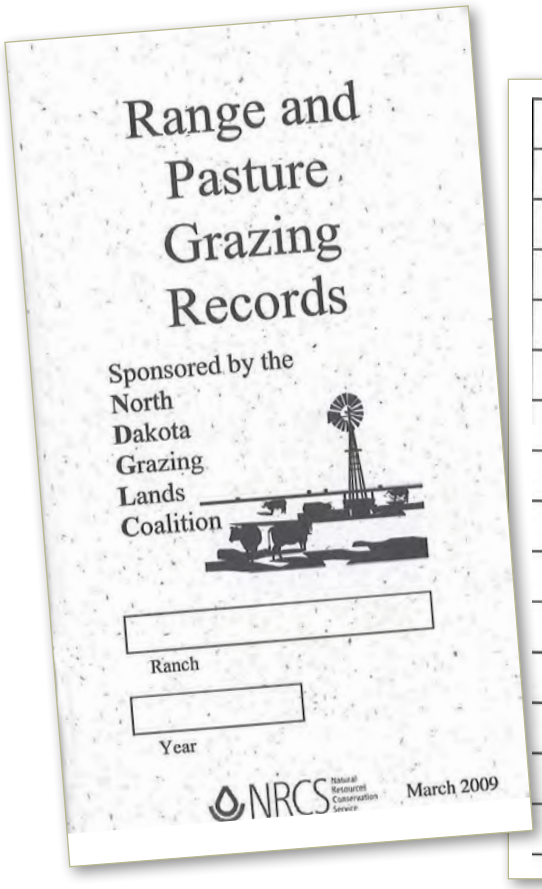
Recordkeeping

Keeping accurate records on how many livestock are in a pasture or pastures, how long they are in a pasture or pastures, growing conditions and some general notes on pasture condition is part of a monitoring system. This information is valuable in analyzing changes that may occur due to grazing patterns and environmental conditions.

This can be as simple as a pocket notebook or as complex as a detailed recordkeeping program. This document contains a range and pasture recordkeeping system for your use. It allows you to document pasture turn-in dates, rotation dates, livestock numbers and weather. When record keeping notes and observations are combined with monitoring data/information, a more informed decision is possible.



Pasture	Turn In Date	Turn In # Class	Remove Date	Remove # Class	Days Grazed	AUMs	AUMs/ Acre	Forage Use

Definitions

Understanding the terminology in rangeland management is important when interpreting ideas, strategies and goals. The following are common terms adapted from the Society for Range Management in the "Glossary of Terms Used in Range Management (1989)":

Acclimatized species: An introduced species that has become adapted to a new climate or a different environment and can perpetuate itself in the community without cultural treatment (cf. *exotic, introduced species*)

Aerial photograph: A photograph of the Earth's surface taken from airborne equipment, sometimes called aerial photo or air-photograph

Aftermath: Residue and/or regrowth of plants grazed after harvesting of a crop

Allelopathy: Chemical inhibition of one organism by another

Animal unit: Considered to be one mature cow of approximately 1,000 pounds, dry or with calf up to 6 months of age, or their equivalent, based on a standardized amount of forage consumed (Abbr = AU)

Animal unit day: The amount of forage on a dry-matter basis required by one animal unit in one day based on a 26 pounds forage allowance based on oven dried or 30 pounds forage allowance based on air dried (Abbr = AUD)

Animal unit equivalent: A number expressing the energy requirements of a particular kind or class of animal relative to one animal unit (Abbr = AUE)

Animal unit month: The amount of dry forage required by one animal unit for one month based on a forage allowance of 26 pounds per day oven dried or 30 pounds per day air dried (Abbr = AUM)

Animal unit conversion factor: A numerical figure expressing the forage requirements of a particular kind or class of animal related to the requirement for an animal unit. A conversion factor is satisfactory with respect to the amount of forage required to maintain an animal, but it may not be applicable in determining stocking rates for range use for particular kinds or classes of animals because of different grazing preferences

Annual plant: A plant that completes its life cycle and dies in one year or less

Apical dominance: Domination and control of meristematic leaves or buds on the lower stem, roots or rhizomes by hormones produced by apical meristems on the tips and upper branches of plants, particularly woody plants

Auxin: A plant hormone promoting or regulating growth

Backfiring: Ignition of a fire on the leeward (downwind) side of a burn area resulting in a slow-moving ground fire (cf. *headfiring*)

Badland: A land type consisting of steep or very steep barren land usually broken by an intricate maze of narrow ravines, sharp crests and pinnacles resulting from serious erosion of soft geologic materials; most common in and or semiarid regions; a miscellaneous land type

Bentonite: A natural clay deposit that has high swelling capabilities when saturated; used to seal earthen stock ponds

Biennial: A plant that lives for two years, producing vegetative growth the first year and usually blooming and fruiting in the second year and then dying

Biomass: The total amount of living plants and animals above and below ground in an area at a given time

Biome: A major biotic site consisting of plant and animal communities having similarities in form and environmental conditions but not including the abiotic portion of the environment

Biota: All the species of plants and animals occurring in an area or region

Biotic: Refers to living components of an ecosystem; for example, plants and animals

Blowout: (1) An excavation in areas of loose soil, usually sand, produced by wind; (2) a breakthrough or rupture of a soil surface attributable to hydraulic pressure, usually associated with sand soils

Breeding herd: The animals retained for breeding purposes to provide for the perpetuation of the herd or band; excludes animals being prepared for market

Broadcast seeding: Process of scattering seed on the surface of the soil prior to natural or artificial means of covering the seed with soil (cf. *dill seeding*)

Browse: (n.) That part of leaf and twig growth of shrubs, woody vines and trees available for animal consumption; (v.) act of consuming browse (cf. *graze*)

Brush: A term encompassing various species of shrubs or small trees usually considered undesirable for livestock or timber management. The same species may have value for browse, wildlife habitat or watershed protection.

Brush control: Reduction of unwanted woody plants through fire, chemicals, mechanical methods or biological means to achieve desired land management goals

Brush management: Manipulating woody plant cover to obtain desired quantities and types of woody cover and/or to reduce competition with herbaceous understory vegetation in accordance with ecologically sound resource management objectives

Buck-fence: A fence constructed of wooden poles fastened horizontally to wooden cross-members; also called buck-pole fence. Such fences withstand heavy snows in mountainous regions and eliminate the need for digging holes for posts in rocky terrain.

Bunch grass: A grass having the characteristic growth habit of forming a bunch; lacks stolons or rhizomes (cf. *sod grass*)

Burn: An area over which fire has passed recently

Butte: An isolated hill with relatively steep sides (cf. *mesa*)

C-3 plant: A plant employing the pentose phosphate pathway of carbon dioxide assimilation during photosynthesis; often a cool-season plant

C-4 plant: A plant employing the dicarboxylic acid pathway of carbon dioxide assimilation during photosynthesis; often a warm-season plant

Cactus: A spiny, succulent plant of the Cactaceae family

Canopy: (1) The vertical projection downward of the aerial portion of vegetation, usually expressed as a percent of the ground so occupied; (2) the aerial portion of the overstory vegetation (cf. *canopy cover*)

Canopy cover: The percentage of ground covered by a vertical projection of the outermost perimeter of the natural spread of foliage of plants. Small openings within the canopy are included. It may exceed 100 percent. (Syn. *aerial cover*)

Carrying capacity: The maximum stocking rate possible that is consistent with maintaining or improving vegetation or related resources. It may vary from year to year on the same area due to fluctuating forage production. (cf. *grazing capacity*)

Cell: A grazing arrangement comprised of numerous subdivisions (paddocks or pastures) often formed by electrical fencing, with a central component to facilitate livestock management and movement to the various subdivisions; normally used to facilitate a form of controlled grazing (cf. *paddock*)

Class of animal: Description of age and/or sex group for a particular kind of animal; for example, cow, calf, yearling, ewe, doe, fawn

Claypan: A dense, compact layer in the subsoil having much higher clay content than the overlaying material from which it is separated by a sharply designed boundary; formed by downward movement of clay or by synthetic of clay in place during soil formation. Claypans are usually hard when dry and plastic and sticky when wet. They usually impede the movement of water and air. (cf. *hardpan*)

Climax: (1) The final or stable biotic community in a successional series that is self-perpetuating and in dynamic equilibrium with the physical habitat; (2) the assumed end point in succession (cf. *potential natural community*)

Community (plant community): An assemblage of plants occurring together at any point in time, while denoting no particular ecological status; a unit of vegetation

Companion crop: A crop sown with another crop (perennial forage or trees or shrubs) that is allowed to mature and provide a return in the first year (cf. *nurse crop*)

Complementary pasture: Short-term forage crop (not necessarily annual) planted for use by domestic stock to enhance the management and productivity of the ranch

Concentrate feed: Grains or their products and other processed food materials that contain a high proportion of nutrients and are low in fiber and water

Conservation: The use and management of natural resources according to principles that assure their sustained economic and/or social benefits without impairment of environmental quality

Conservation district: A public organization created under a state's enabling law as a special-purpose district to develop and carry out a program of soil, water and related resource conservation, use and development within its boundaries; usually a subdivision of state government with a local governing body and always with limited authorities; often called a soil conservation district or a soil and water conservation district

Conservation plan: The recorded decisions of a landowner or operator cooperating with your local conservation district on how he/she plans, within practical limits, to use his/her land according to its capability and to treat it according to its needs for maintenance or improvement of the soil, water and plant resources

Consumption: Dietary intake based on (1) amounts of specific forages and other feedstuffs or (2) amounts of specific nutrients

Contact herbicide: A herbicide that kills primarily by contact with plant tissue rather than as a result of translocation

Continuous grazing: The grazing of a specific unit by livestock throughout a year or for that part of the year during which grazing is feasible. The term is not necessarily synonymous with year-long grazing because seasonal grazing may be involved.

Cool-season plant: A plant that generally makes the major portion of its growth during the late fall, winter and early spring. Cool-season species generally exhibit the C-3 photosynthetic pathway.

Coordinated resource management planning: The process whereby various user groups are involved in discussion of alternate resource uses and collectively diagnose management problems, establish goals and objectives, and evaluate multiple use resource management

Coulee: The term used for deep gulch or ravine in the northern U.S.

Cover: (1) The plants or plant parts, living or dead, on the surface of the ground. Vegetative cover or herbage cover is composed of living plants and litter cover of dead parts of plants (Syn. *foliar cover*). (2) The area of ground cover by plants of one or more species (cf. *basal area*)

Cover type: The existing vegetation of an area

Creep feeding: Supplemental feeding of suckling livestock in such a manner that the feed is not available to the mothers or other mature livestock

Cryptogam: A plant in any of the groups Thallophytes, Byophyte and Pteridiophytes; mosses, lichens and ferns

Cultivar: A named variety selected within a plant species distinguished by any morphological, physiological, cytological or chemical characteristics; a variety of plant produced and maintained by cultivation that genetically is retained through subsequent generations

Cured forage: Forage, standing or harvested, that has been dried and preserved naturally or artificially for future use (cf. *stockpiling*)

Debris: Accumulated plant and animal remains

Deciduous (plant): Plant parts, particularly leaves that are shed at regular intervals or at a given stage of development. A deciduous plant regularly loses or sheds its leaves. (cf. *evergreen*)

Decomposer: Heterotrophic organisms, chiefly the microorganisms, that break down the bodies of dead animals or parts of dead plants and absorb some of the decomposition products while releasing similar compounds usable by producers

Decreaser: Plant species of the original or climax vegetation that will decrease in relative amount with continued disturbance to the norm; for example, heavy defoliation, fire drought. Some agencies use this only in relation to response to overgrazing.

Deferment: Delay of livestock grazing in an area for an adequate period of time to provide for plant reproduction, establishment of new plants or restoration of vigor of existing plants (cf. *deferred grazing, rest*)

Deferred grazing: The use of deferment in grazing management of a management unit but not in a systematic rotation including other units (cf. *grazing system*)

Deferred rotation: Any grazing system that provides for a systematic rotation of the deferment among pastures

Defoliation: The removal of plant leaves by grazing or browsing, cutting, chemical defoliant or natural phenomena such as hail, fire or frost

Degree of use: The proportion of current year's forage production that is consumed and/or destroyed by grazing animals; may refer to a single species or the vegetation as a whole (Syn. *Use*)

Density: The number of individuals per unit area. It is not a measure of cover. However, in the past, the term "density" has been used to mean cover. (cf. *frequency*)

Desert: An arid area with insufficient available water for dense plant growth

Desirable plant species: Species that contribute positively to the management objectives

Desired plant community: A plant community that produces the kind, proportion and amount of vegetation necessary for meeting or exceeding the land use plan/activity plan objectives established for an ecological site or sites. The desired plant community must be consistent with the site's capability to produce the desired vegetation through management, land treatment or a combination of the two.

Deteriorated range: Range in which vegetation and soils departed significantly from the natural potential. Corrective management measures such as seeding would change the designation from deteriorated range to some other term. (Syn. *degenerated range*)

Detritus: Fragmented particulate organic matter derived from the decomposition of debris

Diurnal: Active during daylight hours

Diversity: The distribution and abundance of different plants and animal communities in an area

Dominant: (1) Plant species or species groups, which by means of their number, coverage or site, have considerable influence or control upon the conditions of existence of associated species; (2) those individual animals that, by their aggressive behavior or otherwise, determine the behavior of one or more animals resulting in the establishment of a social hierarchy

Draw: A natural watercourse, including the channel and adjacent areas on either side, that occasionally may overflow or receive extra water from higher adjacent areas; generally having intermittent flows associated with higher intensity rainfall

Drill seeding: Planting seed directly into the soil with a drill in rows, usually 6 to 24 feet apart.

Drip torch: Portable equipment for applying flammable liquids giving a residual flame upon ignition; primarily used in prescribed burning

Drought (drouth): (1) A prolonged chronic shortage of water, as compared with the norm, often associated with high temperatures and winds during spring, summer and fall; (2) a period without precipitation during which the soil water content is reduced to such an extent that plants suffer from lack of water

Dugout: (1) An artificially constructed depression that collects and stores water and differs from a reservoir in that a dam is not relied upon to impound water (cf. *stock pond*); (2) a large hole dug in the ground, frequently on the side of a hill, and often covered with logs and sod, used as a dwelling or shelter

Ecological site: A kind of land with a specific potential natural community and specific physical site characteristics, differing from other kinds of land in its ability to produce vegetation and to respond to management (Syn. *ecological type, ecological response unit. cf. range site*)

Ecological status: The present state of vegetation and soil protection of an ecological site in relation to the potential natural community for the site. Vegetation status is the expression of the relative degree of which the kinds, proportions and amounts of plants in a community resemble that of the potential natural community. If classes or ratings are used, they should be described in ecological rather than utilization terms. For example, some agencies are utilizing four classes of ecological status ratings (early seral, midseral, late seral potential natural community) of vegetation corresponding to 0 to 25, 26 to 50, 51 to 75 and 76 to I00 percent of the potential natural community standard. Soil status is a measure of present vegetation and litter cover relative to the amount of cover needed on the site to prevent accelerated erosion. This term is not used by all agencies. (cf. *range condition*)

Ecological type: A land classification category that is more specific than a phase of a habitat type. Ecological types commonly are used to differentiate habitat phases into categories of land that differ in their ability to produce vegetation or their response to management. (Syn. *ecological response unit, ecological site*)

Ecology: The study of the interrelationships of organisms with their environment

Ecosystem: Organisms, together with their abiotic environment, forming an interacting system, inhabiting an identifiable space

Ecotone: A transition area of vegetation between two communities, having characteristics of both kinds of neighboring vegetation as well as characteristics of its own; varies in width depending on site and climatic factors

Ecotype: A locally adapted population within a species that has certain genetically determined characteristics; interbreeding between ecotypes is not restricted (cf. *biotype*)

Enclosure: An area fenced to confine animals

Endemic: Native to or restricted to a particular area, region or country

Environment: The sum of all external conditions that affect an organism or community to influence its development or existence

Eradication (plant): Complete kill or removal of a noxious plant from an area; includes all plant structures capable of sexual or vegetative reproduction

Erosion: (v.) Detachment and movement of soil or rock fragments by water, wind, ice or gravity; (n.) the land surface worn away by running water, wind, ice or other geological agents, including such processes as gravitational creep

Essential element: A chemical element necessary for the life of an organism

Evergreen (plant): A plant that has leaves all year round and generally sheds them in a single season after new leaves of the current growing season have matured (cf. *deciduous*)

Evapotranspiration: The actual total loss of water by evaporation from soil, water bodies and transpiration from vegetation in a given area with time

Exclosure: An area fenced to exclude animals

Exotic: An organism or species that is not native to the region in which it is found

Exposure: Direction of slope with respect to points of a compass

Fauna: The animal life of a region; a listing of animal species of a region

Feces: Waste material voided through the anus

Fibrous root system: A plant root system having a large number of small, finely divided, widely spreading roots, but no large taproots; typified by grass root system (cf. *taproot system*)

Flushing: Improving the nutrition of female breeding animals prior to and during the breeding season to stimulate ovulation

Flora: (1) The plant species of an area; (2) a simple list of plant species or a taxonomic manual

Foliage: The green or live leaves of plants; mass leaves, leafage

Forage: (n.) Browse and herbage that is available and may provide food for grazing animals or be harvested for feeding; (v.) to search for or consume forage (Syn. *Graze*)

Forage production: The weight of forage that is produced in a designated period of time on a given area. The weight may be expressed as green, air-dry or oven-dry. The term also may be modified as to time of production, such as annual, current year's growth or seasonal forage production.

Forage reserve: Standing forage specifically maintained for future or emergency use

Forb: Any broad-leafed herbaceous plant other than those in the *Gramineae (or Poaceae), Cyperaceae* and *Juncacea* families

Free range: Range open to grazing regardless of ownership and without payment of fees; not to be confused with *open range*

Frequency: The ratio between the number of sample units that contain a species and the total number of sample units

Fresh weight: The weight of plant materials at the time of harvest (Syn. *green weight*)

Full use: The maximum use during a grazing season that can be made of range forage under a given grazing program without inducing a downward trend in range condition or ecological status

Geographic information system (GIS): A spatial type of information management system that provides for the entry, storage, manipulation, retrieval and display of spatially oriented data

Graminoid: Grass or grasslike plant, such as *Poa, Carex* and *Juncus* species

Grass: A member of the family *Gramineae (Poaceae)*

Grassland: Land on which the vegetation is dominated by grasses, grasslike plants and/ or forbs (cf. *dominant*). Non-forest land shall be classified as grassland if herbaceous vegetation provides at least 80 percent of the canopy cover excluding trees. Lands not presently grassland that originally were or could become grassland through natural succession may be classified as potential natural grassland. (cf. *prairie, rangeland*)

Grasslike plant: A plant of the *Cypeaceae* or *Juncacea* families that vegetatively resembles a true grass of the *Gramineae* family

Gravel, cobble, stones: As defined in "Soil Taxonomy" (Soil Conservation Service, 1975): gravel (2 millimeters to 3 inches), cobble (3 to 10 inches), stones (more than 10 inches). (Note: For standard range inventory procedures, gravel smaller than 5 millimeters in diameter should be classed as bare ground in cover determinations)

Graze: (1) (vi.) The consumption of standing forage by livestock or wildlife; (2) (vt.) to put livestock to feed on standing forage

Grazer: A grazing animal.

Grazier: A person who manages grazing animals.

Grazing: (vt.) To graze

Grazing behavior: The foraging response elicited from an herbivore by its interaction with its surrounding environment

Grazing capacity: The total number of animals that may be sustained on a given area based on total forage resources available, including harvested roughage and concentrates (cf. *carrying capacity*) **Grazing distribution:** Dispersion of livestock grazing within a management unit or area

Grazing land: A collective term that includes all lands having plants harvestable by grazing without reference to land tenant, other land uses, management or treatment practices

Grazing management: The manipulation of grazing and browsing animals to accomplish a desired result

Grazing management plan: A program of action designed to secure the best practicable use of the forage resources with grazing or browsing animals

Grazing period: The length of time that animals are allowed to graze on a specific area

Grazing preference: (1) Selection of certain plants or plant parts, rather than others, by grazing animals; (2) in the administration of public lands, a basis upon which permits and licenses are issued for grazing use (cf. *palatability, grazing privilege and grazing right*)

Grazing pressure: An animal-to-forage relationship measured in terms of animal units per unit weight of forage at any instant (AU/T)

Grazing pressure index: An animal-to-forage relationship measured in terms of animal units per unit weight of forage during a period of time (AUM/T)

Grazing season: (1) On public lands, an established period for which grazing permits are issued; may be established on private land in a *grazing management plan*; (2) the time interval when animals are allowed to utilize a certain area

Grazing system: A specialization of *grazing management* that defines the periods of grazing and non-grazing. Descriptive common names may be used; however, the first usage of a grazing system name in a publication should be followed by a description using a standard format. This format should consist of at least the following: the number of pastures (or units), number of herds, length of grazing periods, and length of non-grazing periods for any given unit in the system, followed by an abbreviation of the unit time used. (cf. *deferred grazing, deferred-rotation, rotation, rest-rotation, and short duration grazing*)

Grazing unit: An area of rangeland, public or private, that is grazed as an entity

Ground cover: The percentage of material, other than bare ground, covering the land surface. It may include live and standing dead vegetation, litter, cobble, gravel, stones and bedrock. Ground cover plus bare ground would total 100 percent. (cf. *foliar cover*)

Growing season: In temperate climates, that portion of the year when temperature and moisture permit plant growth. In tropical climates, it is determined by availability of moisture.

Growth form: The characteristic shape or appearance of an organism

Gully: A furrow, channel or miniature valley, usually with steep sides through which water commonly flows during and immediately after rains or snowmelt

Habitat: The natural abode of a plant or animal, including all biotic, climatic and edaphic factors affecting life

Habitat type: The collective area that one plant association occupies or will come to occupy as succession advances. The habitat type is defined and described on the basis of the vegetation and its associated environment.

Half-shrub: A woody based perennial plant with annually produced stems which die each year

Hardiness: The ability to survive exposure to adverse conditions

Hardpan: A hardened soil layer in the lower A or in the B horizon caused by cementation of soil particles with organic matter or with materials such as silica, sesquioxides or calcium carbonate. The hardness does not change appreciably with changes in moisture content, and pieces of the hard layer do not crumble in water.

Harvest: Removal of animal or vegetation products from an area of land

Heavy grazing: A comparative term indicating that the stocking rate of a pasture is relatively greater than that of other pastures; often erroneously used to mean overuse (cf. *light and moderate grazing*)

Herb: Any flowering plant except those developing persistent woody stems above ground

Herbaceous: Vegetative growth with little or no woody component; non-woody vegetation, such as graminoids and forbs

Herbage: (1) Herbs taken collectively; (2) total aboveground biomass of herbaceous plants regardless of grazing preference or availability

Herbage disappearance rate: The rate per unit area at which herbage leaves the standing crop due to grazing, senescence or other causes; Unit: kg/ha/d, or lbs/ac/d

Herbicide: A phytotoxic chemical used for killing or inhibiting the growth of plants

Herbivore: An animal that subsists principally or entirely on plants or plant materials

Herd: An assemblage of animals usually of the same species

Holistic resource management: Holistic resource management (HRM) is a practical, goal-oriented approach to the management of the ecosystem, including the human, financial and biological resources on farms, ranches, public and tribal lands, as well as national parks, vital water catchments and other areas. HRM entails the use of a management model that incorporates a holistic view of land, people and dollars.

Hybrid: Offspring of a cross between genetically dissimilar individuals

Hybrid vigor: The increased performance (rate of gain) associated with F1 crossbreeding

Ice cream species: An exceptionally palatable species sought and grazed frequently by livestock or game animals. Such species often are over-utilized under proper grazing

Increaser: Plant species of the original vegetation that increase in relative amount, at least for a time, under continued disturbance to the norm; for example, heavy defoliation, fire, drought

Indicator species: (1) Species that indicate the presence of certain environmental conditions, seral stages or previous treatment; (2) one or more plant species selected to indicate a certain level of grazing use (cf. *key species*)

Infestation: Invasion by large numbers of parasites or pests

Infiltration: The flow of a fluid into a substance through pores or small openings. It denotes flow into a substance in contradistinction to the word *percolation*.

Infiltration rate: Maximum rate at which soil under specified conditions can absorb rain or shallow impounded water, expressed in quantity of water absorbed by the soil per unit of time; for example, inches/ hour

Interseeding: Seeding into an established vegetation cover; often is planting seeds into the center of narrow seedbed strips of variable spacing and prepared by mechanical or chemical methods

Introduced species: A species not a part of the original fauna or flora of the area in question (cf. *native and resident species*)

Invader: Plant species that were absent in undisturbed portions of the original vegetation of a specific range site and will invade or increase following disturbance or continued heavy grazing

Invasion: The migration of organisms from one area to another area and their establishment in the latter (cf. *ecesis*)

Key management species: Plant species on which management of a specific unit is based

Key species: (1) Forage species of sufficient abundance and palatability to justify its use as an indicator to the *degree of use* of associated species; (2) those species that must, because of their importance, be considered in the management program

Kind of animal: An animal species or species group such as sheep, cattle, goats, deer, horses, elk, and antelope (cf. *class of animal*)

Land: The total natural and cultural environment within which production takes place; a broader term than soil. In addition to soil, its attributes include other physical conditions, such as mineral deposits, climate and water supply; location in relation to centers of commerce, populations and other land; the size of the individual tracts or holdings; and existing plant cover, works of improvement and the like. Some use the term loosely in other senses: as defined above but without the economic or cultural criteria; especially in the expression “natural land;” as a synonym for “soil;” for the solid surface of the Earth; and also for earthly surface formations, especially in geomorphologic expression “land form.”

Land use planning: The process by which decisions are made on future land uses for extended time periods that are deemed to best serve the general welfare. Decision-making authorities on land uses usually are vested in state and local governmental units, but citizen participation in the planning process is essential for proper understanding and implementation, usually through zoning ordinances.

Light grazing: A comparative term indicating that the stocking rate of one pasture is relatively less than that of other pastures; often erroneously used to mean underuse (cf. *heavy and moderate grazing*)

Lime: (1) Calcium oxide; (2) all limestone derived materials applied to neutralize acid soils

Limiting factor: Any environmental factor that exists at suboptimal level and thereby prevents an organism from reaching its full biotic potential

Livestock: Domestic animals

Management area: An area for which a single management plan is developed and applied

Management objective: The objectives for which rangeland and rangeland resources are managed, which include specified uses, accompanied by a description of the desired vegetation and the expected products and/or values

Management plan: A program of action designed to reach a given set of objectives

Marginal land: Land of questionable physical or economic capabilities for sustaining a specific use

Marsh: Flat, wet, treeless areas usually covered by standing water and supporting a native growth of grasses and grasslike plants

Mast: Nuts, acorns and similar products consumed by animals

Meadow: (1) An area of perennial herbaceous vegetation, usually grass or grasslike, used primarily for hay production; (2) openings in forests and grasslands of exceptional productivity in arid regions, usually resulting from high water content of the soil, as in stream-side situations and areas having a perched water table (cf. *dry and wet meadow*)

Moderate grazing: A comparative term indicating that the stocking rate of a pasture is between the rates of other pastures; often erroneously used to mean *proper use* (cf. *heavy and light grazing*)

Monitoring: The orderly collection, analysis and interpretation of resource data to evaluate progress toward meeting management objectives

Morphology: The form and structure of an organism with special emphasis on external features

Mulch: (n.) (1) A layer of dead plant material on the soil surface (cf. *fresh and humic mulch*); (2) an artificial layer of material such as paper or plastic on the soil surface; (v.) cultural practice of placing rock, straw, asphalt, plastic or other material on the soil's surface as a surface cover

Multiple use: Use of range for more than one purpose; for example, grazing of livestock, wildlife production, recreation, watershed and timber production; not necessarily the combination of uses that will yield the highest economic return or greatest unit output

Native species: A species that is a part of the original fauna or flora of the area in question (Syn. *indigenous. cf. introduced and resident species*)

Naturalized species: A species not native to an area that adapted to the area and has established a stable or expanding population; does not require artificial inputs for survival and reproduction; for example, cheatgrass, Kentucky bluegrass, starling

Nonuse: (1) Absence of grazing use on current year's forage production; (2) lack of exercise, of a grazing privilege on grazing lands; (3) an authorization to refrain, temporarily, from placing livestock on public ranges without loss of preference for future consideration

Noxious species: A plant species that is undesirable because it conflicts, restricts or otherwise causes problems under management objectives; not to be confused with species declared noxious by laws concerned with plants that are weedy in cultivated crops and on range

Nurse crop: A temporary crop seeded at or near the time primary plant species are seeded to provide protection and otherwise help ensure establishment of the latter (cf. *companion crop, preparation crop*)

Nutritive value: Relative capacity of given forage or other feedstuff to furnish nutrition for animals. In range management, the term usually is prefixed by *high, low or moderate*.

Open range: (1) Range that has not been fenced into management units; (2) all suitable rangeland of an area upon which grazing is permitted; (3) un-timbered rangeland; (4) range on which the livestock owner has unlimited access without benefit of land ownership or leasing

Organism: Any living entity; plant, animal, fungus, etc.

Outcrop: The exposure of bedrock or strata projecting through the overlying cover of detritus and soil

Oven dry weight: The weight of a substance after it has been dried in an oven at a specific temperature to equilibrium

Overgrazing: Continued heavy grazing that exceeds the recovery capacity of the community and creates a deteriorated range (cf. *overuse*)

Overland flow: Surface runoff of water following a precipitation event (cf. *runoff*)

Overstocking: Placing a number of animals on a given area that will result in *overuse* if continued to the end of the planned grazing period

Overstory: The upper canopy or canopies of plants; usually refers to trees, tall shrubs and vines

Overuse: Utilizing an excessive amount of the current year's growth which, if continued, will result in *range deterioration* (cf. *overgrazing*)

Paddock: (1) One of the subdivisions or subunits of the entire pasture unit, or grazing area enclosed and separated from other areas by fencing or other barriers; (2) a subdivision or subunit of an entire grazing unit (cell) often involved in controlled grazing of some manner; (3) a relatively small enclosure used as an exercise and saddling area for horses, generally adjacent to stalls or stable (Syn. *Pasture*; cf. *cell*)

Palatability: The relish with which a particular species or plant part is consumed by an animal

Pan (soils): Horizon or layer in soils that is strongly compacted, indurated or very high in clay content (cf. *caliche, claypan, hardpan*)

Pasture: (1) A grazing area enclosed and separated from other areas by fencing or other barriers; the management unit for grazing land; (2) forage plants used as food for grazing animals; (3) any area devoted to the production of forage, native or introduced, and harvested by grazing; (4) a group of subunits grazed within a rotational grazing system

Pastureland: Grazing lands, planted primarily to introduced or domesticated native forage species, that receive periodic renovation and/or cultural treatments, such as tillage, fertilization, mowing, weed control and irrigation; not in rotation with crops

Percent use: Grazing use of current growth, usually expressed as a percent of the current growth (by weight), that has been removed (cf. *degree of use*)

Perennial plant: A plant that has a life span of three or more years

Pesticide: Any chemical agent such as herbicide, fungicide or insecticide used for control of specific organisms

Phenotype: The physical appearance of an individual as contrasted with genetic makeup or genotype

Photopoint: An identified point from which photographs are taken at periodic intervals

Photosensitization: A noncontagious disease resulting from the abnormal reaction of light-colored skin to sunlight after a photodynamic agent has been absorbed through the animal's system. Grazing certain kinds of vegetation or ingesting certain molds under specific conditions causes photosensitization.

Pioneer species: The first species or community to colonize or recolonize a barren or disturbed area in primary or secondary succession

Pitting: Making shallow pits or basins of suitable capacity and distribution on range to reduce overland flow from rainfall or snowmelt

Plain: A broad stretch of relatively level treeless land

Plant vigor: Plant health

Poisonous plant: A plant containing or producing substances that causes sickness, death or a deviation from the normal state of health of animals

Prairie: An extensive tract of level or rolling land that originally was treeless and grass-covered (cf. *grassland, rangeland*)

Precipitation: Condensation from the atmosphere, falling as rainfall, snow, hail or sleet

Preferred species: Species that are preferred by animals and are grazed by first choice

Prescribed burning: The use of fire as a management tool under specified conditions for burning a predetermined area (cf. *maintenance burning*)

Primary production: The conversion of solar energy to chemical energy through the process of photosynthesis. It is represented by the total quantity of organic material produced within a given period by vegetation.

Primary productivity: The rate of conversion of solar to chemical energy through the process of photosynthesis

Primary range: Areas that animal prefer to use when management is limited. Primary range will be overused before *secondary range* is fully used.

Pristine: A state of ecological stability or condition existing in the absence of direct disturbance by modern man

Productivity: The rate of production per unit area, usually expressed in terms of weight or energy

Proper grazing: The act of continuously obtaining proper use

Proper stocking: Placing a number of animals on a given area that will result in proper use at the end of the planned grazing period. Continued proper stocking will lead to proper grazing.

Proper use: A degree of utilization of current year's growth which, if continued, will achieve management objectives and maintain or improve the long-term productivity of the site. Proper use varies with time and systems of grazing. (Syn. *proper utilization, proper grazing use*; cf. *allowable use*)

PLS: Abbreviation for pure live seed

Pure live seed: Purity and germination of seed expressed in percent; may be calculated by formula: PLS = % germination X % purity / 100; for example, 91 X 96/100 = 87.36 percent (Abbr., PLS; cf. *seed purity*)

Range: (n.) Any land supporting vegetation suitable for grazing, including rangeland, grazable woodland and shrubland; range is not a use; (adj.) modifies resources, products, activities, practices and phenomena pertaining to rangeland (cf. *rangeland, forested range, grazable woodland, shrubland*)

Range appraisal: The classification and valuation of rangeland from an economic or production standpoint

Range condition: (a) A generic term relating to present status of a unit of range in terms of specific values or potentials. Specific values or potentials must be stated; (b) some agencies define range condition as follows: the present state of vegetation of a range site in relation to the climax (natural potential) plant community for that site. It is an expression of the relative degree to which the kinds, proportions and amounts of plants in a plant community resemble that of the climax plant community for the site. (cf. *ecological status and resource value rating*)

Range condition class: Confusion has existed regarding the definition and use of this term. (1) The following definition fits the thinking expressed in the definition Range Condition (a) above: One of a series of arbitrary categories used to classify ecological status of a specific range site in relation to its potential (early, mid, late seral or PNC) or classify management-oriented value categories for specific potentials; for example, good condition spring cattle range. (2) Some agencies consider range condition class in the context of Range Condition (b) above as follows:

Range Condition Class	% of climax for the range site
Excellent	76-100
Good	51-75
Fair	26-50
Poor	0-25

Range improvement: (1) Any structure or excavation to facilitate management of range or livestock; (2) any practice designed to improve range condition or facilitate more efficient utilization of the range; (3) an increase in the grazing capacity of range; for example, improvement of rangeland condition

Range management: A distinct discipline founded on ecological principles and dealing with the use of rangelands and range resources for a variety of purposes. These purposes include use as watersheds, wildlife habitat, grazing by livestock, recreation and aesthetics, as well as other associated uses.

Range readiness: The defined stage of plant growth at which grazing may begin under a specific management plan without permanent damage to vegetation or soil; usually applied to seasonal range

Range seeding: The process of establishing vegetation by the artificial dissemination of seed

Range site: Synonymous with *ecological site* when referring to rangeland; an area of rangeland that has the potential to produce and sustain distinctive kinds and amounts of vegetation to result in a characteristic plant community under its particular combination of environmental factors, particularly climate, soils and associated native biota. Some agencies use range site based on the climax concept, not potential natural community. (cf. *vegetative type*)

Rangeland: Land on which the native vegetation (climax or natural potential) is predominantly grasses, grasslike plants, forbs or shrubs; includes lands revegetated naturally or artificially when routine management of that vegetation is accomplished mainly through manipulation of grazing. Rangelands include natural grasslands, savannas, shrublands, most deserts, tundra, alpine communities, coastal marshes and wet meadows. (cf. *forestland, range*)

Rangeland inventory: (1) The systematic acquisition and analysis of resource information needed for planning and for management of rangeland; (2) the information acquired through rangeland inventory

Rangeland renovation: Improving rangeland by mechanical, chemical or other means

Reclamation: Restoration of a site or resource to a desired condition to achieve management objectives or stated goals (cf. *revegetation*)

Remote sensing: The measurement or acquisition of information of some property, object or phenomenon by a recording device that is not in physical or intimate contact with the object or phenomenon under study; often involves aerial photography or satellite imagery

Reseeding: Syn. *range seeding*

Rest: Leaving an area ungrazed, thereby foregoing grazing of one forage crop. Normally, rest implies absence of grazing for a full growing season or during a critical portion of plant development, or seed production (cf. *deferment*)

Rest period: A time period of no grazing included as part of a grazing system

Rest-rotation: A grazing management scheme in which rest periods for individual pastures, paddocks or grazing units, generally for the full growing season, are incorporated into a grazing rotation (cf. *grazing system*)

Rhizome: A horizontal underground stem usually sending out roots and above-ground shoots from the nodes

Riparian: Referring to or relating to areas adjacent to water or influenced by free water associated with streams or rivers on geologic surfaces occupying the lowest position on a watershed

Riparian species: Plant species occurring in the riparian zone. Obligate species require the environmental conditions in the riparian zone; facultative species tolerate the environmental conditions and may occur away from the riparian zone.

Riparian zone: The banks and adjacent areas of water bodies, water courses, seeps and springs whose waters provide soil moisture sufficiently in excess of that otherwise available locally so as to provide a moister habitat than that of contiguous flood plains and uplands

Ripping: The mechanical penetration and sheering of range soils to depths of 8 to 18 inches for the purpose of breaking hardpan layers to facilitate penetration of plant roots, water, organic matter and nutrients; a range improvement practice used where native grasses of a rhizomatous nature can spread into the ripped soil (cf. *chiseling*)

Rotation grazing: A grazing scheme in which animals are moved from one grazing unit (paddock) in the same group of grazing units to another without regard to specific graze:rest periods or levels of plant defoliation (cf. *grazing system*)

Roughage: Plant materials containing a low proportion of nutrients per unit of weight and usually bulky and coarse, high in fiber and low in total digestible nutrients. Roughage may be classed as dry or green.

Rumen: The large first compartment of the stomach of a ruminant from which ingested food is regurgitated for rechewing and in which digestion is aided by symbiotic action of microbes

Ruminant: Even-toed, hoofed mammals that chew the cud and have a four-chamber stomach, or *Ruminantia*

Runoff: The total stream discharge of water, including surface and subsurface flow, usually expressed in acre-feet of water yield

Sacrifice area: A portion of the range; respective of site, that is unavoidably overgrazed to obtain efficient overall use of the management area

Seasonlong grazing: See Continuous Grazing

Seasonal grazing: Grazing restricted to a specific season. Synonymous with *season of use*; i.e. spring, summer, fall, winter.

Seasonal use: (1) Synonymous with *seasonal grazing*; (2) seasonal preference of certain plant species by animals

Secondary range: Range that is used lightly or unused by livestock under minimal management and ordinarily will not be fully used until the primary range has been overused

Seed: A fertilized, ripened ovule of a flowering plant

Seed certification: A system whereby seed of plant cultivars is produced, harvested and marketed under authorized regulation toe seed of high quality and genetic purity

Seed, dormant: Live seed in a non-germinated condition because of (1) internal inhibitions in the seed, or hard seed, or (2) unfavorable environmental conditions

Seed inoculation: Treatment of legume seed with rhizobium bacteria before planting to enhance subsequent nitrogen fixation

Seedbed preparation: Soil treatment prior to seeding to: (1) reduce or eliminate existing vegetation, (2) reduce the effective supply of weed seed, (3) modify physical soil characteristics and (4) enhance temperature and water characteristics of the microenvironment

Seed purity: The percentage of the desired species in relation to the total quantity, including other species, weed seed and foreign matter (cf. *pure live seed*)

Seep: Wet areas, normally not flowing, arising from an underground water source

Selective grazing: The grazing of certain plant species, individual plants or plant parts on the range to the exclusion of others

Short-duration grazing: Grazing management whereby relatively short periods (days) of grazing and associated nongrazing are applied to range or pasture units. Periods of grazing and nongrazing are based upon plant growth characteristics. Short-duration grazing has nothing to do with intensity of grazing use. (cf. *grazing system*)

Shrub: A plant that has persistent, woody stems and a relatively low growth habit, and that generally produces several basal shoots instead of a single bole. It differs from a tree by its low stature (generally less than 5 meters, or 16 feet) and non-arborescent form.

Shrubland: Any land on which shrubs dominate the vegetation

Similarity index: The percentage of a specific vegetation state plant community that is presently on the site

Slope: A slant or incline of the land surface measured in degrees from the horizontal, or in the percent (defined as the number of feet or meters change in elevation per 100 of the same units of horizontal distance); may be further characterized by direction (*exposure*)

Sod: Vegetation that grows so as to form a mat of soil and vegetation (Syn. *Turf*)

Sod grasses: Stoloniferous or rhizomatous grasses that form a sod or turf (cf. *bunchgrass*)

Soil: (1) The unconsolidated mineral and organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants; (2) the unconsolidated mineral matter on the surface of the Earth that has been subjected to and influenced by genetic and environmental factors of parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting during a period of time and producing a product-soil-that differs from the material from which it was derived in many physical, chemical, biological, and morphological properties and characteristics

Soil condition class: One of a series of arbitrary categories based principally on the amount of ground cover weighted by the degree of accelerated erosion used to identify soil stability

Species: A taxon or rank species; in the hierarchy or biological classification, the category below genus

Species composition: The proportions of various plant species in relation to the total on a given area. It may be expressed in terms of cover, density, weight, etc.

Spot grazing: Repeated grazing of small areas while adjacent areas are lightly grazed or unused

Spring: Flowing water originating from an underground source

Stand: An existing plant community with definitive bounds that is relatively uniform in composition, structural and site conditions; thus, it may serve as a local example of a community type

Standing crop: The total amount of plant material per unit of space at a given time; often is divided into above-ground and below-ground portions and further may be modified by the descriptors “dead,” or :live” to more accurately define the specific type of biomass

Stem: The culm or branch of a plant

Stock: Livestock

Stocking density: The relationship between number of animals and area of land at any instant of time. It may be expressed as animal-units per acre, animal-units per section or AU/ ha. (cf. *stocking rate*)

Stocking rate: The number of specific kinds and classes of animals grazing or utilizing a unit of land for a specified time period; may be expressed as animal unit months or animal unit days per acre, hectare or section, or the reciprocal (area of land/animal unit month or day). When dual use is practiced (for example, cattle and sheep), stocking rate often is expressed as animal unit months/unit of land or the reciprocal. (Syn. *stocking level*; cf. *stocking density*)

Stockpiling: Allowing standing forage to accumulate for grazing at a later period, often for fall and winter grazing after dormancy (cf. *cured forage*)

Stock pond: A water impoundment made by constructing a dam or by excavating a dugout, or both, to provide water for livestock and wildlife (cf. *catchment, guzzler, drink tank*)

Stock water development: Development of a new or improved source of stock water supply, such as well, spring or pond, together with storage and delivery system

Stolon: A horizontal stem that grows along the surface of the soil and roots at the nodes

Stubble: The basal portion of herbaceous plants remaining after the top portion has been harvested artificially or by gazing animals

Submarginal land: Land that is physically or economically incapable of indefinitely sustaining a certain use

Succession: The progressive replacement of plant communities on a site that leads to the potential natural plant community; for example, attaining stability. Primary succession entails simultaneous successions of soil from parent material and vegetation. Secondary succession occurs following disturbances on sites that previously supported vegetation and entails plant succession on a more mature soil.

Suitable range: (1) Range accessible to a specific kind of animal and that can be grazed on a sustained yield basis without damage to the resource; (2) the limits of adaptability of plant or animal species. One U.S. agency utilizes the term as follows: Land that is accessible or that can become accessible to livestock, that produces forage or has inherent forage producing capabilities and that can be grazed on a sustained yield basis under reasonable management goals. Suitable range includes rangeland and forest land with a grazeable understory that is contained in grazing allotments.

Supplement: Nutritional additive (salt, protein, phosphorus, etc.) intended to remedy deficiencies of the range diet

Supplemental feeding: Supplying concentrates or harvested feed to correct deficiencies of the range diet; often erroneously used to mean *emergency feeding* (cf. *maintenance feeding*)

Surfactant: A surface active agent, or materials used in herbicide formulations to bring about emulsifiability, spreading, wetting, sticking, dispersibility, solubilization or other surface modifying properties

Swale: An area of low and sometimes wet land

Taproot system: A plant root system dominated by a single large root, normally growing straight downward, from which most of the smaller roots spread out laterally (cf. *fibrous root system*)

Terracing: Mechanical movement of soil along the horizontal contour of a slope to produce an earthen dike to retain water and diminish the potential of soil erosion

Tiller: The asexual development of a new plant from a meristematic region of the parent plant

Total annual yield: The total annual production of all plant species of a plant community

Trace element: An element essential for normal growth and development of an organism but required only in minute quantities

Trampling: Treading underfoot; the damage to plants or soil brought about by movements or congestion of animals

Tree: A woody perennial; usually single-stemmed plant, that has a definite crown shape and reaches a mature height of at least 16 feet (5 meters). There is no clear-cut distinction between trees and shrubs. Some plants, such as oaks (*Quecus* spp.), may grow as trees or shrubs

Trend (range trend): Classes and Ecological Status Ratings: Trend in range condition or ecological status should be described as up, down or not apparent. "Up" represents a change toward climax or potential natural community, "down" represents a change away from climax or potential natural community and "not apparent" indicates no recognizable change. This category often is recorded as static or stable. No necessary correlation has been found among trends in resource value ratings, vegetation management status, range condition or ecological status

Trophic levels: The sequence of steps in a food chain or food pyramid from producer to primary, secondary or tertiary consumer

Turf: Syn. *sod*

Twice-over rotational grazing: A variation of the deferred-rotation grazing system that involves grazing three or more native pastures in rotation based on the growth stages of key species. Livestock are rotated through the grazing system faster than a deferred-rotation (once-over), allowing for periods of regrowth and recovery of vegetation, resulting in a second grazing period; thus, twice-over.

Undergrazing: The act of continued underuse

Understocking: Placing a number of animals on a given area that will result in *underuse* at the end of the planned grazing period

Understory: Plants growing beneath the canopy of other plants; usually refers to grasses, forbs and low shrubs under a tree or shrub canopy (cf. *overstory*)

Underuse: A degree of use less than proper use

Undesirable species: (1) Species that conflict with or do not contribute to the management objectives; (2) species that are not readily eaten by animals

Ungulate: A hoofed animal, including ruminants but also horses, tapirs, elephants, rhinoceroses and swine

Unsuitable range: Range that has no potential value for, or which should not be used for, a specific use because of permanent physical or biological restrictions. When unsuitable range is identified, the identification must specify what use or uses are unsuitable (for example, "unsuitable cattle range").

Use: (1) The proportion of current years forage production that is consumed or destroyed by grazing animals; may refer to a single species or to the vegetation as a whole (Syn. *degree of use*); (2) utilization of range for a purpose such as grazing, bedding, shelter, trailing, watering, watershed, recreation, forestry, etc.

Utilization: Syn. *use*

Vegetation: Plants in general, or the sum total of the plant life above and below ground in an area (cf. *vegetative*)

Vegetation type: A kind of existing plant community with distinguishable characteristics described in terms of the present vegetation that dominates the aspect or physiognomy of the area

Vegetative: Relating to nutritive and growth function of plant life in contrast to sexual reproductive functions; of or relating to vegetation

Vegetative reproduction: Production of new plants by any asexual method

Vigor: Relates to the relative robustness of a plant in comparison to other individuals of the same species. It is reflected primarily by the size of a plant and its parts in relation to its age and the environment in which it is growing. (Syn. *plant vigor*; cf. *hybrid vigor*)

Virgin: Syn. *pristine*

Warm-season plant: (1) A plant that makes most or all its growth during the spring, summer or fall and is usually dormant in winter; (2) a plant that usually exhibits the C-4 photosynthetic pathway

Watershed: (1) A total area of land above a given point on a waterway that contributes runoff water to the flow at that point; (2) a major subdivision of a drainage basin

Weed: (1) Any plant growing where unwanted; (2) a plant having a negative value within a given management system

Wetlands: Areas characterized by soils that usually are saturated or ponded; hydric soils that support mostly water-loving plants (hydrophytic plants)

Wetland communities: Plant communities that occur on sites with soils typically saturated with or covered with water most of the growing season

Wet meadow: A meadow where the surface remains wet or moist throughout the growing season, usually characterized by sedges and rushes

Wildlife: Undomesticated vertebrate animals considered collectively, with the exception of fish (cf. *game*)

Winter range: Range that is grazed during the winter months

Wolf plant: (1) An individual plant that generally is considered palatable but is not grazed by livestock; (2) an isolated plant growing to extraordinary size, usually from lack of competition or utilization

Woodland: A land area occupied by trees; a forest, woods

Woody: A term used in reference to trees, shrubs or browse that characteristically contains persistent ligneous material

Xeric: Having very little moisture; tolerating or adapted to dry conditions

Yearling: An animal approximately one year of age. A short yearling is from 9 to 12 months of age and a long yearling is from 12 to 18 months.

Yield: (1) The quantity of a product in a given space and/or time; (2) the harvested portion of a product (Syn. *production, total annual yield or runoff*)

Ecological Sites

An ecological site is a distinctive kind of rangeland based on present or potential natural vegetation, potential productivity and/or soils, and other environmental factors. The kind and amount of vegetation produced on an ecological site will vary in an area due to soil type differences and landscape position (Figure 1).

To help identify ecological sites, the most common sites are illustrated below with location found in the landscape, major vegetation species associated with the site and recommended stocking rate for sites in high good to excellent condition. Lowest levels are for western North Dakota and highest levels for eastern North Dakota and western Minnesota.

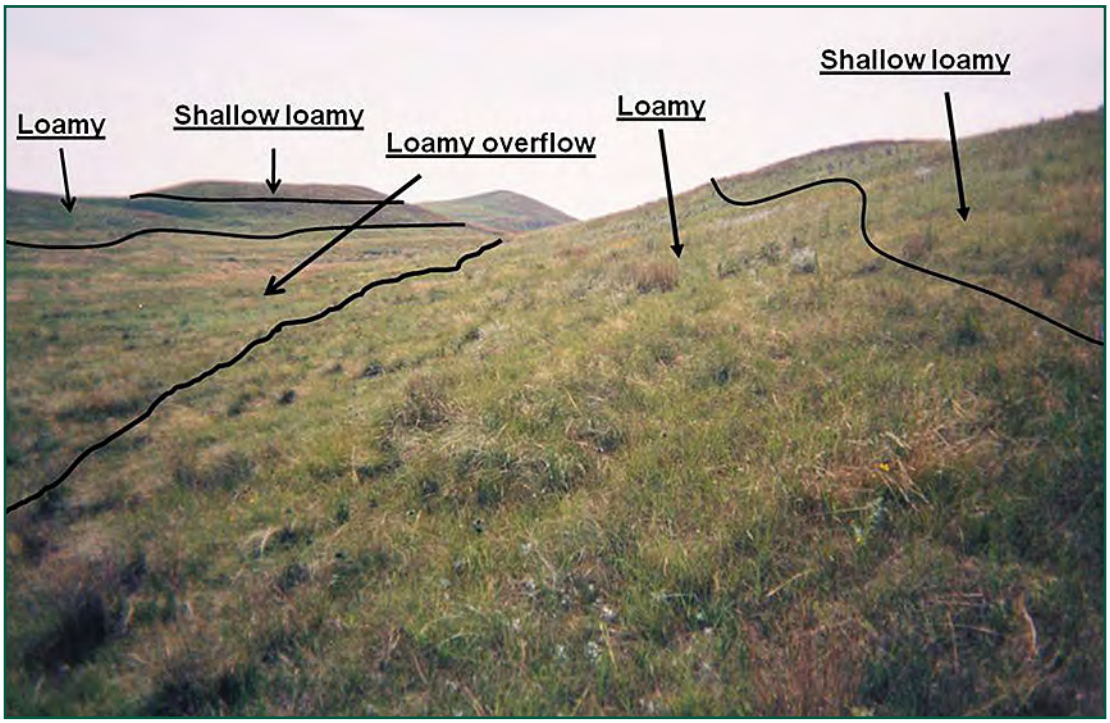


Figure 1. Landscape features and location of all soils types from a common soil sequence.

TIP: See publication "Ecological Sites of North Dakota" (R1556) for detailed plant community and soil description, and photos of selected sites (https://www.ndsu.edu/agriculture/ag-hub/publications/ecological-sites-north-dakota).

TIP: Complete versions of ecological site descriptions are available on the Web at (https://esis.sc.egov.usda.gov/) and ecological site maps for your area of interest are available via Web Soil Survey at (http://websoilsurvey.nrcs.usda.gov/app/).

Clayey

Location: On very fine-textured soils occurring on flat to gentle undulating uplands with slopes of 0 to 25 percent.

Major plant species in reference plant community phase: green needlegrass, porcupine grass, western wheatgrass, prairie Junegrass, blue grama, buffalo grass, western ragweed, silverleaf scurfpea, cudweed sagewort, prairie coneflower, goldenrod species, fringed sagewort, western snowberry, lead plant, prairie rose.

Estimated stocking rate: 0.6 AUM/acre (western North Dakota) to 0.8 AUM/acre (eastern North Dakota, western Minnesota).

Claypan

Location: On very fine to fine-textured soils occurring on flat to undulating uplands, with upland sites containing "benches" and slopes 0 to 25 percent. Subsurface soil layers are restrictive to water movement and root penetration at 6 to 18 inches below soil surface.

Major plant species in reference plant community phase: western wheatgrass, green needlegrass, blue grama, sandberg bluegrass, prairie Junegrass, heath aster, western yarrow, silverleaf scurfpea, wild onion, cudweed sagewort, scarlet globemallow, Missouri goldenrod, fringed sagewort, broom snakeweed, cactus.

Estimated stocking rate: 0.4 AUM/acre (western North Dakota) to 0.6 AUM/acre (eastern North Dakota, western Minnesota).

Loamy

Location: On fine-textured soils occurring on gentle undulating to strongly rolling uplands and high stream terraces.

Major plant species in reference plant community phase: green needlegrass, western wheatgrass, needle-and-thread, blue grama, upland sedges, western ragweed, silverleaf scurfpea, prairie coneflower, fringed sagewort, western snowberry, prairie rose.

Estimated stocking rate: 0.7 AUM/acre (western North Dakota) to 0.9 AUM/acre (eastern North Dakota, western Minnesota).

Loamy Overflow

Location: On nearly level swales and depressions receiving additional moisture from adjacent slopes.

Major plant species in reference plant community phase: big bluestem, switchgrass, green needlegrass, western wheatgrass, porcupine grass, Indiangrass, goldenrod species, cudweed sagewort, American licorice, western snowberry.

Estimated stocking rate: 0.9 AUM/acre (western North Dakota) to 1.2 AUMs/acre (eastern North Dakota, western Minnesota).

Saline Lowland

Location: On saline soils occurring in depressions and along stream channels that receive additional moisture.

Major plant species in reference plant community phase: western wheatgrass, nuttall alkaligrass, slender wheatgrass, inland saltgrass, foxtail barley, silverweed cinquefoil, pursh seepweed, curly dock.

Estimated stocking rate: 0.7 AUM/acre (western North Dakota) to 1.1 AUMs/acre (eastern North Dakota, western Minnesota).

Sands

Location: On loamy, fine-sand-textured soils occurring on nearly level to rolling landscapes.

Major plant species in reference plant community phase: needle-and-thread, prairie sandreed, sand dropseed, blue grama, upland sedges, western wheatgrass, purple prairie clover, green sagewort, Missouri goldenrod, fringed sagewort, prairie rose.

Estimated stocking rate: 0.7 AUM/acre (western North Dakota) to 0.8 AUM/acre (eastern North Dakota, western Minnesota).

Sandy

Location: On fine sandy loam-textured soils occurring on nearly level to strongly rolling uplands and river terraces.

Major plant species in reference plant community phase: needle-and-thread, prairie sandreed, green needlegrass, western wheatgrass, blue grama, upland sedges, western ragweed, green sagewort, Missouri goldenrod, fringed sagewort, prairie coneflower, heath aster, lead plant, prairie rose.

Estimated stocking rate: 0.7 AUM/acre (western North Dakota) to 0.9 AUM/acre (eastern North Dakota, western Minnesota).

Shallow Gravel

Location: On medium to moderately coarse-textured soils overlying sand and gravel on nearly level to gently sloping uplands and stream terraces. Subsurface soil layers are restrictive to root penetration at 14 to 20 inches below soil surface.

Major plant species in reference plant community phase: needle-and-thread, western wheatgrass, blue grama, prairie Junegrass, upland sedges, rush skeletonweed, dotted gayfeather, black samson, fringed sagewort, prairie rose.

Estimated stocking rate: 0.4 AUM/acre (western North Dakota) to 0.6 AUM/acre (eastern North Dakota, western Minnesota).

Thin Claypan

Location: On very fine to fine-textured soils occurring on flat to undulating uplands, with upland sites containing "benches" and slopes 0 to 25 percent. Subsurface soil layers are restrictive to water movement and root penetration at surface to 6 inches below soil surface.

Major plant species in reference plant community phase: western wheatgrass, blue grama, sandberg bluegrass, inland saltgrass, buffalo grass, sedges, health aster, western yarrow, wild onion, cudweed sagewort, scarlet globemallow, fringed sagewort, broom snakeweed, cactus.

Estimated stocking rate: 0.2 AUM/acre (western North Dakota) to 0.4 AUM/acre (eastern North Dakota, western Minnesota).

Thin Loamy

Location: On medium-textured soils occurring on hill tops and steep uplands.

Major plant species in reference plant community phase: little bluestem, sideoats grama, needle-and-thread, prairie sandreed, western wheatgrass, porcupine grass, plains muhly, blue grama, upland sedges, black samson, dotted gayfeather, Missouri goldenrod, purple prairieclover, prairie rose, broom snakeweed.

Estimated stocking rate: 0.5 AUM/acre (western North Dakota) to 0.7 AUM/acre (eastern North Dakota, western Minnesota).

Very Shallow

Location: On medium to moderately coarse-textured soils overlying sand and gravel on nearly level to gently sloping uplands and stream terraces. Subsurface soil layers are restrictive to root penetration at surface to 14 inches below soil surface.

Major plant species in reference plant community phase: little bluestem, needle-and-thread, plains muhly, blue grama, prairie Junegrass, upland sedges, dotted gayfeather, American pasqueflower, hairy goldaster, heath aster, black samson, fringed sagewort, prairie rose.

Estimated stocking rate: 0.2 AUM/acre (western North Dakota) to 0.4 AUM/acre (eastern North Dakota, western Minnesota).

Wet Meadow

Location: On poorly drained medium- and fine-textured soils occurring in swales and depressions of rolling prairies.

Major plant species in reference plant community phase: prairie cordgrass, northern reedgrass, switchgrass, fowl bluegrass, lowland sedges, baltic rush, common wild mint, tall white aster, curly dock.

Estimated stocking rate: 1.2 AUMs/acre (western North Dakota) to 1.4 AUMs/acre (eastern North Dakota, western Minnesota).

Wet Land (Shallow Marsh)

Location: On poorly drained fine-textured soils occurring in shallow basins and depressions of upland prairies.

Major plant species in reference plant community phase: common reedgrass, prairie cordgrass, cattails, reed canarygrass, northern reedgrass, lowland sedges, baltic rush, smartweed species, curly dock, willow species.

Estimated stocking rate: 1.6 AUMs/acre (western North Dakota) to 1.8 AUMs/acre (eastern North Dakota, western Minnesota).

Native Range Plants

Native range plants include species that are a part of the original flora of the area in question. Listed on the following pages are common native range plants found in North Dakota and eastern Minnesota with a short description, season of growth, site on which they are found, forage value and their response to grazing. Plant name, characteristics and a detailed description can be found on the U.S. Department of Agriculture's PLANTS Database (www.plants.usda.gov).

Grasses

Bearded wheatgrass

This cool-season, midstatured, short-lived perennial bunchgrass can be found growing on a variety of moist to dry sites, including loamy overflow, loamy, open woodlands and meadows. It usually is scattered throughout the plant community but can be abundant locally. The basal leaves of bearded wheatgrass are soft and palatable to all classes of livestock. It is considered a decreaser with heavy-grazing pressure. The leaves provide good forage for small mammals, rabbits, white-tailed deer and mule deer during most seasons. Many songbirds use the seeds to a lesser extent because of the presence of awns.

Big bluestem

This is a warm-season, perennial, tall-statured, sod-forming grass found on moist soils and ecological sites. It potentially is abundant on loamy overflow and subirrigated ecological sites. This grass decreases with overgrazing, frequently being replaced by less productive mid and short grass species. Big bluestem is very palatable and nutritious to all classes of livestock when actively growing but becomes coarse late in the season and quality declines.

Blue grama

This is a warm-season, perennial, short-statured bunchgrass found on drier upland sites, including sandy, gravelly, loamy, clayey and claypan soils. This grass increases with overgrazing, frequently replacing more productive mid and tall grass species, and often forming a dense sod intermixed with sedges. Blue grama is low-producing, very palatable and nutritious to all classes of livestock, even during the winter.

Buffalo grass

This warm-season, short-statured, stoloniferous perennial grass is one of the few grasses that reproduce by stolons (above-ground stems) in the northern Great Plains. It's also unusual because those male and female flowers usually are produced on different plants. This species commonly is found on medium- to fine-textured soils associated with the clayey and claypan ecological sites. It is drought-tolerant and is considered an increaser with heavy grazing pressure, displacing higher-producing mid and tall grass species. Buffalo grass is very palatable and has good grazing value for all classes of livestock while providing fair to good grazing value for antelope and whitetail deer. The seeds have some feed value to bird species. Buffalo grass has received much attention as a low-growing grass for lawns, picnic areas, golf courses and airport runways due to its low maintenance requirements.

Canada wildrye

This cool-season, midstatured, short-lived perennial bunchgrass is adapted to a wide variety of soil textures and moistures but is best suited to dry or moist sandy, sand or gravelly sites. This species provides good forage for cattle and horses and fair forage for sheep during the spring. The plant's feed value reduces dramatically as it matures and is used sparingly in the summer and fall. This species is considered a decreaser with grazing pressure.

Foxtail barley

This is a cool-season, perennial, mid-statured bunchgrass found on moist saline sites, often forming a distinctive ring around wetlands. This grass increases with overgrazing, frequently replacing productive mid and tall grasses, and wetland sedges. Due to increase levels of salts caused by a reduction of the more desirable plants species, foxtail barley will increase and dominate these sites. Once this occurs, returning these sites to their original status becomes difficult. Foxtail barley provides fair forage for cattle, horses and sheep when young but becomes unpalatable when mature.

Green needlegrass

A cool-season, perennial, this mid-stature bunchgrass is found on medium- and fine-textured soils. This species grows best on loamy soils but also is found on heavy clay soils. This grass decreases with overgrazing and early season grazing, frequently being replaced by less productive mid and short grass species. Green needlegrass is regarded as the most palatable of the needlegrasses and is nutritious to all classes of livestock.

Inland saltgrass

A warm-season, short-statured, perennial sod-former growing along roads and in low prairie sites, it is associated with moist alkaline or saline soils. Due to its poor palatability, inland saltgrass seldom is grazed and is considered an increaser under heavy grazing pressure. White-tailed deer use this plant's foliage to a small extent, while some shorebirds and small rodents use the seeds.

Little bluestem

This is a warm-season, perennial, mid-statured bunchgrass found on dry ridges, hillsides and sand hill areas; it's often associated with calcareous soils. The grass decreases with overgrazing, frequently being replaced by short grass, such as blue grama, sedges and broad-leaf species. The young shoots or new leaf tissue of little bluestem is regarded as palatable and often selected by grazing livestock. Older plant leaf tissue and seed stocks are avoided, giving the impression that the plant is not being grazed. Mature little bluestem has a classic red tinge in late summer and if ungrazed will become a wolf plant.

Lowland sedges (slough sedge and wooly sedge)

These are cool-season, mid- to tall-statured, perennial grasslike plants found in high-moisture sites such as wet meadow and wetland ecological sites. The number of different wetland sedge species is vast, all with varying degrees of palatability and response to grazing pressure. Slough sedge is considered very palatable to livestock and therefore considered a decreaser, while others are much less palatable and therefore tend to increase as grazing pressure reduces the more palatable species.

Needle-and-thread

This is a cool-season, perennial, mid-statured bunchgrass found on sandy and course-textured soils. This grass initially increases with grazing pressure, eventually decreasing with overgrazing, and is replaced by less productive mid and short grass species. Needle-and-thread is regarded as very palatable by all classes of livestock when grazed before plant maturity. If grazing occurs when seed or "needles" are present, they may be mechanically injurious, especially to sheep.

Plains muhly

It is a warm-season, short-statured, perennial bunchgrass that is found most commonly on stony or gravelly slopes of weakly developed soils along ridges and steep slopes. This species provides fair to good forage for all classes of livestock and is considered a decreaser under heavy grazing pressure. It provides good forage for white-tailed and mule deer, while wild turkeys and other birds use the seeds.

Porcupine grass

It is a cool-season, mid-statured perennial bunchgrass distributed across a number of sites, but it is more frequently on sandy, thin loamy and loamy overflow sites. Less common than needle-and-thread or green needlegrass, porcupine grass provides good forage value for all classes of livestock. Livestock tend to avoid this plant during the seed-hardening stage and until the seeds drop from the plant. Porcupine grass is considered a decreaser under heavy grazing pressure. Songbirds and rodents use the seeds readily. Deer and elk will consume the young vegetative parts of the plant before it is in fruiting condition.

Prairie cordgrass

This warm-season, perennial, tall-statured, sod-forming grass is found on moist soils and ecological sites. It potentially is abundant on moist areas such as wet prairie, including the wet meadow ecological sites. This grass decreases with overgrazing, frequently being replaced by spike rush, undesirable wetland sedges and lower-producing mid grasses. Prairie cordgrass is not readily eaten by livestock except in the spring or in the fall after a killing frost.

Prairie Junegrass

This is a cool-season, short-statured perennial growing in bunch form. Junegrass (not to be confused with Kentucky bluegrass, which some also may call Junegrass) can be found growing on dry prairie sites across a variety of soil textures. It seldom grows in dense stands and most often is associated with blue grama and needle-and-thread plant communities. This species provides good forage for all classes of livestock, as well as deer, antelope and elk.

Prairie sandreed

This warm-season, perennial, tall-statured, sod-forming grass is found on sand, sandy and coarse-textured soils. It often is associated with drier upland sites, forming dense patches or colonies. This grass decreases with overgrazing, frequently being replaced by lower-producing mid and short grasses. Prairie sandreed provides fair to good forage value for bison, cattle and horses and fair for sheep during its first two months of growth and after it cures on the stem for fall and winter grazing.

Red threeawn

This warm-season, short-statured, perennial bunchgrass grows in soils of all textures, but most frequently it's found on sandy soils and drier upland and shallow sites, and commonly is found on hillsides. This species is considered a poor forage plant for all classes of livestock. It's used rarely and grazed only slightly in early spring or after other grasses are overused or displaced. Considered an increaser with grazing pressure, an abundance of red threeawn often is associated with low range condition. Mature awns can cause injury if grazed or consumed in contaminated hay. Red threeawn is considered of little value as grazeable forage to most wildlife species.

Reed canarygrass

This is a cool-season, strongly rhizomatous perennial that is tall-statured. It most commonly is found on wet meadow ecological sites. This grass decreases with overgrazing, frequently being replaced by less productive mid and short grass species. Reed canarygrass is palatable and provides good forage for all classes of livestock.

Sand dropseed

The warm-season, mid-statured perennial bunchgrass is found most commonly on coarser-textured soils, such as sandy, sands and thin-sands ecological sites. Generally, sand dropseed accounts for only a small portion of the plant community on these sites, except when the range becomes depleted from drought and/or overgrazing. Then it can become dominate. Generally thought to be of fair to good grazing value, livestock seldom graze dropseed unless it is the primary component of the plant community. Birds and mammals readily use the seeds and vegetative plant parts for food.

Sandberg bluegrass

A cool-season, short-statured, perennial bunchgrass, it is found primarily in the western two-thirds of the Dakotas on dry hillsides. It is adapted to a wide variety of soils but is most abundant on deep sandy to silt loam soils. The plant becomes rank rapidly once it reaches maturity, causing livestock to avoid it because of its unpalatability. This plant is classified as an increaser with grazing pressure and drought. This species provides fair forage value for cattle and poor to fair value for sheep and horses. Sandberg bluegrass, when green and lush in the spring, provides fair forage value to white-tailed deer, mule deer and antelope. Seeds provide feed for many songbirds and small rodents, mourning doves and ring-necked pheasants.

Sideoats grama

This warm-season, perennial, mid-statured, sod-forming grass is found on fine-textured soils and weakly developed soils of steeper slopes, often associated with calcareous soils. It also may occur on subirrigated and loamy overflow ecological sites in excellent condition. This grass decreases with overgrazing, frequently replaced by short grass species. Sideoats grama is very palatable and nutritious to all classes of livestock throughout much of the summer and fall. Sideoats grama is utilized by antelope, mule deer and, to some extent, white-tailed deer and small rodents. The seeds are utilized by some songbirds and upland birds.

Switchgrass

This is a warm-season, perennial, tall-statured, sod-forming grass found on moist lowland prairies, including loamy overflow and subirrigated ecological sites. This grass decreases with overgrazing, frequently being replaced by lower-producing mid and short grasses, particularly Kentucky bluegrass. Switchgrass provides good forage for bison and cattle when in the vegetative growth stage. As the plant matures in midsummer, nutrient quality and palatability decline dramatically. Switchgrass provides excellent year-round cover for a variety of wildlife species, including pheasants, white-tailed deer and prairie grouse. It provides high-quality nesting cover for grassland birds. Seeds provide food for pheasant, turkey, dove and songbirds.

Upland sedges (needleleaf, threadleaf, sun sedge)

These are cool-season, perennial, short-statured, grasslike plants found on dry prairies, rocky hilltops and sandy to fine-textured soils. These grasslike plants increase with overgrazing, replacing many mid-statured grasses. Upland sedges are good forage for all classes of livestock in early spring, becoming less palatable once mature.

Western wheatgrass

This is a cool-season, perennial, mid-statured, sod-forming grass found on a wide variety of soils and sites, and often is associated with loamy and clayey ecological sites. It also possesses a high tolerance to saline and alkaline soils. This grass decreases when exposed to long-term overgrazing but increases with short-term overuse. Western wheatgrass is regarded as very palatable, nutritious and digestible to all classes of livestock. Many birds and small mammals utilize the seed. The foliage will provide high feed value for foraging wildlife in the spring and early summer, moderate in mid-summer and fair to good into the dormant season. Western wheatgrass is North Dakota's state grass.

Forbs

American licorice

This is a perennial, warm-season, native forb spreading by woody branched rhizomes and producing upright stems 18 to 36 inches tall. Leaves are alternative, odd-pinnate with seven to 21 leaflets, each tipped with a tiny, sharp point. Flowers are yellowish white to almost cream and appear in spikelike racemes from the leaf axils, eventually developing few-seeded, somewhat flattened, oblong seed pods that turn brown at maturity. Pods resemble cockleburs with hooked prickles throughout. American licorice is most common on moist areas or areas that receive additional moisture, and commonly is found along lakeshores, stream valleys, prairie ravines, woody draws, loamy overflow sites and roadsides. This species is considered palatable to all classes of livestock, although it's sparingly grazed in the northern Plains. It is considered an increaser with grazing pressure; however, it decreases under long-term overgrazing.

Black samson

This warm-season perennial grows from an enlarged taproot to produce a stiff, erect stem, single or branched, 1 to 2 feet tall and capped by a showy, single flower. The flower head is disk-shaped, dark brown, domelike and prickly, with sharp-tipped bracts. Rays are rose, purple or occasionally white. Leaves are lance-shaped and near the base. Leaves and stems are covered with short, stiff hairs, especially above, and sometimes are smooth below. This plant flowers from June through August, with rays falling off and a black prickly cone remaining. This plant grows abundantly on most upland soil types but prefers dry prairies and rocky side hills with weakly developed soils. This plant is palatable and nutritious to all classes of livestock; however, it seldom appears to be grazed. It is considered a decreaser with overgrazing. When humans chew the root or seeds, the

plant produces a numbing, anesthetic effect in the mouth. This plant was the Native Americans' most important Great Plains herbal medicine and still is used today as an herbal medicine to improve the immune system. Black samson also is used as a garden ornamental.

Cudweed sagewort

It is a rhizomatous, aromatic, white, wooly, perennial forb that grows 12 to 30 inches tall, often branching upward. Its leaves are white to whitish gray, wooly to irregularly smooth, with multiple tiny, gray flower heads produced in August and September in leafy, spikelike branches. It is a native, warm-season plant that is very adapted and widespread, growing on most prairie sites, hillsides and ditches. It often is found in colonies. This species is classified as having only fair to poor feed value to cattle, horses, sheep and goats. This plant tends to increase under grazing pressure.

Curlycup gumweed

A warm-season, native, biennial or short-lived perennial, it is smooth, contains several stems and grows from 8 to 36 inches tall. This plant contains a gummy "cup" that is the collection of bracts of the flower head. It also has small, curved bracts that secrete a sticky resin. Flower heads are aster-like with yellow rays and disk flowers. Leaves are gland-dotted and also sticky. Curlycup gumweed can become abundant after periods of dryness and grows on most soil types that are depleted of more desirable vegetation. This invader has little value as forage and can form pure stands in long-term overgrazed pastures.

Dotted gayfeather

This showy, native forb is unbranched and grows from 8 to 20 inches tall. It arises from a thickened cormlike rootstock and produces purple to lavender flower heads from July through October. The inflorescences are spikelike with cylindrical to bell-shaped flower heads. Dotted gayfeather is found in the drier plains and hills. It is drought-resistant and adapted to a variety of upland soil types. Livestock and wildlife graze this plant readily, and its abundance decreases with excessive grazing. This plant is recognized as an attractive yard and bouquet ornamental.

Field pussytoes

It is a perennial, cool-season, native forb classified as a ground-hugging plant with spreading, leafy stolons. It has flowering heads atop nearly leafless, fuzzy stalks typically up to 8 inches above the ground. When the rounded flower clusters are immature, they resemble kitten paws. Male and female flower heads appear similar but occur on different plants. Leaves are basal, usually less than ½ inch wide; blades are white-wooly beneath, with the upper surface distinctly darker green with only scattered pubescence. This delicate forb occurs on relatively moist hillsides, often forming patches. Field pussytoes has very little forage value to any class of livestock. It's often classified as increasing with grazing pressure.

Green sagewort

An apparent biennial to short-lived perennial forb, it produces few to several closely grouped stems, normally 2 to 3 feet tall. Numerous, inconspicuous, yellowish cup-shaped heads are borne on branches of a terminal panicle. Basal leaves are numerous, smooth or nearly so with a pungent odor. The previous season's growth turns gray and can remain standing during the following growing season. It is a native, warm-season plant that flowers by August, growing on dry, open prairies, favoring sandy or gravelly soils. This species is considered of little forage value; however, it's commonly cropped (plant tops grazed) by cattle and sheep. This species is considered an increaser with grazing pressure, especially on deteriorated range.

Groundplum milkvetch

A perennial, warm-season, native legume with trailing branches, this plant rarely exceeding 8 inches in length. However, plants may cover an area 2 feet in diameter because of crown branching well beneath the soil surface. Leaves are odd-pinnated, with 15 to 27 green leaflets per leaf. Flowers are white-trimmed purple or violet and produce large, fleshy fruit resembling small plums or cherries that develop on the ground surface. These fruit are green and become reddish to purplish when exposed to the sun and taste like peas. Groundplum milkvetch is one of the most common milkvetches and occurs in most upland rangelands except those high in clay. Most classes of livestock freely graze this plant. It decreases with grazing pressure.

Heath aster

This is a perennial, warm-season, native forb arising from an extensive system of rhizomes and sometimes stolons. This plant can grow as a single, nearly prostrate stem, or it may take on a bushlike appearance up to 18 inches across and 12 to 20 inches tall. A multitude of small white or occasionally pinkish flower heads almost can obscure the linear leaves and stems in late summer. Heath aster is a common fixture of native range in the Northern Plains, occurring in upland and lowland prairies sites. This species is seldom grazed by any class of livestock, and it has low use when the plant is immature. It is considered an increaser with grazing pressure.

Missouri goldenrod

It is a perennial forb that grows as solitary plants or in colonies from rhizomes, reaching heights of 8 to 24 inches. Stems are unbranched, smooth and often reddish tinged and capped by a panicle of recurved branches supporting many tiny yellow flowers. This plant flowers in July and August and has rather stiff, lance-linear leaves that are 1 to 5 inches long, three-ribbed and sparingly serrate, with lower leaves larger. This plant grows in upland and lowland sites, often forming dense colonies, especially on drier uplands. Missouri goldenrod is grazed to some extent in the spring and early summer but generally is considered poor forage for most classes of livestock. Increasing grazing pressure increases its abundance but usually not to the point of becoming a nuisance plant.

Prairie coneflower

It is a perennial, warm-season, native forb that grows 12 to 36 inch tall and has flowers with a cylindrical disk head. Flowers contain showy yellow rays that tend to droop. It occasionally is found with brown or brown and yellow rays. The disk is distinctly columnar, up to 1¾ inches long, with rays 1 inch long. The leaves mostly are deeply pinnately divided, up to 6 inches long and divided into five to nine segments. Prairie coneflower has adapted to a wide variety of soil types. It is found on moist soils of the prairies and plains, and along roadsides. It is less common during times of drought, sometimes forming large stands when moisture levels are high and bare soil is present. This plant is somewhat palatable to all classes of livestock, especially when immature, but it is not used to any great extent. This species is considered an increaser with grazing pressure.

Purple prairie clover

It is a perennial, warm-season, native legume growing from a tough root system. It is multi-branched and reaches heights of 1 to 3 feet. These multiple stems provide a bushy appearance and support odd-pinnate leaves with five (sometimes three or seven) linear, glandular-dotted leaflets. Many small, purple flowers are crowded into a dense, cylindrical spike up to 2 inches long. Purple prairie clover is adapted to a variety of soil types but is most common on dry, thin soils. It can be found on rocky plains and hillsides, open woods and roadsides. This species is palatable to most classes of livestock, and sheep use it more than cattle. It is considered a decreaser with grazing pressure.

Silverleaf scurfpea

A perennial, warm-season, native legume with taproots and erect branching from a tough base of root and stem, it forms colonies by shoots from spreading roots. It is a bushy-topped plant growing 1 to 2 feet tall. Its leaves alternate, with three to five palmately arranged leaflets covered with white, silky hairs. The plant forms small blue flowers in clusters from upper leaf axils in midsummer. Silverleaf scurfpea commonly grows on prairies, rocky or steep hillsides and slopes, sandy areas and stream valleys. This species is seldom grazed by any class of livestock, and it's considered an increaser with grazing pressure.

Skeleton weed

A nearly leafless, warm-season, native perennial forb, it grows from 4 to 18 inches tall. The stem is woody, erect with yellow milky juice, smooth and not hairy, branching from the base, often bearing numerous spherical galls that solitary wasps produce. The roots are rhizomatous and often exceed 20 feet in depth, making rush skeleton weed very drought hardy. Flowers are rather small and pink to lavender. This plant is found on dry, especially sandy soils. It's also often found in barren alkaline sites. Skeleton weed provides no grazing value to cattle or horses and poor grazing for sheep or goats. This plant may increase with overgrazing but is not a key indicator species because it grows in a scattered pattern.

Soft goldenrod

This warm-season perennial and rhizomatous forb has stems 12 to 20 inches tall, either as a separate plant or loosely clustered. This plant flowers in July and August. The flower is inflorescent, dense, often cone shaped and yellow to golden. Leaves are thickened, firm and slight to moderately rough with hairs, with the prominently three-nerved lower leaves being much larger than the upper, broadly elliptic leaves, which are widest and rounded at the tip. This plant grows in dry or drying prairies and is often found in open woodlands and frequently along fence rows. It's commonly found on most dry range sites. Soft goldenrod will provide some grazing value to cattle in the spring and fair to good grazing value for sheep and goats during the spring and early summer, but it's generally considered poor forage. Excessive grazing pressure increases the abundance to the point that it may become a nuisance plant.

Stiff goldenrod

A warm-season perennial and stiff forb, it grows from a thick woody stock 1 to 3 feet tall as a separate plant or with several stiff-clustered stems. This plant only branches at the top and contains a cover of rough pubescence, forming a domed or flat-topped cluster of yellow to golden flower heads from August through October. Leaves are thick, rigid and rough on both surfaces, oblong, normally one-nerved and stalked. This plant grows in dry prairies, rocky open sites and sandy soils. Stiff goldenrod is considered to have poor to fair forage value to cattle and horses, and fair for sheep. Cattle often will eat the tops off stiff goldenrod in July and August. Increasing grazing pressure increases the abundance to the point that it may become a nuisance plant.

Stiff sunflower

This perennial, warm-season, native forb often grows in open colonies that form from spreading rhizomes. This plant's stems are stiff, rough and commonly tinged purple, growing 1 to 3 feet tall, typically with a single flower head atop each stem. Leaves mostly are paired and basal, somewhat gray green, rough, stiff, leathery and lanceolate, with three prominent ribs. Flower heads have yellow rays and brown to purplish disk flowers. Stiff sunflower is found on upland and frequently lowland prairie sites, occupying the same sites as little bluestem. This species is palatable to most classes of livestock, but the palatability reduces with grazing pressure.

Wavy leaf thistle

This is a tap-rooted perennial forb with stout leafy stems that grow 1 to 3 feet tall. Flower heads are large, ¾ to 1⅝ inches), purple and urn-shaped, blooming from mid-July through September. Wavy-margined leaves have lobes and teeth tipped with spines. A dense cover of wooly hairs, especially on the underside of leaves, presents a grayish-green appearance. It is a native, warm-season plant that grows in moist, open sites commonly found in rangeland, seldom becoming abundant. This plant is considered an unpalatable forb and usually not considered a nuisance plant. Horses and calves frequently eat the flowers.

Western ragweed

A perennial, strongly rhizomatous, warm-season native forb, it stands 1 to 2 feet tall. Generally inconspicuous male flowers occur in small heads on the upper part of the flowering stalks, whereas female flower heads are few and clustered near the base of the flowering stalk at the point where the upper leaves are attached. Most leaves are rough-surfaced and deeply pinnately lobed in irregular patters. Western ragweed is found on the plains and prairies, inhabiting a variety of soils and becoming abundant in waste places and on cropland, and sometimes invading poorer native grasslands and tame pastures. This species is considered unpalatable to most classes of livestock because of its bitter taste. It increases with grazing pressure.

Western wallflower

This biennial or short-lived cool-season, native perennial forb grows 8 to 27 inches tall on a single erect stalk that normally is unbranched. The leaves are numerous, linear to much longer than broad, often toothed and erect. The flower first appears dense and showy, with each flower having four bright yellow or occasionally orange-yellow petals up to 1 inch long. Fruit develop as slender, four-angled pods 2½ to 5 inches long below the blooming tip. Western wallflower commonly grows on upland prairies, sandhills and open woodlands. This plant is seldom grazed. Although this plant is considered an increaser with grazing pressure, it is indicative of native rangeland and rarely a nuisance plant.

Western yarrow

It is a perennial, cool-season, aromatic forb normally growing 10 to 30 inches tall. Some erect stems are capped with a flat-topped cluster of white to cream flower heads. Leaves are alternate and equally distributed along the stem, but lower and middle stem leaves are the largest, with a sagelike aroma and fernlike appearance. Soft hairs cover the leaves and stem, and the plant flowers from June through September. This plant grows on a wide variety of soil types in grassland and shrubby areas, becoming most common on dry, open sites. This species provides poor forage for horses, fair to poor for cattle and goats, and fair to good for sheep. It provides little forage value to all classes of livestock if favorable plants are abundant. This species is considered an increaser with grazing pressure, often forming small, dense patches in overgrazed rangeland.

White wild onion

This is a perennial, cool-season, native forb with slender stems and leaves arising from onion- or garlic-scented bulbs that resemble miniature domestic onions. White flowers appear in a compact, rounded umbel at the stem tip. Flowers have three petals and three sepals that all are petallike. Leaves usually are long and narrow. Wild onions occupy plains, foothills, meadows, thickets and woodlands. Occasionally they're found on stony hills. This species provides green, succulent herbage early in the spring, and cattle and sheep graze it readily. Grazing occurs on this plant as it matures. It's classified as a decreaser with grazing pressure.

Yucca

This stiff, evergreen-looking plant grows in a single to often clumped form. Leaves are smooth, green and bayonet-shaped with threadlike margins that stretch upward and outward from a thickened plant base. This plant grows primarily on dry, sandy, gravelly or rocky slopes, and flowers from June through August, with bell-shaped, greenish-white flowers on a stout stalk reaching 1 to 4 feet tall. This plant provides some grazing value to cattle and sheep when young. The flowers also are used to some extent. This is considered a native species that increases unless grazed in the winter, when it may decline.

Shrubs

Broom snakeweed

It is a warm-season, native perennial half-shrub arising from a heavy taproot that partially dies back each year. It is bushy and grows from 6 to 12 inches tall, occasionally reaching 3 feet in height with fine, brittle stems. Numerous small, yellow, radiate heads are clustered near the branch tips. Principle leaves are 1 to 3 inches long, linear and dotted with resinous glands that contain minute hairs. Broom snakeweed is common on most soils of the Plains, and frequently is found on dry prairies and hills, and upland sites. This species is considered poor forage for all classes of livestock. Spring growth sometimes is toxic when cattle, sheep, horses or goats eat it, although this is very rare. It is considered an increaser with grazing pressure.

Buffaloberry

This cool-season, large, deciduous, perennial shrub commonly grows to heights of 6 feet or more. Branches are whitish and thorny, with leaves that are opposite, oblong with rounded ends and silver-scaly on both sides. Numerous small, brownish flowers appear in the spring. Clustered berries that are small, round, shiny, red to golden yellow and tart form in late summer. Buffaloberry grows in small clumps along streams, on hillsides and in ravines. Livestock rarely uses this species due to its thorny twigs. Numerous birds, including robins and sharp-tailed grouse, eat the buffaloberry fruit.

Fringed sagewort

This is a low, spreading perennial half-shrub reaching 4 to 16 inches in height, with abundant nodding, grayish flower heads crowded along branches in the upper portions. Leaves are fragrant with whitish or grayish soft hairs, mostly basal, and round in outline, with stems rising from a tough, woody crown. It is a native, cool-season plant flowering in late July, and is found on high, open prairies and roadsides. It is most abundant on dry soils, preferring sandy to loamy soils. This plant is very drought-resistant and increases with grazing pressure. It provides poor grazing for cattle and horses, fair for goats, and fair to good for sheep.

Leadplant

This is a cool-season perennial shrub that can grow up to 3 feet tall and has nitrogen-fixing abilities. Leadplant generally is present on well-managed loamy and sandy sites. It is excellent forage with high palatability that accounts for its decreased abundance or disappearance with heavy grazing. Prairie birds use leadplant for nesting, while sharp-tailed grouse eat its seeds in the fall.

Plains pricklypear

This is a warm-season, perennial shrub that grows in clumps primarily on drier sites in the western third of North Dakota. Plains pricklypear commonly is found on hillsides, buttes, clay flats and fine-textured soils. It provides little forage value to livestock due to its sharp spines. It is considered an increaser with grazing pressure. Plains pricklypear does provide some feed value to large mammals, including white-tailed deer and antelope. Many small rodents, rabbits, songbirds and upland game birds use the seeds and fruit.

Silver sagebrush

The branching, woody, rhizomatous, aromatic, perennial shrub grows less than 3 feet tall. This plant is erect to spreading with coarse, freely branching stems covered with shredding tan to grayish brown bark. Leaves are silver or grayish pubescent, and flowers are yellowish in spike-like clusters. It is a native, warm-season plant that flowers in August and September, growing on rocky open sites, river valleys, upland and flood plains, and is associated with moist to moderately dry soils. This plant often is most abundant in deep loamy and sandy soils. It is tolerant to alkali soils, and spreads or resprouts from rhizomes after mowing and fire. This species is considered to have good feed value for cattle in the fall and winter but is rated as only fair in the Dakotas due to its lower ranking, compared with dominating graminoid species. It provides fair to good forage for sheep and goats. It is classified as an increaser under cattle browsing but a decreaser under sheep and goat browsing.

Western snowberry/ buckbrush/ wolfberry

A cool-season, rhizomatous, root-sprouting, perennial shrub, it grows on a wide variety of soils and sites. Western snowberry grows on prairie hillsides, open woods, coulees and riverbanks, often forming dense clumps. It provides good forage for sheep and fair for goats. Generally, cattle do not select this plant for forage when other grasses and forbs are green and palatable but do consume it late in the summer when these other forages are mature and western snowberry leaves are green. The fruit of western snowberry produces valuable food for sharp-tailed grouse and various nongame birds. Deer and antelope eat the leaves and twigs extensively. Western snowberry also provides nesting cover and protective cover for upland nesting waterfowl, game birds, rabbits and other small animals.

TIP: The ability to identify about 20 key plants will enhance your management ability and allow you to recognize changes in your pastures.

Wild prairie rose

It is a cool-season, rhizomatous, perennial half-shrub (a plant having woody stems that die back to the base each year) that is adapted to a wide variety of soils and sites. It can be found on prairies and bluffs, in ravines and thickets, and along stream banks and roadsides. Wild prairie rose provides fair forage for sheep and cattle. It often decreases with grazing pressure. This species produces red fleshly fruit known as rose hips that remain on the plant into the winter months. Deer, antelope, elk, sheep, sharp-tailed ground, prairie chicken, pheasants and various song birds readily eat the rose hips.

Winterfat

A cool-season, perennial half-shrub with a stout woody base, winterfat grows primarily in the western third of North Dakota on dry prairies and hills, dry clay or chalky soils and often in saline or alkaline soils. Winterfat provide excellent forage for livestock, white-tailed deer, mule deer, antelope and elk. This species will decrease with overuse and overgrazing due to high selectivity and palatability.

Introduced Plants

Introduced plants include species that are not a part of the original flora of the area in question. Listed on the following pages are common introduced grasses and forbs found in North Dakota and eastern Minnesota with a short description, season of growth, site found on, forage value and their response to grazing. Plant name, characteristics and a detailed description can be found on the USDA Plants Database (www.plants.usda.gov).

Grasses

Altai wildrye

It is a cool-season, perennial bunchgrass adapted to a wide range of soils and sites. This grass is a special-purpose grass used to extend the grazing season into late summer and fall (October and November). It is recommended as a single-species stand for grazing. Altai wildrye provides good wildlife winter cover, but its use by foraging wildlife is limited.

Creeping foxtail

This very early maturing, highly palatable, cool-season, perennial, sod-forming grass grows best on poorly drained to somewhat poorly drained soils. It tolerates long periods of flooding in early spring. This grass primarily is used for hay and pasture on sites that flood frequently or have poor drainage. This species can be difficult to plant because of the light, fluffy nature of the seeds. Fields should be uniformly moist, exceeding 50 percent field capacity, for successful stand establishment. This species can be invasive on wet sites because the seed is very light and easily transported. When producers want high forage yield, they should use the variety Garrison.

Crested wheatgrass

This cool-season, perennial bunchgrass is adapted to a wide variety of soils and sites, particularly in western North Dakota. This grass is a special-purpose grass used for spring grazing (early May to mid-June); however, it can and has become a nuisance, invading native rangeland. It is recommended as a single-species stand for grazing and hayland or mixed with alfalfa for hay production. Spring growth and fall regrowth provide high feed value to some foraging wildlife, especially deer in spring and fall.

Downy brome/ Cheatgrass

Downy brome is a weedy, winter annual, cool-season pest that grows to heights of 4 inches to 2 feet. Seed heads are quite variable in size, generally open and drooping, with spikelets on very thin branches. At maturity, spikelets often are reddish purple, and the grains frequently are infected with smut. Soft, white hairs cover the leaves and florets, giving it the common name “downy.” Downy brome, also called cheatgrass and annual brome, is an invader with undesirable forage qualities. However, during its brief, vegetative growth stage, it provides palatable feed. This grass is a nuisance on range and pastureland, cultivated lands, disturbed areas and conservation program lands in the western Dakotas and western U.S.

Hard fescue

This is a special-purpose, semi-erect, densely tufted, drought-tolerant, perennial, cool-season bunchgrass that is highly competitive, durable and shade tolerant with an extensive root system. Its primary use is for revegetation of disturbed areas, roadsides, ditch banks, conservation plantings and turf around farmyards, airports and other heavy-use areas. Shallow planting is critical. Seedlings develop slowly the first year.

Intermediate /Pubescent wheatgrass

This is a cool-season, perennial sod-forming grass adapted to a wide range of soils and sites; however, it does not tolerate saline soils. This grass is a special-purpose grass used for pastureland, hay and conservation programs. Intermediate/ pubescent wheatgrass can provide grazing from late spring into early summer and produce a large quantity of hay. This grass provides tall, dense clumps that will maintain height and structure during the winter months, providing good winter cover for many bird, and small and midsized mammals. Spring growth and fall regrowth provide high feed value to some foraging wildlife, especially deer in spring and fall.

Field brome/ Japanese brome

Japanese brome is a shallow-rooted, weedy, winter annual, cool-season bunchgrass reproducing by seed. Numerous seeds are produced on erect or spreading stems up to 24 inches tall. Japanese brome, also called annual brome, is an invader that has seed germination in the autumn, with young plants overwintering with a basal rosette of leaves. Spring growth is rapid, with maturation occurring by June. Japanese brome is undesirable forage, although it is palatable when green in the autumn and again in the spring prior to flowering. This grass is a nuisance on range and pastureland, and cultivated lands in the western Dakotas and western U.S. This plant often is confused with downy brome. Downy brome is more prevalent in cropland, and Japanese brome more common in range and pasture lands.

Green wheatgrass (RS hybrid)

It is a long-lived, perennial grass with a moderate amount of vegetative spread developed as a hybrid between quackgrass and bluebunch wheatgrass. This grass has demonstrated a relative high level of tolerance to salinity. Green wheatgrass is more saline tolerant than crested and intermediate wheatgrass and nearly as tolerant as tall wheatgrass. This grass generally is recommended for pasture and hay on saline sites not suited for crested and intermediate wheatgrass, and smooth bromegrass. It is a more palatable forage and drought tolerant than tall wheatgrass. This grass provides high feed value for foraging wildlife in the spring and early summer, moderate in midsummer and fair into the dormant season. Many birds and small mammals use the seeds.

Kentucky bluegrass

This is a cool-season, perennial, short-statured, sod-forming grass found on moist, well-drained soils. It often is associated with loamy, loamy overflow and subirrigated ecological sites. This grass invades and increases with overgrazing and no use, frequently replacing desirable native mid and tall grass species. Kentucky bluegrass is very palatable and nutritious to all classes of livestock when immature. Nutritional quality and palatability decline rapidly with maturity. Regrowth in the fall provides good-quality feed when favorable growing conditions occur. Many ranchers refer to Kentucky bluegrass as Junegrass.

Meadow bromegrass

This is a cool-season, perennial bunchgrass found on fine to moderately fine-textured soils. It generally is not recommended for western North Dakota due to its low drought tolerance. This grass is a special-purpose grass used for spring and early summer grazing (early May to mid-July). It is recommended alone or in combination with other introduced grasses or legumes for grazing and hay production. Spring growth and fall regrowth provide high feed value to some foraging wildlife, especially deer in spring and fall. Regrowth is very palatable to Canada geese. Birds and rodents eat its large seeds.

Russian wildrye

This is a cool-season, perennial bunchgrass adapted for fine to moderately textured soils (loamy and clayey). This grass is a special-purpose grass used to extend the grazing season into late summer and fall (October to December). It is recommended as a single-species stand for grazing. This grass provides high feed value for foraging wildlife in the spring and good from early summer through the fall months.

Smooth bromegrass

This is a cool-season, perennial sod-forming grass found on fine to moderately fine-textured soils. In western North Dakota, it often is associated with sites that receive additional moisture. This grass is a special-purpose grass used for spring grazing (early May to mid-June); however, it can and has become a nuisance invading plant on native rangeland. Smooth bromegrass, when present, will increase and dominate when idled for an extended period of time.

Sweetclover

An introduced, cool-season biennial legume adapted to a wide variety of soil textures and sites, sweet clover primarily is used in seed mixtures for conservation cover and wildlife habitat. Sweet clover provides good-quality hay when seeded alone or in combination with other cool-season grasses. Note: Sweet clover is an inefficient user of water, often depleting moisture and creating a droughtlike effect.

Tall wheatgrass

It is a coarse, cool-season, perennial bunchgrass found on fine to moderate-textured soils. This is a special-purpose grass used to revegetate saline/alkali soils and for conservation programs to enhance wildlife habitat. This plant, a late-maturing, cool-season grass, becomes coarse and unpalatable to livestock as it matures. Tall wheatgrass generally is not recommended for pasture. However, it may provide adequate hay if harvested prior to seed-head development. This grass will provide good feed value for foraging wildlife in the spring and fair in early summer; however, the feed value is poor from midsummer through the dormant season. Many birds and small mammals use the seeds.

Forbs

Alfalfa

This is an introduced, cool-season perennial legume adapted to a wide variety of soil textures. Alfalfa's primary use is for hay production, but it also is included in varying amounts in pasture and conservation program seeding mixtures. Alfalfa can be seeded alone or in combination with cool-season grasses to provide a high-quality feed for livestock and most wildlife.

Dandelion

This is a stemless perennial and introduced forb, with all leaves basal, that grows from a strong, fleshy taproot. Flower heads are borne on leafless, tubular stalks 2 to 20 inches tall. All plant parts contain a milky, bitter juice. The flower heads are yellow, about 1 inch across and most abundant in the spring, but they can be produced as long as moisture conditions are favorable. Tiny seeds with their umbrellalike pappus form silvery "puffballs" before the wind carry them away. Dandelion is a pest, spreading easily and crowding out more desirable vegetation. This plant is considered palatable by sheep, cattle and horses, although its growth form makes it generally unavailable for grazing.

Similarity Index

The similarity index, previously known as range condition, is the present state of vegetation of an ecological site in relation to the potential reference plant community for the site based on kind, proportion and amounts of plants present; it suggests current productivity and diversity relative to reference potential.

The similar index is a reflection of past land use and environmental conditions. In the past, range condition was expressed in terms of "poor," "fair," "good" or "excellent." The term "similarity index" is used to indicate how similar the present plant community is to the reference plant community for a particular site.

TIP: Long-term heavy grazing by domestic livestock or native ungulates tends to reduce the similarity index by decreasing the higher-producing desirable plants and increasing low-producing, often less desirable plants.

TIP: Long-term heavy grazing results in shallow-rooted plants, lower herbage production, reduced water infiltration and increased soil surface temperatures. This results in decreased forage production and subsequent stocking rates.

TIP: Long-term nonuse results in lower plant vigor and less plant diversity, often creating opportunities for invasive exotic plant species (smooth bromegrass, Kentucky bluegrass and crested wheatgrass). Less plant diversity resulting from this invasion may reduce forage quality and production.

Length of time would depend upon the ecological site being considered (wetter sites – 3 years; dryer sites – 5 years), and the current composition of the plant community (amount of invasion by Kentucky bluegrass and/or smooth bromegrass).

Example: a loamy ecological site in Dunn County, North Dakota.

Both photos show a loamy ecological site in western North Dakota. Both sites were lightly grazed to ungrazed prior to being photographed.

The loamy site on the top has a similarity index (SI) rating of 73 percent of the site potential. The site is dominated by mid-statured grasses such as green needlegrass and western wheatgrass, with lesser amounts of needle-and-thread, prairie Junegrass, blue grama and upland sedges. In addition, it has a good diversity of forbs, including several species of native legumes. Also present are shrubs/half-shrubs western snowberry and fringed sagewort.

The total annual production for this site was estimated at 2,365 pounds/acre air-dry weight. Of this total production, about 77 percent (approximately 1,800 pounds) was produced by grasses and sedges, while the remaining 23 percent was produced by forbs and shrubs.

The loamy site on the bottom has a similarity index rating of 31 percent of the site potential. This site is dominated by shorter-statured grasses and sedges, and forbs. The main grass species include blue grama, needle-and-thread and upland sedges. Fringed sagewort and silver-leaf scurfpea were the dominant forbs/half-shrubs present in the plant community.

The total annual production for this site was estimated at 1,536 pounds/acre air-dry weight. Of this, 1,536 pounds/acre, about half was blue grama and sedges.

Loamy site: SI = 73% of reference plant community

Loamy site: SI = 31% of reference plant community

Stocking Rate and Carrying Capacity

Stocking rate: defined as the number of specific kinds and classes of animals grazing or utilizing a unit of land for a specified time period, commonly expressed as animal units per acre. An animal unit is considered to be one mature cow of approximately 1,000 pounds with a calf of up to 6months of age (see animal unit equivalent guide for proper conversions for other classes or kinds of grazing animals). The stocking rate typically is expressed as the number of animal units grazed for a specific time period (days, months) in a given pasture or unit.

Carrying capacity: defined as the maximum stocking rate possible that is consistent with maintaining or improving vegetation or related resources. It may vary from year to year on the same area due to fluctuating forage production. Carrying capacity usually is expressed as the number of animal units that can be grazed for a specified time period. In short, carrying capacity is the amount of forage available for grazing animals and expressed as the number of available animal unit months (AUMs), or number of animal units grazed for one month.

Animal unit equivalents guide[1]

Kinds/classes of animals	Animal Unit Equivalent (AUE)	Forage consumed in Pounds (oven-dry)		Forage consumed in Pounds (air-dry[2])	
		Day	Month	Day	Month
1,000-lb. cow, dry	0.92	24	727	28	851
1,000-lb. cow, with calf	1.0	26	790	30	913
1,200-lb. cow with calf	1.15	30	909	35	1,064
1,400-lb. cow with calf	1.29	33.5	1,022	39	1,186
Bison cow mature	1.00	26	790	30	913
Bison bull mature	1.50	39	1,182	45	1,368
Horse, mature	1.25	32.5	988	38	1,155
Sheep, mature	0.20	5.2	158	6	182
Goat, mature	0.15	3.9	118	5	152
Deer, white-tailed, mature	0.15	3.9	118	5	152
Deer, mule, mature	0.20	5.2	158	6	182
Elk, mature	0.60	15.6	474	18	547
Antelope, mature	0.20	5.2	158	6	182
Sheep, bighorn, mature	0.20	5.2	158	6	182
Jackrabbit, white-tailed	0.02	0.5	15	0.6	18
Prairie dog	0.004	0.1	3	0.1	3

[1] NRCS National Range and Pasture Handbook (1997) and Montana State University Range and Pasture Records (1993).

[2] Air-dry weights refer to forage that is allowed to dry under natural environmental conditions during an extended period of time, such as plants harvested for hay production. This value is approximately 87 percent dry matter versus oven-dry matter, which depicts 100 percent dry matter.

The animal unit is a convenient denominator for use in calculating the relative grazing impact of different kinds and classes of domestic livestock and common wildlife species. An animal unit (AU) is generally one mature cow of approximately 1,000 pounds and a calf as old as 6 months, or their equivalent (AUE). An animal unit month (AUM) is the amount of forage required by an animal unit for one month.

TIP: **The stocking rate should not be greater than the carry capacity to assure proper resource management, and, frequently, it should be lower due to different ecological and management objectives. Methods to estimate carrying capacity:** Carrying capacity or forage quantity can be estimated in several ways. Two common techniques used in the field include clip and weigh, and interpreting usable forage production from similarity index calculations. The clip-and-weigh method requires the actual harvesting of standing forage at a given time to predict available forage. The similarity index calculation provides current species composition by weight and requires interpretation to arrive at a recommended stocking rate.

Clip and Weigh: The most accurate method to assess the amount of forage in a pasture is to clip five to 15 samples of a 1.92 -square-foot area, and dry and weigh (using a gram scale) each sample. The average amount of forage available is equal to the dry weight of all samples collected divided by the number of samples, then multiplied by 50 to calculate the weight in pounds per acre. Clipping several samples and making sure these samples represent the variation within the pasture is important. The number of samples necessary depends on the uniformity of the pasture. The more variable the forage growth, the greater the number of samples necessary.

Once forage production for the pasture is determined, the actual stocking rate will be calculated using a harvest efficiency multiplier. Harvest efficiency usually varies from 25 to 35 percent on native rangeland, depending upon the level of grazing management, and 30 to 40 percent on tame pasture, depending upon grazing management. ***A harvest efficiency of 25% is recommended when developing an initial stocking rate and should not change until your grazing management creates a proper functioning system.***

Example: If calculated herbage production is 2,000 pounds per acre on native rangeland being managed using seasonlong grazing, available forage would be 500 pounds per acre (2,000 pounds/acre X 0.25 = 500 pounds/acre). The 500 pounds/acre then would be divided by the forage consumed in pounds per month by kind or class of animal

See Animal Unit Equivalent Guide on Page 42 for monthly forage intake amounts. For example, if grazing a 1,000-pound cow with calf, forage consumption would be 913 pounds per month (based on air-dried weights). Because the available forage in our example is 500 pounds per acre, the stocking rate would be 0.54 animal unit months per acre (500 pounds/acre divided by 913 pounds/month = 0.54 animal unit months/acre).

Similar Index Analysis: To estimate the stocking rate based upon a similarity index evaluation, consult your local county Extension agent or Natural Resources Conservation Service office. See the similarity index section on Page 42 for further information on similarity index evaluation.

TIP: **The estimated stocking rate could be based on local knowledge and past stocking rates if the similarity index, health and trend have met the producer's objectives without degrading the resource.**

Pasture and Hayland Plant Selection

Pasture and hayland plant selection is a function of forage suitability groups. These groups are derived from a combination of soils with similar potentials and limitations for forage production. Soils within a forage suitability group are sufficiently uniform to:

- Support the same adapted forage plants under the same management conditions
- Require similar conservation treatment and management to produce the forages selected in the quality and quantity desired
- Have comparable potential productivity

TIP: The following includes common forage suitability groups and recommended plant species to seed in the western half of North Dakota, and the eastern half of North Dakota and western Minnesota.

Loam soils: deep, mostly well and moderately well-drained, medium-textured soils on uplands

Western North Dakota	Eastern North Dakota/ Western Minnesota
Introduced	
Altai wildrye	Altai wildrye
Crested wheatgrass	Intermediate wheatgrass
Intermediate wheatgrass	Pubescent wheatgrass
Pubescent wheatgrass	Meadow bromegrass
Meadow bromegrass	Russian wildrye
Russian wildrye	Smooth bromegrass
Smooth bromegrass	
Native	
Green needlegrass	Big bluestem
Slender wheatgrass	Green needlegrass
Western wheatgrass	Indiangrass
	Slender wheatgrass
	Switchgrass
	Western wheatgrass
Legumes	
Alfalfa	Alfalfa
Cicer milkvetch	Cicer milkvetch
Sainfoin	

Limy upland: deep, well and excessively drained, medium-textured soils occurring on ridges and knobs and subject to runoff

Western North Dakota	Eastern North Dakota/ Western Minnesota
Introduced	
Crested wheatgrass	Intermediate wheatgrass
Pubescent wheatgrass	Pubescent wheatgrass
Native	
Little bluestem	Little bluestem
Prairie sandreed	Prairie sandreed
Sideoats grama	Sideoats grama
Western wheatgrass	Western wheatgrass
Green needlegrass	Green needlegrass
Legumes	
Alfalfa	Alfalfa
Cicer milkvetch	Cicer milkvetch
Sainfoin	

Very droughty loam soils: deep, well and moderately well-drained, moderately coarse-textured soils on uplands and flood plains

Western North Dakota	Eastern North Dakota/ Western Minnesota
Introduced	
Crested wheatgrass	Intermediate wheatgrass
Pubescent wheatgrass	Pubescent wheatgrass
	Meadow bromegrass
Native	
Prairie sandreed	Prairie sandreed
Sand bluestem	Sand bluestem
Western wheatgrass	Slender wheatgrass
	Sideoats grama
	Switchgrass
Legumes	
Alfalfa	Alfalfa
Purple prairie clover[1]	Purple prairie clover[1]
White prairie clover[1]	White prairie clover[1]
Sainfoin	

[1] Recommended for pasture only

Very shallow to gravel soils: deep, well and excessively drained, medium to coarse-textured soils with gravel and/or coarse sand at depths of 14 to 24 inches

Western North Dakota	Eastern North Dakota/ Western Minnesota
Introduced	
Crested wheatgrass	Crested wheatgrass
Pubescent wheatgrass	Intermediate wheatgrass
	Pubescent wheatgrass
Native	
Little bluestem	Little bluestem
Sideoats grama	Sideoats grama
Slender wheatgrass	Slender wheatgrass
Western wheatgrass	Western wheatgrass
Legumes	
Alfalfa	Alfalfa

TIP: Other native and introduced legumes are available for use. Examples would include Canada milkvetch and red clover (eastern North Dakota).

Saline soils: deep, somewhat poorly and poorly drained, coarse to fine-textured saline soils

Western North Dakota	Eastern North Dakota/ Western Minnesota
Introduced	
Altai wildrye	Altai wildrye
Russian wildrye	Russian wildrye
Tall wheatgrass	Tall wheatgrass
Green wheatgrass	Green wheatgrass
Native	
Beardless wildrye	Beardless wildrye
Western wheatgrass	Western wheatgrass
Slender wheatgrass	Slender wheatgrass
Legumes	
Alsike clover	Alsike clover

Wet soils: deep, poorly drained, coarse to fine-textured soils on flood plains or low areas on till and lake plains

Western North Dakota	Eastern North Dakota/ Western Minnesota
Introduced	
Creeping foxtail	Creeping foxtail
	Meadow foxtail
Native	
Big bluestem	Big bluestem
Reed canarygrass	Reed canarygrass
Slender wheatgrass	Slender wheatgrass
Western wheatgrass	Western wheatgrass
Switchgrass	Switchgrass
Prairie cordgrass	Prairie cordgrass
Legumes	
Alsike clover	Alsike clover

Pasture Development/ Seeding Rates

When developing a pasture, one first must decide on the intended season of use for the pasture (spring grazing, summer grazing, full-season grazing) and soil types. Once you have fully recognized your objectives for the land being developed and classified the soil type, see the section "Pasture and Hayland Plant Selection" for recommended alternatives for plant species to seed. The following guidelines are suggested for spring pasture, summer pasture, fall pasture and full-grazing season pasture.

Spring Pasture Development

Spring pasture normally will consist of exotic (tame) cool-season grasses that reach grazing readiness by early to mid-May. See the "Pasture and Hayland Plant Selection" section on those species that can be grown on the soil type in your area. Recommended cool-season grasses include: crested wheatgrass (early May), intermediate or pubescent wheatgrass (mid-May), and meadow bromegrass (early to mid-May). Legumes (alfalfa, clover) may be added for potential improvement of diet quality, soil fertility and overall long-term productivity of the stand.

Summer Pasture Development

Summer pasture is intended for summer use (June to September) and consists of native warm-season grasses, but mixtures of native warm and cool-season grasses sometimes are used. Grazing readiness for warm-season grasses usually occurs during the second to third week of June. See the "Pasture and Hayland Plant Selection" section on those species that can be grown on the soil type in your area. Recommended warm-season grasses include: big bluestem (can be seeded alone or with a mixture of other warm-season grasses), side-oats grama (recommended as a part of a warm-season grass mixture) and switchgrass (recommended to be seeded alone).

Fall Pasture Development

Fall pasture normally will consist of exotic (tame) cool-season grasses for fall use (October to December). See the "Pasture and Hayland Plant Selection" section on those species that can be grown on the soil type in your area. Recommended cool-season grasses include: altai wildrye (seeded alone, October to mid-November) and Russian wildryre (seeded alone, October to December). Note: Altai wildrye is usually 50 to 100 percent more productive than Russian wildrye; however, Russian wildrye has a 2 to 3 percent higher crude protein content than altai wildrye in November and December. Neither grass will support sufficient nutritional quality for a lactating cow after mid-October. For fall-calving herds, consider utilizing cover crop mixtures for improved forage quality and production.

Full-grazing Season Pasture Development

The first decision a rancher must make is whether to plant a native or exotic (tame) grass/legume mixture. We recommend you do not mix native and exotic grasses due to palatability (taste) differences, the highly competitive nature of exotic grasses and the difficulty of properly managing these native/exotic mixtures.

Full-grazing season pastures normally will consist of: 1) a native cool- and warm-season grass mixture or 2) an exotic cool-season grass/legume mixture using a proper rotational grazing system (June to October). Grazing readiness for cool- and warm-season grass mixtures

usually occurs in late May to early June. See the "Pasture and Hayland Plant Selection" section on those species that can be grown on the soil type in your area.

Recommended cool- and warm-season grass options for a full-season seed mixture include a combination of the following: big bluestem, side-oats grama, blue grama, prairie sandreed and switchgrass for warm-season grasses; and western wheatgrass and green needlegrass as cool-season grasses. The rancher should try to achieve a balanced mixture of warm- and cool-season grasses to maintain the full season of grazing. Legumes that could be added to the mixture include: purple and white prairie clover, cicer milkvetch (light rate) and Canada milkvetch.

Recommended cool-season exotic grasses and legume options for a full-season seed mixture include the following: meadow bromegrass and alfalfa, and intermediate/pubescent wheatgrass and alfalfa. Note: Bloat (a deadly condition associated with ruminant animals) must be addressed before grazing pasture with more than 30 percent alfalfa. Ranchers must learn how and when to graze alfalfa, particularly with animals unaccustomed to grazing it. Once ranchers gain experience in managing grazing animals on alfalfa safely, the risk of bloat is reduced and they can achieve potential returns from higher livestock performance.

TIP: Legumes seeded during the late fall (dormant) seeding period may be subject to injury if early germination occurs followed by a late spring freeze, reducing stand establishment.

TIP: If cool- and warm-season grasses are mixed, use the recommended seeding dates that correspond to the dominant grass type.

Guidelines for Seeding

Seedbed preparation

The seedbed must be essentially free of competing vegetation, firm enough to permit seed placement at the desired depth (¼ to ¾ inch) and protected against erosion. A firm seedbed hardly should reveal adult footprints. Seeding may be done into standing stubble from the previous crop, provided that weeds and volunteers of the previous crop are controlled properly, and an appropriate seeding drill is used to penetrate the crop residue properly and place the seed at the proper depth while achieving good seed-soil contact. If seeding into crop residue, be sure to consider herbicide carryover effects.

Seeding equipment

A drill designed to seed grass is highly recommended. These drills have agitators and feeder mechanisms to provide a uniform flow of seed at the desired rate. They are equipped with double disc furrow openers with depth bands or other depth-control devices.

Grain drills may be used to seed most of the tame grass species, legumes and some native grasses. Having a properly prepared, firmly packed seedbed is critical to achieving successful stands when using a grain drill.

Seeding dates

	Southern third of North Dakota Southern two-thirds of Minnesota	Northern two-thirds of North Dakota Northern third of Minnesota
Cool-season grasses		
Spring	Before May 10	Before May 20
Late summer	Aug. 10 to Sept. 15	Aug. 10 to Sept. 1
Late fall (dormant)[1]	After Nov. 1	After Oct. 20
Warm-season grasses		
Spring	May 10 to June 25	May 10 to June 25
Legumes		
Spring	Before May 10	Before May 20
Late summer	Aug. 10 to Aug. 25	Aug. 10 to Aug. 25
Late fall (dormant)[1]	After Nov. 1	After Oct. 20

[1]Soil temperatures should be below 40 F for three consecutive days to minimize risk of seed germination.

Seeding rates

Most grass species in North Dakota and western Minnesota are seeded at a rate of 25 to 30 seeds per square foot (see Table 1: Full Seeding Rates). The lower rates generally are recommended in western North Dakota or on drier sites. The higher rates generally are recommended in eastern areas on sites with more favorable moisture conditions. Adjustments are made for some species based on seed size, seedling vigor and seed conditioning. These rates are for drill planting with a row spacing of 12 inches or less, the recommended row spacing for most grass planting purposes. Seeding rates are shown in pure live seed (PLS) pounds per acre.

Table 1. Full Seeding Rates [1, 2]

Species	Seeds/Pound	Eastern North Dakota/ Western Minnesota		Western North Dakota	
		Seed/Sq Ft	#PLS/Ac	Seed/Sq Ft	#PLS/Ac
Introduced Cool-season Grasses					
Bromegrass					
Meadow (BRBI2)	80,000	30	16.5	25	13.5
Smooth (BRIN2)	135,000	25	8	20	6.5
Creeping foxtail (ALAR)	750,000	60	3.5	60	3.5
Hard fescue (FEBR7)	565,000	50	4	35	3
Timothy (PHPR3)	1,300,000	30	1	NR	NR
Wheatgrass					
Green (ELHO3)	135,000	46	14	33	10
Crested (AGCR)	175,000	28	7	25	6
Intermediate (THIN6)	88,000	20	10	17	8.5
Pubescent (THIN6)	88,000	20	10	17	8.5
Siberian (AGFR)	175,000	30	7.5	25	6
Tall (THPO7)	79,000	23	13.5	20	11
Wildrye					
Altai (LEAN3)	68,000	30	19	25	16
Dahurian (ELDA3)	86,000	20	10	17	8.5
Mammoth (LERA5)	55,000	30	24	25	20
Manystem (LEMU11)	150,000	30	8.5	25	7.5
Russian (PSJU3)	175,000	30	7.5	25	6
Native Cool-Season Grasses					
American mannagrass (GLGR)	1,280,000	45	1.5	45	1.5
Fowl bluegrass (POPA2)	3,156,000	70	1	70	1
Green needlegrass (NAVI4)	180,000	30	7.5	25	6
Needle-and-thread (HECO26)	115,000	25	9.5	25	9.5
Nutall alkaligrass (PUNU2)	2,108,000	50	1	50	1
Porcupine grass (HESP11)	57,000	25	19	25	19
Prairie Junegrass (KOMA)	2,315,000	50	1	50	1
Reed canarygrass (PHAR3)	530,000	40	3.5	40	3.5

[1] FOTG – Section 1 – Reference subject – Plant Materials Herbaceous Vegetation Establishment Guide (February 2012)
[2] For additional information see USDA PLANTS
[3] NR – Not recommended

Table 1. Full Seeding Rates [1, 2]

Species	Seeds/Pound	Eastern North Dakota/ Western Minnesota		Western North Dakota	
		Seed/Sq Ft	#PLS/Ac	Seed/Sq Ft	#PLS/Ac
Native Cool-Season Grasses (continued)					
Wheatgrass					
Bluebunch (PSSP6)	140,000	NR[3]	NR	25	8
Slender/awned/bearded (ELTR7)	155,000	25	5.5	17	5
Streambank/Thickspike (ELLAL)	155,000	NR	NR	25	7
Western (PASM)	112,000	25	10	20	8
Whitetop (SCFE)	191,000	11	2.4	11	2.4
Wildrye					
Basin (LECI4)	140,000	NR	NR	25	8
Canada (ELCA4)	115,000	20	7.5	17	6.5
Virginia (ELSU)	96,000	20	10	NR	NR
Native Warm-season Grasses					
American sloughgrass (BESY)	1,150,000	25	0.9	25	0.9
Bluestem					
Big (ANGE)	176,000	30	7.5	25	6
Little (SCSC)	286,000	30	4.5	25	4
Sand (ANHA)	113,000	30	12	25	9.5
Buffalograss (BODA2)	50,000	30	26	25	23
Grama					
Blue (BOGR2)	750,000	40	2.5	30	2
Sideoats (BOCU)	180,000	30	7.5	25	6
Indian ricegrass (ACHY)	235,000	30	5.5	25	4.5
Indiangrass (SONU)	193,000	30	7	25	5.5
Prairie cordgrass (SPPE)	183,000	30	7	30	7
Prairie sandreed (CALO)	275,000	30	5	25	4
Prairie dropseed (SPHE)	224,000	25	5	25	5
Sand dropseed (SPCR)	5,680,000	70	0.5	70	0.5
Switchgrass (PAVI)	390,000	40	4.5	30	3.5
Native Grasslikes					
Fox sedge (CAVU2)	1,600,000	37	1	37	1
Slough sedge (CAAT2)	230,490	25	4.7	25	4.7
Native Forbs and Legumes					
American vetch (VIAM)	30,000	25	36	25	36
Black-eyed susan (RUHI2)	1,450,000	25	0.8	25	0.8
Blanket flower (GAAR)	157,000	25	7	25	7
Blue vervain (VEHA2)	1,488,000	34	1	34	1
Blue aster (SYLAL3)	880,000	30	1.5	30	1.5
Butterfly milkweed (ASTU)	67,000	25	16.2	25	16.2

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[2] For additional information see USDA PLANTS
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Table 1. Full Seeding Rates [1, 2]

Species	Seeds/Pound	Eastern North Dakota/ Western Minnesota		Western North Dakota	
		Seed/Sq Ft	#PLS/Ac	Seed/Sq Ft	#PLS/Ac
Native Forbs and Legumes (continued)					
Canada milkvetch (ASCAC6)	266,000	25	4	25	4
Canada tickclover (DECA7)	88,000	25	12.3	25	12.3
Coneflower					
Grayhead (RAPI)	625,000	25	1.7	NR	NR
Narrow-leaved purple (ECAN2)	120,000	25	9	25	9
Prairie (RACO3)	737,000	25	1.5	25	1.5
Purple (ECPU)	120,000	25	9	25	9
Cudweed sagewort (ARLU)	4,000,000	25	0.3	25	0.3
Culver's root (VEVI4)	12,800,000	30	0.1	NR	NR
Cup plant (SIPE2)	22,400	10	9	NR	NR
False boneset (EUPE3)	2,560,000	25	0.4	25	0.4
False sunflower (HEHES)	60,000	25	18	25	18
Fragrant giant hyssop (AGAST)	1,440,000	25	0.8	25	0.8
Gayfeather					
Dotted (LIPU)	136,000	25	8	25	8
Thickspike (LIPY)	136,000	25	8	NR	NR
Golden Alexander (ZIAU)	176,000	25	6.2	25	6.2
Goldenrod					
Canada (SOCA6)	4,600,000	25	0.2	25	0.2
Missouri (SOMI2)	1,998,000	25	0.5	25	0.5
Stiff (SORI2)	772,000	25	1.4	25	1.4
Heath aster (SYER)	3,200,000	30	0.4	30	0.4
Hoary vervain (VEST)	450,000	25	2.4	25	2.4
Illinois bundleflower (DEIL)	60,000	25	18	25	18
Ironweed (VEFA2)	385,000	25	2.8	25	2.8
Joe Pye weed (EUMAB)	1,520,000	25	0.7	25	0.7
Lewis flax (LILE3)	287,000	25	3.8	25	3.8
Maximilian sunflower (HEMA2)	250,000	6	1.0	6	1.0
New England aster (SYNO2)	1,300,000	25	0.8	NR	NR
Partridge pea (CHFAF)	43,000	10	10	10	10
Plains coreopsis (COTI3)	1,650,000	25	0.7	25	0.7
Prairie onion (ALST)	176,000	25	6.2	25	6.2
Purple meadow rue (THDA)	176,000	25	6.2	25	6.2
Purple prairieclover (DAPU5)	290,000	25	3.8	25	3.8
Scarlet globemallow (SPCO)	500,000	25	2	25	2
Silvery lupine (LUAR3)	126,000	NR	NR	25	8
Shell-leaf penstemon (PEGR7)	273,000	25	4	25	4
Sneezeweed (HEAU)	2,100,000	25	0.4	25	0.4

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Table 1. Full Seeding Rates [1, 2]

Species	Seeds/Pound	Eastern North Dakota/ Western Minnesota		Western North Dakota	
		Seed/Sq Ft	#PLS/Ac	Seed/Sq Ft	#PLS/Ac
Native Forbs and Legumes (continued)					
Spiderwort (TROC)	166,000	25	7	25	7
Stiff sunflower (HEPAS)	85,000	5	2.5	5	2.5
Swamp milkweed (ASIN)	72,000	25	15	25	15
Western yarrow (ACMIO)	2,800,000	25	0.4	25	0.4
White prairieclover (DAAL)	278,000	25	3.9	25	3.9
Wild bergamot (MOFI)	1,200,000	25	0.9	25	0.9
Introduced Legumes					
Alfalfa (MESA)	210,000	30	6.5	25	5.5
Birdsfoot trefoil (LOCO6)	418,000	50	5	NR	NR
Black medic (MELU)	280,000	25	4	25	4
Cicer milkvetch (ASCI4)	134,000	30	10	25	8
Clover					
Alsike (TRHY)	680,000	50	3	50	3
White clover (TRRE3)	800,000	25	1.5	25	1.5
Red (TRPR2)	275,000	30	5	NR	NR
Strawberry (TRFR2)	300,000	25	3.5	25	3.5
Sweet (MEOF)	260,000	25	4	20	3
Hairy vetch (VIVI)	20,000	15	30	10	20
Sainfoin (ONVI)	18,500	15	35 (hull)	15	35 (hull)
Native Shrubs					
Buffaloberry (SHAR)	41,000	4	4.2	4	4.2
Chokecherry (PRVIV)	5,000	3	26	3	26
False indigo (AMNA)	52,000	30	25	25	21
Fourwing saltbush (ATCA2)					
Dewinged	52,000	7	6	7	6
Gardner saltbush (ATGA)	110,000	30	12	25	10
Golden currant (RIAU)	240,000	30	5.5	25	4.5
Juneberry (AMAL2)	82,000	30	16	25	13
Leadplant (AMCA6)	200,000	30	6.5	25	5.4
Prairie rose (ROAR3)	45,000	30	29	25	24
Western snowberry (SYOC)	74,400	30	17.5	25	14.6
Winterfat (KRLA2)	150,000	30	8.5	25	7
WY big sagebrush (ARTRW8)	2,466,000	NR	NR	28	0.5

[1] FOTG – Section 1 – Reference subject – Plant Materials Herbaceous Vegetation Establishment Guide (February 2012)
[2] For additional information see USDA PLANTS
[3] NR – Not recommended

Grazing Management

Grazing management is defined as the manipulation of grazing animals to accomplish desired results when considering animal, plant, land or economic responses.

1) Grazing readiness:

the defined stage of plant growth at which grazing may begin under a specific management plan without permanent damage to vegetation or soil. Grazing readiness should be monitored to determine when grazing can begin in the spring. Grazing readiness, as it relates to plant phenology, is similar among most grasses; however, when it occurs can vary dramatically.

TIP: The following is a guide to aid in determining when plants are ready to be grazed.

Leaf Stage Development

- Native grasses at the 3½-leaf stage
- Exotic (tame) grasses at the three-leaf stage

Leaf Height

(minimum vegetative height in inches)

- 4 inches: crested wheatgrass, Kentucky bluegrass, little bluestem, Russian wildrye, sideoats grama
- 6 inches: alfalfa, sweetclover, green needlegrass, slender wheatgrass, western wheatgrass
- 8 inches: big bluestem, sand bluestem, creeping foxtail, Indiangrass, intermediate wheatgrass, pubescent wheatgrass, prairie sandreed, reed canarygrass, smooth bromegrass, tall wheatgrass
- 12 inches: switchgrass

Approximate Date

(range readiness primarily should be determined by leaf stage and height; calendar dates should be used as a guide only)

April 20 to May 1: crested wheatgrass, sweetclover

May 1-10: Russian wildrye, smooth bromegrass

May 10-20: creeping foxtail, Kentucky bluegrass, reed canarygrass, slender wheatgrass

May 20-30: alfalfa, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, western wheatgrass

June 20-30: blue grama, prairie sandreed, sideoats grama, switchgrass

After July 1: big bluestem, little bluestem, sand bluestem

Minimum Heights of Pasture Species for Beginning and Ending Grazing[1]

Vegetative Species	Begin Grazing: Minimum and Optimum Height of Approximate Growth in Inches	Begin Grazing: Date	End Grazing: Minimum Stubble Height in Inches	End Grazing: Minimum Regrowth Before Killing Frost in Inches
Alfalfa	6–10	May 15	3	8
Sweetclover	6–10	May 1	2	-
Big bluestem	8–14	July 1	6	6
Crested wheatgrass	4–6	April 20	3	4
Green needlegrass	6–8	May 15	3	5
Indiangrass	8–14	July 1	6	6
Intermediate wheatgrass	8–14	May 15	4	6
Kentucky bluegrass	4–6	May 7	2	4
Little bluestem	4–6	July 1	3	4
Pubescent wheatgrass	8–14	May 15	4	6
Prairie sandreed	8–14	June 20	4	6
Reed canarygrass	8–8	May 7	4	6
Russian wildrye	4–4	May 7	3	4
Sideoats grama	4–6	June 20	2	4
Slender wheatgrass	6–12	May 7	3	6
Smooth bromegrass	8–14	May 7	4	6
Switchgrass	12–20	June 20	8	10
Tall wheatgrass	8–14	May 7	4	6
Western wheatgrass	6–10	May 15	4	5

*Grass and legume mixtures should be grazed in a manner that favors the dominant desired species.

*Height is the average height when leaves are lifted to a vertical position.

*To get the highest return from smooth bromegrass, intermediate wheatgrass and pubescent wheatgrass, start grazing when the plant is in the early boot stage. Clip high prior to seed set to trigger regrowth of basal sprouts.

*The last harvest of alfalfa for pasture or hay generally should be made 35 to 45 days prior to the time when the first hard freeze normally occurs.

*Minimum regrowth is critical if stand is to be maintained. On pasture grazed only during the dormant season, stubble height at the end of the grazing period is applicable.

*Approximate date is for continuous grazing. Rotation grazing usually can begin three to seven days earlier.

[1]NRCS Field Office Technical Guide, May 2010.

2) Rotational grazing:

a system of grazing requiring two or more pasture units between which grazing animals are moved in sequence, thereby resulting in grazing periods being followed by nongrazing periods. Rotational grazing is a management strategy that is **highly recommended**.

NOTE: We highly recommend that before implementing a rotational grazing system, you should complete a resource inventory to help develop the proper rotational sequence based on goals and available labor of the land manager. For assistance in completing a resource inventory, see the technical assistance section of this guide.

TIP: The number of pastures in a rotation should be based on the producer's goals, management abilities, available labor, terrain and water availability. The number of pastures influences the length of time a pasture will be grazed and rested after grazing. Three probably is the minimum number of pastures needed for a rotation to be effective. However, without proper grazing management, the number of pastures becomes inconsequential, and higher pasture numbers actually may be detrimental.

TIP: **Plant health and growing conditions will influence the number of days a plant needs to recover from grazing. A general rule is to plan for a minimum of 30 days of recovery in western Minnesota and eastern North Dakota and 45 days of recovery in western North Dakota under good growing conditions (fast plant growth). As plant growth slows, recovery periods need to be extended to permit proper plant recovery after grazing. Recovery periods of at least 45 days in western Minnesota and eastern North Dakota and 65 days in western North Dakota probably are required. Under drought conditions, longer recovery periods will be needed to ensure grazed plants recover adequate leaf area prior to the next grazing.**

We recommend monitoring plant growth and adjusting these recovery periods during the grazing season to reflect actual growing.

TIP: **A proper rotation should consider impacts on the plant and grazing animal. Grazing pastures once during the grazing season may reduce the nutritional value of the pastures grazed later in the growing season due to a high degree of mature plants being utilized. Grazing a pasture twice in the same growing season may improve plant vigor while potentially increasing nutritional value of the grazed plants, provided you achieve sufficient plant recovery between grazing periods.**

TIP: **For native pastures (rangeland), alternate grazing periods from year to year so that a pasture is not grazed during the same time of the growing season two years in a row. For example, eliminate the "classic" spring pasture, summer pasture and fall pasture rotation schedule.**

TIP: **For tame pastures (pastureland), grazing periods need not be altered from year to year, provided you maintain proper grazing management and soil fertility. For example, a crested wheatgrass pasture could be grazed first in the spring each year.**

3) Degree of utilization:

the proportion of the current year's forage production that is consumed and/or destroyed by grazing animals (may refer to a single plant species or a portion or all the vegetation).

TIP: **Proper utilization varies by plant species. However, most plants do not tolerate overgrazing (overuse of a plant for consecutive years). Grazing utilization is classified as slight, moderate, full, close and severe (see following table for description of each grazing use category). Proper utilization should be monitored using those grasses that are desired by the type of livestock being grazed and meet your management objectives: for example, needle-and-thread versus sand dropseed, or green needlegrass versus upland sedges. If you are managing your rangeland for forage production, you would want to monitor the level of use on green needlegrass because green needlegrass is a more desirable forage species than upland sedges.**

TIP: **The general rule of thumb would be proper utilization is moderate to full use when obtaining optimum livestock production while maintaining or improving the range resource. Proper utilization levels may vary depending on plant species.**

TIP: **No use or slight use, during an extended period of time, will be detrimental to plant vigor, plant diversity and overall rangeland health.**

TIP: **The degree of utilization is a measure of grazing intensity. A proper utilization level helps ensure that the grazed plant maintains adequate leaf area for photosynthesis and a deep, healthy root system. It also ensures that some plant material remains in the pasture for ground cover.**

Utilization	Level %	Use Description[1]
Slight	0–20	Appears practically undisturbed when viewed obliquely. Only choice areas and forage grazed.
Moderate	20–40	Most all of accessible range shows grazing. Little or no use of poor forage. Little evidence of trailing to grazing.
Full	40–60	All fully accessible areas are grazed. The major sites have key forage species properly utilized (about half taken and half left). Points of concentration with overuse limited to 5 to 10 percent of accessible area.
Close	60–80	All accessible range plainly shows use and major sections closely cropped. Livestock forced to use less desirable forage, considering seasonal preference.
Severe	greater than 80	Key forage species completely used. Low-value forages are dominant.

[1]E.J. Dyktserhuis. 1951

Figures 2, 3 and 4 show different grasses and the relationship between plant height and weight. Because most of the weight of a grass plant is near the base, 50 percent use by weight is not the same level as 50 percent use by height.

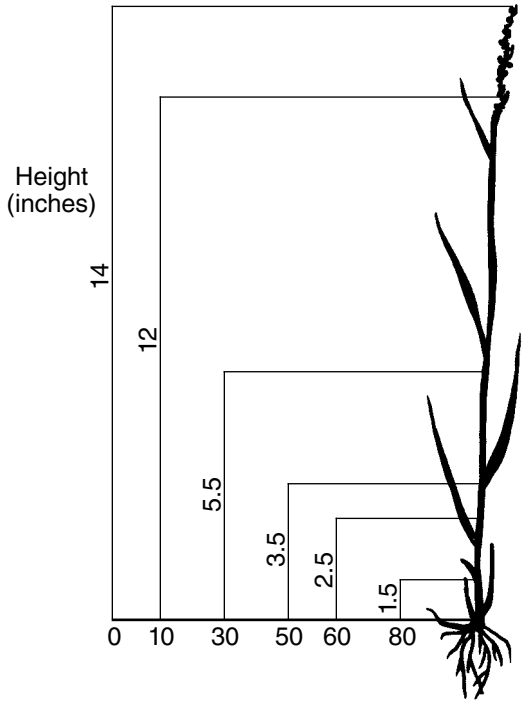


Figure 2. Percent of weight of western wheatgrass utilized at different stubble heights[1]

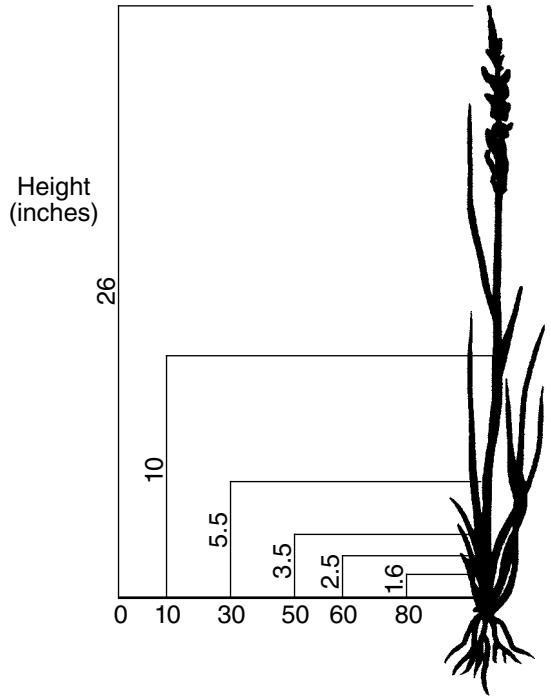


Figure 4. Percent of weight of green needlegrass utilized at different stubble heights[1]

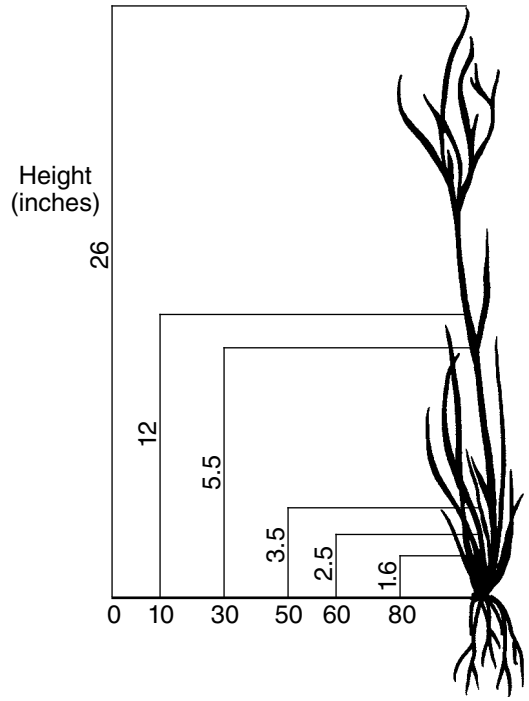


Figure 3. Percent of weight of needle-and-thread utilized at different stubble heights[1]

The amount of leaf material removed during the growing season also affects how rapidly a grazed plant will recover from a grazing event (Figure 5). The following table from "Grass: A stockman's crop and how to harvest more of it" (Harland E. Dietz) illustrates the impact of leaf removal on plant root growth stoppage.

Percent leaf of volume removed	Percent of root growth stoppage
10	0
20	0
30	0
40	0
50	2-4
60	50
70	78
80	100
90	100

[1]Montana State University. 1987.

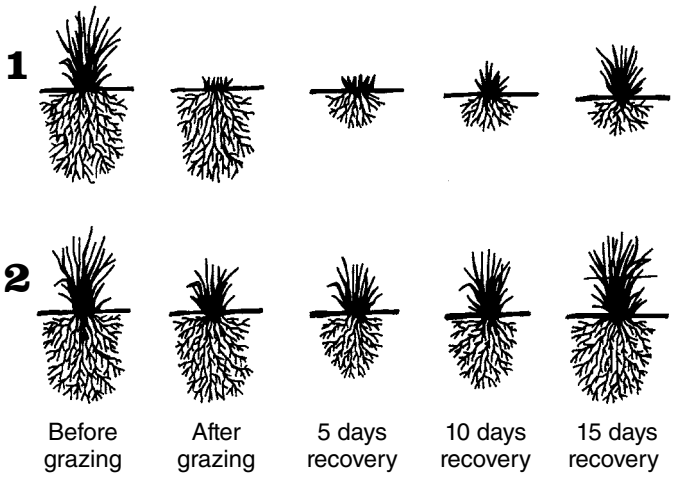


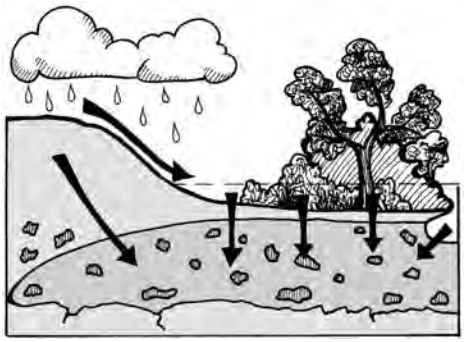
Figure 5. Plant regrowth rates depend on the amount of leaf removed by a grazing event. Plant 2 regrows more quickly because it can fix more energy through photosynthesis than Plant 1, which must draw on its root reserves for energy to regrow. (Reprinted with permission from "Pasture Vegetation – The Monitoring Tool Box" Land Stewardship Project. June 2000.)

TIP: **The more leaf area removed from a plant during each grazing event, the more time the grazed plant(s) will need to recover. Pastures in a rotation that are grazed short (more than 50 percent of the leaf area removed) will need to be given more recovery/rest time. This is especially important during periods of less than ideal growing conditions.**

TIP: **For monitoring degree of use information, see "Monitoring" section.**

Riparian Grazing Management

Riparian areas consist of a zone of vegetation influenced by water associated with streams, rivers or wetlands. This vegetation of grasses, shrubs and trees has important functions of filtering pollutants, stabilizing banks along streams and wetlands, buffering flood flows, and providing critical wildlife and fisheries habitat.



Healthy flood plains that are well-vegetated slow the flow of water allowing it to spread and soak in effectively.

Water flows faster over flood plains and loamy overflow sites with poor vegetation health with channelized portions or cutoffs, and does not linger long enough to fill the ground water or recharge zone.

Riparian areas in North Dakota and western Minnesota can be quite variable due to changes in weather conditions, geology and land use patterns. Riparian areas in central and western North Dakota are usually woody draws with scattered overstory trees, including American elm, native cottonwood, green ash, Rocky Mountain juniper and boxelder, and dominant understory shrubs, including native plum, common chokecherry, gooseberry, wild and woods rose, buffaloberry, Juneberry, hawthorne and snowberry with a herbaceous understory.

In western woody draws, management is often in conjunction with adjacent uplands utilized for grazing or hay production. In eastern North Dakota and western Minnesota, the riparian areas are generally bottomland hardwood forests dominated by a well-developed overstory of trees, including American elm, native cottonwood, green ash, American basswood and boxelder. In eastern North Dakota, bottomland hardwood riparian areas generally are found in association with cropland and, therefore, usually fenced and grazed as individual units.

This tip guide discusses grazing management techniques that will sustain woody draws and bottomland hardwoods for riparian benefits of stream bank protection, water quality, wildlife and fisheries habitat. These techniques should provide for regeneration of trees and shrubs and maintenance of herbaceous riparian plants necessary for riparian benefits important to ranchers while providing forage production for livestock grazing.

TIP: The overall grazing management strategy is still one of controlling the frequency, intensity and amount of time (opportunity) plants have to recover from a grazing event.

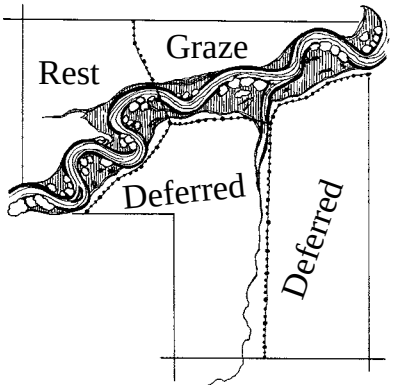
Grazing Management in Woody Draws Associated with Riparian Zones (associated with adjacent upland pasture)

Livestock are attracted to woody draws because they may provide a source of water, a source of forage that is generally greener longer into the grazing season, and shade. Also, livestock tend to loaf in these areas. To offset the attractiveness of these areas to livestock and reduce the amount of time livestock spend in these areas, the manager needs to:

- **Alter livestock distribution patterns through:**
  - Moving salt and mineral away from woody draws
  - Developing fresh stock water on the uplands
  - Installing drift fence to alter cattle trailing
  - Placing or herding animals (low-stress animal handling)

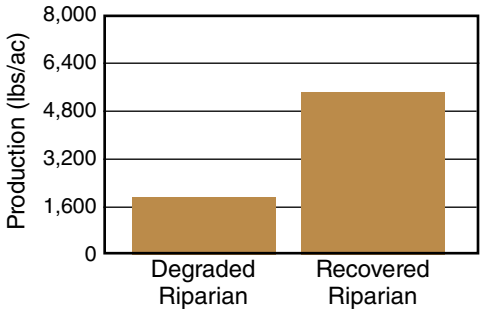
TIP: Off-stream water sources have been shown to reduce time livestock spent in streams by up to 89 percent and in stream areas by 51 percent. Cattle preferred drinking from a fresh water source up to 92 percent of the time, compared with drinking from the stream. Stream bank erosion was reduced by up to 77 percent when off-stream water sources were utilized.
Source: Sheffield. 2003.

- **If stream is to be used as water source:**
  - Provide ease of access through graveling or hardened access points that livestock will prefer to use.
- **Control the timing of grazing when woody draws are vulnerable.**
  - Avoid soft stream banks in the spring or after major rainfall events.
- **Install a rotational grazing system.**
  - Enhances plant vigor, which allows for bank stability
  - Provides rest and deferment for riparian areas, allowing tree and shrub seedlings to grow and reach a more grazing-resistant stage
  - Minimizes the time livestock spend in the riparian area



TIP: Installing a rotational grazing system will permit an easy transition to altering the grazing periods in the woody draws so that damage during vulnerable time periods can be minimized. See the Grazing Management section for further guidelines on developing and using a rotational grazing system.

- **Develop pastures containing woody draws.**
  - Fence the riparian area into a separate pasture, with separate management objectives and strategies.



A change to rotational grazing, from a season-long to continuous style, produced a significant response in forage production. Forage production went from pounds/acre to tons/acre.

TIP: Riparian pastures increase the rancher's control over the grazing process, including animal numbers, season of grazing, length of grazing and recovery/rest periods.

- **Develop exclusion fencing.**
  - Although not a favorable option, this prevents livestock from having access to high-risk or chronic problem areas and allows for riparian restoration.

Riparian Grazing Management in Bottomland Hardwoods (not associated with adjacent upland pasture)

Managing grazing in bottomland hardwoods is difficult because maintaining and regenerating overstory trees in pasture are hard to. This is particularly true in areas that do not have adjacent upland pasture typical of eastern landscapes. If your primary objective is to maximize forest health, vigor and production in bottomland hardwoods, seasonlong livestock grazing is not compatible.

In addition, forage production in bottomland hardwoods is much more limiting than in woody draws or upland pastures. Bottomland hardwood pasture has the additional liability of livestock injury due to downed woody debris and uneven ground. Because forage production can be highly variable, proper stocking rates should be determined on-site. Although management options are limited, impacts on bottomland hardwood riparian areas can be reduced.

- **Reduce livestock impacts on bank stability.**
  - Provide off-stream watering points.
  - Provide ease of access through graveling or hardened access points that livestock will prefer to use.
- **Develop a rotational grazing system.**
  - Enhances plant vigor, which allows for bank stability
  - Provides rest and deferment for riparian areas, allowing tree and shrub seedlings to grow and reach a more grazing-resistant stage
- **Develop forage capability in adjacent uplands.**
  - Convert adjacent marginal cropland into spring or summer pasture.
  - Plant high-producing forage crops.

TIP: Rotational grazing involves a planned sequence of grazing and rest periods. Changing the sequence of deferment from year to year allows any given pasture to never be grazed at the same time of the growing season two years in a row.

TIP: **Monitor livestock diet quality and/or stubble heights so that livestock can be moved when diet quality of herbaceous cover drops below that of the woody vegetation, thus reducing browsing.**
("Stubble height as a tool for management of riparian areas" by Warren Clary and Wayne Leininger. J. Range Management. November, 2000).

TIP: **Refer to the North Dakota Forestry Best Management Plan (BMP) Manual for more detailed guidelines on managing riparian areas.**

TIP: **For more information on riparian and forest habitat management under the North Dakota Forest Service program, visit www.ndsu.edu/ndfs/; write to Molberg Forestry Center, 307 1st St. E., Bottineau, ND 58318-1100; telephone (701) 228-5422; fax (701) 228-5448; or email forest@state.nd.us.**

TIP: **For more information on riparian grazing management, see North Dakota Extension publications "Riparian Ecosystems of North Dakota" (R1539), "Grazing Riparian Ecosystems: Grazing System" (R1540), "Grazing Riparian Ecosystems: Grazing Intensity" (R1541), "Grazing Riparian Ecosystems: Season of Use" (R1542) or "Grazing Riparian Ecosystems: Water Development" (R1543).**

Hayland and Haying Management

The amount and quality of hay needed to winter livestock in North Dakota and western Minnesota varies with location, type of operation and goals of the rancher. Due to the unpredictability of the winters, in length and severity, accurately predicting the amount of hay needed each year is difficult.

TIP: Generally, each ton of hay will provide 2.5 to 3 animal unit months (AUM) of forage for wintering livestock. Hay production will have a year-to-year variability based on environmental factors (rainfall and temperature).

Management: Balancing quality and quantity will depend on species mixture, plant stage at the time of harvest, soil fertility and storage method. Maximum quantity generally will not give you maximum quality. Hay harvest management is a matter of timing. Remember, wintering stock cows will not need hay with as high of quality as lactating cows.

Species Groupings	When to Cut	Minimum Stubble Height Inches
1) Beardless wildrye Creeping foxtail Intermediate wheatgrass Pubescent wheatgrass Meadow bromegrass Smooth bromegrass Tall wheatgrass Western wheatgrass	1st cutting – medium to full head 2nd and succeeding cuttings when new basal sprouts appear	3
2) Crested wheatgrass Green needlegrass	Boot to early heading	3
3) Reed canarygrass	1st cutting – early boot Later cuttings – when basal sprouts appear	3
4) Big bluestem Indiangrass Prairie sandreed Switchgrass	Early boot to late-boot stage	3
5) Alfalfa	1st cutting – bud to early bloom Last cutting – early bloom to 25 percent stand flowering	2
6) Sweetclover	Bud to early flower	3

TIP: Tame hayland and native hayland on sites that have a water table throughout the growing season or receive additional moisture throughout a major portion of the growing season may be harvested once per year and some years more than once a growing season. To optimize quality and quantity, harvesting should take place when the major species is in the late boot or early heading stage. Tame hayland in eastern North Dakota and western Minnesota may allow for multiple cuttings when moisture conditions are good.

TIP: On native hayland on ecological sites that do not have a water table or do not receive additional run-on moisture, harvesting for hay is limited to one harvest every two years. To allow adequate recovery after hay harvest, grazing is limited to the dormant season (usually Oct. 15 to April 15). To optimize quality and quantity, harvesting should take place when the major species is in the late-boot or early heading stage.

For management of annual forages for hayland, see "Annual Forage" section.

TIP: Grazing hayland following the removal of a hay crop generally is not recommended due to the potential for decreasing subsequent yields and long-term viability of the stand. Under a high level of management, which includes careful monitoring of plant regrowth and soil fertility levels, double use can be accomplished successfully during years of abundant production. The grazing intensity level should be light to moderate to maintain adequate growth prior to fall dormancy.

TIP: Hayland consisting of introduced species (smooth bromegrass, alfalfa, crested wheatgrass) becomes deficient in nitrogen (N) approximately four to five years after establishment, requiring fertilization to maintain maximum yields. A general rule of thumb is to fertilize with 40 to 90 pounds/acre of actual N per year, with lighter rates occurring in western North Dakota and heavier rates in western Minnesota. Research has indicated that applying 60 to 135 pounds/acres of actual N every other year produces similar yields as yearly applications at the previously discussed rate with less overall cost per acre.

TIP: Soil testing for phosphorus deficiencies is highly recommended before applying phosphorus as a fertilizer.

Annual Forages

Annual crops can be used for mid to late-summer forage production, providing good options for pasture or hayland. When selecting an annual crop, the rancher should decide on the intended use (grazing, hay or both). Some annual forage crops provide good hay but lack sufficient root structure to support grazing, while others are recommended for pasture use only. Many annual forage crops can be hayed or grazed and often used for both in the same year. A common practice would be to plant a forage crop for hay and graze the regrowth in late summer or early fall (regrowth is very dependent on late-summer moisture conditions, and a risk exists if you're dependent on that regrowth for grazing). Recommended annual forages for hayland, pastureland or double cropping of hayland followed with grazing include:

Hay Type Only[1]	Pasture Type Only	Hay and Pasture Type
Siberian foxtail millet	Annual ryegrass	Sudangrass
Common foxtail millet	Winter rye	Oats
German foxtail millet		Forage barley
		Sorghum-sudangrass
		Pearl millet
		Triticale

[1]Foxtail millet can be used for pasture if allowed to reach boot stage or later prior to grazing.

TIP: All forage crops can be planted throughout North Dakota and western Minnesota, except German foxtail millet and pearl millet are NOT recommended in the western half of North Dakota.

TIP: Peas may be added with oats, forage barley and triticale for hay or pasture mixtures. This may improve overall nutritional quality and soil fertility.

TIP: Sudangrass and sorghum-sudangrass forages have potential for PRUSSIC ACID POISONING and should not be grazed until 18 inches tall for sheep and 24 inches tall for cattle. Newer sudangrass varieties have a much lower risk of prussic acid poisoning. Prussic acid toxicity also increases when plants are stressed by drought conditions or after a frost. See NDSU Extension publication V1150, "Prussic Acid Poisoning," for more information.

TIP: NITRATE POISONING can occur in oats, forage barley, triticale, pearl millet, sudangrass and sorghum under drought-stress conditions or in the early stages of plant development. The risk of nitrate poisoning also increases with the amount of nitrogen fertilizer used to start the crop. See NDSU Extension publication V839, "Nitrate Poisoning of Livestock," for more information.

Cover Crops

Note: The following section is adapted from excerpts from USDA NRCS publication "Conservation Practice Specification: Cover Crop – 340" and in accordance with the NRCS standard, as detailed in Section IV – Conservation Practices subfolder of the "North Dakota Field Office Technical Guide" (FOTG).

Cover crops are crops that usually are not grown for harvest but serve multiple functions in crop rotation systems. Cover crops typically are grown to prevent soil erosion or for improvement of soil quality; however, other important roles include the enhancement of soil structure, improvement of soil fertility, and management of weeds, insect pests and plant pathogens. Cover crops also have been shown to be important forage for livestock.

Producers often want to achieve more than one purpose with the cover crop practice. Selecting the best species or species mixture is important to achieve the intended purpose(s) or primary use. Generally, no single cover crop species is ideal for all purposes. Achieving multiple purposes usually requires some compromise in the selection of species or mixture of species to plant.

In most cases, cover crop mixtures provide more or greater functions than single-species plantings. For example, oats and peas planted together tend to yield more and provide additional soil quality benefits than when planted alone. Where soil compaction is a concern, research has indicated a yield increase in crops following a cover crop of forage radish and rye versus following either planted alone. Radish also is known to enhance nutrient cycling by scavenging nitrogen that is lower in the soil profile, moving it closer to the rooting zone for the following crop.

No-till or direct-seeding of cover crops is recommended wherever possible. A firm, weed-free seedbed is desirable to ensure accurate seed placement and good seed-soil contact at the proper depth to facilitate germination and stand success. Cover crops have been grown successfully when seeded at the same time as the primary crop, interseeded or broadcast at some point after primary crop emergence and seeded after harvest of the primary crop. The most successful techniques in establishing cover crops is seeding post-harvest or seeded as the primary crop.

Seeding dates should be based on the following guidelines for cover crops:

- April 1 through June 15 – predominantly cool-season species
- May 15 through June 30 – mixture of cool- and warm-season species
- June 15 through Aug. 1 – predominantly warm-season species
- Aug, 1 through Sept. 1 – predominantly cool-season species

Planning Considerations

- Species such as mustard, winter rape or canola, radish, turnip and winter cereals are very winter hardy and will not terminate growth until air temperatures are at 25°F or less.
- Utilize cover crops to enhance crop diversity by adding crop types that are missing in the cash crop rotation (cool-season grass, cool-season broadleaf, warm-season grass, warm-season broadleaf).
- Consider applying starter fertilizer, especially in areas of nutrient-deficient or low organic matter soils. Where residue accumulation is excessive, soil tests are recommended.
- Consider using seed sources already on hand to reduce expense.
- Harvest cover crops for grazing, leaving at least 50 percent of the available biomass as soil-surface residue throughout the field.

- Utilize cover crops in a manner that provides sufficient ground cover to prevent erosion.
- Consider the potential use of cover crops by wildlife for food or shelter.

Provide Supplemental Forage

Where cover crops are planted for supplemental grazing, plan grazing to ensure proper management of cover crop growth and utilization amounts so that adequate residue remains to cover soil surface (take half, leave half). Where cover crops are intended for use as supplemental hay, plan harvesting to provide good-quality forage and maintain soil quality benefits.

Cover crops species such as turnips and radishes, and new-growth cereals, are high in water content and low in digestible fiber. Adding a supplemental fiber-based diet such as harvested hay (straw, lower-quality hay) or standing stubble will improve rumen function and create safe, high-quality grazeable forage. Refer to Table 1, Column 7 – Provide Supplemental Grazing or Column 6 – Provide Supplemental Hay to determine suitable cover crop species.

In addition to providing supplement forage, properly managed cover crops can increase soil organic matter content (refer to Table 1, Column 2 – Increase Soil Organic Matter Content and Column 17 – Mycorrhizal Fungi Association), capture and recycle or redistribute nutrients in the soil profile (Refer to Table 1, Column 3 – Capture/Recycle Soil Nutrients, Column 8 – Rooting Depth/Water Use and Column 15 – Carbon:Nitrogen Ratio), enhance mycorrhizal fungi association (See Table 1, Column 17 – Mycorrhizal Fungi Association), increase biodiversity, and minimize and reduce soil compaction

(Refer to Table 1, Column 9 – Minimize/Reduce Soil Compaction).

Designing Cover Crop Mixture

The first step in developing a cover crop mixture is determining the intended use and goals of the land. We highly recommend you create a mixture because mixtures have distinct advantages over monocultures as they relate to soil health, forage quality and symbiotic relationships with soil microbes. The use of cover crops mixtures has shown a greater potential for successful establishment under stressful conditions, such as drought, temperature extremes and poor soil conditions.

When creating a mixture of crops species, determine the desired percentage of each species (for example, 10 percent turnips, 50 percent oats and 40 percent millet). Calculate the recommended seeding rate by multiplying the percentage by full seeding rate (Refer to Table 1, Column 12 – Full Seeding Rate) for that species (10 percent x 4 pounds/acre = *0.4 pound/acre turnips*, 50 percent x 60 pounds/acre = *30 pounds/acre oats*, 40 percent x 20 pounds/acre = *8 pounds/acre millet*).

TIP: See USDA NRCS "Cover Crop Specification – Conservation Practice 340" in Section IV of the "Field Office Technical Guide."

TIP: See USDA ARS Northern Great Plain Research Lab Cover Crop Chart at www.ars.usda.gov/Services/docs.htm?docid=20323.

Table 1: Cover Crop - Common Species and Properties

Cover Crop	Erosion Reduction	Increase soil organic matter	Capture, recycle, redistri-bute nutrients in the soil profile	Promote biological nitrogen fixation	Weed suppression	Provide supplemental hay	Provide supplemental grazing	Rooting Depth / Plant Water Use[1]	Minimize / reduce soil compaction	Seed size (Large or Fine)	Crop Type[2]	Full seeding rate, lbs/acre	Seeding depth, inches	Salinity tolerance	C:N Ratio	Attract Beneficial Insects	Mycorrhizal fungi association
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
barley	G	G	F	N	G	G	F	MM	F	L	CG	100	0.75 - 2.0	G	M	Y	L
annual ryegrass	G	G	F	N	G	F	F	SM	F	F	CG	10	0.25 - 1.1	P	M	N/A	M
berseem clover	P	P	F	Y	F	F	G	MH	F	F	CB	8	0.25 - 1.0	F	L	Y	L
buckwheat	G	F	G	N	G	P	P	SL	P	F	WB	48	0.5 - 1.5	P	L	Y	N/A
canola	F	F	G	N	P-G**	F	F	MM	G	F	CB	5	0.25 - 0.75	G	L	Y	N/A
corn	G	G	G	N	P-G**	F	F	DH	G	L	WG	20	1.0 -1.5	P	H	N/A	H
cowpea	P	P	F	Y	G	F	F	SL	F	L	WB	30	1.0 - 1.5	P	L	Y	M
crimson clover	G	F	F	G	F	F	F	MM	F	F	CB	15	0.25 - 0.75	NA	L	Y	H
sunn hemp	F	F	G	G	G	NA	NA		G	F	WB	5	0.5 - 1.5	NA	L	N/A	M
flax	F	F	F	N	P	P	P	SM	P	F	CB	50	0.25 - 0.75	P	H	N/A	H
hairy vetch	G	F	F	Y	P	F	G	SM	F	L	WB	15	0.5 - 1.5	P	L	Y	M
lentil	P	P	F	Y	P	F	F	SL	P	F	CB	80	1.0 -1.5	P	L	N/A	M
medic	P	P	G	Y	F	F	F	MM	F	F	CB	8	0.25 - 0.75	P	L	N/A	M
millet	G	G	F	N	G	G	F	SL	F	L	WG	15-25	0.25 - 0.75	F	M	N/A	H
mustard, tame	F	F	F	N	G	F	F	MH	F	F	CB	5	0.25 - 0.75	P	L	Y	N/A
oats	G	G	F	N	F	G	G	MM	F	L	CG	60	0.5 - 1.5	P	M	N	L
peas	P	P	P	Y	F	G	F	SL	P	L	CB	50	1.5 - 3.0	P	L	Y	M
phacelia	F	F	F	N	F	NA	NA	SL	P	F	CB	5	0.25 - 0.75	NA	L	Y	M
radishes	P	P	G	N	G	P	G	DH	G	F	CB	5	0.25 - 0.5	P	L	Y	N/A
red beets	P	P	G	N	F	P	F	DM	G	L	CB	8	0.5 - 0.75	F	L	N	L
red clover	F	F	F	Y	P	F	F	MM	F	F	CB	6	0.25 - 0.75	NA	L	Y	H
safflower	F	F	G	N	F	F	G	DH	F	L	WB	30	1.0 - 1.5	F	M	N	H
sorghum	G	G	G	N	G	G	F	MM	G	L	WG	25-35	0.5 - 1.5	P	M	Y	H
soybeans	P	P	F	Y	P-G**	F	F	SM	P	L	WB	45	1.0 - 1.5	P	L	N/A	M
spring rye or wheat	G	G	G	N	G	F	F	MH	F	L	CG	60	0.5 - 1.5	F-G	M	Y	L
sudangrass, sudan-sorghum hybrid	G	G	G	N	G	G	G	MM	G	L	WG	25-35	0.5 - 1.5	F-G	M	Y	H
sugarbeets	P	P	G	N	F	P	G	DH	G	F	CB	8	0.25 - 0.5	G	L	N/A	L
sunflowers	F	F	G	N	F	P	G	DM	F	L	WB	4	0.5 - 1.0	F	M	N/A	H
sweet clover	G	F	F	Y	F	F	F	MM	F	F	CB	6	0.25 - 1.0	F	L	Y	M
triticale	G	G	G	N	G	G	F	MH	F	L	CG	60-100	0.5 - 1.5	G	M	Y	L
turnipes	P	P	G	N	G	P	G	DH	G	F	CB	4	0.25 - 0.5	P-F	L	N/A	N/A
winter rye or wheat	G	G	G	N	G	F	G	MH	F	L	CG	60-100	0.75 - 2.0	P	M	Y	L

[1]**Rooting Depth/Water Use:** SL = Shallow rooted/Low water use; SM = Shallow rooted/Medium water use; SH = Shallow rooted/High water use; ML = Medium rooted/Low water use; MM = Medium rooted/Medium water use; MH = Medium rooted/High water use; DL = Deep rooted/Low water use; DM = Deep rooted/Medium water use; DH = Deep rooted/High water use; Shallow = 6-18 inches; Medium = 18-24 inches; Deep = 24+ inches

[2]**Crop types:** CG = cool-season grass; CB = cool-season broadleaf; WB = warm-season broadleaf; WG = warm-season grass

Ratings: L = Low; M = Medium; H = High; N/A = Not Available; G = Good; F = Fair; P = Poor

**Poor weed competitor, but herbicide-tolerant varieties are available.

Table 1 was compiled from several sources listed in the "Cover Crop Design and Installation Guide" reference section and field observations.

Expired CRP Lands

Land in the Conservation Reserve Program is considered cropland; however, not all cropland is created equally in terms of erosion and yield potential. In fact, many of the acres enrolled in CRP may be best suited to other land uses, such as buffers, pasture, hay, and wildlife habitat.

Taking a look at your soils and considering these land use alternatives before making any decisions is a good idea. Steeper portions, potentially the more erosive soils of CRP land, may be best suited to stay in CRP or used for pasture and hayland with some renovation and investment. Other areas, including wetlands, saline areas, filter strips or buffer areas where you may have established grass, trees or shrubs, could continue to provide excellent wildlife habitat and add diversity to your farm. These areas may be eligible for re-enrollment under Continuous CRP. Land coming out of CRP also presents a unique opportunity to initiate organic farming production.

More than likely, the decision you make will depend on a variety of factors:

- Personal goals and interests
- Profitability
- Soil types
- Rental rates
- Family situations
- Yield expectation

Your choices will impact the local economy, landscape and environment.

Options:

- Re-enroll eligible acres in Continuous CRP
- Return to a cropland rotation
- Utilize and enhance forage as pasture or hayland
- Manage the expired CRP for wildlife

Before deciding what to do when your CRP contract expires, you must consider several factors: soil productivity and limitations, past yields, commodity prices, production, conversion or renovation costs and other required investments. To help guide you through the decision process, review the following questions. Some are more general while others are specifically related to potential land use(s) you may be considering. Feel free to discuss any of these questions or issues with the staff at your local NRCS field office or county Extension agent.

Land Use Decision Checklist

Re-enroll eligible acres in Continuous CRP

- ❑ Is the entire contract eligible for a continuous CRP practice?
- ❑ Is a portion of the contract eligible for a continuous CRP practice?
- ❑ For how many years will your CRP contract be re-enrolled?
- ❑ What is the new CRP rental rate?
- ❑ What enhancements or renovations will be needed if the land is re-enrolled in CRP (greater species diversity, weed control, brush removal, mid-contract management, etc.)?
- ❑ Other income or cost-share sources (North Dakota Game and Fish PLOTS program, Ducks Unlimited, Pheasants Forever, etc.)?

Return to a cropland rotation

- ❑ Do you plan to farm or rent the land for cropland?
- ❑ What is the planned crop rotation and expected yields?
- ❑ Do you have a current soil test?
- ❑ Do you plan to use a no-till system to initiate cropping?
- ❑ What conservation practices will be required for conservation compliance on HEL fields?
- ❑ Are you considering planting winter wheat in the year of contract expiration?
- ❑ Do you plan to apply herbicide the fall before planting?
- ❑ Do you know where the more productive and less productive soils on the farm are located?
- ❑ Is salinity a concern in some areas of your CRP?

Utilize and enhance forage as pasture or hayland

- ❑ If you don't own livestock, would you consider leasing the CRP as pasture(s) to another operator?
- ❑ Would you need additional cattle to make a grazing system economical?
- ❑ Do you have an adequate source of water?
- ❑ What type of fencing would you use? Are current fences adequate?
- ❑ Do you have a noxious weed problem on the fields?
- ❑ Is the existing forage (grass and legumes mix) adequate for grazing and/or haying?
- ❑ Would you use any of the pasture for hay?
- ❑ What management activities (renovation, fertilization, weed control, prescribed grazing, etc.) are required to maintain or improve the existing stand?

Manage the expired CRP for wildlife

- ❑ Which species of wildlife do you want to support?
- ❑ Managed grazing can enhance the area for wildlife. Would you consider livestock grazing as a management strategy to maintain a healthy plant community?
- ❑ Do you plan to apply herbicide the fall before planting?
- ❑ What improvements are needed to make the land more desirable for wildlife species of your choice?
- ❑ Other income or cost-share sources (North Dakota Game and Fish PLOTS program, Ducks Unlimited, Pheasants Forever, etc.)?

Renovating CRP for Pasture and Hayland

Evaluate the existing stand for noxious or perennial weed problems, vigor and overall stand viability. Then proper renovation techniques that will improve the stand quality and quantity may be selected.

Burning, fertilization, heavy harrowing, interseeding or complete re-establishment may be needed to produce a healthy, productive stand for use as pastureland, hayland or other conservation uses (for example, wildlife habitat).

Prescribed burning primarily would be used to remove old plant residues, increase the amount of sunlight for new plant growth, stimulate soil biological activity and release tied-up nutrients. A prescribed burn plan is recommended to ensure the burn accomplishes the objectives in a safe manner.

Fertilization with nitrogen (N) may be needed to rejuvenate CRP stands, especially if the legume component of the stand is limited and no longer providing fertility to the grass component. The amount of nitrogen needed will vary from 40 to 90 pounds of actual N, depending on soils and rainfall (higher rainfall areas and sandier soils will require the higher rates).

Phosphorus also may be limited. A soil test is recommended before fertilizing with phosphorus to determine if the need exists.

Heavy harrowing using two to four passes will remove standing litter, disturb low-vigor plants, and minimize pocket gopher mounds. A more robust regrowth with greater vigor often is achieved using this technique.

Interseeding may be an option if the existing stand has excessive bare ground (if unrelated to soil type, for example, very shallow, claypan) or if the legume component is missing from the stand. If bare ground exists, interseed with the one or more species that have management requirements similar to the existing stand; however, success has been poor when seeding grasses into an established grass stand.

If the objective of the interseeding is to introduce one or more new plant species into the existing grass stand, interseeding with a legume has proven the most effective. Suppression of the existing vegetation with a herbicide is recommended when adding legumes to the stand to reduce competition and enhance seedling establishment.

In either case, without conventional seedbed preparation, a drill that can penetrate the plant residues, place the seed at the proper depth and firm the soil around the seed is critical. A dormant seeding is recommended, but spring seeding also may be used if moisture conditions are favorable.

Grazing management
(see grazing management section)

Haying management
(see haying management section)

TIP: For further information, see "CRP Land Alternatives and Options Fact Sheet" (USDA NRCS, https://prod.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_000356.pdf), "Life after CRP" (North Dakota Game and Fish, http://gf.nd.gov/gnf/private-lands/docs/life-after-crp.pdf) and "Bringing Land in the CRP Back into Crop Production and Grazing" (NDSU Extension, https://www.ndsu.edu/agriculture/ag-hub/publications/bringing-land-conservation-reserve-program-back-crop-production-or-grazing).

Range Nutrition

The key to range nutrition is matching the needs of the grazing animal with the available forage. The needs of the animal will vary with the age of the animal, if mature; stage of pregnancy, if lactating; and the age of nursing offspring. The nutritional value of forage will vary with the stage of plant development and environmental conditions.

This section is modified from a publication by C. Wayne Cook, which was accessed through the Colorado State University website on May 27, 2005.

TIP: The quality of a range plant is judged primarily on palatability, or how readily animals eat it, and its nutritive content with respect to its phenological development. Some plant species are eaten only during early growth and, in special cases, only certain portions of a particular species are consumed during the latter stages of development.

During their annual life cycles, individual plant species vary in nutrient content. Most forage plants are high in nutrients during early growth. However, as they mature, they lose nutrients markedly. Some plant species mature rather rapidly and, as a result, decrease substantially in nutritional value; other species mature rather slowly and, consequently, remain high in nutrient content during an extended period. Still other plant species, even after they mature, appear to cure rather well and retain comparatively high quantities of nutrients for indefinite periods.

The true test of the nutrient value of a forage species, or a mixture of species, is the ability of the usable forage to meet the nutritional requirements for the physiological functions being performed by the grazing animal during the various seasons of the year. Most physiological functions of the grazing animal are performed as everyday functions and generally are referred to as "maintenance requirements," which include travel, mastication and digestion, maintaining body temperature and growing hair or wool.

The nutrient evaluation of most range areas can be based on how much protein, energy and phosphorus are in the forage plants. Phosphorus, digestible protein and energy content are the three main nutrients that are most important in evaluating the status of range nutrition.

The comparative nutritive value among the forage classes (browse, forbs and grasses) can be discussed best by measuring their apparent ability to meet the nutritional requirements of large herbivores for the more important physiological functions such as maintenance, gestation, growth and lactation.

In addition to the influence of relative preference and floristic composition on nutritive content of range forage, factors such as stage of growth and variable site conditions also are important.

Nutritional Content and Stage of Growth

For the most part, rangelands of the West can be evaluated for nutritional value on the basis of phosphorus, digestible protein and digestible energy. Some local areas also may have other nutrients that should be considered. These nutrients in the Dakotas, Minnesota and south-central Canada include copper and zinc.

During the period of initial growth, and for a time thereafter, all forage classes are high in nutrient content, and their nutritional contents are not materially different. However, as growth stages advance, the nutritional differences among forage classes become more evident. Researchers generally agree that young, growing animals and lactating animals have comparable requirements when expressed on a percentage basis.

The common belief is that animals grazing green plant growth on spring and summer ranges receive adequate nutrients; however, on fall and winter ranges where plants are dry and mature, the diets of grazing animals are thought to be deficient in some nutrients.

Several studies have shown that chemical composition varies with season, largely as a result of changes in the stem-to-leaf ratio and the normal maturing process that causes a translocation of nutrients in the plant parts. In addition to the actual decrease in chemical content of herbage with advancement of growth, the forage likewise decreases in digestibility because of lignification and calcification of the plant material.

Digestible Protein

The correlation between total protein and digestible protein in the mixed ration normally used in farmstead feeding is rather high. In range forages, the digestibility of protein may vary from 70 percent in early growth to as low as 10 to 15 percent in the quiescent stages. Thus, evaluating grazing animals' diet on the basis of digestible protein rather than on total protein appears to be more logical unless standards have considered the high variability in the digestibility of protein as plants mature.

Grass species decline in digestible protein rather rapidly and generally fail to meet the lactation requirements at about the time they come into full anthesis (flowering) (Figure 6). This is the result of a rather rapid loss of total protein and a more rapid decrease in digestibility of protein that occurs with advanced growth. Grasses, in general, lose 75 percent of their protein during the period from early growth to seed formation; on the other hand, browse lose only about 40 percent of their protein content during a similar period. As a result, grasses that have matured are considered poor sources of digestible protein. Shrubs, however, are considered good sources of digestible protein during most of their active growing period; and even after they reach full maturity, they continue to meet gestation requirements.

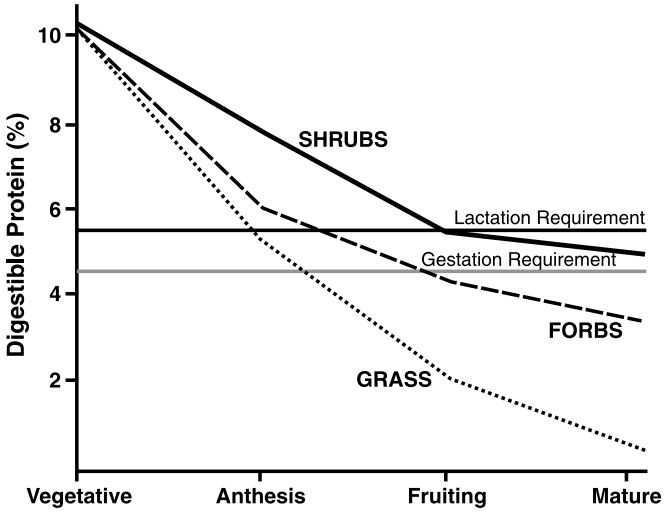


Figure 6. Average content of digestible protein for the three forage classes compared with phenological development and herbivore requirements for lactation and gestation.

Forbs are intermediate between browse and grass with respect to protein content during most seasons. Most forb species fail to furnish adequate digestible protein to meet the requirements of animal gestation after reaching the fruiting stage.

Energy

In some cases, neither grass energy nor digestible energy in shrubs is considered a good index to the true energy values of forage because of the high content of essential oils, resins or waxes that suggest high energy content, but these materials are not available for livestock metabolism. The digestible energy values for browse shown in Figure 7 have been adjusted for species high in essential oils so that the trends are based on realistic digestible energy values.

Shrubs are not considered good sources of energy after they reach the phenological stage of fruit development. Thereafter, they generally fail to meet the energy requirement for animals in gestation.

Grasses generally are considered good or excellent sources of energy, primarily because of their high content of cellulose. Forbs are intermediate between shrubs and grasses in energy-furnishing constituents and, like shrubs; they generally fail to meet the energy requirements for gestation after reaching full maturity and dormancy.

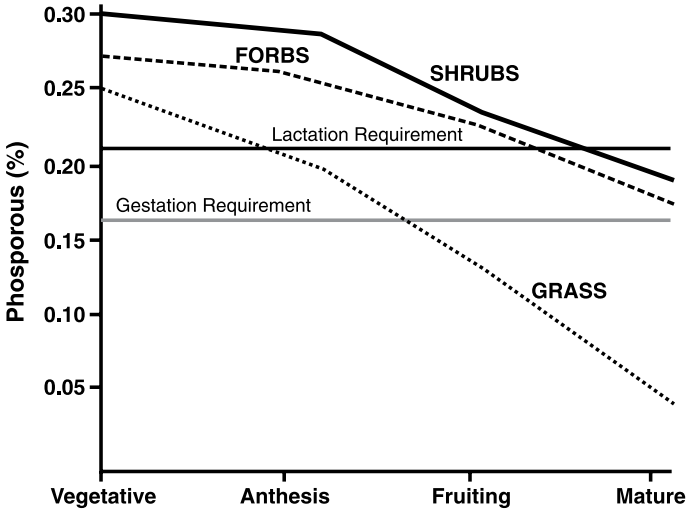


Figure 7. Average content of digestible energy for three forage classes compared with various stages of phenological development and requirements for lactation and gestation.

Phosphorus

Even when mature, shrubs generally are considered good sources of phosphorus for general animal maintenance and gestation unless they are deciduous. Even deciduous shrubs are perhaps only borderline if the young twigs are eaten readily (Figure 8). Most forbs have a phosphorus content that is only slightly lower than that of shrubs.

Grasses, however, are low in phosphorus soon after they form seed, so they are considered poor sources of phosphorus when mature and not actively growing. Most grasses lose considerable phosphorus content when temporarily forced into dormancy by even brief periods of drought. However, when precipitation occurs and growth is renewed, the phosphorus content increases and lactation requirements again are met.

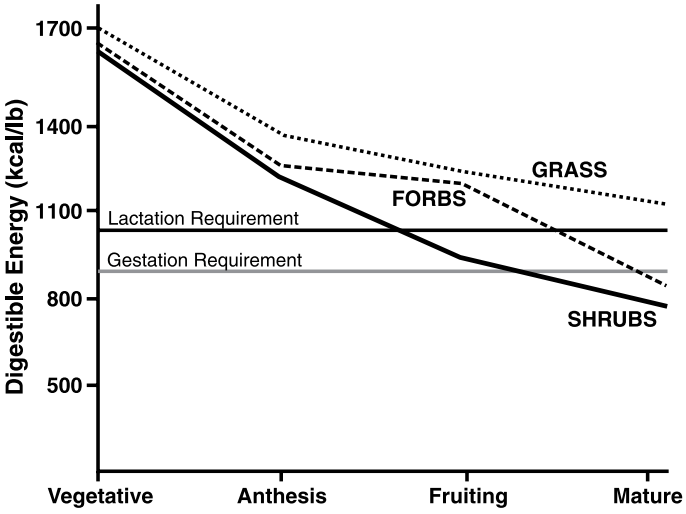


Figure 8. Average percent of phosphorus for three forage classes compared with stage of growth and herbivore requirements for lactation and gestation.

TIP: Maintaining or improving the diversity of grasses, forbs and shrubs in your rangeland pastures will permit livestock the opportunity to select the forages that will best meet their nutritional needs throughout the grazing season.

Copper and Zinc

Range and pastureland in the northern Great Plains region are considered deficient especially of copper but also of zinc by the seed head stage of development. Cattle will become deficient of copper by early summer and may show signs of deficiency by midsummer, especially red pigmented cattle when the water source is high in sodium. If the drinking water is known to be high in sodium, adding extra copper to the mineral program is highly recommended starting midsummer and through the winter feeding program.

Sheep can be poisoned easily by excess copper supplementation, so caution is warranted when adding copper to the pasture when sheep are present. Year-to-year variation in the zinc content of pasture plants occurs; however, it becomes borderline to deficient by midsummer.

Nutritive Value as Affected by Site

Site conditions are important because they influence the growth characteristics of range plants and, thus, indirectly affect their nutritive value. Sites also indirectly affect the chemical content of plants and plant parts through soil and plant development, water runoff, intensity of shade and other environmental factors.

Shrubs and forbs, when they approach maturity, are considerably leafier on less favorable growing sites. Grasses in advanced stages of growth are, likewise, leafier on poorer sites than on more favorable sites, but differences between sites are less conspicuous for grasses than for shrubs or forbs. As a result, plants on unfavorable sites are more palatable, more digestible and, therefore, more nutritious than plants on the favorable sites.

Nutrient content of plants on poor sites during advanced growth stages generally are considered more nutritious because of the finer material and the presence of more leafy material, compared with stems. The differences in stem-to-leaf ratios would, to a large degree, account for chemical differences between plants growing on favorable and unfavorable sites because leaves are higher in ether extract, protein, ash, calcium, phosphorus, and nitrogen-free-extract, whereas stems are higher in lignin, crude fiber and cellulose.

Predominantly grass ranges such as mixed and tall grasses are considered deficient in phosphorus, protein and vitamin A when the plants approach hard seed formation or maturity (See Figures 6, 7 and 8). Therefore, grass ranges generally are believed to be deficient in these three nutrients in late summer, fall and winter, and supplementation should be considered.

While generally not considered a nutrient, water is critical to livestock performance. Forage intake is directly proportional to water intake, and providing adequate, high-quality water is important. Refer to Tab 19 for further information about water developments.

Other References

1. Grazing Land Animal Nutrition Lab at Texas A&M University available at: http://cnrit.tamu.edu/ganlab/
2. Livestock nutrition publications: http://cnrit.tamu.edu/ganlab/
3. Grasses for the Northern Plains: Vol. I Cool-season. R1323 – North Dakota State University Extension and USDA Plant Material Center (www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/ndpmcbk7681.pdf). Grasses for the Northern Plains, Volume 1 - Cool-Season
4. Grasses for the Northern Plains: Vol. II Warm-season. R1390 – North Dakota State University Extension and USDA Plant Material Center (www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/ndpmcbk9425.pdf). Grasses for the Northern Plains, Volume 2 - Warm-Season

Fencing Options

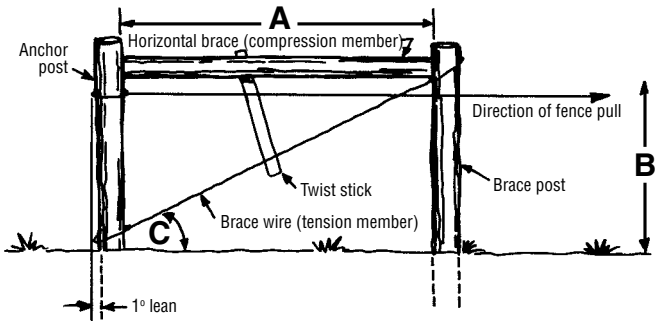
The goal of fencing is to facilitate the management of the livestock herd. The type and design of a fencing system will vary with the type of animal and the level of management. Boundary fences should be constructed to a higher standard to minimize liability concerns associated with livestock leaving the property. Although cross-fences should be designed to contain livestock to the prescribed pasture, they may be constructed to a more economical level (for example, one- to two-strand electric fence vs. four-strand barbed wire).

Options for fencing include barbed wire, two-strand smooth wire, single-strand smooth wire (energized or nonenergized), temporary or permanent electric (energized) fence, woven wire and electric mesh. The choice of fencing will depend on the animal type and/or class of animal to be controlled and the producer's objectives or comfort level.

Corner bracing

Properly installed corner-brace assemblies are the cornerstone of any fence. Fences with poor corners generally require more maintenance and have a shorter lifespan than those with well-designed and installed corner braces.

The key to properly installed corners lies in understanding the relationship among the length of the cross-brace (A), the height at which the cross-brace is installed (B) and the resulting angle formed between the brace wire and the ground (C). To be effective, the length of the cross-brace (A) must be at least twice the distance at which it is installed from the ground (B). Maintaining this relationship will ensure that the angle between the brace wire and the ground (C) will be 30 degrees or less. If this angle is greater than 30 degrees, the pull from the fence wires will tend to lift the back post out of the ground.



TIP: Experience and research indicates that a corner-brace assembly with a brace post at least 8 feet long mounted approximately 4 feet off the ground is the minimum design criteria for an effective corner assembly. For a stronger corner, one fencing contractor recommends installing a brace post that is at least 2.5 times as long as the top wire is from the ground. For example, if the top wire is installed at 48 inches, the brace post would need to be at least 120 inches long.

Energizers (fence chargers)

Low-impedance vs. high-impedance energizers

Impedance refers to the amount of restriction manufacturers place on the flow of electricity (amperage) exiting the energizer. Energizers with a long spark duration and high amperage have the potential to start grass fires and injure or possibly kill anything caught in the wire. Therefore, manufacturers install resistors in these types of energizers to reduce the amperage, thereby reducing the potential damage. These types of energizers are termed "high impedance."

High-impedance chargers tend to short out easily because their amperage has been reduced.

Low-impedance energizers have been designed with much shorter spark duration. This shorter spark duration eliminates the need for reducing the amperage with resistors, hence the term "low impedance." Because these chargers operate with higher amperage, they are less likely to short out on weeds or other items that may come in contact with the fence. They are safe to operate with this high amperage because the spark is extremely short in duration (usually around 0.0003 second).

TIP: For most animals, the generally accepted optimal voltage range is between 2,000 and 6,000 volts. The more or thicker the hair on the animal, the greater the required voltage for control.

Energizer grounding

Lack of an adequate grounding system on electric fences is one of the most common causes of ineffective animal control. Follow the energizer manufacturer's recommendations for proper grounding.

Generally, proper grounding requires at least two half-inch galvanized rods at least 6 feet in length driven entirely into the earth. Grounding wire from the energizer should be attached to these rods securely using the proper fastener.

To check the adequacy of your ground system, you will need a digital volt meter (DVM).

Testing the ground system

Before testing your fence's grounding system, you will need to place the fence under a heavy load. You can do this by resting several steel stakes (steel fence posts work well) on the live wire(s) of the fence at least 330 feet away from the energizer. Keep adding stakes until the fence voltage is reduced to 2 kV or less.

Using the DVM, measure the voltage between the energizer's ground wire (the wire attached to the negative post on the energizer) and an independent grounding rod placed at least 3 feet from the energizer's grounding rods. If the reading on the DVM is greater than 200 volts, then more grounding rods are needed. Add permanent ground rods to the energizer's grounding system and repeat measurements until the proper reading is obtained.

Water Options

Tank size

The minimum livestock storage tank capacity should be enough to meet the minimum water requirements for the number of animals being grazed per day. The water tank should supply adequate water for two to three days using an electric (hard-wired) pump or three to seven days using a wind- or solar-type pump.

TIP: **Use the following formula when calculating storage requirements:**

Number of livestock	X	Days storage required	X	Requirements gallons/head/day	=	Total gallons needed

For example:
50 cow/calf pairs X 4 days X 13 gallons/head/day = 2,600 gallons

TIP: **Use the following formula when calculating tank storage capacity:**

Capacity = 23.5 X r2 X d;
where r = diameter of tank / 2 and d = depth of tank

For example:
Diameter of tank = 15 feet, depth = 2 feet
23.5 X (15 / 2)2 X 2 = 2,644 gallons

TIP: **The EXPECTED water consumption per head per day (low requirements reflect cooler temperatures and higher requirements reflect high temperatures and dry conditions).**

Beef cattle: 6 to 18 gallons/head/day
Dairy cattle: 10 to 30 gallons/head/day
Sheep and goats: 1 to 4 gallons/head/day
Horses: 8 to 12 gallons/head/day

TIP: **Quick reference:**

Tank diameter (in feet)	Capacity at depth of 2 feet
8	752 gallons
9	952 gallons
10	1,175 gallons
11	1,422 gallons
15	2,644 gallons
20	4,700 gallons
30	10,575 gallons

Water quality

TIP: Studies in Montana and Alberta, Canada, show a 5 to 30 percent weight advantage in calves and yearlings that had access to higher-quality water in tanks.

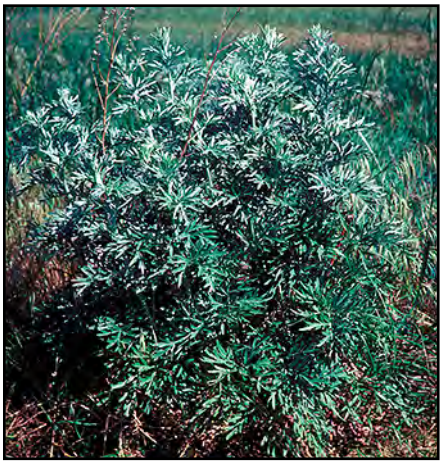
TIP: Water sources that provide higher-quality water include wells, wells with pipelines, and fenced dugouts or dams where water is pumped from the dugout or dam into a tank.

TIP: Forage intake is directly related to water intake, so ensuring adequate, and high-quality water will help to meet animal performance objectives.

Noxious Weeds

Noxious plants are undesirable in light of planned land use or unhealthy to range or pasturelands. Noxious plants are categorized by the State Department of Agriculture and will vary from state to state.

TIP: See "Invasive and Troublesome Weeds of North Dakota" developed by North Dakota State University and the North Dakota Department of Agriculture for a more detailed description, photos and control alternatives for North Dakota's noxious and other common invasive weeds.



Absinth wormwood

This is an introduced perennial forb that is found on dry soils; in overgrazed pasture and rangeland, disturbed areas and CRP fields; and on roadsides. Absinth wormwood is recognized easily by its color (gray) and strong sage odor. Absinth is a prolific seed producer that also can spread by short roots. This plant is unpalatable to most classes of livestock, causing economic losses by reducing available forage.

TIP: The presence of absinth wormwood is a symptom of an unhealthy plant community characterized by bare ground and low plant vigor.

TIP: Herbicides should be applied when the plant is at least 12 inches tall and actively growing (late June to mid-August).

Canada thistle

This introduced perennial forb is found on moist sites; in overgrazed pasture and rangeland, disturbed areas and CRP fields; and on roadsides. Canada thistle usually grows 2 to 3 feet tall and has alternate dark green leaves that vary in size. Canada thistle has small, compacted flower heads that appear on the upper stems and range from lavender to pink or white. This plant causes economic losses by reducing available forage. Sometimes flowers are consumed by calves, yearling cattle and horses.

TIP: Canada thistle is less of a problem in healthy plant communities. The plant becomes an aggressive invader in areas with bare ground and low plant vigor resulting from excessive overgrazing or over-rest.

TIP: Prevention is the best control method. Because thistle often invades overused or disturbed land, the best preventive measure is to reseed the disturbed area with a desirable species as soon as possible. Proper grazing management and rotational grazing practices should be established and maintained.

Dalmatian and yellow toadflax

These are introduced, perennial plants that often grow to a height of 2 to 3 feet. Dalmatian and yellow toadflax are highly competitive, aggressive species belonging to the snapdragon family. Both species have an extensive creeping rhizomatous root system. The most distinctive difference between the species is that Dalmatian toadflax has broad, heart-shaped leaves that clasp a woody stem, whereas, yellow toadflax has narrow, linear leaves with a narrow stem. Flowers of the toadflaxes grow at the bases of the upper leaves and are bright yellow (Dalmatian) or bright yellow with an orange center (yellow) with a long spur on the end. A single toadflax plant can produce up to 500,000 seeds beginning in late June or early July.

Cattle and most wildlife usually will avoid both toadflax species. Occasional cases of mild poisoning have been reported for cattle. Sheep will consume toadflaxes readily, showing no apparent ill effects.

TIP: Prevention is the best method to keep toadflax from invading cropland, rangeland and wildlands. New infestations usually occur from seeds or vegetative buds on root pieces; therefore, keeping seeds and contaminated materials or equipment out of uninfected areas is good strategy.

TIP: Because the toadflaxes are relatively new noxious weeds to North Dakota and Minnesota, aggressive herbicide control is recommend when found.

Leafy spurge

It is an introduced perennial forb widely established in North Dakota and western Minnesota on a variety of soils and sites. Leafy spurge normally grows 2 to 3 feet tall from a woody crown that is below the soil surface. This plant produces a flat-topped cluster of showy yellowish-green bracts that bear small green flowers. The root system is extensive and consists of numerous coarse and fine roots that occupy a large volume of soil and can extend to a depth of 15 feet or more.

Leafy spurge contains a toxic substance that, when consumed by most livestock and wildlife, is an irritant and purgative. However, sheep and goats will graze leafy spurge and can provide a form of cultural control.

TIP: Leafy spurge will invade pasture and rangeland regardless of management practices. However, proper land management will minimize the rate of spread.

TIP: Early detection and treatment of new infestations is critical to provide effective control and minimize economic losses.

TIP: Best control techniques include a combination of herbicide, and biological and cultural tools.

Musk thistle

This is an introduced biennial forb found in dry upland and sandy soils, and occurs in overgrazed pastures and disturbed sites. Musk thistle often grows in excess of 6 feet and has very large flowers that tend to droop. The flower has very characteristic brown bracts that resemble pine cones. Flowers are usually deep rose, solitary and very large, producing in excess of 10,000 seeds per plant.

TIP: Prevention is the best control method. Proper grazing management and rotational grazing practices should be established and maintained.

Purple loosestrife

This is an introduced rhizomatous perennial forb that is found on moist or marshy sites, often along the margins of wetlands. Purple loosestrife is best known as a beautiful garden ornamental, first introduced into North America in the early 1800s. The plant grows from 1.5 to 8 or more feet tall. Stems are 4 to 6 angled and smooth or pubescent with few branches. Leaves are simple, 1 to 4 inches long and 0.25 to 0.5 inch wide, and can be opposite or whorled. The most identifiable characteristic of purple loosestrife is the striking rose to purple flowers. The plant usually flowers from early July to mid-September. Purple loosestrife spreads primarily by seed but also can spread vegetatively by stem and root cuttings. One plant can produce approximately 2.7 million seeds. Although unpalatable to most classes of livestock, purple loosestrife's greatest threat is to the ecological integrity, shoreline/bank stability and wildlife habitat along wetlands, lakes, rivers and streams.

TIP: Several methods are available for purple loosestrife control, including mechanical, biological and chemical. The size and location of the infestation will determine the best control method.

TIP: In general, small infestations of a few plants can be controlled by digging or mechanical removal. Properly dispose of plants and roots by drying and burning, or composting in an enclosed area. Continue monitoring these small infestations to ensure long-term control.

Saltcedar

Saltcedar, or tamarisk, is a perennial shrubby bush or tree introduced into the U.S. to reclaim eroded areas and prevent further loss of stream banks. This plant ranges in size from 5 to 20 feet tall, the bark is reddish brown and the leaves are small and flat, resembling an evergreen shrub. Flowers are pink to white and appear in mid to late summer. Saltcedar reproduces by seeds, which are spread by water and wind, or root growth when top growth is mechanically removed.

Saltcedar has been sold in the horticultural industry, primarily for its wide adaptability and pink flowers. Saltcedar has been known to escape from home-owner plantings into waterways. However, the largest infestations are from a vigorous, wild type of saltcedar, which is spreading into western North Dakota along the Yellowstone and Missouri rivers from Montana. Although unpalatable to most classes of livestock, saltcedar quickly can become a monoculture along lakes and waterways, displacing native riparian and wetland species, potentially drying up entire lakes or streams.

TIP: Prevention is the best method to keep saltcedar from invading North Dakota and Minnesota's wetlands and wildlands. Because saltcedar is a new noxious weed in North Dakota, early detection and aggressive control is critical to minimizing the ecological impacts.

Knapweed (Diffuse, Russian, Spotted)

Knapweeds are introduced perennial forbs that rapidly invade pasture and rangeland, causing serious decline in forage production. The knapweeds are found on a wide variety of soils and sites. They are a prolific seed producer, producing up to 1,000 seeds per plant. Seed remains viable in the soil for five years or more, so infestations may occur a number of years after vegetative plants have been eliminated. Knapweeds can release a toxin that reduces the growth of neighboring plants.

TIP: Prevention is the best control for the knapweed species. People are the major cause of knapweed spread. The weed is spread readily in hay and on vehicle undercarriages. Avoid driving through patches of knapweed and do not transport hay containing this weed.

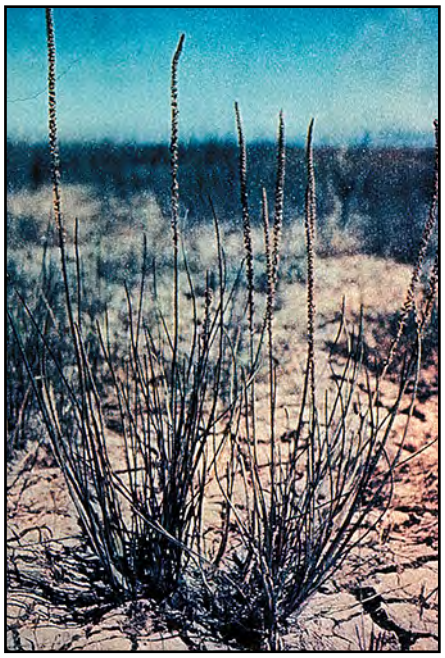
TIP: The plant generally is easy to control with herbicides, but the area must be monitored for several years and retreated as necessary.

TIP: Some of the species mentioned here, as well as other species considered to be weeds, may be utilized by livestock under the right management conditions. Species identification is important to avoid toxicity, but the adage of "use what you've got and manage for what you want" may apply when dealing with weeds.

Poisonous Plants

Poisonous plants are those that produce poisonous substances that harm livestock. Depending on the poison and the amount of plant material eaten, an animal may die, be disabled permanently or recover completely. Although poisonous plants do occur in North Dakota and western Minnesota, they generally are not a problem. If they do become a problem, that generally is a symptom of inadequate forage production resulting from low range condition, drought or a combination of the two.

Listed are the more common poisonous plants found in North Dakota and western Minnesota.



Arrowgrass

Arrowgrass is a perennial plant found in wet meadow, and wetland and saline lowland ecological sites. As long as arrowgrass has adequate moisture, it does not cause poisoning; however, when growth is stunted from lack of moisture or an early frost, plants quickly become toxic due to a high level of hydrocyanic or prussic acid.

Affected livestock: cattle, sheep, bison, elk and goats

Symptoms of poisoning:

- nervousness
- abnormal breathing - rapid or slow and deep
- trembling or jerking muscles
- blue coloration of the lining of the mouth
- spasms or convulsions continuing at short intervals until respiratory failure causes death

TIP: Arrowgrass will be present even in high-condition rangeland but seldom grazed if adequate forage is available.

Blue green algae (Cyanobacteria)

Blue green algae is found in stagnate sloughs, dugouts and dams, sometimes causing poisoning, usually when animals drink stagnant water during hot weather in mid to late summer. Toxic cyanobacterial blooms occur because of favorable conditions, including hot, sunny days and warm, nutrient-rich water. Algae blooms usually do not last long; however, affected animals rarely range far from the water source.

Affected livestock: All classes of domestic livestock, dogs, and some small wild animals

Symptoms of poisoning:

- nervous derangement
- staggering
- tremors
- severe abdominal pain

TIP: Animals intoxicated with cyanobacteria are characterized by convulsions, incoordination, bloody diarrhea and sudden death.

TIP: A number of ways are available to determine the presence of cyanobacteria. If concentrations of cyanobacteria are suspected in a water body, walk around to the leeward side of the water body. If any dead animals such as mice, muskrats, birds, snakes or fish are present, assume a poisonous condition exists.

Houndstongue

This biennial plant usually is found in rangeland, wooded swales, shrub thickets and disturbed sites. This plant tends to increase when bare soil occurs, such as areas where livestock congregate, and wildfires and mechanical disturbances have occurred. The seeds are burlike and typically dispersed by attaching to the hair of livestock and wildlife. The toxic substance is pyrrolizidine alkaloid, which causes liver cells to stop reproducing.

Affected livestock: Horses, cattle and rarely sheep

Symptoms of poisoning:

- digestive disturbances
- restlessness
- lack of coordination
- convulsions
- coma

TIP: Houndstongue seldom is grazed by livestock; however, when other forage plants are reduced due to drought or overgrazing, animal consumption may occur. This is especially true for horses.

Larkspur

This perennial plant is found on upland prairie ecological sites. All plant parts, especially the leaves, are poisonous. In North Dakota, cattle rarely feed on larkspur when good forage is available. The toxic substance is an alkaloid.

Affected livestock: Cattle, rarely sheep or horses

Symptoms of poisoning:

- nervousness
- staggering and falling
- nausea
- excessive salivation
- frequent swallowing
- twitching of muscles
- rapid, irregular heart action
- respiratory paralysis

Locoweed and milkvetch

These perennial plants generally are found on the drier upland ecological sites. These plants are poisonous during all stages of growth and may be dangerous throughout the year. All plant parts are toxic due to an alkaloid named swainsonine. Usually, an animal must eat large amounts of plant material for two to five weeks before death occurs. In cows and ewes with acute poisoning, abortion frequently occurs.

Common species include Lambert's crazyweed, two-grooved milkvetch and tine-leaf milkvetch.

Affected livestock: cattle, horses, sheep and goats

Symptoms of poisoning:

- loss of flesh
- irregular gait
- loss of a sense of direction
- nervousness
- weakness
- withdrawal from other animals
- lack of muscular control
- violent actions when disturbed

TIP: Animals ordinarily will not eat locoweed unless feed is scarce. But some animals may prefer locoweed to good forage.

Oak

Oak is a perennial tree found on dry uplands, woody draws and some riparian zones. Poisoning is caused by consuming young trees, mature foliage, acorns and fallen leaves. Toxic substances are oak tannins.

Affected livestock: cattle, bison, and horses

Symptoms of poisoning:

- gaunt, tucked-up appearance
- constipation, frequently followed by profuse diarrhea
- weakness
- tendency to remain near water
- reluctance to follow the herd
- emaciation
- mucus in droppings
- dark-colored urine
- collapse

TIP: Oak is most dangerous in the budding and leafing stages.

TIP: A diet containing more than 50 percent oak browse will cause sickness, with more than 75 percent of the affected animals dying.

TIP: Make sure animals are not suffering from a depraved appetite because of a lack of phosphorus.

Russian thistle, kochia, pigweed and goosefoot

These are annual introduced plants found on disturbed sites, bare areas and areas of low range and pasture condition. These plants are potassium nitrate accumulators. Nitrate toxicity occurs at elevated levels and is greatest when plants are young or stressed due to drought or frost.

Affected livestock: cattle, horses, sheep, goats and bison

Symptoms of poisoning:

- bluish/chocolate brown mucous membranes
- rapid, difficult breathing
- noisy breathing
- rapid pulse
- salivation, bloat, tremors, staggering
- weakness, coma, death
- dark “chocolate-colored” blood

TIP: See NDSU Extension publication V839, “Nitrate Poisoning of Livestock.” https://www.ndsu.edu/agriculture/extension/publications/nitrate-poisoning-livestock.

Water hemlock

This perennial plant generally is found in wet meadow and wetland ecological sites and along creek bottoms. Water hemlock is probably the most poisonous plant that grows in the U.S. The toxic substance is cicutoxin, a highly poisonous unsaturated alcohol. The most toxic part of the plant is the root, followed by young growth.

Affected livestock: all animals and humans

Symptoms of poisoning:

- muscle twitching
- rapid pulse
- rapid breathing
- tremors
- convulsions
- dilation of pupils
- excessive salivation
- frothing at the mouth
- coma

TIP: Roots are exposed by grazing livestock and/or haying equipment pulling plants from the ground.

TIP: Animals seldom eat water hemlock if good forage is available.

Monitoring

Very good reasons exist for monitoring. Monitoring helps you make decisions, provides trends so a manager can plan for the future, confirms good management practices, reveals potential problems early and teaches about relationships in nature. **We need to monitor to help us make better decisions in managing our natural resources for the future.**

At the most basic level, monitoring is just watching what is happening and then adjusting your management to assure you meet your goals. The only problem is, you have to watch those things that will help you decide what your management has done, or will do, to your resources in meeting those goals.

Before you implement a monitoring program, you should set your goals and objectives. Your goals and objectives will help you determine the level of detail you need in your monitoring program.

Vegetation can be monitored using species composition, frequency, density, production, cover and various combinations, and to a lesser degree, structure. Each method provides unique types of information that can be used to describe a plant community, and each has different limitations.

Many techniques have been developed by various agencies and universities to help ranchers and land managers monitor their resources. Select a monitoring program that fits your objectives, resources, labor and time. For information on establishing a monitoring program for your ranch, including defining monitoring objectives, selecting monitoring techniques and interpreting results, see "Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems," Volume 1 and 2, available from the USDA-ARS Jornada Experimental Range. Copies can be downloaded at http://jornada.nmsu.edu/node/2895.

The following information was modified from "Wyoming Rangeland Monitoring Guide" (2001) to provide an option to monitor your natural resources.

TIP: Many people wonder whether monitoring the land is necessary when they already are monitoring livestock weights. Although tracking animal performance is definitely worthwhile, these records do not tell much about the health of the land. The principal reason is that a time lag exists between when the land deteriorates and when the degradation is reflected in animal performance. The land deteriorates first and may degrade appreciably before the animals show any effect. This is because the animals initially can compensate by feeding on less preferred forage plants and by using energy and nutrients stored in their bodies. By the time animal performance declines, the land may have been degraded to the point where it will require decades to recover.

Permanent Photo-point Transect

Repeated photographs taken at permanent locations are an effective and efficient method for long-term monitoring. When using this method, you must: 1) use similar techniques, 2) identify the date and location in the picture, 3) take the picture during the same stage of plant growth, 4) include the same skyline in the landscape picture and 5) carefully relocate the photo points each time. Maintaining consistency in camera type (lens size), film, timing and associated documentation also is important.

Repeated landscape-scale photographs can provide basic documentation of range trends. Landscape photos should be taken from the same designated point at approximately the same time of year. Photographs that include a distinctive landmark in the background or on the horizon are easier to relocate. Locating previously established photo points is very difficult without a portion of the horizon in the photograph. Previous photographs (or photocopies) also can be helpful in "framing" the photo consistently from year to year.

Equipment:

- Baseline Information Form and Photo Point Transect form
- Two carpenter rulers, two transect stakes, 100-foot tape
- Camera and Photo Information Sheet

Procedure:

- Establish a 100-foot-long transect and install a permanent stake at either end.
- Complete the Baseline Information Form for the site.
- From behind the stake at the start of the transect, take a landscape photograph looking down the transect towards a re-locatable bearing point.
- Using the two carpenter rulers, create a 3-foot by 3-foot-square frame and lay it over the tape so it intersects at the 5-foot and 8-foot marks. Standing over the tape, take a photograph looking down at the framed section with the 5-foot mark in the foreground and the 8-foot mark in the background.
- Repeat the previous process (using the frame) at the 50-foot to 53-foot mark and the 92-foot to 95-foot mark.
- At the 100 foot end of the transect, take a photograph looking back down the transect to the 0 foot mark.
- Use the **Photo Information Sheet** in all photographs if possible. **You will have a total of five photos per transect.**

Notes:

- A single photograph from a permanently marked site (fence post, rock, etc.) of a stream crossing, gully, head cut or other impacted site can be very effective in demonstrating resource recovery or the need to modify current management.
- Finding the location of an old photograph (scenery, fishing trip with a stream in the background, etc.) and retaking it can provide good information on past use and trends of a site.

(Reference: All references cited in the introduction describe permanent photo methods similarly.)

Monitoring Trends with Photos

Equipment:

- Digital camera or 35 mm with color print film (exposure index of 100)
- 3 by 3-foot frame – 2 carpenter rulers or PVC pipe

Things to remember:

- Take photos of the plot and the general view.
- If retaking photos, be sure to match the plot frame size used previously.
- Permanently mark at least three corners of the plot frame location with stakes. Paint steel stakes a bright color, such as orange.
- If the photo plot is difficult to locate, use a witness post. Make sure the photo plot is at least 20 feet away from the post. For all photo points, consistently document the photo plot location with respect to the witness post.
- Include the Photo Information Sheet in the photo. Colored paper works best because white is too bright.
- Usually take the photo from the north side of the plot to avoid casting a shadow into the photo.
- Include at least three photo plots per pasture.
- Photos should be repeated at the same location and time of year.

TIP: **The oldest photo you ever will have is the one you take today. Start taking pictures!!!**

Permanent Photo-Point Transect

Transect ID _____

Date _____

Observer _____

Allotment Name _____

Pasture Name _____

Grazing System _____

Period of Use _____ to _____

Transect/Point Location _____

_____

Direction Photo is Looking Toward _____

Photo Subjects _____

_____

Purpose of Photo _____

_____

_____

Sample photo information sheet

Unit Name:	Lake Creek
Pasture Name:	Baldy
Study Site:	#1 – Billy Creek
Observer:	R. Jones
Date:	06/20/2001

Drought Strategies

Drought Management

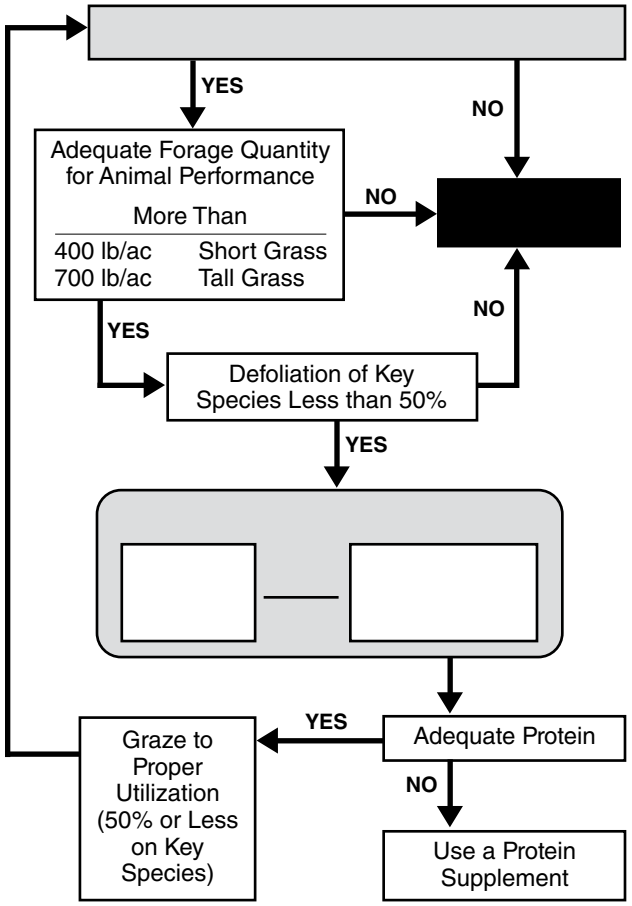
Drought is a constant and normal part of the rangeland environment. It is not a question of whether drought will occur, but when and how severe. In the northern Great Plains, ranchers are always in some phase of drought management. Ranchers who understand the need to prepare for, endure and recover rapidly from drought will survive the guaranteed but unpredictable drought cycles.

No special prescription exists for drought management. **Good range management is good drought management.** This embodies utilizing a good prescribed grazing system, proper livestock distribution, season of use and stocking rate, as well as kind and class of livestock. Of these, stocking rate is the most important. **No tricks can compensate for overgrazing.**

A basic understanding of the potential capabilities and limitations of all ranch resources is fundamental to sound management. High levels of plant vigor and range condition are critical for the endurance of and rapid recovery from drought. Knowing which practices optimize livestock performance and minimize risk of financial loss is equally important. Drought considerations must be incorporated into each year's management plan.

The flow chart on the right demonstrates a sequence of decision-making processes for management of drought-stricken rangeland.

Flow chart demonstrating a sequence of decision-making processes for the management of drought-stricken rangeland



Source: "Drought Management on Range and Pastureland: A Handbook for Nebraska and South Dakota Nebraska Cooperative Extension"

Management Preparation for Drought

Drought will challenge the mental toughness of even the best managers. Diverse practices can be used to maintain ownership of cows under drought conditions. Some ranches will liquidate or relocate part or all of their breeding stock. The value of keeping breeding herds on the ranch must be weighed against the additional costs that probably are incurred when drought continues.

Recovery of additional production costs will depend upon: (1) productivity of livestock, (2) productivity of rangelands and (3) livestock market prices during and following drought. Several additional questions will help you determine how much risk you can afford to accept:

- What are your family and ranch goals?
- What are your short- and long-term family needs?
- What is your current financial position, including financial assets and obligations?
- How secure is your relationship with the banker?
- Are you prepared to accept the additional stress of added risk?
- How soon must losses incurred during and following drought be recovered?
- Would you rather risk the loss of the ranch and/or breeding stock herd than sell out?

Desperation caused by financial problems can lead to the use of excessive stocking rates that reduce animal performance and cause dramatic reductions in plant vigor. Overgrazed land is also worth less to future buyers or renters. If serious financial problems exist before drought, the best option may be to sell before remaining equity is lost or additional debt is incurred.

Even when range livestock operations are solvent liquidating or relocating part of or the entire breeding herd may be prudent to avoid additional production costs or damaging rangeland. Under severe or prolonged drought conditions, the cost of replacement livestock is almost always less that the cost of long-term reductions in rangeland productivity. Furthermore, acting early likely will be more beneficial at the sale barn, compared with waiting until everyone else is selling cattle after most of the grass is gone.

Herd Management

The best alternative for drought management is to reduce total forage requirements. Reducing stocking rates during drought pays dividends in terms of:

- Optimized animal performance
- Reduced supplemental and winter feeding costs
- Minimized damage to forage resources
- Enhanced range and pasture recovery following drought

Sell or relocate livestock as soon as shortages in forage and feed resources are anticipated because market value tends to be highest at the beginning of a regional drought. If additional shortages in forage occur, calculate the additional costs associated with keeping cows on the ranch (feed, interest, labor, etc.) or transporting the cows to another location with adequate feed or forage. If your calculations show an unreasonably high cost of producing a weaned calf, selling or relocating part of or the entire cow herd may be prudent. The following practices can help minimize liquidation of the breeding herd:

- Wean early to extend the forage base.
- Practice early and heavy culling of less productive cows, such as late-calving cows and older cattle.
- Remove yearlings from summer pastures early.
- Consider curtailing the production of replacement heifers for one year.
- Supplement bulls earlier than other classes of livestock if necessary so they are in acceptable condition when the breeding season begins.
- Maintain a percentage of the livestock, such as yearlings or stockers, as a readily marketable class of stock.

Past and Future Stocking Rates

Grazing management during years preceding drought is a major factor in range vegetation response to drought. Managers may have assumed that no change in stocking rate has occurred on their ranches because they have not increased livestock numbers.

The amount of forage consumed in a pasture depends upon animal size as well as animal numbers and days of grazing. The average size of cows, calves and yearlings has increased on many ranches during the past 10

years. A 10 to 40 percent increase in average animal weight should be equated to a 7 to 28 percent increase in stocking rate based on metabolic body weight.

Inadvertent increases in stocking rates may lead to overgrazing and reduced plant vigor before drought. All range livestock producers need to evaluate their animal weights critically and use an appropriate animal unit (AU) equivalent when calculating stocking rates. Inadvertent overstocking may reduce animal performance and will damage the forage resource.

See Stocking Rate and Carrying Capacity section, for more information on determining proper stocking rates and animal unit equivalents.

Drought Management Plan

A drought plan should minimize financial hardships and hasten vegetation recovery after drought. Plans identify action to be taken at the first sign of drought, as well as with continued indications of pending forage shortages. Plans for stocking rate adjustments need to be specific in terms of method and date. The timing of actions should be based upon seasonal checkpoints.

TIP: The Drought Calculator is a tool developed by the USDA-ARS to assist ranchers and other rangeland managers assess the impacts of drought on forage production. This tool utilizes local precipitation data (downloaded from the closest weather station or entered by the rancher/manager from local records) to establish an average long-term precipitation baseline against which it compares current precipitation to estimate the impact of below-normal precipitation on forage production.

The North Dakota version of the Drought Calculator is available at http://nrrc.ars.usda.gov/DCND/.

Critical evaluation dates at which livestock requirements are balanced with available forage and feed resources are:

April 15–30

- Determine the average depth of moist soil and estimate probable stocking rates.
- Assess the growth of introduced cool-season pastures.
- Evaluate stand quality and probable forage production of winter and spring cereal.

May 1–31

- Determine if yield of native cool-season species on rangeland is above or below average.
- Monitor green-up of native warm-season species on rangeland.
- Alternative forages, stocking rate reductions and/or modifications of grazing strategies may be needed if a delay occurs in plant growth.

TIP: Estimate probable stocking rates and alternative (annual) forages based upon April through May precipitation to compensate for forage production shortfalls on pasture and rangeland.

TIP: See Grazing Management section, for average recommended leaf heights for grazing readiness.

June 1–30

- Assess the establishment and stand quality of summer annual forages and soil moisture conditions.

TIP: Most plant growth in North Dakota and Minnesota occurs in June. If drought conditions have occurred in May and continue into June, forage production will be reduced dramatically for the season regardless of the amount of moisture received after June 30. Serious consideration should be given to stocking rate reductions and herd management as discussed in the "Herd Management" section.

July 1–30

- Determine if the yield of native warm-season species on rangeland is above or below average.
- Assess the establishment and stand quality of late-planted summer annual forages and soil moisture conditions.

Aug. 1–30

- Estimate or measure the yield of summer annuals harvested for feed or grown for late-season grazing.

TIP: The diet quality of annual forages declines dramatically after the soft-dough stage. If maximum tonnage is the objective, then harvesting after the soft-dough stage may be desirable. If high forage quality is the objective, harvest at the late-boot to soft-dough stage.

Sept. 1–30

- Assess current year and carryover winter feed inventories. Purchase hay resources as needed.
- Make a final assessment of the yield of annual forages grown for late-season grazing.
- Inventory other harvested feed and determine the quantity of crop residue on cropland.
- Estimate the amount of forage in winter pastures.

Oct. 1–30

- Use September through October precipitation to predict stocking rates for the next summer.

TIP: Exercise caution. The color green can have profound psychological effects on range livestock producers. Even a small amount of spring or fall green-up can cause a false sense of security and delay of prudent management decisions. Premature, aggressive restocking can cause serious economic loss because of long-term reductions in the rate of vegetation recovery. If vegetation recovery is slow or restricted by continued drought, a destocking plan will be needed.

TIP: A plan of action should be developed for best- and worst-case scenarios. If drought breaks early the following year, a gradual restocking plan may be appropriate.

The majority of the information in this section was obtained from "Drought Management on Range and Pastureland: A Handbook for Nebraska and South Dakota," Nebraska Cooperative Extension EC91-123. Modifications were made to adjust guidelines for North Dakota and Minnesota.

Technical Assistance

On-site technical assistance may be available from the following agencies:

NDSU Extension
www.ndsu.edu/extension/

Natural Resources Conservation Service
North Dakota: www.nrcs.usda.gov/wps/portal/nrcs/site/nd/home/
South Dakota: www.nrcs.usda.gov/wps/portal/nrcs/site/sd/home/
Minnesota: www.nrcs.usda.gov/wps/portal/nrcs/site/mn/home/

U.S. Fish and Wildlife Service – Private Lands Coordinator
www.fws.gov/offices/Directory/OfficeDetail.cfm?OrgCode=62830

N.D. Department of Trust Lands
www.land.nd.gov/

U.S. Forest Service (National Grasslands)
www.fs.usda.gov/dpg/

North Dakota Forest Service
www.ndsu.edu/ndfs/

U.S. Department of Agriculture –
North Dakota Agricultural Experiment Station
www.ag.ndsu.edu/research/

For more information on this and other topics, see www.ndsu.edu/extension

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2.5M-10-14, 500-6-22