Rancher’s Guide to Grassland Management

Kevin K. Sedivec
Jeffrey L. Printz

North Dakota State University
Fargo, North Dakota 58105

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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 hayland management. References for other sources of information are provided should the reader wish to research the topic in greater depth. See tabs for desired section for guidelines, tips and notes on grassland management.

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

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

**Acclimatized Species:** An introduced species which 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 1000 pounds, either dry or with calf up to six 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-pound forage allowance. 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. 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 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 located on the lower stem, roots, or rhizomes by hormones produced by apical meristems located 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 arid or semiarid regions. A miscellaneous land type.

**Bentonite:** A natural clay deposit which 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 unit 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 within an area or region.

Biotic: Refers to living components of an ecosystem, e.g., 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 boils.

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. Such fences withstand heavy snows in mountainous regions, and eliminate the need for digging holes for posts in rocky terrain. Also called buck-pole fence.

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

**Burn:** An area over which fire has recently passed.

**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 which 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 sub-divisions (paddocks or pastures) often formed by electrical fencing, with a central component to facilitate livestock management and movement to the various sub-divisions. 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. Example, cow, calf, yearling, ewe, doe, fawn, etc.

**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 which 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 State 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 a 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:** An 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, since seasonal grazing may be involved.

**Cool-Season Plant:** A plant which generally makes the major portion of its growth during the late fall, winter, and early spring. Cool-season species generally exhibit the C3 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 USA.

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 which is genetically retained through subsequent generations.

Cured Forage: Forage, either standing or harvested, that has been naturally or artificially dried and preserved 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, i.e. 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, e.g. 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 which provides for a systematic rotation of the deferment among pastures.

Defoliation: The removal of plant leaves, i.e. 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 either to a single species or to the vegetation as a whole. Syn. use.

Density: (1) 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 which contribute positively to the management objectives.
**Desired Plant Community:** A plant community which 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(s). 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 where vegetation and soils have significantly departed 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 within 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 which, 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, which may occasionally 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' apart.

**Drip Torch:** Portable equipment for applying flammable liquids giving a residual flame upon ignition; primarily used in prescribed burning.
**Drouth (Drought):** (1) A prolonged chronic shortage of water, as compared to 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, mid-seral, late seral, potential natural community) of vegetation corresponding to 0-25%, 26-50%, 51-75% and 76-100% 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 which is more specific than a phase of a habitat type. Ecological types are commonly used to differentiate habitat phases into categories of land which 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 which 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, including 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 which is 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, over a given area with time.

Exclosure: An area fenced to exclude animals.

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

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


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 which 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 within a designated period of time on a given area. The weight may be expressed as either green, air-dry, or oven-dry. The term may also 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 which provides for the entry, storage, manipulation, retrieval, and display of spatially oriented data.

**Graminoid**: Grass or grass-like 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% of the canopy cover excluding trees. Lands not presently grassland that were originally 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 which vegetatively resembles a true grass of the *Gramineae* family.
Gravel, Cobble, Stones: As defined in Soil Taxonomy (Soil Conservation Service 1975): Gravel (2 mm-3 inches), cobble (3-10 inches), stones (over 10 inches). (Note: For standard range inventory procedures it is recommended that gravel smaller than 5 mm in diameter 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 which 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, over 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, i.e., AU/T.

Grazing Pressure Index: An animal to forage relationship measured in terms of animal units per unit weight of forage over a period of time, i.e., 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 which 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; 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, which 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 potion 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 which 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 perennial plant with a woody base whose annually produced stems 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 which indicates 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 which 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 are often overutilitized 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, e.g., 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 connotes 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, e.g., 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, which must, because of their impotence, be considered in the management program.
Kind of Animal: An animal species or species group such as sheep, cattle, goats, deer, horses, elk, antelope, and etc. 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 over extended time periods that are deemed to best serve the general welfare. Decision-making authorities on land uses are usually 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 which indicates that the stocking rate of one pasture is relatively less than that of other pastures. Often erroneously used to mean under use. cf. heavy and moderate grazing.

Lime: (1) Calcium oxide. (2) All limestone-derived materials applied to neutralize acid soils.

Limiting Factor: Any environmental factor which 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 includes 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 which are 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 which indicates 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, i.e., 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 which 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 but which adapted to that area and has established a stable or expanding population. Does not require artificial inputs for survival and reproduction. Examples: cheatgrass, Kentucky bluegrass, starling, etc.

**Nonuse:** (1) Absence of grazing use on current year's forage production. (2) Lack of exercise, temporarily, 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 to insure 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 is usually prefixed by *high, low or moderate.*
**Open Range:** (1) Range which has not been fenced into management units. (2) All suitable rangeland of an area upon which grazing is permitted. (3) Untimbered 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 which 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, i.e. a 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) which has been removed. cf. *degree of use.*

**Perennial Plant:** A plant that has a life span of 3 or more years.

**Pesticide:** Any chemical agent such as herbicide, fungicide, insecticide, etc., 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 cause sickness, death or a deviation from the normal state of health of animals.

**Prairie:** An extensive tract of level or rolling land that was originally 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 which animals 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 modem 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.*

**P.L.S.:** Abbreviation for pure live seed.

**Pure Live Seed:** Purity and germination of seed expressed in percent; may be calculated by formula: $P.L.S. = \frac{\% \text{ germination} \times \% \text{ purity}}{100}$; e.g. $91 \times 96/100 = 87.36\%$. Abbr., PLS or P.L.S. 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 both 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 either 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, e.g., good condition spring cattle range. (2) Some agencies consider range condition class in the context of Range Condition (b) above as follows:

<table>
<thead>
<tr>
<th>Range Condition Class</th>
<th>% of climax for the range site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>76-100</td>
</tr>
<tr>
<td>Good</td>
<td>51-75</td>
</tr>
<tr>
<td>Fair</td>
<td>26-50</td>
</tr>
<tr>
<td>Poor</td>
<td>0-25</td>
</tr>
</tbody>
</table>

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, i.e., 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 which 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, grass-like 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 of an object or phenomenon by a recording device that is not a 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; i.e., 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 within the riparian zone. Obligate species require the environmental conditions within 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 more moist 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 where 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 either 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, hooved mammals that chew the cud and have a 4-chamber stomach., i.e. *Ruminantia*.

**Runoff:** The total stream discharge of water, including both 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.

**Season Long Grazing:** See Continuous Grazing.

**Seasonal Grazing:** Grazing restricted to a specific season.

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

**Secondary Range:** Range which is lightly used or unused by livestock under minimal management and will ordinarily 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 to insure seed of high quality and genetic purity.
**Seed, Dormant:** Live seed in a non-germinative condition because of (1) internal inhibitions in the seed, i.e., 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 micro-environment.

**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 non-grazing are applied to range or pasture units. Periods of grazing and non-grazing 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.

**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 which grows so as to form a mat of soil and vegetation. Syn. *turf*.

**Sod Grasses:** Stoloniferous or rhizomatous grasses which 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 over 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 aboveground and belowground portions and further may be modified by the descriptors ‘dead,’ ‘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 (e.g., cattle and sheep), stocking rate is often 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.

**Stockwater Development:** Development of a new or improved source of stockwater supply, such as well, spring, pond, together with storage and delivery system.

**Stolon:** A horizontal stem which 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 either artificially or by gazing animals.
Submarginal Land: Land that is either physically or economically incapable of indefinitely sustaining a certain use.

Succession: The progressive replacement of plant communities on a site which leads to the potential natural plant community: i.e., 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 which 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 both rangeland and forest land with a grazable understory which are 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: (surface active agent). 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 wetland.
**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 (*Quercus* spp.) may grow as either 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 there is no recognizable change. This category is often recorded as static or stable. There is no necessary correlation between trends in resource value ratings, vegetation management status, and trend in 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, which 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 which 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 (e.g., “unsuitable cattle range”).

**Use**: (1) The proportion of current years forage production that is consumed or destroyed by grazing animals. May refer either 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 which 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 C4 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 are usually saturated or ponded, i.e., 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 is generally 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 contain 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.
Range (Ecological) Sites

Author’s note: The Natural Resources Conservation Service (NRCS) is presently updating its range site descriptions. The new site descriptions will be called Ecological Site Descriptions (ESD) and will contain more extensive plant community and related data.

An ecological (range) 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 a range site will vary within an area due to soil type differences and landscape position (Figure 1).

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

**Tip: Actual stocking rates for these sites will vary from ranch to ranch depending on actual site condition.**

### Overflow

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

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

*Recommended stocking rate:* 0.9 AUMs/acre (western North Dakota) – 1.4 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: western wheatgrass, nuttall alkaligrass, slender wheatgrass, inland saltgrass, foxtail barley, silverweed cinquefoil, pursh seepweed, curly dock.

Recommended stocking rate: 0.9 AUMs/acre (western North Dakota) – 1.2 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: needle-and-thread, prairie sandreed, sand dropseed, blue grama, upland sedges, western wheatgrass, purple prairieclover, green sagewort, Missouri goldenrod, fringed sagewort, prairie rose.

Recommended stocking rate: 0.7 AUMs/acre (western North Dakota) – 1.2 AUMs/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: needle-and-thread, prairie sandreed, green needlegrass, western wheatgrass, blue grama, upland sedges, western wheatgrass, western ragweed, green sagewort, Missouri goldenrod, fringed sagewort, prairie coneflower, heath aster, lead plant, prairie rose.

Recommended stocking rate: 0.7 AUMs/acre (western North Dakota) – 1.1 AUMs/acre (eastern North Dakota, western Minnesota).
**Shallow-to-gravel**

*Location:* On medium to moderately coarse textured soils overlying sand and gravel on nearly level to gently sloping uplands and stream terraces.

*Major plant species:* needle-and-thread, western wheatgrass, blue grama, prairie junegrass, upland sedges, rush skeletonweed, dotted gayfeather, black samson, fringed sagewort, prairie rose.

*Recommended stocking rate:* 0.5 AUMs/acre (western North Dakota) – 0.7 AUMs/acre (eastern North Dakota, western Minnesota).

**Silty**

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

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

*Recommended stocking rate:* 0.7 AUMs/acre (western North Dakota) – 1.1 AUMs/acre (eastern North Dakota, western Minnesota).
**Thin upland**

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

*Major plant species:* 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.

*Recommended stocking rate:* 0.7 AUMs/acre (western North Dakota) – 1.0 AUMs/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:* prairie cordgrass, northern reedgrass, switchgrass, fowl bluegrass, lowland sedges, baltic rush, common wild mint, tall white aster, curly dock.

*Recommended stocking rate:* 1.6 AUMs/acre (western North Dakota) – 1.8 AUMs/acre (eastern North Dakota, western Minnesota).
**Wet Land**

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

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

*Recommended stocking rate:* 2.0 AUMs/acre (western North Dakota) – 2.6 AUMs/acre (eastern North Dakota, western Minnesota).
Forage Suitability Groups

A forage suitability group is a grouping 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.

Tip: Other native and introduced legumes are available for use. Examples would include cicer milkvetch, sainfoin, birdsfoot trefoil, red clover, and purple prairie clover.
Loamy and silty soils (A1): deep, mostly well and moderately well drained, medium textured soils on uplands.

<table>
<thead>
<tr>
<th>Western North Dakota</th>
<th>Eastern North Dakota/Western Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduced:</strong></td>
<td></td>
</tr>
<tr>
<td>Altai wildrye</td>
<td>Altai wildrye</td>
</tr>
<tr>
<td>Crested wheatgrass</td>
<td>Intermediate wheatgrass</td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td>Pubescent wheatgrass</td>
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<td>Pubescent wheatgrass</td>
<td>Meadow bromegrass</td>
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<tr>
<td>Meadow bromegrass</td>
<td>Russian wildrye</td>
</tr>
<tr>
<td>Russian wildrye</td>
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</tr>
<tr>
<td></td>
<td>Western wheatgrass</td>
</tr>
<tr>
<td><strong>Legumes:</strong></td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>Alfalfa</td>
</tr>
<tr>
<td>Sweetclover</td>
<td>Sweetclover</td>
</tr>
</tbody>
</table>
Thin upland soils (A2):
deep, well and excessively drained, medium textured soils occurring on ridges and knobs and subject to runoff.

<table>
<thead>
<tr>
<th>Western North Dakota</th>
<th>Eastern North Dakota/Western Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduced:</strong></td>
<td></td>
</tr>
<tr>
<td>Crested wheatgrass</td>
<td>Intermediate wheatgrass</td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td>Pubescent wheatgrass</td>
</tr>
<tr>
<td><strong>Native:</strong></td>
<td></td>
</tr>
<tr>
<td>Little bluestem</td>
<td>Little bluestem</td>
</tr>
<tr>
<td>Prairie sandreed</td>
<td>Prairie sandreed</td>
</tr>
<tr>
<td>Sideoats grama</td>
<td>Sideoats grama</td>
</tr>
<tr>
<td><strong>Legumes:</strong></td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>Alfalfa</td>
</tr>
<tr>
<td>Sweetclover</td>
<td>Sweetclover</td>
</tr>
</tbody>
</table>
**Sandy soils (A6):**
deep, well and moderately well drained, moderately coarse textured soils on uplands and floodplains.

<table>
<thead>
<tr>
<th>Western North Dakota</th>
<th>Eastern North Dakota/ Western Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduced:</strong></td>
<td></td>
</tr>
<tr>
<td>Crested wheatgrass</td>
<td>Intermediate wheatgrass</td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td>Pubescent wheatgrass</td>
</tr>
<tr>
<td></td>
<td>Smooth bromegrass</td>
</tr>
<tr>
<td><strong>Native:</strong></td>
<td></td>
</tr>
<tr>
<td>Prairie sandreed</td>
<td>Prairie sandreed</td>
</tr>
<tr>
<td>Sand bluestem</td>
<td>Sand bluestem</td>
</tr>
<tr>
<td></td>
<td>Slender wheatgrass</td>
</tr>
<tr>
<td></td>
<td>Switchgrass</td>
</tr>
<tr>
<td><strong>Legumes:</strong></td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>Alfalfa</td>
</tr>
<tr>
<td>Sweetclover</td>
<td>Sweetclover</td>
</tr>
</tbody>
</table>
Shallow to gravel soils (B1):
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
- Pubescent wheatgrass
- Crested wheatgrass
- Intermediate wheatgrass
- Pubescent wheatgrass

**Native:**
- Little bluestem
- Slender wheatgrass
- Western wheatgrass
- Little bluestem
- Slender wheatgrass
- Western wheatgrass

**Legumes:**
- Alfalfa
- Sweetclover
- Alfalfa
- Sweetclover
**Saline soils (G4):**
deep, somewhat poorly and poorly drained, coarse to fine-textured saline soils.

<table>
<thead>
<tr>
<th>Western North Dakota</th>
<th>Eastern North Dakota/Western Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduced:</strong></td>
<td></td>
</tr>
<tr>
<td>Altai wildrye</td>
<td>Altai wildrye</td>
</tr>
<tr>
<td>Russian wildrye</td>
<td>Russian wildrye</td>
</tr>
<tr>
<td>Tall wheatgrass</td>
<td>Tall wheatgrass</td>
</tr>
<tr>
<td><strong>Native:</strong></td>
<td></td>
</tr>
<tr>
<td>Alkali sacaton</td>
<td>Alkali sacaton</td>
</tr>
<tr>
<td>Beardless wildrye</td>
<td>Beardless wildrye</td>
</tr>
<tr>
<td>Western wheatgrass</td>
<td>Western wheatgrass</td>
</tr>
<tr>
<td><strong>Legumes:</strong></td>
<td></td>
</tr>
<tr>
<td>Alsike clover</td>
<td>Alsike clover</td>
</tr>
<tr>
<td>Sweetclover</td>
<td>Sweetclover</td>
</tr>
</tbody>
</table>
**Wet soils (C1):**
depth, poorly drained, coarse to fine-textured soils on floodplains or low areas on till and lake plains.

<table>
<thead>
<tr>
<th>Western North Dakota</th>
<th>Eastern North Dakota/ Western Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduced:</strong></td>
<td></td>
</tr>
<tr>
<td>Creeping foxtail</td>
<td>Creeping foxtail</td>
</tr>
<tr>
<td>Meadow foxtail</td>
<td></td>
</tr>
<tr>
<td><strong>Native:</strong></td>
<td></td>
</tr>
<tr>
<td>Big bluestem</td>
<td>Big bluestem</td>
</tr>
<tr>
<td>Reed canarygrass</td>
<td>Reed canarygrass</td>
</tr>
<tr>
<td>Slender wheatgrass</td>
<td>Slender wheatgrass</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>Switchgrass</td>
</tr>
<tr>
<td><strong>Legumes:</strong></td>
<td></td>
</tr>
<tr>
<td>Alsike clover</td>
<td>Alsike clover</td>
</tr>
</tbody>
</table>
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 found on, forage value, and their response to grazing.
**Big bluestem**
A warm-season, perennial, tall-stature, sod-forming grass found on moist soils and ecological sites. Potentially abundant on 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**

A warm-season, perennial, short-stature bunch-grass found on drier upland sites including sandy, gravelly, silty, clayey, and claypan soils. This grass increases with overgrazing, frequently replacing more productive mid and tall grass species, 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.
**Foxtail barley**

A cool-season, perennial, mid-stature bunch-grass 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, it becomes difficult to return these sites to their original status. Foxtail barley provides fair forage for cattle, horses, and sheep when young but becomes unpalatable when mature.
Green needlegrass
A cool-season, perennial, mid-stature bunch-grass found on medium and fine textured soils. This species grows best on sandy to loamy soils but is also 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.
Little bluestem
A warm-season, perennial, mid-stature bunch-grass found dry ridges, hillsides, and sand hill areas; often associated with calcareous soils. The grass decreases with overgrazing, frequently being replaced by short grass, such as bluegrama, 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 becomes wolfy and has a classic red tinge color in late summer.
Needle-and-thread
A cool-season, perennial, mid-stature bunch-grass found on sandy and course textured soils. This grass initially increases with grazing pressure, eventually decreasing with overgrazing, 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.
Prairie cordgrass
A warm-season, perennial, tall-stature, sod-forming grass found on moist soils and ecological sites. Potentially 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 sandreed**

A warm-season, perennial, tall-stature, sod-forming grass found on sand, sandy, and coarse textured soils. Often 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.
Reed canarygrass
A cool-season, strongly rhizomatous perennial that is tall-stature. It is most commonly 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.
Sideoats grama
A warm-season, perennial, mid-stature sod-forming grass found on fine textured soils and weakly developed soils of steeper slopes, often associated with calcareous soils. May also occur on subirrigated and 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.
**Switchgrass**

A warm-season, perennial, tall-stature sod-forming grass found on moist lowland prairies, including 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 mid summer, nutrient quality and palatability decline dramatically.
Western wheatgrass
A cool-season, perennial, mid-stature, sod-forming grass found on a wide variety of soils and sites, often associated with loamy and clayey ecologically sites. It also possesses a high tolerance to saline and alkaline soils. This grass decreases when exposed to long-term over-use but may increase with short-term overuse. Western wheatgrass is regarded as very palatable, nutritious, and digestible to all classes of livestock. Western wheatgrass is North Dakota’s state grass.
**Upland sedges** (needleleaf, threadleaf, sun sedge)
Cool-season, perennial, short-stature, grass-like plants found on dry prairies, rocky hilltops, and sandy to fine-textured soils. These grass-like plants increase with overgrazing, replacing many mid grasses. Upland sedges are good forage for all classes of livestock in early spring, becoming less palatable once mature.
Forbs
Broad-leaf herbaceous plants other than those in the grass, grass-like, or shrub families. Forbs provide the greatest diversity of plant species on the prairie, occurring on a wide range of soils and ecological sites. Some forbs, such as fringed sagewort, green sagewort, and curly-cup gumweed, increase with overgrazing; most native legumes such as purple prairie clover decrease with poor grazing management.
**Shrubs**
A plant that has persistent woody stems and relatively low growth habit. Common shrubs would include western snowberry (buckbrush), lead plant, prairie rose, sage brush, and some willow species. Most shrubs tend to increase with lack of grazing and fire.
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.
**Altai wildrye**
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). Recommended as a single species stand for grazing.
Crested wheatgrass
A cool-season, perennial bunchgrass 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-mid June); however, it can and has become a nuisance invading plant on native rangeland. Recommended as a single species stand for grazing and hayland or mixed with alfalfa for hay production.
Intermediate/Pubescent wheatgrass

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.
Kentucky bluegrass
A cool-season, perennial, mid-stature sod-forming grass found on moist, well drained soils. Often associated with overflow, loamy, 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 declines rapidly with maturity. Regrowth in the fall provides good quality feed with favorable growing conditions occur. Many ranchers refer to Kentucky bluegrass as junegrass.
Meadow bromegrass
A cool-season, perennial bunchgrass found on fine to moderately fine texture soils. It is generally not recommended in 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). Recommended alone or in combination with other introduced grasses or legumes for grazing and hay production.
Russian wildrye
A cool-season, perennial bunchgrass adapted for fine to moderately textured soils (silty and clayey). This grass is a special purpose grass used to extend the grazing season into late summer and fall (October–December). Recommended as a single species stand for grazing.
**Smooth bromegrass**
A cool-season, perennial sod-forming grass found on fine to moderately fine texture soils. In western North Dakota it is often 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. Recommended alone or in combination with other introduced grasses or legumes for grazing and hay production.
**Tall wheatgrass**

A coarse, cool-season, perennial bunch-grass 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 is not generally recommended for pasture. However, it may provide adequate hay if harvested prior to seedhead development.
Alfalfa
An introduced, cool-season perennial legume adapted to a wide variety of soil textures. Alfalfa’s primary use is for hay production but it is also 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.
**Sweetclover**
An introduced, cool-season biennial legume adapted to a wide variety of soil textures and sites. Sweet clover is primarily 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 not an efficient user of water, often depleting moisture and creating a drought-like affect.
Range Condition

Range condition is the present state of vegetation of an ecological site in relation to the potential natural plant community for the site based on kind, proportion, and amounts of plants present; suggests current productivity relative to natural productivity potential. Range condition is a reflection of past land use and environmental conditions. In the past, range condition has been expressed in terms of “Poor,” “Fair,” “Good,” or “Excellent.” The term “similarity index” will be used in the future to indicate how similar the present plant community is to the potential plant community for a particular site.

Tip: Long-term heavy grazing by domestic livestock or native ungulates tends to reduce range condition 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 non-use results in lower plant vigor and less plant diversity, often creating opportunities for invasive exotic plant species (i.e., smooth bromegrass, Kentucky bluegrass, and crested wheatgrass). Less plant diversity resulting from this invasion may reduce forage quality and production.
Example: a loamy ecological site in Burleigh County, North Dakota.

Both photos show a loamy (silty) ecological site in central North Dakota. Neither site had been grazed prior to being photographed.

The loamy site on the top was rated at 65 to 75 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. A
good diversity of forbs, including several species of native legumes. Also present are shrubs such as lead plant and western snowberry (buckbrush).

Total annual production for this site was estimated at 2900 lbs/ac air dry weight. Of this total production, about 70 percent (approximately 2000 lbs) was produced by grasses and sedges while the remaining 30 percent was produced by forbs and shrubs.

The loamy site on the bottom was rated at 35 to 45 percent of the site potential. This site is dominated by shorter-statured grasses and forbs. The main grass species include blue grama, needle-and-thread and upland sedges. Fringed and green sagewort were the dominant forbs with few native legumes present in the plant community.

Total annual production for this site was estimated at 2300 lbs/ac air dry weight. Of this 2300 lbs/ac, about half was grasses or sedges while the remainder was produced by forbs.
Grazing Management

The manipulation of grazing animals to accomplish desired results when considering of 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 3 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 brome-grass, tall wheatgrass
12 inches: switchgrass

Approximate Date
(range readiness should primarily be determined by leaf stage and height, calendar dates should be used as a guide only):
April 20 - May 1: crested wheatgrass, sweetclover
May 1 - May 10: creeping foxtail, Kentucky bluegrass, reed canarygrass, Russian wildrye, slender wheatgrass, smooth brome-grass
May 10 - May 20: alfalfa, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, western wheatgrass
June 20 - June 30: blue grama, prairie sandreed, sideoats grama, switchgrass
After July 1: big bluestem, little bluestem, sand bluestem
<table>
<thead>
<tr>
<th>Species</th>
<th>Begin Grazing</th>
<th>End Grazing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum &amp; Optimum</td>
<td>Minimum Stubble Height Before Killing Frost in Inches</td>
</tr>
<tr>
<td></td>
<td>Height of Vegetative Growth in Inches</td>
<td>Approximate Date</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>6 – 10 May 15 3</td>
<td>3 8</td>
</tr>
<tr>
<td>Sweetclover</td>
<td>6 – 10 May 1 2</td>
<td>-</td>
</tr>
<tr>
<td>Big bluestem</td>
<td>8 – 14 July 1 6</td>
<td>6 6</td>
</tr>
<tr>
<td>Crested wheatgrass</td>
<td>4 – 6 April 20 3</td>
<td>4 4</td>
</tr>
<tr>
<td>Green needlegrass</td>
<td>6 – 8 May 15 3</td>
<td>3 5</td>
</tr>
<tr>
<td>Indiangrass</td>
<td>8 – 14 July 1 6</td>
<td>6 6</td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td>8 – 14 May 15 4</td>
<td>4 6</td>
</tr>
<tr>
<td>Kentucky bluegrass</td>
<td>4 – 6 May 7 2</td>
<td>4 4</td>
</tr>
<tr>
<td>Little bluestem</td>
<td>4 – 6 July 1 3</td>
<td>4 4</td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td>8 – 14 May 15 4</td>
<td>4 6</td>
</tr>
<tr>
<td>Prairie sandreed</td>
<td>8 – 14 June 20 4</td>
<td>4 6</td>
</tr>
<tr>
<td>Reed canarygrass</td>
<td>8 – 8 May 7 4</td>
<td>4 6</td>
</tr>
<tr>
<td>Russian wildrye</td>
<td>4 – 4 May 7 3</td>
<td>4 4</td>
</tr>
<tr>
<td>Sideoats grama</td>
<td>4 – 6 June 20 2</td>
<td>4 4</td>
</tr>
<tr>
<td>Slender wheatgrass</td>
<td>6 – 12 May 7 3</td>
<td>3 6</td>
</tr>
<tr>
<td>Smooth bromegrass</td>
<td>8 – 14 May 7 4</td>
<td>4 6</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>12 – 20 June 20 8</td>
<td>8 10</td>
</tr>
<tr>
<td>Tall wheatgrass</td>
<td>8 – 14 May 7 4</td>
<td>4 6</td>
</tr>
<tr>
<td>Western wheatgrass</td>
<td>6 – 10 May 15 4</td>
<td>4 5</td>
</tr>
</tbody>
</table>

*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 for hay should generally 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 can usually begin three to seven days earlier.

1NRCS Field Office Technical Guide, April 1998
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 non-grazing periods. Rotational grazing is a management strategy that is HIGHLY RECOMMENDED.

**NOTE:** It is highly recommended that before implementing a rotational grazing system a resource inventory be completed 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.

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**Tip:** The number of pastures within 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 the length of time a pasture will be rested after grazing. Three pastures are probably 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 may actually 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 rest in western Minnesota and eastern North Dakota and 45 days of rest in western North Dakota under good growing conditions (fast growth). As plant growth slows, rest periods need to be extended to permit proper plant recovery after grazing. Rest periods of at least 45 days in western Minnesota and eastern North Dakota and 65 days in western North Dakota are probably required. Under drought conditions, longer rest periods may be needed to ensure grazed plants recover adequate leaf area prior to next grazing.

Monitoring plant growth and adjusting these rest periods during the grazing season to reflect actual growing conditions is recommended.
Tip: A proper rotation should consider impacts on both the plant and grazing animal. Grazing pastures once during the grazing season may reduce 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.

Tip: For native pastures (range-land), 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 proper grazing management and soil fertility are maintained. For example, a crested wheatgrass pasture would be grazed first in the spring each year.
3) **Degree of utilization:** the proportion of current year’s forage production that is consumed and/or destroyed by grazing animals. May refer to a single plant species or to 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 use (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 since green needlegrass is a more desirable forage species than upland sedges.

**Tip:** General rule of thumb would be proper utilization is moderate to full use, depending on plant species.
<table>
<thead>
<tr>
<th>Utilization Level</th>
<th>% Use $^1$</th>
<th>Description $^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>0 – 20</td>
<td>Appears practically undisturbed when viewed obliquely. Only choice areas and forage grazed.</td>
</tr>
<tr>
<td>Moderate</td>
<td>20 – 40</td>
<td>Most all of accessible range shows grazing. Little or no use of poor forage. Little evidence of trailing to grazing.</td>
</tr>
<tr>
<td>Full</td>
<td>40 – 60</td>
<td>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.</td>
</tr>
<tr>
<td>Close</td>
<td>60 – 80</td>
<td>All accessible range plainly shows use and major sections closely cropped. Livestock forced to use much poor forage considering seasonal preference.</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt; 80</td>
<td>Key forage species completely used. Low value forage carrying grazing load.</td>
</tr>
</tbody>
</table>

$^1$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% use by weight is not the same level as 50% use by height.

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

Figure 2. Percent weight of western wheatgrass utilized at different stubble heights¹
Figure 3. Percent weight of needle-and-thread utilized at different stubble heights
Figure 4. Percent weight of green needlegrass utilized at different stubble heights

1Montana State University. 1999.
Tip: 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.

Tip: No use, over an extended period of time, will be detrimental to plant vigor, plant diversity and overall rangeland health.

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 growth.
<table>
<thead>
<tr>
<th>Percent leaf removed</th>
<th>Percent of root growth stoppage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>30%</td>
<td>0%</td>
</tr>
<tr>
<td>40%</td>
<td>0%</td>
</tr>
<tr>
<td>50%</td>
<td>2 - 4%</td>
</tr>
<tr>
<td>60%</td>
<td>50%</td>
</tr>
<tr>
<td>70%</td>
<td>78%</td>
</tr>
<tr>
<td>80%</td>
<td>100%</td>
</tr>
<tr>
<td>90%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Tip: The more leaf area that is removed from a plant during each grazing event, the more time the grazed plant(s) will need to recover. Pastures within 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.
Figure 5. Plant regrowth rates depend on the amount of leaf removed at a grazing. 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: For monitoring degree of use information, see “Monitoring” section, Tab 19.
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 six months of age (see animal unit equivalent guide for proper conversions for other classes or kinds of grazing animals). Stocking rate is typically 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 is usually 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.

**Tip:** Stocking rate should equal carry capacity for proper resource management.
Methods to estimate carrying capacity:
Carrying capacity or estimating forage quantity can be estimated in several ways. Two common techniques used in the field include clip and weigh, and interpreting forage production based upon a range condition evaluation. Clip and weigh method requires actual harvesting of standing forage at a given time to predict available forage. A range condition evaluation estimates baseline species composition and requires interpretation to arrive at a recommended stocking rate using the NRCS guidelines for a specific range site and region.

Clip and Weigh: The most accurate method to assess the amount of forage in a pasture is to clip 5 to 15 samples of a 2 square foot area, 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 multiplied by 50 to calculate the weight in pounds per acre. It is important to clip several samples and to be sure these samples represent the variation within the pasture. 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, actual stocking rate will be calculated using a harvest efficiency multiplier. Harvest efficiency usually varies from 25 to 35% on native rangeland depending upon level of grazing management and 35
to 50% on tame pasture depending upon grazing management.

**Example:** If calculated herbage production is 2000 pounds per acre on native rangeland being managed using seasonlong grazing, available forage would be 500 pounds per acre (2000 lb./ac \( \times 0.25 = 500 \) lb./ac). The 500 lb./ac would then be divided by the forage consumed in pounds per month by kind or class of animal. See Animal Unit Equivalent Guide on page 106 for monthly forage intake amounts. For example, if grazing a 1000 pound cow with calf, forage consumption would be 790 pounds per month. Since available forage in our example is 500 pounds per acre, the stocking rate would be 0.63 Animal Unit Months per acre (500 lb./ac divided by 790 lb./month = 0.63 animal unit months/acre).

**Range Condition Analysis:** To estimate stocking rate based upon a range condition evaluation, consult your local County Extension Agent or NRCS office. See range condition section on page 85 for further information on range condition evaluation.

**Tip:** Estimated stocking rate could be based on local knowledge and past stocking rates if range condition, health and trend have met the producers objectives without degrading the resource.
<table>
<thead>
<tr>
<th>Kinds/classes of animals</th>
<th>Animal Unit Equivalent (AUE)</th>
<th>Forage consumed in Pounds (air dry) Day</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 lb. cow, dry</td>
<td>0.92</td>
<td>24</td>
<td>727</td>
</tr>
<tr>
<td>1000 lb. Cow, with calf</td>
<td>1.0</td>
<td>26</td>
<td>790</td>
</tr>
<tr>
<td>1200 lb. cow with calf</td>
<td>1.15</td>
<td>30</td>
<td>909</td>
</tr>
<tr>
<td>1400 lb. cow with calf</td>
<td>1.29</td>
<td>33.5</td>
<td>1022</td>
</tr>
<tr>
<td>Bison cow mature</td>
<td>1.00</td>
<td>26</td>
<td>790</td>
</tr>
<tr>
<td>Bison bull mature</td>
<td>1.50</td>
<td>39</td>
<td>1182</td>
</tr>
<tr>
<td>Horse, mature</td>
<td>1.25</td>
<td>32.5</td>
<td>988</td>
</tr>
<tr>
<td>Sheep, mature</td>
<td>0.20</td>
<td>5.2</td>
<td>158</td>
</tr>
<tr>
<td>Goat, mature</td>
<td>0.15</td>
<td>3.9</td>
<td>118</td>
</tr>
<tr>
<td>Deer, white-tailed, mature</td>
<td>0.15</td>
<td>3.9</td>
<td>118</td>
</tr>
<tr>
<td>Deer, mule, mature</td>
<td>0.20</td>
<td>5.2</td>
<td>158</td>
</tr>
<tr>
<td>Elk, mature</td>
<td>0.60</td>
<td>15.6</td>
<td>474</td>
</tr>
<tr>
<td>Antelope, mature</td>
<td>0.20</td>
<td>5.2</td>
<td>158</td>
</tr>
<tr>
<td>Sheep, bighorn, mature</td>
<td>0.20</td>
<td>5.2</td>
<td>158</td>
</tr>
<tr>
<td>Jackrabbit, white-tailed</td>
<td>0.02</td>
<td>0.5</td>
<td>15</td>
</tr>
<tr>
<td>Prairie dog</td>
<td>0.004</td>
<td>0.1</td>
<td>3</td>
</tr>
</tbody>
</table>


The animal unit is a convenient denominator for use in calculating 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 1000 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.
Hayland and Haying Management

The amount of hay and the quality of hay needed to properly 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, both in length and severity, it is difficult to accurately predict the amount of hay needed each year.

**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 upon environmental factors (rainfall and temperature).

**Management:** Balancing quality and quantity will depend on species mixture, plant stage at time of harvest, soil fertility and storage method. Maximum quantity will not generally give you maximum quality. Hay harvest management is a matter of timing. Remember, wintering stock cows will not need as high of quality of hay as milk cows.
<table>
<thead>
<tr>
<th>Species Groupings</th>
<th>When to cut</th>
<th>Minimum Stubble Height Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Beardless wildrye Creeping foxtail Intermediate wheatgrass Pubescent wheatgrass Meadow brome grass Smooth brome grass Tall wheatgrass Western wheatgrass</td>
<td>1st cutting — medium to full head</td>
<td>3</td>
</tr>
<tr>
<td>2) Crested wheatgrass Green needlegrass</td>
<td>Boot to early heading</td>
<td>3</td>
</tr>
<tr>
<td>3) Reed canarygrass</td>
<td>1st cutting — early boot Later cuttings — when basal sprouts appear</td>
<td>3</td>
</tr>
<tr>
<td>4) Big bluestem Indiangrass Prairie sandreed Switchgrass</td>
<td>Early boot to late boot stage</td>
<td>3</td>
</tr>
<tr>
<td>5) Alfalfa</td>
<td>1st cutting — bud to early bloom Last cutting — Early bloom to 25 percent stand flowering</td>
<td>2</td>
</tr>
<tr>
<td>6) Sweetclover</td>
<td>Bud to early flower</td>
<td>3</td>
</tr>
</tbody>
</table>
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 both 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: 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 October 15 to April 15). To optimize both quality and quantity, harvesting should take place when the major species is in the late boot or early heading stage.
Tip: Grazing hayland following the removal of a hay crop is generally 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 successfully accomplished during years of abundant production. Grazing intensity level should be light to moderate to maintain adequate growth prior to fall dormancy.

Tip: Hayland comprised of introduced species (i.e., 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 as a fertilizer.

For management of annual forages for hayland, see “Annual Forage” section.
Pasture Development

When developing a pasture, one must first decide on the intended season of use for the pasture (i.e. spring grazing, summer grazing, full season grazing) and the soil type you are dealing with. Once you have fully recognized your objectives for the land being developed and classified the soil type, see the section “Forage Suitability Groups” 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 will normally comprise exotic (tame) cool-season grasses that reach grazing readiness by early to mid May. See the “Forage Suitability Group” 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), meadow bromegrass (early to mid May), and smooth 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 will normally comprise native warm-season grasses or a mixture of native warm and cool-season grasses for summer use (June-September). This section will concentrate on warm-season grass options. See the section that follows for a detail description of full-grazing season pasture options that includes mixtures of both warm and cool-season plants. Grazing readiness for warm-season grasses usually occurs during the second to third week of June. See the “Forage Suitability Group” section on those species that can be grown on the soil type in your area. Recommended warm-season grasses include: big bluestem (can be either 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 will normally comprise exotic (tame) cool-season grasses for fall use (October-December). See the “Forage Suitability Group” 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-mid November) and Russian wildrye (seeded alone, October-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.

**Full-grazing Season Pasture Development**

The first step a rancher must decide is whether to plant a native or exotic (tame) grass/legume mixture. It is recommended NOT to mix native and exotic grasses together due to palatability (taste) differences, highly competitive nature of exotic grasses, and the difficulty of properly managing these native/exotic mixtures.

Full-grazing season pastures will normally comprise either: 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-October). Grazing readiness for cool- and warm-season grass mixtures usually occurs in late May to early June. See the “Forage Suitability Group” 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 crown milkvetch.

Recommended cool-season exotic grasses and legume options for a full-season seed
mixture include the following: smooth brome-grass and alfalfa, meadow bromegrass and alfalfa, smooth and meadow bromegrass and alfalfa, and intermediate/pubescent wheatgrass and alfalfa. Sweetclover can be added to all mixtures at 5 percent if desired. Note: bloat (a deadly condition associated with ruminant animals) must be addressed before grazing pasture with over 30 percent alfalfa. Ranchers must learn how and when to graze alfalfa, particular with animals unaccustomed to grazing alfalfa. Once ranchers gain experience in managing grazing animals on alfalfa safely, the risk of bloat is reduced and potential returns from higher livestock performance achieved.

Guidelines for seeding

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

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:

<table>
<thead>
<tr>
<th></th>
<th>Southern 1/3 of ND</th>
<th>Southern 2/3 of MN</th>
<th>Northern 2/3 of ND</th>
<th>Northern 1/3 of MN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cool-season grasses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>Before May 10</td>
<td>Before May 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late summer</td>
<td>Aug. 10 to Sept. 15</td>
<td>Aug. 10 to Sept. 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late fall (dormant)</td>
<td>After Nov. 1</td>
<td>After Oct. 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Warm-season grasses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>May 10 to June 15</td>
<td>May 10 to June 15</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>Before May 10</td>
<td>Before May 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late summer</td>
<td>Aug. 10 to Aug. 25</td>
<td>Aug. 10 to Aug. 25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late fall (dormant)</td>
<td>After Nov. 1</td>
<td>After Oct. 20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Soil temperatures should be below 40 degrees 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. The lower rates are generally recommended in western North Dakota or on drier sites. The higher rates are generally 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>
<thead>
<tr>
<th>Species/Variety</th>
<th>lb/ac PLS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduced Grasses</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Bromegrass</strong></td>
<td></td>
</tr>
<tr>
<td>Meadow</td>
<td>13.5 - 16.5</td>
</tr>
<tr>
<td>Smooth</td>
<td>6.5 - 8.0</td>
</tr>
<tr>
<td><strong>Fescue</strong></td>
<td></td>
</tr>
<tr>
<td>Hard</td>
<td>3.0 - 4.0</td>
</tr>
<tr>
<td><strong>Foxtail</strong></td>
<td></td>
</tr>
<tr>
<td>Creeping</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Wheatgrass</strong></td>
<td></td>
</tr>
<tr>
<td>Bluebunch/Quackgrass Hybrid</td>
<td>10.0 - 14.0</td>
</tr>
<tr>
<td>Crested</td>
<td>6.0 - 7.0</td>
</tr>
<tr>
<td>Intermediate</td>
<td>8.5 - 10.0</td>
</tr>
<tr>
<td>Pubescent</td>
<td>8.5 - 10.0</td>
</tr>
<tr>
<td>Siberian</td>
<td>6.0 - 7.5</td>
</tr>
<tr>
<td>Tall</td>
<td>11.0 - 13.5</td>
</tr>
<tr>
<td><strong>Wildrye</strong></td>
<td></td>
</tr>
<tr>
<td>Altai</td>
<td>16.0 - 19.0</td>
</tr>
<tr>
<td>Dahurian</td>
<td>8.5 - 10.0</td>
</tr>
<tr>
<td>Mammoth</td>
<td>20.0 - 24.0</td>
</tr>
<tr>
<td>Russian</td>
<td>6.0 - 7.5</td>
</tr>
<tr>
<td>Species/Variety</td>
<td>lb/ac PLS</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td><strong>Native Cool-Season Grasses</strong></td>
<td></td>
</tr>
<tr>
<td>Canarygrass</td>
<td></td>
</tr>
<tr>
<td>Reed</td>
<td>3.5</td>
</tr>
<tr>
<td>Needlegrass</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>6.0 - 7.5</td>
</tr>
<tr>
<td>Wheatgrass</td>
<td></td>
</tr>
<tr>
<td>Bluebunch</td>
<td>8.0 - 9.5</td>
</tr>
<tr>
<td>Slender</td>
<td>5.0 - 5.5</td>
</tr>
<tr>
<td>Streambank</td>
<td>7.0 - 8.5</td>
</tr>
<tr>
<td>Thickspike</td>
<td>7.0 - 8.5</td>
</tr>
<tr>
<td>Western</td>
<td>8.0 - 10.0</td>
</tr>
<tr>
<td>Wildrye</td>
<td></td>
</tr>
<tr>
<td>Basin</td>
<td>8.0</td>
</tr>
<tr>
<td>Beardless</td>
<td>7.5 - 8.5</td>
</tr>
<tr>
<td>Canada</td>
<td>6.5 - 7.5</td>
</tr>
<tr>
<td><strong>Native Warm-Season Grasses</strong></td>
<td></td>
</tr>
<tr>
<td>Bluestem</td>
<td></td>
</tr>
<tr>
<td>Big</td>
<td>6.0 - 7.5</td>
</tr>
<tr>
<td>Little</td>
<td>4.0 - 4.5</td>
</tr>
<tr>
<td>Sand</td>
<td>9.5 - 12.0</td>
</tr>
<tr>
<td>Buffalagrass (bur)</td>
<td>23.0 - 26.0</td>
</tr>
<tr>
<td>Cordgrass</td>
<td></td>
</tr>
<tr>
<td>Prairie</td>
<td>7.0</td>
</tr>
<tr>
<td>Grama</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>2.0 - 2.5</td>
</tr>
<tr>
<td>Sideoats</td>
<td>6.0 - 7.5</td>
</tr>
<tr>
<td>Indiangrass</td>
<td>5.5 - 7.0</td>
</tr>
<tr>
<td>Sandreed</td>
<td></td>
</tr>
<tr>
<td>Prairie</td>
<td>4.0 - 5.0</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>3.5 - 4.5</td>
</tr>
</tbody>
</table>
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.
### Annual Forages

Annual crops can be used for mid to late summer forage production providing good options for pasture or hay land. When selecting an annual crop, the rancher should decide on the intended use (grazing, hay, or both). Some annual forage provides good hay but lacks 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 dependant on that regrowth for grazing). Recommended annual forages for hay land, pastureland or double cropping of hayland followed with grazing include:

<table>
<thead>
<tr>
<th>Hay Type Only¹</th>
<th>Pasture Type Only</th>
<th>Hay and Pasture Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siberian foxtail millet</td>
<td>Annual ryegrass</td>
<td>Sudangrass</td>
</tr>
<tr>
<td>Common foxtail millet</td>
<td></td>
<td>Oats</td>
</tr>
<tr>
<td>German foxtail millet</td>
<td></td>
<td>Forage barley</td>
</tr>
<tr>
<td>Sorghum-sudangrass</td>
<td></td>
<td>Sorghum-sudangrass</td>
</tr>
<tr>
<td>Pearl millet</td>
<td></td>
<td>Triticale</td>
</tr>
</tbody>
</table>

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

**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: 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: 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 Service Circular 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 Service Circular V839, “Nitrate Poisoning of Livestock,” for more information.
Expired CRP Lands

Evaluation for productivity of expiring CRP stands

Once the rancher evaluates the existing stand for noxious or perennial weed problems, vigor, and overall stand viability, proper renovation techniques may be implemented to improve the stand quality and quantity.

Renovation

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 (i.e. wildlife habitat).

Prescribed burning would be primarily used to remove old plant residues, increase the amount sunlight for new plant growth and release tied-up nutrients.

A prescribed burn plan is recommended to ensure the burn accomplishes the objectives in a safe manner.

Fertilization with N may be needed to rejuvenate CRP stands, especially if the legume component of the stand has become limited. 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 may also be limiting. 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 is often achieved using this technique.

Interseeding may be an option if the existing stand is weak (bare ground) or one or more desired plant species 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. 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 an 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 may also be used if moisture conditions are favorable.

**Grazing management**
(see grazing management section)

**Haying management**
(see haying management section)
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 properly contain livestock to the prescribed pasture, they may be constructed to a more economical level (i.e. 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 non-energized), temporary or permanent electric (energized) fence, woven wire and electric mesh. 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 life span than those with well designed and installed corner braces.

The key to properly installed corners lies in understanding the relationship between 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 into 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 a 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 a 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 seconds).

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.
Comparing energizers

Most companies rate their energizers by the “Miles of Fence” standard (Minding Your Fences. March 1977. Thomas K. Cadwallader. Pasture Prophet. Vol.5, No. 1. Grazing Lands Technology Institute). Energizer A will charge 10 miles of fence versus energizer B which will charge 15 miles of fence. However, this standard does not take into consideration the weed loading or the electromagnetic resistance that occurs in multiple wire fences. To obtain an accurate comparison of energizers, you need to determine the amount of amperes (amps) that each energizer is generating. To do this, you need a basic understanding of the following electrical terminology and how to use this information to compute the amps each energizer generates.

Tip: Amps (Amperes) are a measure of the “amount” of electricity that flows through the circuit. It is the amperage, not the voltage that causes the greatest amount of numbing pain and potential damage when anything receives a shock.

Tip: Watts are a measure of the electrical rate of doing work. It is a unit of electrical power that is similar to horsepower. It is calculated by: Amps x Volts = Watts
Tip: A joule is a unit of electrical energy equaling the amount of energy required to produce one watt for one second. Joules are calculated by: Watts x Seconds = Joules

Tip: Pulse time is the length of time the fence is “on.” May also be referred to as “spark duration.”

Tip: An example to evaluate energizers: We can evaluate energizer A and B using variations in the above formulas.

Energizer A is listed as a 4.5 joule unit that can maintain 5,000 volts under low weed pressure. If energizer A’s pulse time is 0.0003 seconds, then we can make the following calculations:

\[
4.5 \text{ joules} / 0.0003 \text{ seconds} = 15,000 \text{ watts} \\
15,000 \text{ watts} / 5000 \text{ volts} = 3 \text{ amps}
\]

Energizer B is also a 4.5 joule unit that can maintain 5,000 volts but has a pulse time of 0.0006 seconds:

\[
4.5 \text{ joules} / 0.0006 \text{ seconds} = 7,500 \text{ watts} \\
7,500 \text{ watts} / 5000 \text{ volts} = 1.5 \text{ amps}
\]

As you can see in this example, energizer B produces only one half the amps of energizer A.
due to the difference in pulse duration. Energizer B is actually only a 2.25 joule energizer.

**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 securely attached to these rods 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 three 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 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 wind or solar type pump.

Tip: Use the following formula when calculating storage requirements:

<table>
<thead>
<tr>
<th>Number of Livestock</th>
<th>Days storage required</th>
<th>Requirements gallons/head/day</th>
<th>Total gallons needed</th>
</tr>
</thead>
</table>

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 = $23.5 \times \frac{r^2 \times d}{2}$
where $r = \text{diameter of tank} / 2$ and $d = \text{depth of tank}$

For example:

Diameter of tank = 15 ft, depth = 2 ft
$23.5 \times \left(\frac{15}{2}\right)^2 \times 2 = 2,644 \text{ gallons}$
Tip: Quick reference:

<table>
<thead>
<tr>
<th>Tank diameter (in feet)</th>
<th>Capacity @ Depth of 2 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>752 gallons</td>
</tr>
<tr>
<td>9.0</td>
<td>952 gallons</td>
</tr>
<tr>
<td>10.0</td>
<td>1,175 gallons</td>
</tr>
<tr>
<td>11.0</td>
<td>1,422 gallons</td>
</tr>
<tr>
<td>15.0</td>
<td>2,644 gallons</td>
</tr>
<tr>
<td>20.0</td>
<td>4,700 gallons</td>
</tr>
<tr>
<td>30.0</td>
<td>10,575 gallons</td>
</tr>
</tbody>
</table>

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
Water quality

Tip: Studies in Montana and Alberta, Canada show a 5-30 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.
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 age of animal, if mature; stage of pregnancy, if lactating; and age of nursing offspring. Nutritional value of forage will vary with stage of plant development and environmental conditions.

Tip: Nutritional quality of range plants is highest in the spring when they are actively growing, often becoming deficient upon maturity (latter half of the growing season). Grazing management can possibly enhance diet quality during the later portion of the grazing season.
Figure 6. Crude protein content (%) of cool- and warm-season grasses and typical native range
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.

Absinth wormwood.
Introduced perennial forb which is found on dry soils, in overgrazed pasture and rangeland, disturbed areas, Conservation Reserve Program (CRP) fields and roadsides. Absinth wormwood is easily recognized by its grey color and strong sage odor. Absinth is a prolific seed producer that can also 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).
**Tip:** Herbicides are the most frequently used control technique. The NDSU publication W-838, “Absinth Wormwood Control,” lists the most affective herbicides to control absinth wormwood, including clopyralid (Stinger or Curttail), dicamba (Banvil), 2,4-D and picloram (Tordon). See table for results from experiments conducted in North Dakota (Lym et al. 1994).

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rates (lb/ac)</th>
<th>3</th>
<th>12</th>
<th>15</th>
<th>Months after treatment (% control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>dicamba</td>
<td>0.5</td>
<td>20</td>
<td>70</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>dicamba</td>
<td>1.0</td>
<td>60</td>
<td>90</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2,4-D</td>
<td>1.0</td>
<td>15</td>
<td>75</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>2,4-D</td>
<td>2.0</td>
<td>50</td>
<td>85</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>picloram</td>
<td>0.13</td>
<td>35</td>
<td>90</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>picloram</td>
<td>0.19</td>
<td>60</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>picloram</td>
<td>0.25</td>
<td>90</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>clopyralid</td>
<td>0.19</td>
<td>50</td>
<td>90</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>clopyralid</td>
<td>0.25</td>
<td>75</td>
<td>100</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>clopyralid + 2,4-D</td>
<td>0.19 + 0.75</td>
<td>85</td>
<td>100</td>
<td>95</td>
<td></td>
</tr>
</tbody>
</table>
Canada thistle. Introduced perennial forb found on moist sites, in overgrazed pasture and rangeland, disturbed areas, Conservation Reserve Program (CRP) fields, and roadsides. Canada thistle usually grows two to three 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 in color from lavender to pink or white. This plant is unpalatable to most classes of livestock, causing 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 over grazing or over rest.

Tip: Prevention is the best control method. Since 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.
Tip: Herbicides are the most frequently used control technique. The NDSU publication W-799, “Perennial and Biennial Thistle Control,” lists the most effective herbicides to control Canada thistle, including 2,4-D, clopyralid (Stinger or Curttail), dicamba (Banvil), and picloram (Tordon). See table for results from experiments conducted in North Dakota (Lym and Zollinger 1995).

Tip: Control is greatest when applied at the early bud growth stage (early summer) or in the fall to plants in the rosette form.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rates (lb/ac)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>dicamba</td>
<td>0.5 to 4.0</td>
<td>use surfactant high rate for patch treatment</td>
</tr>
<tr>
<td>2,4-D</td>
<td>1.5 to 2.0</td>
<td>suppression only</td>
</tr>
<tr>
<td>picloram</td>
<td>0.25 to 1.0</td>
<td>restricted use high rate for patch treatment</td>
</tr>
<tr>
<td>picloram + 2,4-D</td>
<td>0.125 to 0.5 + 1.0</td>
<td>restricted use</td>
</tr>
<tr>
<td>clopyralid</td>
<td>0.25 to 0.5</td>
<td>expensive but very effective</td>
</tr>
<tr>
<td>clopyralid + 2,4-D</td>
<td>0.3 + 1.5</td>
<td>cost-effective for large infestations</td>
</tr>
</tbody>
</table>

*aConsult the specific label for use and grazing restriction, surfactant requirements, and specific application rate.*
Leafy spurge. 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 which bear small and green flowers. The root system is extensive and consists of numerous coarse and fine roots which 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 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, biological and cultural tools. Biological control includes insects which are available from the North Dakota Department of Agriculture. Cultural control includes managed grazing by sheep and goats alone or in combination with cattle (see NDSU Extension Service circular R-1093, “Controlling Leafy Spurge Using Goats and Sheep”).

Herbicide treatments include picloram (Tordon), dicamba (Banvil), 2,4-D, picloram + 2,4-D, glyphosate + 2,4-D (Landmaster BW) and imazapic + MSO (Plateau). See NDSU Extension Service circular W-765, “Leafy Spurge Identification and Control,” for detailed recommendations.
Musk thistle.
Introduced biennial forb found in dry upland and sandy soils, occurring in overgrazed pastures and disturbed sites. Musk thistle often grows in excess of 6 feet, has very large flowers that tend to droop, and flower has very characteristic brown bracts that resemble pine cones. Flowers are usually deep rose colored, 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.

**Tip:** Control techniques include herbicides and biological. Weevils have been introduced to control musk thistle with limited success. Herbicides commonly used to control musk thistle include 2,4-D, clopyralid (Stinger or Curttail), dicamba (Banvil), and picloram (Tordon). See table for results from experiments conducted in North Dakota (Lym and Zollinger 1995).

**Tip:** Control is greatest when herbicides are applied in the fall but prior to a killing frost.
<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rates</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>dicamba</td>
<td>0.5 to 1.0</td>
<td>use surfactant high rate for patch treatment</td>
</tr>
<tr>
<td>2,4-D</td>
<td>1.5 to 2.0</td>
<td>suppression only</td>
</tr>
<tr>
<td>picloram</td>
<td>0.125 to 0.5</td>
<td>restricted use high rate for patch treatment</td>
</tr>
<tr>
<td>picloram + 2,4-D</td>
<td>0.125 + 1.0</td>
<td>restricted use</td>
</tr>
<tr>
<td>clopyralid</td>
<td>0.125 to 0.5</td>
<td>expensive but very effective</td>
</tr>
<tr>
<td>clopyralid + 2,4-D</td>
<td>0.2 to 0.3 + 1.5</td>
<td>cost-affective for large infestations</td>
</tr>
</tbody>
</table>

*a Consult the specific label for use and grazing restriction, surfactant requirements, and specific application rate.
Spotted knapweed.
Introduced perennial forb that rapidly invades pasture and rangeland causing serious decline in forage production. Spotted knapweed is found on a wide variety of soils and sites. It is a prolific seed producer, producing up to 1000 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. Spotted knapweed releases a toxin that reduces growth of neighboring plants.

Tip: Prevention is the best control for spotted knapweed. People are the major cause of spotted knapweed spread. The weed is spread readily in hay and on vehicle undercarriages. Avoid driving through patches of spotted 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: Herbicides should be applied when the plant is in the rosette growth stage in the fall or in the bud to bloom stage in the spring. Herbicides commonly used to control spotted knapweed include clopyralid + 2,4-D (Curttail), dicamba (Banvil), and picloram (Tordon). See NDSU Extension Service circular W-842 “Spotted Knapweed,” for recommended control guidelines (Lym and Zollinger 1992).
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, may be disabled permanently or may recover completely. Although poisonous plants do occur in North Dakota and western Minnesota, they are generally not a problem. If they do become a problem, it is generally 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.**
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 early frost, plants quickly become toxic due to high level of hydrocyanic or prussic acid.

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

**Symptoms of poisoning:**
- nervousness
- abnormal breathing, either 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 causing death

**Tip:** Arrowgrass will be present even in high condition rangeland but seldom grazed if adequate forage is available.
Blue Green Algae (Cyanobacteria).
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: There are a number of ways 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, snake or fish are present, assume a poisonous condition exists.
Larkspur.
Perennial plant 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 allkaloid.

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.
Perennial plants generally 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 crazy-weed, two-grooved milkvetch, and tine-leaf milkvetch.

**Affected livestock:** cattle, horses, sheep and goats.

**Symptoms of poisoning:**
- loss of flesh
- irregular gait
- loss 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.
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, kocha, pigweed and goosefoot.
Annual introduced plants found on disturbed sites, bare areas and on areas of low range and pasture condition. These plants are potassium nitrate accumulators. Nitrate toxicity occurs at elevated levels and 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 Service publication V-839, “Nitrate Poisoning of Livestock.”
Water hemlock.
Perennial plant generally found in wet meadow and wetland ecological sites and along creek bottoms. Water hemlock is probably the most poisonous plant that grows in the United States. 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

There are very good reasons to monitor. 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, then adjusting your management to make sure you will 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 structure, species composition, frequency, density, production, cover and various combinations. Each method provides unique types of information that can be used to describe a plant community and each has different limitations.
Tip: Many people wonder whether it is necessary to monitor the land when they are already 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 can initially 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.
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. Because each operation varies by resources and goals, we can not recommend one monitoring technique over another. Potential sources of information on monitoring include:


For assistance in developing a monitoring program that fits you and your operation, see the “Technical Assistance” section.
Record Keeping

Keeping accurate records on how many livestock are in a pasture(s), how long they are in a pasture(s), growing conditions and some general notes on pasture condition are all 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 a detailed record keeping program. This document contains a range and pasture record keeping system for your use. It allows you document pasture turn-in dates, rotation dates, livestock numbers and weather.
Technical Assistance

On-site technical assistance may be available from the following agencies.

NDSU Extension Service
http://www.ext.nodak.edu/

Natural Resources Conservation Service
http://www.nd.nrcs.usda.gov/
http://www.mn.nrcs.usda.gov/

U.S. Fish and Wildlife Service – Private Lands Coordinator
http://offices.fws.gov/directory/
OfficeDetail.cfm?OrgCode=62440

N.D. State Land Department
(State School Lands)

U.S. Forest Service (National Grasslands)
http://www.fs.fed.us/r1/dakotaprairie/