Navajo Nation Range Management Handbook

Needle-and-threadgrass
Stipa comata
Atsábikʻaʻítłʻoh

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This handbook is dedicated to the memory of Alex Tsosie, Soil Conservationist with the Bureau of Indian Affairs in Window Rock. Alex had a deep love for his Navajo land and its livestock. He had the desire to both improve the future of his land and to stay close to the culture of his ancestors. His dedication to the care of the lands will always be an inspiration to those of us who knew and worked with him.

Alex, we are glad that you passed among us. May your moccasins always walk in the soft green grass and may you never thirst for cool, clear water. Amen.

The *Navajo Nation Range Management Handbook* has been developed through the efforts of many individuals.

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Allan Blacksheep
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Range—To Have and To Use

What is Range?

Range is any large area of level, rolling, broken, or steep mountainous land, usually not adapted to farming. Because it is land covered with native grasses, forbs, shrubs, and sometimes trees this land is best suited for grazing by livestock and wild animals.

Does the Range Concern You?

Yes, each one of us has a real interest in our rangeland. It is the main source of our meat supply. It is important in the production of wool and leather products. It is a valuable source of water, clean air and wildlife. It offers many types of recreation. It is just as important for the non-user of rangeland to promote its conversation and protection for the future as it is for the person raising livestock and living on the range.

Way Back When…

Rangeland—the vegetation, soil, and water—is the Navajo's greatest and most valuable natural resource. Rangeland has played an important part in the history, the culture and the life of Navajo People.

According to history, the first Navajo People were not stockmen. Before the 16th century, the Navajos were a nomadic tribe concerned with hunting and tending small patches of dry farmland. The first Navajo livestock came through trading with the Spaniards and picking up the animals left behind as the Spaniards were driven south into Mexico. Many Navajo legends include livestock along with all of the other "Gifts from God." Whatever the origin, livestock have been a part of the Navajos' life for 400 years.

By the 19th century, livestock were a vital part of the Navajo life and economy. Large bands of sheep and many horses roamed the grasslands of the reservation. Wealth and importance were measured by the number of animals a family had. This lifestyle, however, was not to last long. Battles with and ultimate surrender to U.S. troops brought an end to the Navajos' way of living and to their livestock. The "Long Walk" to Fort Sumner and the following period of "captivity" are still in the memories of the Navajo People.

Then, after four years, they were allowed to return to their homeland with a small number of sheep and goats and a few horses. By 1900, the Navajo People were back in the livestock business. Many families had bands of 3,000 or more sheep. The people were content, moving their families from place to place—following areas of grass as it would green up in the spring. Soon, however, it became obvious that the number of animals and the system of yearlong grazing was taking its toll on the plant cover. The grazing, plus periods of prolonged drouth, was destroying the cover of their "Mother Earth."

The U.S. Government, in an attempt to prevent complete destruction of the rangelands, tried to get the people to reduce their number of animals voluntarily. This was ineffective, and it was then decided that the needed reduction would be made by force. This brought about the infamous "livestock reduction" of the 1930s. This, too, is a bitter point in the memory of many older Navajo People. They, along with many other people today, look back on this event as a tragic mistake.

Today, only about one-third of the Navajo People are actively engaged in a livestock business. Many others, however, maintain small numbers of sheep and horses or a few cows. These provide food, wool, additional income, and—most important—help the Navajos to stay in touch with their old traditions and culture.

The Navajo People today are still criticized for their overgrazing and the loss of lands through erosion. It is now being recognized, though, that the problems do not stem so much from overgrazing as from the lack of any form of grazing management. Changes in attitudes of the people, revised tribal regulations, and new federal programs are making things look brighter for Navajo livestock and rangeland resources. It is hoped that this generation will adopt new ideas, use the programs and resources available to them, and care for their "Mother Earth" so that the future generations may also live and enjoy the life of the Navajo.

What is Range Management?

Range management is the care and use of rangeland to get the highest continual yield of animal products without damaging the soil and water resources or other uses of the land. Animal products of the range are meat, wool, mohair and hides. Other very important products are water, clean air, wildlife and recreation.

The goals of management are:

1. To keep the range covered with good forage plants.
2. To maintain a reserve of range forage.
3. To increase livestock and wildlife products.
4. To reduce and control the flow of water from rangelands.
5. To control soil erosion on rangelands and watersheds.

Have you ever noticed when a rancher sells his product, he is paid for the pounds and not for the number sold? Pounds of products sold (meat, wool, mohair) are the best measure of a good range management plan.

Know Your Range!

You can keep the range healthy and productive by knowing the plants and animals that live there and how to manage them properly. Plants and animals live together as a "community." When livestock or game animals graze an area, changes take place in the plant community. To be a good range manager, you must recognize the changes that result from grazing. You must be able to tell why the changes took place and whether the changes are good or bad. To know about the rangelands and how to manage and care for them, you must have some knowledge of soils, water, climate and plants.

Soils

There are many different kinds of soils. They differ from each other in depth, texture, structure and slope. These are called physical features. We can see and feel them.

Soil depth is the thickness of the soil above the parent material (material from which the soil is made). It takes millions of years for bare rock to be turned into rich fertile soil that will support plants and animals. As the soil is formed, it is deposited in layers. The upper layer is called topsoil; and the second layer is called the subsoil. Below the subsoil is the parent material.

In most areas, it takes 500 years to change bedrock into one inch of topsoil. Under the dry, desert-like conditions on the Navajo Nation, it would take even longer. When the plant cover is removed or destroyed, this valuable topsoil is carried away by erosion from water and wind. One storm can carry away more topsoil than it took 500 years to form. This loss is the result of poor management.

Soil texture refers to size of the soil particles. There are four main textures or sizes; gravel, sand, silt and clay. Gravel is the largest particle and clay is the smallest. Most soils are a mixture of the different-sized particles. Coarser soils (gravels and sands) are more drouthy because they do not have the ability to hold water. Fine textured soils (silts and clays) are generally more productive soils because they can take in and store more moisture. They are also generally more fertile.

Soil structure relates to the way in which the soil particles are held together. In most soils, we find groups of soil particles "glued" together like the grains of a popcorn ball. These "popcorn balls" or chunks of soil are called soil aggregates. These aggregates may be in the shape of blocks, or long tubes, or flat plates or appear as mixtures of these. When soils are well aggregated, air, water and plant roots can move through the soil easily. These soils can take in and store moisture, and they are not as easily damaged by water and wind erosion.

Slope refers to steepness. Slopes may vary from level and gently rolling to steep and broken hills and mountains. The steeper the slope, the more easily it erodes. Slope also makes a difference in the kinds and amounts of plants that grow in the soil. Soils on south-facing slopes produce different kinds and amounts of forage plants than will be found on north-facing slopes. These differences are the result of higher temperatures and less favorable moisture conditions on the southern slopes as compared to the cooler and more shaded northern slopes.

Organic matter is dead and decaying plant and animal material on the soil surface and down in the soil. Leaves and plant tops dry out and fall on the surface to form a layer called **mulch**, a protective cushion on the soil surface. Plant roots die and furnish food for millions of tiny living animals called **soil organisms**. These organisms work all the time to break down the soil mineral particles into a form that can be used as food for the plants.

Generally, the more organisms in the soil, the better the production of the range forage. To keep soils productive, we need to return something to the soil every year. At the end of the grazing season, some dry plant material should be left on the range. This "left over" material helps to prevent erosion and increases the movement of water into and through the soil.

Water

Water is the one factor which usually limits production on rangelands. Water is needed for the growth of range plants just as it is for the vegetables or flowers in your garden. When there is a shortage of water, all plants and animals suffer.

Have you heard about the water cycle? It begins at the ocean, goes to the sky, falls back on the land, then flows back to the ocean (Figure 1). Water evaporates from the surface of the ocean into the atmosphere. The moisture is lifted by air currents, and as the warm, moist air rises, it cools and forms clouds. The clouds are carried by wind over the land, and the moisture eventually falls back to the land as rain, snow, hail, sleet or fog. Some of this moisture evaporates as it falls. That which reaches the ground will either move down into the soil, or it will be lost as runoff. The water that moves down into the soil is either used by the plants, or it moves deeper into the soil and helps to recharge underground water supplies. This underground water keeps our springs and wells flowing.

Some of the water that is held in the topsoil is lost through evaporation. Water is also lost into the air by plants through a process called **transpiration**. On Navajo rangelands, with the high daytime temperatures, low rainfall and drying winds, the loss of soil moisture through evaporation and transpiration is extremely high.

The moisture which is lost through surface runoff is of great importance to the rancher, the farmer, the range manager and to all the people. This "lost" water could have been used by the plants to produce more range forage. Instead, it is lost to the plants. Even more seriously, it erodes the land and carries away the valuable topsoil.

It is necessary that we find more and better ways to save water and reduce this surface runoff. The good range manager knows that the best way to do this is to maintain a healthy cover of range plants. This good cover helps to protect the soil from the force of falling rain drops and slows down the movement of water over the soil surface. This allows more moisture to soak into the soil. A good plant cover also keeps the soil surface cooler and reduces the loss of moisture from evaporation.

Range Plants

It is important that the rancher become familiar with the plants growing on his range. He should know them by name and be able to recognize their importance as forage producing plants (Figure 2).

Plants will tell you what kind of range you have and how good a manager you are. Each plant will tell you a story of what is happening. The presence or absence of certain plants tells the condition of the range, how the range is being used and what needs to be done to improve and protect the range. On the next pages is a list of the most common of hundreds of range plants that grow on the Navajo Reservation (Table 1).

This list is intended to be of assistance to Navajos in knowing both Navajo and English names for the plants they encounter and also as an aid to those working with Navajos. In discussing range or livestock it is often necessary to refer to a specific plant by name, and this should provide a means of knowing some of these names in Navajo so the Navajos involved will know exactly which plant is being referred to. This is strictly a preliminary list. Many of the plants will be known by other names, either Navajo or English, in other areas.

You do not need to know all of these plants. You should know those which furnish the most and

best forage for livestock. Generally, there will be 10 to 15 plants on any one range area that will be important. You should know these plants and how to manage them so they can be made to produce the most livestock and livestock products and still protect the land.

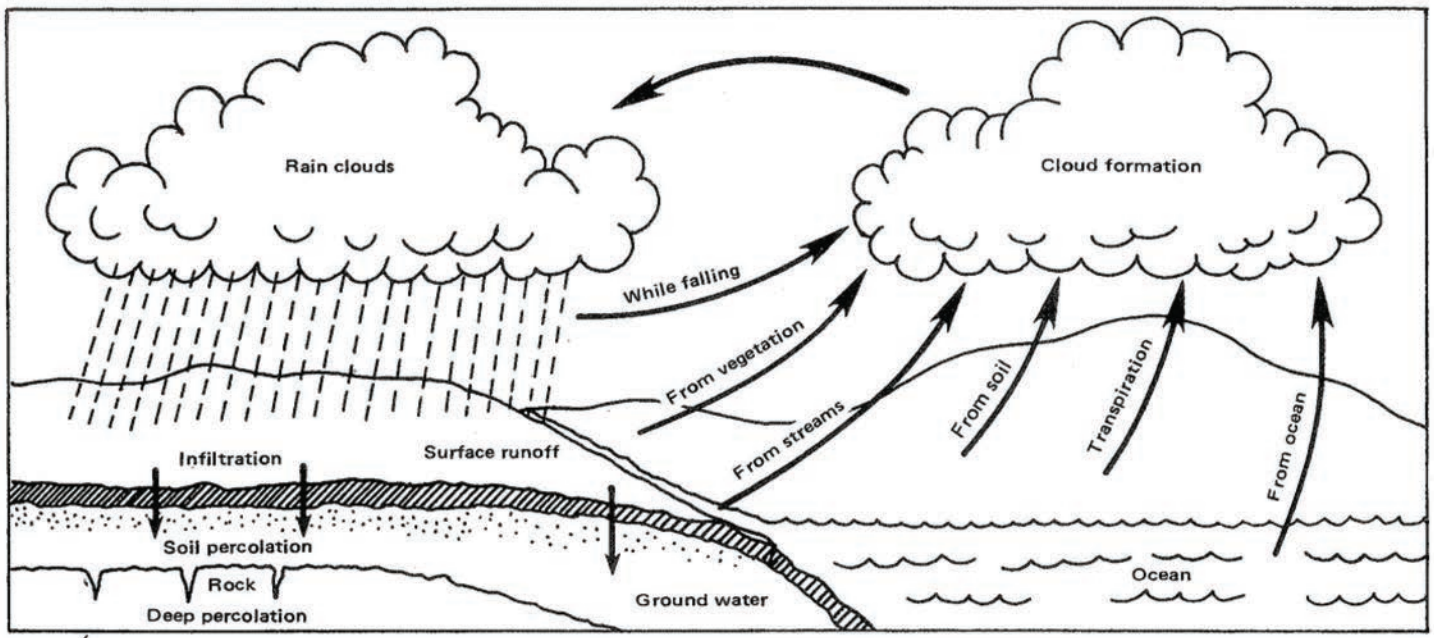


Figure 1. The water cycle.

Table 1. Navajo Range Plants

*** This list was compiled in 1981 and some plants are now known by altered scientific names. We have retained the original 1981 list here.**

—Ed. (2018)

Alder	K'ish	*Alnus spp.*
Algerita	Tsin‌ɬitsoi	*Berberis Fremontii*
Alkali cordgrass	Tɬ'ohdá'ákáɬiitsoh	*Spartina gracilis*
Alkali sacaton	Tɬ'ohdá'ákáɬiitsoh	*Sporobolus airoides*
Antelope bitterbrush	Tsék'ina'aɬch'ízhii	*Purshia tridentata*
Antelopehorn	Azee'ɬa'dilt'éhé	*Ascelpidora decumbens*
Arizona fescue	Tsinyaatɬ'ohyilzólí	*Festuca arizonica*
Arrowgrass	Tɬ'ohk'aa'í	*Triglochin maritima*
Aster (devilweed)	Niiʔyiiɬtɬ'iihii	*Aster spinosis*
Baltic rush	Tééhtɬ'oh	*Juncus spp.*
Sixweeks fescue	Tɬ'ohyilzólídijooli	*Festuca octoflora*
Beeplant	Waa'	*Cleome lutea*
Big rabbitbrush	Ts'iɬdiilyésiitsoh	*Chrysothamnus spp.*
Big sagebrush	Ts'ahtsoh	*Artemisia tridentata*
Bigelow sagebrush	Ts'ahɬibáhí	*Artemisia Bigelovii*
Birdbeak	Tsésnádáá'	*Cordylanthus spp.*

Bisquitroot	Nímasiichilí	*Lomatium spp.*
Bitterweed	Ch'ilbiłátahłitsxoidíchi'ï'ï	*Hymenoxys odorata*
Blackbrush	Ch'iłłizhiní	*Coleogyne ramosissima*
Black grama	Tł'ohnástasiłizhiní	*Bouteloua eriopoda*
Black sagebrush	Tsétah Ts'ah	*Artemisia nova*
Blanketflower	Ch'ilbiłátahózhóón	*Gaillardia spp.*
Bluebells	Dahiitiihídáá'dootł'izhí	*Mertensia arizonica*
Blue grama	Tł'ohnástasi	*Bouteloua gracilis*
Blue-eyed-grass	Azeetł'ohí	*Sisyrinchium demissum*
Broadleaf milkweed	Ch'ilabe'ébit'aa'niteelí	*Asclepias latifolia*
Buckwheat	Bisnideeshchii'	*Eriogonum racemosum*
Bundleflower	K'ei'chilí	*Desmanthus spp.*
Camelthorn	Ch'ilhoshí	*Alhagi camelorum*
Canadian wildrye	Tł'ohndtł'iziłtsoh	*Elymus canadensis*
Cheatgrass	Shíyináldzidí	*Bromus tectorum*
Chokecherry	Didzédik'ózhí	*Prunus virginiana*
Cholla	Hoshdítsáhii	*Opuntia spp.*
Cliffrose	Awéét's'áál	*Cowania neomexicana*
Cocklebur	Tá'niits'éhii	*Xanthium saccharatum*
Colorado pinyon	Chá'oł	*Pinus edulis*
Common purslane	Tsiighájiłchii'	*Portulaca oleracea*
Cottonwood tree	Ts'iisbit'aa'niteelí	*Populus spp.*
Copperweed	K'iitsoinitł'izí	*Oxytenia acerosa*
Cow parsnip	Azee'haagai	*Heracleum lanatum*
Crazyweed loco	Ch'ilaghánítsoh	*Oxytropis lambertii*
Crested wheatgrass	Tł'ohdeindtł'izí	*Agropyron desertorum*
Curleycupgumweed	Ch'ilbiłátahaltsóií	*Grindelia squarrosa*
Daisy	Nidíyiliiłigaii	*Erigeron spp.*
Dandelion	Bééshyilt'áa'ï	*Taraxacum officinale*
Death camas	Yiiłtsíniitsoh	*Zygadenus spp.*
Desert needlegrass	Tł'ohtsahí	*Stipa speciosa*
Dropseed, Giant	Tł'ohyilzólítsoh	*Sporobolus giganteus*
Dropseed, Pine	Tł'ohyilzóli	*Blepharoneuron Tricholepis*
Dropseed, Spike	Tł'ohyilzólídeeníní	*Sporobolus contractus*
Ellis loco	Ch'ilaghánídoolgasí	*Astragalus spp.*
Evening primrose	Tł'é'yiigáhii	*Oenothera spp.*
Filaree	Dahiitiihídáá'łikaní	*Erodium cicutarium*
Four O'clock	K'íneeshdlíshiidáá'łigai	*Allionia incarnata*
Four-winged saltbush (Chamiza)	Díwózhiiłbéií	*Atriplex canescens*
Foxtail barley	Azéé'iilwo'iitsoh	*Hordeum jubatum*
Fremont cottonwood	Ts'iis	*Populus fremontii*
Fringed sagebrush	Tóyikáál	*Artemisia frigida*
Galleta	Tł'ohdich'ízhí	*Hilaria jamesii*
Gambel oak	Tséch'ilnitł'izí	*Quercus gambelli*
Geranium	Dahiitiihídáá'tsoh	*Geranium richardsonii*
Gilia	Azéehaaleeh	*Gilia spp.*

Goldenweed	Teeɬyilt'aa'í	*Haplopappus spp.*
Grama, sideoats	Tɬ'ohɬichi'í	*Bouteloua curtipendula*
Greasewood	Diwózhiishjiin	*Sarcobatus vermiculatus*
Horsemint	Kétɬoh	*Mentha spp.*
Horsenettle	Nááɬtsoi	*Solanum elaegnifolium*
Horsetail	Ch'ilabe'éts'óóz	*Equisetum spp.*
Indian ricegrass	Ndídlídii	*Oryzopsis hymenoides*
Indian paintbrush	Dahiitiihídáá'tsoh	*Castilleja spp.*
Iris	Bílátahyígaii	*Iris missouriensis*
Cliff fendlerbush	K'iishzhiní	*Fendlera rupicola*
Jacobsladder	Azee'naachii'	*Polemonium spp.*
Jimsonweed	Ch'óhojiléél	*Datura stramonium*
Junegrasss	Tɬ'oolét's'ózí	*Koeleria cristata*
Juniper	Gad	*Juniperus monosperma*
Kentucky bluegrass	Tsétahtɬ'oh	*Poa pratensis*
Lambsquarter	Tɬ'ohdeináɬgai	*Chenopodium album*
Larkspur	Tádídiíndootɬ'izh	*Delphinium spp.*
Lichen	Ni'hadláád	*Various genera*
Little bluestem	Tɬ'ohdeiɬichi'í	*Andropogon scoparius*
Little rabbitbrush	Ch'ildiilyésiiyázhí	*Chrisothamnus spp.*
Little ricegrass	Ndídlídiidijooli	*Oryzopsis micrantha*
Lupine	ɬiídáá'	*Lupinus sparsiflorus*
Sandhill muhly	Béé'ézhóó'	*Muhlenbergia pungens*
Milkweed	Ch'ilabe'é	*Asclepias spp.*
Mormon tea	Tɬ'ohozihii	*Ephedra spp.*
Mountain brome	Tɬ'ohtsohndtɬ'izí	*Bromus marginatus*
Mountain mahogany	Tsé'ásdaazii	*Cercocarpus montanus*
Mountain muhly	Bé'ézhóó'	*Muhlenbergia montana*
Mullein	Biihyiljáa'í	*Verbascum thapsus*
Mutton grass	Tɬ'ohnikání	*Poa fenderliana*
Mustard	Oostse'	*Brassica spp.*
Navajo tea	Ch'ilgohwéhí	*Thelosperma subnudum*
Needle-and-threadgrass	Atsábik'a'iitɬ'oh	*Stipa comata*
New Mexico feathergrass	Tɬ'ohdit'ódítsoh	*Stipa neomexicana*
Nightshade	Ma'iidáá'	*Solanum nigrum*
Oregon grape	Tséch'ilndtɬ'iziíyilt'áa'í	*Mahonia repens*
Patterson loco	Ch'ilaghání	*Astralagus pattersonii*
Penstemon	Tsédídéél	*Penstemon spp.*
Pinque	Ch'ilɬibáhilátahtsoi	*Hymenoxys richardsonii*
Poison hemlock	Didzédáá'	*Conium maculatum*
Poison ivy	K'ishishjiin	*Toxicodendron radicans*
Ponderosa pine	Ndíshchiił	*Pinus ponderosa*
Pricklypear	Hoshniteelí	*Opuntia spp.*
Puncturevine	Ch'ilhoshí-Naakaibihosh	*Tribulus terrestris*
Quaking aspen	Ts'iisbéił	*Populus tremuloides*
Rabbitbrush	Ch'ildiilyésiits'óóz	*Chrysothamnus spp.*
Rattleweed	Dá'ághálii	*Rhinanthus rigidus*

Rayless goldenrod	K'iiɬtsoiɬizhiní	*Haplopappus heterophyllus*
Redtop	Tɬ'ohlátahyíchii'í	*Agrostis alba*
Redstem peavine	Ch'ilna'át'ó'í	*Lathyrus spp.*
Ring muhly	Bé'ézhóó'ɬichiiʔí	*Muhlenbergia torrevi*
Rocky mountain birch	K'ishchiiʔ	*Betula occidentalis*
Roundleaf buffaloberry	Dibédáá'	*Shepherdia rotundifolia*
Rubberweed	Né'éshjaa'yilkee'é	*Hymenoxys richardsonii*
Rush, bull	Lók'aatɬ'ohtsoh	*Scirpus spp.*
Rush, sun	Lók'aatɬ'ohts'óóz	*Juncus spp.*
Rushes, wire	Lók'aa'bits'óóz	*Juncus balticus*
Russian knapweed	Ch'ildích'i'iɬibáhí	*Centaurea picris*
Russian thistle	Ch'ildeeníní	*Salsola kali*
Russian wildrye	Tɬ'oolétsohndtɬ'izí	*Elymus juncus*
Saltgrass	Tɬ'ohdik'ózhí-tɬ'oolédich'ízhí	*Distichlis stricta*
Coyotewillow	K'ei'ɬibáhí	*Salix exigua*
Sand dropseed	Tɬ'ohtsohzhóó'	*Sporobolus cryptandrus*
Sandsagebrush	Ch'ilzhóó'	*Artemisia filifolia*
Sand verbena	K'íneeshdlíshiidáá'	*Abronia spp.*
Scarlet globemallow	Azeenitɬ'inii	*Sphaeralcea parvifolia*
Scribner Needlegrass	Tɬ'ohtsahí	*Stipa scribneri*
Sedges	Téehtɬ'oh	*Carex spp.*
Sego-lily	Gáagiibitɬ'ohchin	*Calochortus nuttallii*
Senecio	Ch'ilbílátahaltsoi	*Senecio spp.*
Serviceberry	Didzédit'ódí	*Amelanchier spp.*
Shadscale	Dá'ák'ózhdijoolí	*Atriplex confertifolia*
Skunkbush	Ch'ilɬichiin	*Rhus trilobata*
Slender wheatgrass	Tɬ'ooléyilts'oozí	*Agropyron trachycaulum*
Smooth horsetail	K'iiɬtsoi ɬizhiní	*Equisetum laevigatum*
Sneezeweed	Niiʔii'niɬ	*Helenium spp.*
Spike muhly	Bé'ézhóó' tsahí	*Muhlenbergia wrightii*
Squirreltail, bottlebrush	Azéé'iilwo'iindtsaaí	*Sitanion hystrix*
St. Johnswort	Biɬhaazhch'ih	*Hypericum perforatum*
Subalpine fir	Ch'ódeeníní	*Abies lasiocarpa*
Sunflower	Nidíyilii	*Helianthus annuus*
Sunflower, giant	Nidíyiliitsoh	*Helianthus spp.*
Tall mormon tea	Tɬ'ohozihiitsoh	*Ephedra spp.*
Saltcedar	K'ei'ɬichiiʔits'óóz	*Tamarix pentandra*
Tansymustard	Ostse'tsoh	*Descurainia pinnata*
Thistle	Ch'ildeeníní	*Cirsium spp.*
Threadleaf groundsel	Azeehááldzidí	*Senecio longilobus*
Threadleaf sedges	Téehtɬ'ohts'ózí	*Carex spp.*
Three-awns	Azéé'iilwo'iiyázhí	*Aristida spp.*
Tobacco	Dziɬnát'oh	*Nicotiana spp.*
Tufted hairgrass	Tɬ'oh Deits'óózí	*Deschampsia caespitosa*
Water hemlock	Shashdáá'	*Cicuta douglasii*
Wax currant	K'íníjiɬahí	*Ribes cereum*
Western wheatgrass	Tɬ'oolé	*Agropyron smithii*

Western yarrow	Téé́hch'ĩhóózhood	*Achillea lanulosa*
Wild carrot	Chaasht'ezhiitsoh	*Lomatium dissectum*
Red plum	Didzé	*Prunus americana*
Wild rose	Chooh	*Rosa spp.*
Winterfat	Gahtsohdáá'	*Eurotia ceratoides*
Wolfberry	Haasch'éé́hdáá'	*Lycium spp.*
Wormsweed	Tsé'ázhiĩh	*Chenopodium ambrosioides*
Wooly Indianwheat	Azee'haatɬ'inii	*Plantago purshii*
Wooly loco	Ch'ilaghání	*Astragalus mollissimus*
Yucca	Tsá'ászi'	*Yucca spp.*

Range plants are so numerous and so different in their forms and growth habits that they need to be grouped for easier identification and management. One type of grouping is by kind of plants. There are four main kinds (Figure 2).

Grasses are plants with jointed, usually hollow stems. The leaves are in two rows on the stem, and leaf veins are parallel. Grasses are the most important range plants. Examples are western wheatgrass, Indian ricegrass and blue grama.

Grass-like plants look like grasses, but they have solid stems which are sometimes triangular (three-sided). The stems have no joints. The leaves are parallel-veined like grass leaves. Examples are baltic rush, bull rush, sun sedge and threadleaf sedge.

Forbs are plants with annual stems or tops and net-like veins in the leaves. These plants are usually called "weeds." Many of the forbs are valuable as forage for livestock, especially for sheep and goats. Examples are western yarrow, lambs quarter, kochia, sunflower and dandelion.

Shrubs are plants with woody stems which live over from year to year. Usually, these plants have many branches coming out from the base of the plant. Examples are big sagebrush, sand sagebrush, four-wing saltbush, greasewood, rabbitbrush and snakeweed.

In addition to being grouped as kinds of plants, plants may also be grouped another way:

Annual plants are those that live only one year. Examples are sunflowers and mustard.

Biennial plants are those that begin growth one year and die the second year. Examples are the sweet clovers.

Perennial plants are those which live over for several years. They produce stems and leaves from the same crown—or base—for many years. Examples are Indian ricegrass, blue grama and western wheatgrass.

Native plants are those plants which originally grew on a certain area. Examples are western wheatgrass and Indian ricegrass.

Introduced plants are those which have been brought into an area from some outside source. They did not grow there originally. Examples are crested wheatgrass, Russian wildrye and Kentucky bluegrass, Russian wildrye and Kentucky bluegrass.

Cool season plants are those which begin growth early in the spring and make most of their growth during the cool weather of spring and early fall. Examples are western wheatgrass and Indian ricegrass.

Warm season plants are those which begin growth and make most of their growth during the hot summer months. Examples are blue grama and sand dropseed.

Plant Parts

Plants are like people—they have bodies and parts. Each plant has some parts that are different from those of all other plants. Since grasses are the most important range plant, we should first learn their parts and compare these with the parts of other plants. Plants usually have stems, crowns, roots, leaves and flowers. To tell one plant from another, we need to

know the names of the main parts, where the parts are located, and how to identify differences. Figures 3 and 4 will help you to locate and identify these parts.

Stems hold the plants up to the sunlight. They are made up of nodes (joints) and internodes (the stem between the nodes). They are usually hollow, but sometimes have pithy (fleshy) centers like corn

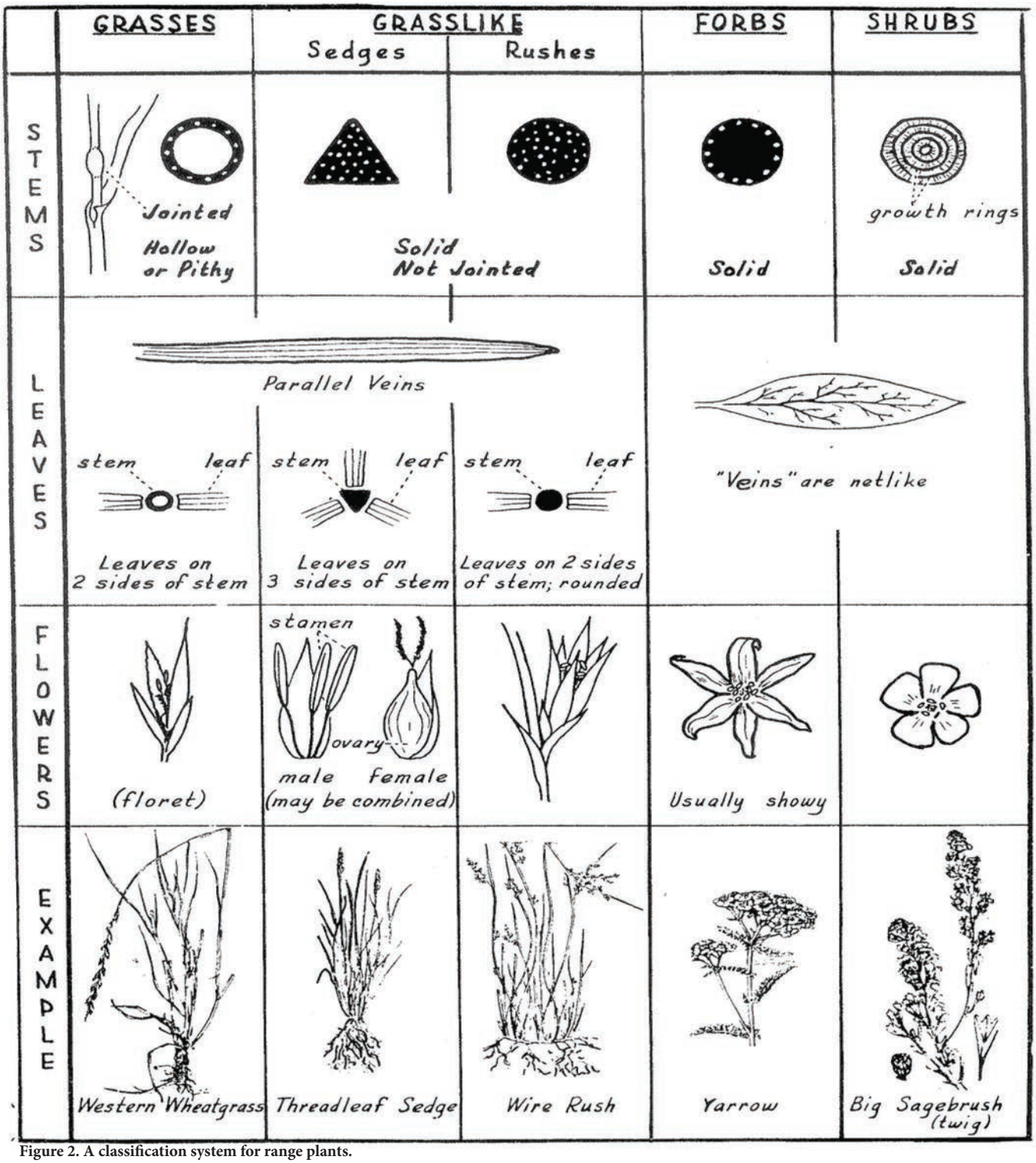
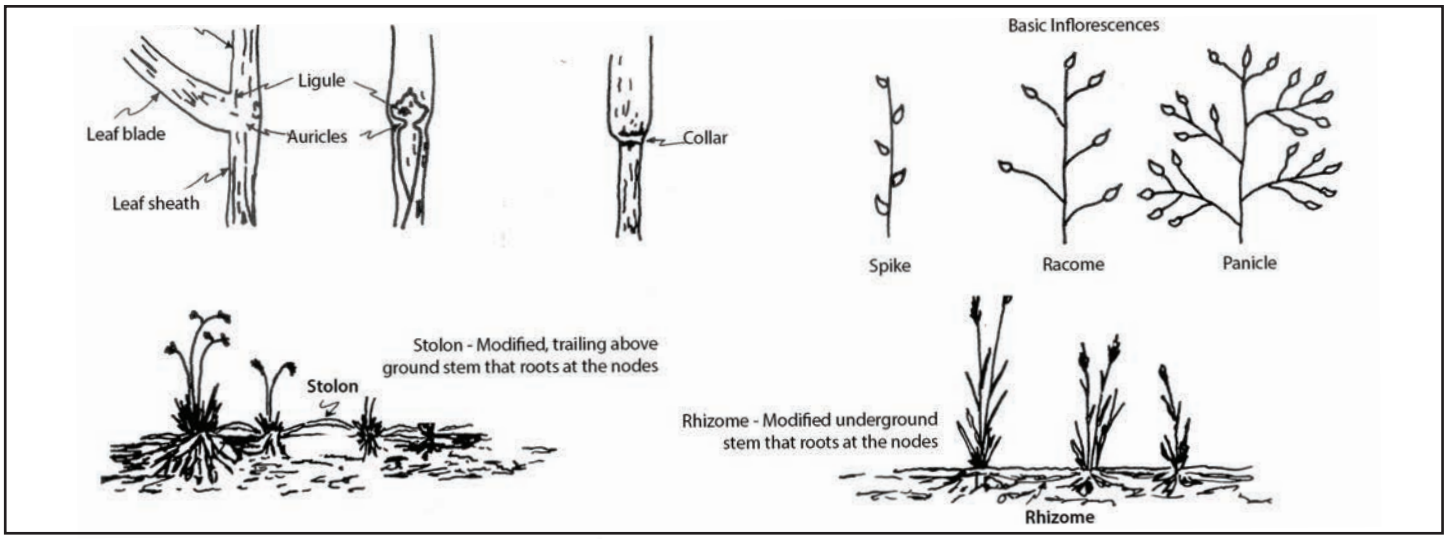


Figure 2. A classification system for range plants.



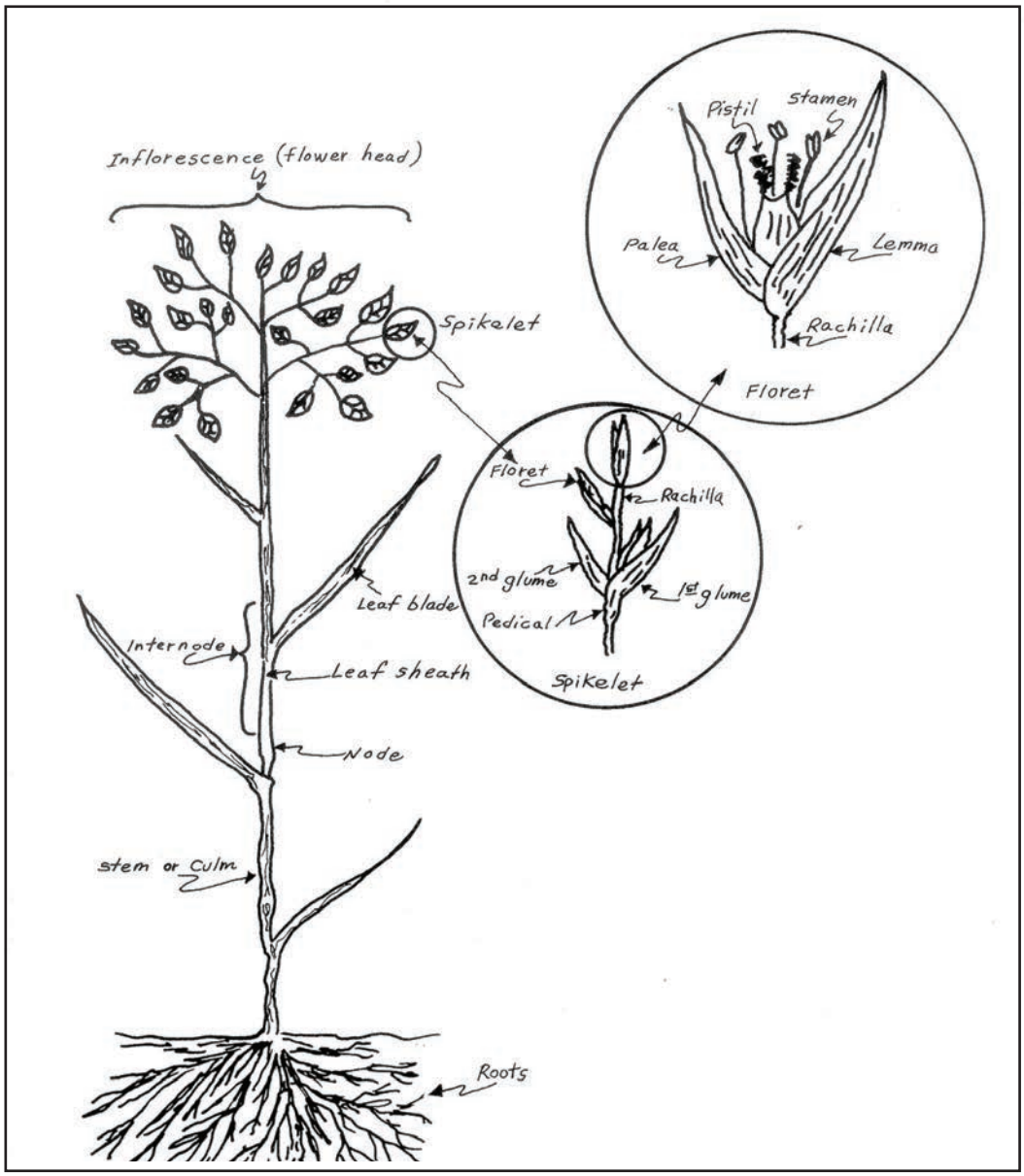
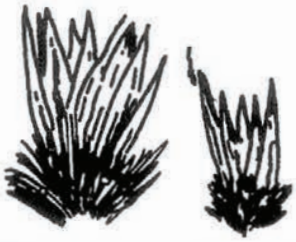


Figure 3. Illustrations of range plant parts.

Wheatgrass Tribe

Spikelets with many florets, these crowded and overlapping. Glumes about equal, about ½ as long as spikelet. Spikelets placed sideways on rachis (stem). Heads spike-like (finger-like). Examples: western wheatgrass, crested wheatgrass.



Galleta Tribe

Spikelets in groups of three, long hairy at base. Spikelet falls entire, leaving a zig-zag rachis (stem). Flower heads are spike-like, purplish in color. Has a perfect floret (1) and sterile florets (2,3). Examples: galleta grass, tobossa grass.

Grama Tribe

Spikelets have one perfect flower and one-two partial flowers. One or two (sometimes more) comb-like spikes per stem. Glumes are narrow and unequal, usually awned. Spikelets in two rows along one side of rachis. Examples: blue grama, black grama, sideoats grama.

Ricegrass Tribe

Spikelets with just one floret. Glumes about equal, generally shorter than spikelet. Flower heads finger-like or much spread out. Examples: Indian ricegrass, needle-and-thread grass, sand dropseed, mountain muhly, three-awn.

Oat Tribe

Spikelets with two to many florets, close and overlapping. Glumes about equal, much longer than spikelet. Flower heads finger-like or much spread out. Examples: wild oats, parry oatgrass, June grass, tufted hairgrass.

Fescue Tribe

Spikelets with many florets, these close together. Glumes unequal, much shorter than spikelet. Flower heads finger-like or much spread out. Examples: Arizona fescue, bluegrasses, smooth brome, saltgrass, cheat grass.

Figure 4. Important Navajo grass tribes.

stalks. Stems transport water and plant food from the roots to the leaves and return manufactured food from the leaves to the roots.

Roots, unlike stems have no joints, no leaves and no flowers. The growing point of the root is at the tip. The main functions of the roots are to transport water and minerals from the soil to the stems, to store plant food and to anchor the plants in the soil.

Rhizomes are actually creeping underground stems with joints and leaf-like scales. Rhizomes can store food and also produce new plants.

Stolons are like rhizomes except that they grow and creep on top of the ground. They do the same things and have the same properties as rhizomes.

Above ground, a grass plant may be divided into two parts—vegetative (growing) and flowering parts. The vegetative part includes the stems and leaves.

The stem is made up of nodes (joints) and internodes (between the joints). At each node on the stem, there is a bud which may produce a new leaf or may remain dormant. The leaf is made up of two parts—the sheath, which fits closely around the stem, and the blade, which is the long expanded part. The two parts are joined together at the collar. On the inside of the collar, next to the stem, is a small leaf-like projection known as the ligule. The ligule may be skin-like or it may be a tuft of hairs.

Some grasses have two finger-like projections or tips on the outside of the collar which tend to reach around the stem. These "fingers" are called auricles.

The flowering parts of a grass plant are called the inflorescence. The inflorescence is made up of many smaller units known as spikelets. At the base of each spikelet are two leaf-like bracts called glumes. A single grass flower is called a floret. Where there is more than one floret in each spikelet, each floret is attached to a short stem called the rachilla. Each floret, when it is mature, produces a seed. The seed is enclosed by two leaf-like bracts called the lemma and the palea. In some grasses, such as western wheatgrass, the lemma and palea remain with the seed after it matures and falls. In other grasses, such as sand dropseed, the seed falls free from the lemma and the palea.

Now that you have some knowledge of the parts of plants, you can use this information to help identify some plants. Since grasses are the most important range forage plants, practice identification with these plants.

Generally, it will be more convenient for you to place grasses into groups called "tribes" as you get to know their characteristics. This will help you to place an unknown grass into a group with its nearest "relative" and will help you to identify it. There are six important grass "tribes" on the Navajo Nation. In learning grasses, it is helpful to first place them in their proper "tribes."

The simple "**key**" below and the sketches and descriptions found on page 13 will help you to place an unknown grass in its proper "tribe."

Key to Grass "Tribes."

la. Stems ending in a single spike (head).	2a
2a. Spikelets placed sideways on rachis (stem).	Wheatgrass tribe
2b. Spikelets in clusters of 3, long hairy at base.	Galleta tribe
1b. Stems not ending in a single spike.	3a
3a. Stems with side spikes, comb-like.	Grama tribe
3b. Stems ending in branching flower heads.	4a
4a. Spikelets with a single flower or seed.	Ricegrass tribe
4b. Spikelets with more than one flower .	5a
5a. G lumes longer than lemmas.	Oat tribe
5b. Glumes shorter than lemmas.	Fescue tribe

The sketches shown in Figure 4 will help you to identify the flower heads of the six different tribes.

How Plants Live, Grow

Range plants are living things which require light, water, air and food if they are to live and reproduce. If any one of these items is missing, the plant will weaken and die. Each year, most of our range plants will produce seed which can sprout and grow into mature plants—if they are managed properly.

A green plant is nature's automatic food-making machine. For power, it uses energy from the sun. Water, air and minerals are the raw materials used in this food manufacturing process. Some of the finished products are sugar and starch (for energy) and proteins (growth). The waste products are oxygen and water (Figure 5).

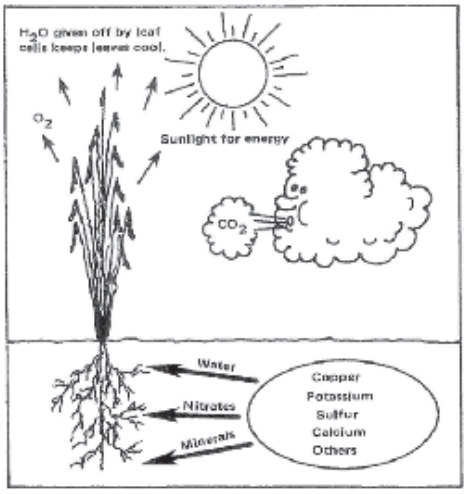


Figure 5. How grass makes food.

Water makes up 70% to 90% of the weight of green grass and from 8% to 25% of the weight of dry grass. Some of this water is used by the grass just to "keep it cool." Water serves as a carrier to transport food materials to different parts of the plant. Most of this water is taken in through the roots, but a small amount also enters through the leaves. The young green leaves contain more water and nutrients than any part of the plant. Grasses—like all plants—require large amounts of water to produce one pound of dry forage. On the Navajo rangelands, grasses need from 300 to 1,200 pounds (36 to 145 gallons) of water to produce one pound of dry forage. This seems like a lot, but when we realize that it takes from 2,000 to 3,000 pounds (240 to 360 gallons) of water to produce one pound of twigs and leaves of big sagebrush or greasewood, we can readily see that grasses are very efficient users of water and that brush plants are very wasteful (Figure 6).

Air is the next most important

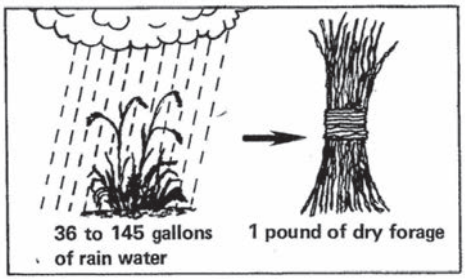


Figure 6. Grass uses water efficiently.

element needed for grass growth. The plant "breathes in" carbon dioxide through small openings on the bottom side of the leaves. Inside the plant, the carbon dioxide is combined with water and other materials to form sugars, starches, fats and proteins that the animals need for growth. The grass plants take in carbon dioxide and give off oxygen—oxygen that supports human life on earth. If all of the lands were covered with green plants, humans would never suffer a shortage of oxygen to breathe.

Minerals taken from the soil are also an important element in the manufacturing process. As many as 36 different minerals have been found in plants, and it is known that 11 of these are needed for plant growth. These are calcium, nitrogen, phosphorous, potassium, iron, sulphur, silicon, magnesium, zinc, boron, and manganese. Each of these minerals in small amounts has a definite place in the life and growth cycle of a grass plant. When any of these minerals is missing, some part of the growth cycle is stopped.

Plant Communities

Different kinds of plants "group" into communities just as people do. Have you noticed that the "group" of plants on a north slope are different from the "group" of plants on the south slope? Plant "groups" on a loose sandy soil are different than the "groups" on a heavy clay soil. These "groups" are called Plant Communities.

The kinds of plants in a community are determined by the type of soil and by climate. Even though the plant community never seems to change, it is never standing still. There are always changes taking place. These changes may be good—or they may be bad. The good range manager must be able to recognize these changes and to know whether they are good or bad. If the changes are bad, the manager must know whether this is the result of poor moisture and growing conditions or if it is

because of management methods.

Changes in the plant community are usually the result of flooding, long and severe periods of drouth, fire or grazing. The most important of these is grazing—because it can be controlled by man.

When rangelands are grazed by livestock, the balance of nature is disturbed. Some plants are grazed more readily than others. Some are not grazed at all. If the plants are kept closely grazed, the roots are damaged. This makes the grazed plant weaker and less able to compete for moisture and plant food. The ungrazed plants remain strong and healthy.

On rangelands that are being grazed, the shorter plants and those that are not liked by livestock have a big advantage over the taller grazed plants. For example, consider an Indian ricegrass plant and blue grama plant growing side by side. If these plants were both grazed to the same height—two inches, about 25% of the blue grama top growth would be removed. However, grazing Indian ricegrass to a height of two inches would remove over 75% of its top growth. It is easy to see that the taller Indian ricegrass would be at a disadvantage because its food-making machinery is reduced too much to provide food for growth and for storage. The plant becomes weak and may even die. Its place will be taken by short-growing blue grama or some other ungrazed plant. The careful range manager always plans to leave enough of the forage growth each year so that the plants can continue to manufacture food for their growth and storage. This stored food is vitally needed by the plant during the dormant or winter season and for early, healthy growth the next spring. A plant with very little top growth has only a weak and shallow root system. A plant with a weak and shallow root system cannot compete and will eventually die out.

Range Sites

To provide a good method for inventorying and studying rangelands, they have been broken into range sites. A range site is an area of land that is capable of growing a certain kind and a certain amount of native vegetation. The kind and amount of vegetation are determined by the type of soil, topography and climate. As you might guess, because of the wide variation of soils, topography and climate, there are many different range sites on the Navajo Nation.

Range Condition

Range condition is the "health" of the range. It is a comparison of the range as it is today with what it was in its original state before drouth, grazing, or other man-related activities caused it to change. There are four main range condition classes; excellent, good, fair and poor.

Excellent condition range exists where 75% to 100% of the plant cover is made up of plants that are native to the site. They were the dominant plants found there before the site was disturbed.

Good condition range exists where 50% to 75% of the plant cover is made up of plants that are native to the site. Short-growing grasses, forbs and shrubs become more numerous.

Fair condition range exists where only 25% to 50% of the plant cover is made up of plants that are native to the site. The site is now dominated by low-growing and unpalatable plants and shrubs or trees.

Poor condition range exists where less than 25% of the plant cover is made up of plants that are native to the site. The site is now covered mainly with shrubs, trees, annual weeds, and low-growing, less desirable forage grasses.

Range site descriptions and condition data have been developed for much of the rangeland of the Navajo Nation. These descriptions contain a list of the kinds and amounts of different plants on the site, a description of soils, the amount of erosion, and how much of the ground surface is covered with living vegetation. These descriptions will help you to "inventory," to better understand and to manage your range area.

Range trend is the direction of change in range condition, whether stable, toward (upward) or away (downward) from the site's potential. A range trend guide is illustrated in Table 2.

The present condition of each range area is a history of past management. The future condition

Table 2. U.S. Soil Conservation Service Range Trend Guide

Range Trend—Improving, Declining, Stable

Things to Look for:

1. Seeding plants
   Yes or No
2. Mulch or litter on the ground
   Yes or No
3. Erosion—Sheet and Gully
   a. Are plants spreading down from soil pedestals?
      Yes or No
   b. Is gully erosion being controlled?
      Yes or No
4. Plant vigor or health considerations
   a. Number of seed heads
   b. Length of stems
   c. Amount of leaves and length
   d. Length of rhizomes or ground runners.

   Are the plants healthy?
   Yes or No
5. Plant composition

   Is there a variety of perennial species of plants?
   Yes or No

   Is there less than 205 annual weeds?
   Yes or No

In General:

- If you answered yes to all questions; range trend is improving.
- If you answered no to all questions; range trend is declining.
- If you answered yes to half and no to half; range trend is probably stable.

or any improvement of the range is up to the user. lmprovements in range condition through proper management will provide for more and better livestock forage; for improvements to the land, to the soil, and to the plants; for better healthier livestock; and for greater profits to the land user.

Rangelands cannot be improved in the same manner as farmlands. They cannot be irrigated and fertilized; it is difficult and expensive to control weeds, brush, and erosion and they generally cannot be made to grow other kinds of soil building crops.

The best way we have of improving these valuable lands is to graze them properly. The amount of grazing should always be in balance with the amount of forage produced. A good rule to follow is to "take half and leave half' of the current season's growth.

A good grazing plan, based on range condition and forage types will help to maintain and improve range condition. A good grazing plan will consider the proper season of use for each part of the range. Grasses should not be grazed in the spring until they have made enough leaf growth to replace food reserves taken from the roots to start their early growth. Since the seasons of growth of grass plants vary (cool-season and warm-season), this time of "range readiness" will vary according to the main species present; and the grazing plan will consider different "starting times" for different parts of the range. Also, different parts of the range will produce plants that are best-liked and best used at different periods of the grazing seasons (early spring, summer, fall or winter).

Another important part of the grazing plan is the system—or manner—by which the livestock will graze—or harvest—the range forage. There are five primary grazing systems which are most commonly used:

1. continuous or year-long grazing,
2. deferred grazing,
3. rotation grazing,
4. deferred-rotation grazing, and
5. rest-rotation grazing.

Continuous grazing on the Navajo Nation generally means stocking the range with the proper number of animals and leaving them there for the entire year.

Deferred grazing means leaving a range unit ungrazed until after seed maturity so the desired plants can build up vigor, make seed and increase in the stand.

Rotation grazing consists of dividing a range unit into smaller units and grazing each unit for a short time, then moving to another unit.

Deferred-rotation grazing is a combination of two systems. The range is divided into smaller units and one unit is allowed to produce mature seeds before it is grazed. All other units are grazed for short periods on a rotation basis.

Rest-rotation grazing is similar to the deferred-rotation system except that one of the units is deferred from grazing for an entire year. All other units are grazed on a deferred rotation system.

In summary, there are four main factors to consider if a grazing program is to bring about an improvement in range condition:

1. Balance between livestock numbers and usable forage produced,
2. Give attention to "range readiness,"
3. Proper season of use, and
4. Develop a grazing system that fits your particular range unit.

Range Improvement Practices

The most common and most needed range improvement practices on the Navajo Nation are erosion control, brush control, livestock water developments, boundary and cross fences and range seeding.

Erosion Control

Each year tons of valuable topsoil and thousands of gallons of life-giving water are lost through runoff and erosion from both wind and water. One storm can carry away more topsoil than can be developed in 500 years. This priceless topsoil is carried downstream where it is deposited as sediment in reservoirs, ditches, water channels and on valuable farm lands and floodplain areas. Both areas—the lands where the

soil is removed and the lands where it is deposited—are being damaged and, in some cases, being permanently destroyed.

The best control against erosion—from both water and wind—is a healthy, deep-rooted cover of native vegetation. This is nature's own way of protecting the soil and the land. When this cover of vegetation is damaged or destroyed, we must use other methods to hold the water and topsoil in place and protect our lands. A few of the most common methods of erosion control are listed below.

Earthen dams are constructed on the larger, more active gullies and washes to store or hold back water and to prevent further erosion. These dams should be used only when other measures will not accomplish the job. They involve the use of large earth-moving equipment, they are expensive to build, and many times they cause more lands to be damaged and laid bare, encouraging even more erosion.

Debris basins are probably the best and the cheapest structures used to control erosion. They may be built out of rocks, brush, trees, logs, fence posts and wire, concrete blocks, or even plain trash. The purpose of debris basins is not to impound or store water; but rather to slow the water down and reduce its "cutting" ability. When the water is slowed down, sediment can settle to the bottom, eventually filling the gully. Since this sediment generally carries a lot of seed with it, these areas are able to reseed themselves naturally, thus speeding up the natural healing process.

Contour terraces or furrows are dikes or ditches built on the contour (across the slope) to prevent runoff and erosion on some of the more gentle slopes.

Pitting is the construction of small pits or trenches on the land to form hundreds of small reservoirs to hold back moisture, prevent runoff and to permit more of the moisture to penetrate into the soil to recharge ground water supplies.

Brush Control

Thousands of acres of valuable Navajo rangelands are covered with thick stands of pinyon, juniper and different kinds of brush. Some of the brush plants, such as fourwing saltbush and winterfat, are valuable livestock feed. Others such as sagebrush, rabbitbrush, greasewood, snakeweed, goldenweed, and wolfberry are almost worthless as forage plants. They are grazed only when no other feed is available. Brush plants also provide very little protection against erosion. Even more serious, however, is that they are deep rooted, and they rob the grasses of moisture needed for plant growth. If these worthless brush plants can be removed—or at least reduced—moisture would then become available for increased grass growth.

Unwanted and useless brush plants can be controlled by mechanical methods, by chemicals, and sometimes by controlled burning. Mechanical methods are desirable because they are easier to control and they can be done during most any part of the year. Late fall and winter are good times to plan for mechanical brush control because the plants are relatively dry and brittle during this period. There is also less chance of damaging the soils during this period. No mechanical control methods, however, should be used when the soils are wet.

Some sprouting brush species, such as oak brush, rabbitbrush and wolfberry can only be controlled effectively with the use of chemicals. 2,4-D mixed with water is the most widely used and most effective chemical to use for brush control. Chemicals may be applied with ground spraying equipment or by airplane. Considerable caution is needed, however, since this material may "drift" onto areas where it may cause more harm than good. It should also be noted that timing, stage of growth, climate and weather conditions are all very critical for good success.

Regardless of the methods used, any area that is treated for brush control should be deferred from grazing during the first full growing season following the control. If possible, two years of deferment are even better. The rest from grazing after brush control is needed to give the understory grasses a chance to take advantage of the additional moisture, develop deeper and healthier root systems, and to build up their vigor before being grazed.

Livestock Water Development

Most of the Navajo rangelands are lacking in sufficient water for livestock; water sources are few and they are great distances apart. Even in areas of good forage, livestock many times must travel great distance to water. They tend to graze areas close to water again and again, rather than move a long distance to other, and perhaps even better, forage. This results in heavy use on some areas and almost no use on others. More watering facilities lead to better animal distribution, better livestock gains and better grazing management.

The amount of water needed by livestock differs with the kind of forage, the amount of salt being eaten, the climate, the season of use and the kind of livestock. The amount of water needed per day is about twelve (12) gallons for cattle and about one (1) gallon for sheep or goats.

Cattle like to drink daily during the hot summer months. They usually drink every other day during the cooler months in fall and winter.

Sheep may go without water for one or two days during summer and for even longer periods during the cooler months.

Water developments on the reservation are mainly wells and tanks, spring developments, live streams (in a few areas), water catchments and earthen pits or tanks. Wells are generally used because they can be located in desired places—where water is needed—and they are the most dependable. Usually, it is wise to drill the well on high ground and pump the water into a huge storage tank. Plastic pipelines can then be laid out to carry water to other desired and needed locations.

Springs, where they exist, are also an excellent source of water. Many of these, however, will tend to go dry during the hot summer period. It is also difficult, and often impossible, to pipe spring water for any great distance or to any location because of the low quantity of water and the fact that springs sometimes are located on lower ground.

Open pits or dams have been used in the past to collect and store runoff and the water from wells or springs. These, however, are of limited value because of the seepage losses in most Navajo soils. Open tanks or ponds also lose a lot of water into the air through evaporation. They are also a poor choice because: (1) there is very little runoff on good condition ranges, and (2) the ponds tend to fill with silt and sediment to a point where little or no storage capacity remains on poor or low condition ranges.

The use of horizontal wells into the sides of some of the broken and fractured hills and the development of catchment basins offer excellent possibilities for additional livestock water. Developments such as these are an advantage because they are cheaper to install, they require no source of power, and they require little or no maintenance.

Fencing

Fencing—although disliked and rejected by many of the Navajo people and by Navajo Tribal regulations—is an important range improvement practice. This includes both boundary and cross fences. It is difficult—if not impossible—to obtain good grazing and range management without some means of controlling livestock. The main reasons for fencing are:

1. Fences help prevent straying or trespassing of livestock.
2. Fences help to distribute livestock and provide more uniform grazing of all the range.
3. Fences make deferred and rotation grazing possible
4. Fences make it possible to prevent grazing in special or problem areas, such as reseeded areas, critical erosion sites or poisonous plant areas.
5. Fences make it possible to separate kinds of animals or classes of livestock.

Barbed wire fences are generally used for controlling cattle, while woven wire is used to control sheep and goats. Regardless of the type of fence built, a few guidelines should be followed.

1. Fences should follow the natural lay of the land.
2. Fenced-in areas should have uniform vegetation of the whole area.
3. Fenced-in areas should have access to water.
4. Pastures should be about equal in the number of animals that can be grazed safely.
5. Special use areas (spring pas-

tures, hay fields) should be fenced separately.

6. Fences should be built so as not to interfere with the movements of wildlife:
   a. Deer areas—top wire should not be over 48" from the ground.
   b. Antelope range—bottom wire should be at least 18" from the ground surface.

Salting

Grazing animals generally need more salt than they can get from plants. The lack of salt causes animals to lose their appetite and to lose weight.

Proper distribution of salt is one of the best and cheapest methods of obtaining good livestock distribution and even range use. Livestock need salt—just as we do—and they will travel a long way to find it.

Salt grounds should be located away from water and in areas of good forage. Salt blocks should be moved as often as is necessary to obtain even use of all forage areas. They should not be located on areas that are easily eroded.

Cattle generally require about two (2) pounds of salt per month. For sheep, one half pound per month is adequate. Salt blocks should be at least one-quarter of a mile from water.

Range Seeding

Thousands of acres of Navajo rangelands are in need of seeding. These areas represent small abandoned farm fields, critically eroding areas, rangelands that have been misused for many years and lands that have been invaded by worthless brush plants, pinyon, and juniper. The combination of a lack of grazing management and the prevailing desert like climate has resulted in the loss of a good vegetative cover and low forage production.

Seeding is an expensive and risky range improvement practice. Therefore, it is recommended only as a "last resort"—only on sites where the native vegetation has been destroyed to the point that good grazing management will not bring about range improvement.

Where range seeding is needed, good planning is necessary to insure success. Plans for seeding should include:

1. Select the right species or mixture for the site.
2. Prepare a good seedbed.
3. Seed the proper amount.
4. Use proper seeding method.
5. Seed at the proper time.
6. Protect and manage the new seeding.

Plant Selection

It is very important to select plants that are adapted to the soils and climate in a specific area. Grasses such as western wheatgrass are well suited to heavy bottom land soils, while Indian ricegrass and sand dropseed are well adapted to the deep sandy soils. Crested wheatgrass and Russian wildrye are adapted to the drier sites, having less than 10 inches of annual precipitation. Pubescent wheatgrass, intermediate wheatgrass and smooth brome are adapted to moister areas. Regardless of species, it is always important to plant high quality seed (seed having high rates of purity and germination). The seeding chart that follows lists some of the most used species, where they are best suited, and gives their seeding rates.

Preparing a Seedbed. A good seedbed is absolutely essential for the establishment of grass seedlings. Many seedlings fail or are unsatisfactory because of poor seedbed preparation.

A good seedbed must be firm, as smooth as is possible and free of weeds or other vegetation. Newly plowed fields should be dragged several times to make them firm before the seed is planted. A firm seedbed will stay moist longer than a rough, loose one. A firm seedbed also helps to prevent planting the small seeds too deep.

On loose, sandy soils and on steeper eroding sites, it will be necessary to cover the soil with a straw mulch to keep the soils cooler, to prevent the soil from drying out too fast and to prevent losses from wind and water erosion.

Seeding Rates. Seeding rates for the most commonly used species are shown on Table 3. Seeding rates are shown in pounds of pure live seed (PLS) per acre. These rates are based on planting 20 to 25 PLS per square foot using a regular grass drill. If the seed has to be broadcast, the seeding rate should be doubled.

Seeding Methods. Grass seed should be planted with a drill equipped with depth regulator bands. Seeds planted too deep will never make it to the surface. Neither will seeds planted too shallow. It is necessary to plant the seed deep enough to have moisture and yet shallow enough so it can emerge through the surface. Small seeds should be planted ¼ to ½ inch deep, the larger seeds about one inch. Double this depth when seeding on coarse sandy soils. Broadcast seeding (spreading the seed on top of the ground) is not a good practice. In steep or rough country, however, this may be the only way to get seed on the ground.

Time of Seeding. The best time for seeding most of the Navajo rangelands is from June 15 to July 1 or in the month of October. Most of the summer rains come during July, August, and early September. June plantings can take advantage of this moisture to develop good top and root growth before "freeze-up" comes. October plantings will rely on snow cover and moisture the following spring for germination and growth. Always try to avoid planting on any site or soil when it is extremely dry.

Management on New Seeding While new seedlings are getting established, they should not be grazed. New range seedings should not be grazed during the growing season (May 1 to September 1) for two years after planting. Light grazing in the fall or to control weeds is

Table 3. Range Seeding Rates for Pure Live Seed

The first few years of a new seeding is the most critical time, and all efforts should be made to insure success of the stand.

Species (Native)	Seeding Rate (lbs. PLS/Acre)	Where Adapted	Inches of Rain
Western wheatgrass	9	Loam, clay: upland, bottom	6-14
Galleta grass	5-6	Sand, loam, clay; upland, bottom	6-14
Indian ricegrass	4	Sand, loam, clay; upland, bottom	6-14
Blue grama	1-2	Sand, loam, clay; upland, bottom	6-14
Sand dropseed	1/4	Sand, loam, clay; upland, bottom	6-14
Thickspike wheatgrass	7	Sand; upland, bottom	6-14
Alkali sacaton	1	Sand, loam, clay; upland, bottom	6-18
Vine mesquite	6	Loam, clay; bottom	6-14
Streambank wheatgrass	6	Loam, clay; upland bottom	6-14
Basin wildrye	7	Loam, clay, salty, bottom	6-18
Smooth wildrye	7	Loam, clay, salty, bottom	6-14
Spike muhly	1/2	Loam, clay, shallow; upland	6-14
Sideoats grama	6	Loam, clay, shallow; upland	10-14
Black grama	3/4	Sand, loam; upland, bottom	10-14
Little bluestem	3-4	Sand, loam, shallow: upland	6-14

allowed if it is found necessary.

Species (Native)	Seeding Rate (lbs. PLS/Acre)	Where Adapted	Inches of Rain
Big bluestem	7	Sand, loam, shallow; upland	6-14
Arizona fescue	2	Loam, clay; upland	6-14
Sheep fescue	1	Loam, clay; upland	10-30
Mountain muhly	1	Loam, clay, shallow; upland	10-30
Mountain brome	7	Loam, clay, shallow; upland	10-30
Timothy	3/4	Loam, clay, wet; bottom	18-30
Redtop	1	Loam, clay, wet; bottom	18-30
Giant dropseed	2	Sand, loam; upland	6-14
Giant wildrye	8	Sand. loam; upland	6-14
Big bluegrass	1	Loam, clay; upland	10-30
Fourwing saltbush	4-5	Sand, loam, clay; upland. bottom	6-14
Winterfat	6	Sand, loam, clay; shallow; upland	6-14

Species (Introduced)	Seeding Rate (lbs. PLS/Acre)	Where Adapted	Inches of Rain
Crested wheatgrass	6	Sand, loam; upland, bottom	6-14
Siberian wheatgrass	6	Sand, loam, clay; upland	6-14
Russian wildrye	5	Loam, clay; bottom, salty	6-14
Tall wheatgrass	12	Loam, clay; upland, bottom	6-14
Pubescent wheatgrass	11	Loam, clay; upland, bottom	6-14
Intermediate wheatgrass	10	Loam, clay; bottom, salty	6-14
Tall fescue	5	Loam, clay; bottom, salty	6-18
Meadow fescue	4	Loam, clay; bottom, salty	6-14
Smooth brome	7	Sand, loam, clay; upland, bottom	6-14
Meadow brome	7	Sand, loam, clay; upland, bottom	6-18
Orchard grass	2	Sand, loam, clay; upland, bottom	6-14
Reed canarygrass	2	Sand, loam, clay; wet bottom	6-14
Creeping meadow foxtail	4	Sand, loam, clay; wet bottom	10-14
Alfalfa	4	Sand, loam, clay; bottom	10-14
Sweet clover	3	Sand, loam, clay; upland, bottom, shallow	6-14
Cicer milkvetch	6	Sand, loam, clay; wet bottom	6-14
Sanfoin	12	Sand, loam, clay; upland, bottom, shallow	6-14
Alsike clover	2	Sand, loam, clay; wet bottom	10-30

Glossary

Aggregate - A mixture or grouping of soil particles.

Annual - A plant that completes its life in one year.

Atmosphere - The air surrounding the earth.

Auricles - Finger-like tips on the collar of some grasses.

Awn - The long bristle or thread-like tail on some grasses.

Biennial - A plant completing its life in two years.

Blade - The part of a grass leaf extending away from the stem.

Collar - The point where the leaf blade bends away from the stem.

Culm - The stem of a grass plant.

Evaporation - The loss of water from a surface as vapor.

Floret - The flower of a grass plant.

Glume - The outer bracts of the grass spikelet.

lnternode - The space between nodes or joints of a stem.

Lemma - The lower bract of a grass floret.

Ligule - The skin-like or hairy growth inside the collar of a grass plant.

Mulch - Dead plant material remaining on the plant or on the ground surface.

Node - The swollen "joints" of a grass stem.

Organic Matter - Decayed material lying on and down into the soil.

Palea - The top or inner bract around a grass floret.

Panicle - A wide and much branched flower head.

Pedicel - The "stem" which connects a grass floret to the main stem.

Perennial - A plant that lives for several years.

Pistil - The female part of a flower.

Plant Community - A group of plants growing (living) together on a given area.

Raceme - A narrowly branched flower head.

Rachilla - The "stem" connecting a floret to the rachis.

Rachis - The main stem of a flower head.

Range Readiness - Refers to the time that plants have grown enough to allow grazing and the soils are dry enough to prevent damage from livestock trampling.

Rhizome - An underground stem with nodes which give rise to new plants.

Sediment - Soil which is carried in water and settles to the bottom when the movement of water is slowed down.

Sheath - The part of a grass leaf which wraps around the stem.

Soil Organisms - Small living bodies (insects, worms, etc.) within the soil.

Spike - A finger-like flower head.

Spikelet - A part of a grass head made up of one or more florets.

Stamen - The male part of a flower.

Stolon - An above ground stem, trailing along the surface, that takes root at the nodes and develops new plants.

Structure - Refers to the way soil particles are "glued" together.

Texture - Refers to the size of soil particles.

Transpiration - The loss of moisture from the surface of plants.