Forage Production
on Arizona Ranges, IV.
COCONINO, NAVAJO, APACHE Counties
A Study in Range Condition

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COVER PICTURE

Aspens on the North Kaibab, in Coconino County

Betts, October, 1955. 6 M.
Forage Production on Arizona Ranges
IV. Coconino, Navajo, Apache Counties
A Study in Range Condition

By: Robert R. Humphrey

FOREWORD

Forage production on range lands is determined largely by three factors: productivity of the site, weather and management. In some areas, notably California and Florida, site productivity has been improved by fertilization. Other site-improvement techniques that have been used with success in some localities include pitting, ripping and contour furrowing.

Although, as this is written, proof is still lacking that any appreciable control of the weather is possible, evidence is accumulating that seems to indicate that some control over weather may become an actuality in the near future. At present, however, Arizona ranchers still have to trust to the whims of rain clouds to drop moisture where they will.

In contrast with site productivity and the weather, man usually can, though he often does not, control his own activities and their effect on his range lands. This type of control comes under the heading of range management.

Range lands, the forage they grow and the livestock they support are largely at the mercy of the land owner or administrator. The immediate effect of good or poor management is reflected in the current economic welfare of the operator; its long-time effect may not only make or break the operator; it may similarly affect future generations.

Range forage production on any specific area is not an exact figure that can be used and relied on year after year. Many things may cause the forage crop to fluctuate widely from one year to the next. Deficient rainfall may result in little or no forage production; better-than-average rains may cause a temporary increase above the average. These decreases or increases may be large. A long-continued drought may so reduce available forage that livestock numbers have to be cut almost to zero; several years of better-than-average rains may double or treble the numbers that can be carried.

Grasshoppers or crickets almost overnight may destroy a forage crop that was relied on to give many months’ grazing. Game animals may increase to a point where they overgraze the range and reduce forage production; or, management of domestic livestock may improve or deplete a range and radically change its grazing capacity within a few years. These continual changes in forage production may make any tabulation of forage resources of little value from one year to the next. The fact that these fluctuations do exist, however,
should not be taken to mean that a given range does not have an average grazing capacity. On a long-time basis, provided there is not a change in condition class, any given range does have an average number of stock that it will support. For example, a given desert-shrub range will have one average carrying capacity, desert grassland another, juniper-pinyon another, etc.

Although grazing capacity tabulations may mean very little, it is highly important to a rancher that he be able to tell whether the various parts of his ranch are producing as they should. It is the purpose of this bulletin to present a general method of determining range condition and to illustrate its application by showing how a rancher in Coconino, Apache or Navajo County may determine the condition of his range. A map showing principal forage types and the location of places named will be found inside the back cover.

RANGE CONDITION—WHAT IT MEANS

The value of rangelands commonly depends on the quality and quantity of forage produced. This is reflected indirectly in livestock production. Forage production can be expressed as range condition; in general the more forage produced on a given site the better the range condition.

The range lands included in this publication are classified into four condition classes. Each class is determined largely by the amount of forage produced expressed in terms of the percent the same site should produce. The four condition classes and the forage produced on each are:

- **Excellent**: Producing from 75 to 100 per cent of all the forage the site should produce.
- **Good**: Producing from 50 to 75 per cent of the forage the site should produce.
- **Fair**: Producing from 25 to 50 per cent of the forage the site should produce.
- **Poor**: Producing less than 25 per cent of the forage the site should produce.

FORAGE PRODUCTION NOT THE WHOLE STORY

Although the condition of a range is defined in terms of forage production, several factors have to be evaluated to determine the condition class into which a given area falls. These are composition of vegetation, ground cover or density, litter or dead plant material on the ground, forage vigor, seed production and degree of erosion. All of these may not always be involved but each one should be considered.

COMPOSITION

The kind of plants on a range, possibly more than any other single item, determines its condition. When most of the plants are good forage producers, the range usually rates high in a condition classification. Conversely, when low-forage-value plants predominate on a range that should support better plants, a low condition is indicated.

On the other hand, since range condition is defined in terms of
the amount of feed a range is producing as compared with the amount it should produce, it is possible to have a type with few or no forage-producing plants rated high on a range-condition scale. A creosote-bush flat, for example, may never have grown anything except creosote bush. Even though this plant has no grazing value, the type was never any better and has no apparent possibilities for future improvement. As it is already producing all the forage possible, it would be rated in excellent condition. There is some question whether worthless or near worthless areas of this sort should even be classed as range. If they are, however, the same principle of classification should be applied to them as to any other range area.

GROUND COVER

The amount of ground covered by vegetation, sometimes called density, may affect both forage production and erosion. In general, ranges producing a large amount of forage have a denser ground cover than less productive areas. This is not true in some extreme cases where grasses have become sodbound. Under such a condition the greatest forage production may occur on comparatively open stands. As a general rule, however, high densities mean high forage production and little erosion. These combine to indicate an excellent condition range. Similarly, lower densities on the same type of range are generally associated with poorer range condition.

LITTER

The amount of litter or undecayed dead plant material on the ground helps to indicate condition. Moisture penetration and seed germination are both increased where litter is abundant. Ranges with a good cover of litter, therefore, generally produce more forage and are less eroded than ranges where litter is thin or lacking. In most instances large amounts of litter are associated with good or excellent condition; smaller amounts with fair or poor condition.

PLANT VIGOR

The vigor of plants is often useful in determining condition. A vigorously growing plant produces more forage and is more effective in controlling erosion than one that is weak.

When the better forage plants are vigorous this usually indicates a good or excellent condition, or, at least, an improving range. When the poor forage plants are vigorous, on the other hand, and the good plants are weak, this is an indication of a deteriorated range or a range that is on the downgrade.

SEED PRODUCTION

Seed production is frequently of value as a criterion of range condition. This is particularly true on run-down ranges where seed production is important in revegetation. Grasses with low or decreasing vigor tend to set little viable seed. Those with good or increasing vigor, on the other hand, tend to set a good crop of viable seed.

There are exceptions to the foregoing: where ranges in top condition may set very little seed, most of the plants' energy going
into vegetative growth. The low seed production in these cases does not affect range condition since the areas are already producing all the forage of which they are capable.

SOIL EROSION

Nothing is as essential to the ultimate productivity of a range as its soil. When a range is classed as being in excellent condition this means that for practical purposes it cannot be improved. Any range that is actively eroding has something wrong with it and is not in excellent condition. Soil erosion, therefore, is highly important as a factor that affects range condition. A range that is being severely eroded is not in excellent condition even though it might still be producing 75 per cent or more of all the forage possible on the site.

RANGE TRENDS

It is of great practical importance to know not only the present condition of a range but also whether that range is improving or deteriorating. Range forage production never stands still, never remains the same year after year. Some of the causes of these changes can be controlled, some cannot be. Management methods that are improving a range should be continued if at all possible. On the other hand, when a range is on the downgrade because of management, the need for a change is evident. The ability to determine trends helps a rancher to see where his ranch and, consequently, his own finances and future are headed.

Factors other than grazing, such as climate or fire, may affect condition trends. Even when a range deteriorates because of drought, the ability to detect the direction of trend early may permit management changes that will help to check the damage being done. Or, when a range is improving as a result of abnormally heavy rains, the ability to recognize this improvement may permit increased stocking or other changes in management to take advantage of the extra forage being produced.

INDICATORS OF AN IMPROVING RANGE

EROSION

Old gullies that are becoming grassed over indicate a range that is improving or that has improved recently. The amount of runoff from grazing lands is usually in rather direct proportion to the condition of those lands. Loss of both soil and water is generally excessive from run-down range but, as the condition improves, more water is held where it falls. Gullies that before were actively cutting will carry less water and soil, and will have a chance to start healing.

PLANT VIGOR

Vigorous growth on the better forage plants generally indicates range that is on the upgrade or is already in top condition. Range condition is literally range health, and a range is no more healthy than the forage-producing plants growing there.

DEGREE OF USE

Moderate to light grazing of the better forage plants will lead to improvement of a run-down range or to maintenance of a range al-
ready in top condition. When the better forage plants are unevenly grazed and have a ragged appearance by the end of the grazing season, this indicates grazing that is not too heavy. The poorer plants on this same range should be grazed little or not at all. These are indications of a degree of use that will build up a run-down range and maintain one already in top condition. Vegetation weakened by too-heavy grazing cannot produce the feed that it would were it growing vigorously. Weakened plants must be grazed lightly if they are to be brought back to a healthy and vigorous state.

**LITTER**
Accumulation of litter on most ranges is an indication of improvement. Litter protects the bare soil from the erosive and sealing action of beating raindrops and greatly increases the amount of water that enters the soil. Rain striking bare soil soon washes silt and clay into the soil pores and seals over the surface. This greatly reduces moisture penetration and increases runoff and erosion. Dead stems and leaves lying on the ground slow down the rate of runoff and cause soil to be deposited that would otherwise be carried off. Water is slowed down as it moves across the ground and has a longer time to soak into the soil. A range without enough litter to control erosion cannot be on the upgrade even though some of the other indicators may seem to point that way.

**SEEDLING ESTABLISHMENT**
Establishment of many new plants of the better forage species and few plants of the poorer species indicates an improving range. Most run-down ranges do not have an adequate ground cover of forage-producing species. Establishment of seedlings of these species indicates that conditions for seed production and germination were favorable and points toward an increase in forage production. On the other hand, when undesirable plants are not maintaining themselves by establishment of new plants, this may indicate that these undesirables are being replaced by plants of some value as feed and that the range is improving.

**INDICATORS OF A RANGE ON THE DOWNGRADE**

**EROSION**
Active erosion (with gullies that are not becoming vegetated) is one of the best indications that a range is on the downgrade. A range that is losing soil by erosion is deteriorating and will continue to produce less and less feed.

Water lost as runoff is directly reflected in the amount of forage produced because plant growth on most Arizona ranges is limited primarily by available moisture. Ground that is protected by a cover of either living or dead plant material does not seal over during rains but remains porous and absorbs moisture more readily than it would without this protective cover.

**PLANT VIGOR**
Full forage production is not obtained from small, weak plants, or from those with little forage value. Consequently, weak growth
of the better forage plants or vigorous growth on those that produce little or no forage indicates a range on the downgrade. When plants are weakened year after year, portions of them or sometimes the whole plant may die. An abundance of the better forage plants dead or dying indicates a range that is deteriorating rapidly.

**DEGREE OF USE**

Excessive use of the better forage plants is another indication that a range may be on the downgrade. Most species can stand occasional heavy grazing with little harm. When heavy grazing is continued year after year, on the other hand, the plants become weaker, the soil is exposed to excessive erosion, and forage production decreases.

**LITTER**

A range with little or no dead plant material or litter on the ground is generally on the downgrade. This is in part because there is little accumulation of organic matter to build topsoil or retard runoff. Forage production is related very closely to soil fertility and soil tilth. Both fertility and tilth are in part the direct result of organic-matter accumulation, and any litter that is allowed to accumulate and build topsoil increases the ability of that range to produce.

**SEEDLING ESTABLISHMENT**

Unless a range is in top condition, it is on the downgrade when few or no young plants of the better forage species are present. A range can be maintained or improved only by maintaining or increasing the quality and quantity of forage. When death losses of the better plants more than equal replacements, that range is deteriorating. Similarly, when young plants of poor or worthless species are much in evidence this also is an indication that the range is on the downgrade.

**VEGETATION TYPES OF COCONINO, NAVAJO AND APACHE COUNTIES**

Four generalized forage types are included in this classification: grassland, browse, juniper-pinyon and conifer-aspen forest. Some of these consist of two or more subtypes, each dominated by certain species that occur only occasionally or not at all in the other subtypes.

The grassland, for example, is subdivided into alpine grassland, shortgrass and sand bunchgrass. Arizona or sheep fescue, mountain muhly and pine dropseed are the major dominants in the alpine grassland; blue grama in the shortgrass; and Indian ricegrass, sand dropseed and Mormon tea in the sand bunchgrass. Similarly, the browse is broken down into sagebrush, saltbushes and blackbrush. The sagebrush, in turn, is described under three finer subtypes: big sagebrush, sand sagebrush and black sagebrush.

These finer breakdowns are necessary because in each case the subtypes do not intermix, but grow separately under different soil or climatic conditions. Finally, because of the differences in vegetation or soil and climate, specific subtypes require specific management practices.
GRASSLAND

Although there is an understory of grasses beneath the trees or shrubs of most of the forage types within the area, only the open grassland is classed here as a grassland type. The other types, even those supporting large amounts of grass, are designated by the dominant overstory vegetation.

Three kinds of open grassland occur in Coconino, Apache and Navajo counties: alpine grassland, shortgrass and sandgrass.

The alpine grassland is found only at high elevations in openings in the timber type. The term is the result of local usage, as the grass composition here is not typical of the true alpine grassland of other states but more nearly resembles that of the adjacent timber stands.

The shortgrass is similar in part to the desert grassland of the Southwest; in part to the shortgrass of the Great Plains.

The sandgrass is restricted to sandy-soil areas, highly susceptible to wind erosion.

Arizona fescue, pine dropseed and mountain muhly are the principal grasses in the alpine grassland; blue grama, black grama and galleta in the shortgrass; blue grama, Indian ricegrass, galleta and sandhill muhly in the sandgrass. As the range deteriorates these grasses are replaced by low-value weeds and brush.

Forage production in most of the grasslands was formerly much greater than it is today. Most of the stands have been thinned out or the better grasses replaced to some extent by grasses with little or no grazing value. In many places low-value shrubs such as sagebrush and rabbitbrush have moved in as the grasses have disappeared. This has changed the aspect from one of grassland or grassland with scattered shrubs to one of shrubs with or without grass.

Other areas that were formerly grassland have been taken over by junipers. Some of these areas are now almost completely devoid of grass and severely eroded.

Shortgrass ranges usually have a fine-textured soil readily subject to water erosion. Sandgrass ranges, on the other hand, lose almost no soil from water erosion but are often severely wind eroded.
Alpine rassland—excellent condition; Ft. Apache Reservation between McNary and Springerville.

Reasons for an excellent condition rating on this range:

The area is producing essentially all the forage of which it is capable. Such perennial grasses as Arizona fescue, pine dropseed and mountain muhly make up more than 90 per cent of the plant cover. The plants are vigorous and there is no erosion.

Comments:

Although the alpine grassland has a short grazing period of about four months during the summer, the high rainfall normally produces an abundance of forage during this period.
Alpine grassland—good condition; North Kaibab on road to park headquarters.

Reasons for a good condition rating on this range:

The vegetation is composed largely of the better forage plants. Most of these are grasses and include primarily such species as sheep fescue, junegrass, needlegrass and pine dropseed. Perennial weeds such as cinquefoil, pussytoes, fleabane and dandelion occur as a minor fraction of the vegetation. There is a rather large amount of litter and almost no erosion.

Comments:

Although the alpine grassland is a high-altitude type, it is not above timberline. Fires may have destroyed the trees on these grasslands at some time in the distant past. The sites are apparently poorly adapted to tree production; as a consequence revegetation to trees is slow.
Alpine grassland—fair condition, Fort Apache Reservation between Alpine and Maverick.

Reasons for a fair condition rating on this range:

Although the grasses that principally characterize good and excellent-condition alpine grassland are still present, they have been replaced to a considerable extent by less valuable grasses and by weeds. The most common of these less desirable plants are nutgrass and other sedges, squirreltail, Kentucky bluegrass, fleabane, yarrow and iris or blue flag.

Comments:

Even on fair-condition alpine-grassland ranges the high rainfall produces a sufficiently dense cover of vegetation largely to prevent erosion. The carrying capacity, however, will be less than half that of excellent-condition areas in this same type.
Alpine grassland—poor condition, Apache County near Big Lake.

Reasons for a poor condition rating on this range:

Only a small portion of the vegetation consists of such desirable grasses as Arizona fescue, pine dropseed or mountain muhly. These grasses have been replaced in large part by such low-value weeds as sedges, iris and fleabane daisy. Plants of the better grasses that do remain are weak in vigor and produce little volume of feed.

Comments:

Alpine grassland ranges have a high production potential and even when severely depleted will recover rapidly under careful handling. Whenever possible, poor-condition areas should be deferred during July and August every other year, or at least one year out of three, until they improve to a good condition rating.
Shortgrass range—excellent condition, eastern Coconino County; Chamise and blue grama dominant.

Reasons for an excellent condition rating on this range:

There is an excellent cover of highly productive forage species. The plants are vigorous and producing a large volume of feed. There is no measurable erosion or runoff.

Comments:

Although this range is classed as grassland, it supports an abundance of chamise in addition to the grasses. This combination of palatable grasses and palatable browse provides a balance of forage unobtainable on even the best straight grass ranges.
Shortgrass range—good condition, eastern Coconino County; blue grama and chamise dominant.

Reasons for a good condition rating on this range:

There is a good cover of palatable grasses and a scattered stand of chamise. There is little erosion or runoff.

Comments:

The grasses are more widely spaced and less vigorous than on excellent condition range. A few low-value grasses such as ring muhly or sand dropseed are beginning to come in.
Shortgrass range—fair condition, eastern Coconino County; blue grama dominant.

Reasons for a fair condition rating on this range:

Although blue grama is the dominant grass, there is a moderate amount of such low-value species as ring-muhly and red three-awn. There is a moderate amount of erosion and runoff.

Comments:

Chamise and the larger grasses such as Indian ricegrass and needlegrass are almost entirely absent. This tendency for the large forage plants to give way under grazing is characteristic of most grassland ranges. All shortgrass ranges in northeastern Arizona did not originally support chamise, though the majority probably did.
Shortgrass range—poor condition, northeast Coconino County between Seligman and Rose Well; blue grama and rabbitbrush dominant.

Reasons for a poor condition rating on this range:

There is an abundance of the worthless rabbitbrush growing between the grass clumps. Erosion is active and there are large amounts of water lost as runoff.

Comments:

Poor-condition shortgrass ranges typically have an abundance of such low-value grasses as ring-muhly and red three-awn. There may or may not be an overstory of rabbitbrush or snakeweed.
Shortgrass range—poor condition, eastern Coconino County near Rose Well; vegetation largely Russian thistle.

Reasons for a poor condition rating on this range:

The original grasses and chamise have been almost completely replaced by Russian thistle. This provides an uncertain forage crop and is relatively ineffective in controlling erosion and runoff.

Comments:

Ranges that have deteriorated this far require reseeding to perennial grasses to restore them to full production.
Sandgrass range—good condition, near Kaibito, Navajo Indian Reservation; blue grama, Indian ricegrass, galleta dominant.

Reasons for a good condition rating on this range:

There is a good cover of such high-forage-value grasses as blue grama, galleta and Indian ricegrass. Although it cannot be distinguished in this photograph, there is also a rather large amount of Mormon tea mixed in with the grasses.

Comments:

Excellent-condition range in this type would appear rather similar to this but would have a higher grass density and less Mormon tea.
Sandgrass range—fair condition, near Kaibito, Navajo Indian Reservation; Mormon tea, galleta, sand dropseed dominant.

Reasons for a fair condition rating on this range:

There is only a moderately thick stand of grasses. The plants are less vigorous and consequently producing a smaller volume of forage than on good- or excellent-condition ranges. There is local evidence of wind erosion.

Comments:

Sandgrass ranges in fair condition often have an abundance of Mormon tea, rabbitbrush and sand sagebrush.
Sandgrass range—poor condition, near Tuba City, Navajo Indian Reservation; sand dropseed, red three-awn, snakeweed dominant.

Reasons for a poor condition rating on this range:

There is a thin stand of grasses that are low in vigor. Wind erosion is active during periods of higher-than-average wind movement.

Comments:

Although some of the better forage grasses occur here, a large proportion of the vegetation is made up of low-value red three-awn and such worthless shrubs as snakeweed and threadleaf groundsel.
Sandgrass range—poor condition, near Tuba City, Navajo Indian Reservation; snakeweed, Russian thistle, sand sagebrush and chamise dominant.

Reasons for a poor condition rating on this range:

Most of the original grass cover has disappeared leaving extensive sandy areas open to wind erosion. The few grasses that do remain are less palatable and provide less forage than those that were at one time dominant here.

Comments:

Even though the grasses have been replaced in part by chamise, this shrub is producing less than ¼ as much forage as was formerly produced here.
JUNIPER-PINYON

Juniper-pinyon is one of the most extensive vegetation types in the Coconino-Apache-Navajo County area. The acreage this type occupies today is much greater than when the country was first settled by white men and first grazed by domestic livestock. There is an ever-increasing body of evidence indicating that a reduction in the number of range fires has been the principal factor directly responsible for the spread of juniper to areas that were formerly grassland.

The juniper-pinyon type lies largely between ponderosa pine above and grassland below. Although many of the forage species common in ponderosa pine occur in juniper-pinyon stands, livestock obtain most of their food from shrubs that normally are most abundant in juniper and pinyon pine or from grasses that are typical dominants of the adjacent grassland.

Every species of juniper known to occur anywhere in the state can be found in these three counties. One-seeded and Utah juniper are most abundant and cover the greatest area. Neither species is a “sprouter” and can be effectively controlled by fire or other treatments that kill the tops of the plants.
Juniper pinyon—good condition, Coconino County north of Ashfork.

Reasons for a good condition rating on this range:

There is a fairly good cover of perennial grasses, principally blue grama, Indian ricegrass and Wright's muhly. If there were a better cover of these grasses, the plants were more vigorous, and there were less blue grama in relation to the taller-growing grasses, this range would rate "excellent."

Comments:

The carrying capacity of a range is determined by volume production. This is the result of two factors: density and height. Blue grama, even when rather heavily grazed, may have a good density; it usually is not very tall, consequently is rarely a top volume producer.
Juniper-pinyon—fair condition, Navajo Indian Reservation near Canyon de Chelly.

Reasons for a fair condition rating on this range:

Long-continued grazing pressure and competition by the trees for moisture and light have weakened and thinned the stand of grasses. Only one species, blue grama, remains. Although the trees rather effectively control wind erosion, water erosion may be severe.

Comments:

Although grazing management could be used to increase forage production here, full production cannot be attained without removing the trees. Stands of this sort lend themselves rather well to burning or cabling as control measures.
Juniper-pinyon—poor condition, east of Kaibito, Navajo Indian Reservation.

Reasons for a poor condition rating on this range:

This area once produced a good cover of valuable forage grasses; it now produces none. Erosion is severe and most of the original topsoil has been eroded away.

Comments:

This range is at the bottom of the poor-condition classification and could be classed as depleted. It can, however, still be reseeded successfully to perennial grasses if the trees are removed and the reseeding is followed by sound range management.
BROWSE

A large portion of the Apache-Navajo-Coconino county area supports brush of one sort or another. As most of the species have some forage value they will be referred to here as browse.

The principal browse types that occur here are (a) sagebrush (b) saltbushes and (c) blackbrush. All of these are commonly included in the ecological grouping known as the northern-desert shrub. Although these types are not shown separately on the forage-type map at the back of this bulletin, they are discussed separately in the bulletin in the pages that follow.

SAGEBRUSH

Sagebrush is restricted to the northern portions of Coconino, Apache and Navajo counties. Three species occur most commonly: big sagebrush, black sage and sand sagebrush. These three species of sagebrush usually grow intermixed with perennial grasses. Even where few or no grasses remain, the presence of any of these three sagebrush species is a reliable indication that an area is potential grassland.

Big sagebrush is by far the commonest sagebrush species in this three-county area. Although blue grama is usually the most abundant grass growing today in stands of big sagebrush, it is probable that all such areas are capable of supporting higher-forage-producing grasses such as crested wheatgrass. On the better sagebrush sites even larger grasses such as intermediate wheatgrass should be adapted.

Big sagebrush on Arizona cattle ranges should be classed as a moisture-consuming and space-occupying weed. It may be controlled very effectively by burning; somewhat less so by spraying with 2,4-D or 2,4,5-T.

Big sagebrush has a vigorous growth habit and is able to grow in dense stands. For these reasons range-improvement programs in sagebrush-infested areas require control of the brush. After the brush has been killed, the carrying capacity can usually be increased two or more times. This may be accomplished by seeding to adapted grasses or simply as a result of the brush control combined with sound management.

It should be kept in mind that big sagebrush usually grows on rangelands that are potentially highly productive and that can produce excellent grass. Like all ranges, however, they cannot be expected to produce at capacity if they are overstocked or otherwise managed unwisely.

Sand sagebrush occurs only on sandy areas, usually in much more open stands than big sagebrush. Grazing or drought that kills some of the grasses often results in an increase of sand sagebrush.

This species, like big sagebrush, has little forage value and uses moisture that could produce grass. Unlike big sage, however, it grows on light sandy soils highly subject to blowing when the plant cover has been destroyed. For this reason its control, particularly by fire, should be attempted only after careful evaluation of the local erosion hazard.
Sagebrush—good condition, Navajo Indian Reservation north of Kaibito; blue grama, galleta and big sagebrush dominant.

Black sagebrush occurs largely on a few rocky hillsides in the juniper-pinyon type and is of minor importance in the area. It shows a marked preference for fine-textured "heavy" soils with a high clay content. Typically a much smaller plant than either of the two other sagebrushes common in these counties, it probably uses less moisture than these others and does not compete so actively with the grasses either for moisture or growing room. Partly for this reason and partly because it has considerable forage value, black sagebrush should not be controlled on most sites.

Reasons for a good condition rating on this range:

Although there is a good cover of nutritious grasses here, forage production could be increased by complete control of the brush. There is almost no measurable erosion.

Comments:

Even with the best possible cover of forage species between the brush, sagebrush ranges will rarely produce enough feed to be rated excellent. When a portion of the limited rainfall is used to grow brush, it is not available to grow grass; also, ground occupied by brush cannot at the same time be occupied by grass. Full production, therefore, can be obtained only by control of the brush.
Sagebrush—Poor condition, South Kaibab near Cameron: big sagebrush and blue grama dominant.

Reasons for a poor condition rating on this range:

The ground cover is largely big sagebrush. There is only a thin stand of forage grasses that are low in vigor and producing almost no seed. Large amounts of soil and water are lost during periods of rain and snow melt.

Comments:

Areas of this sort can be reseeded profitably to grasses. The brush should be removed by burning, mechanical treatment or chemicals prior to seeding.
Black sage—good condition, Navajo Indian Reservation near Round Rock.

**Reasons for a good condition rating on this range:**

There is a good cover of such forage-producing species as blue grama, galleta grass and black sage. There is almost no erosion and most of the precipitation that falls soaks into the ground and is utilized to produce forage.

**Comments:**

Although black sage is grazed to some extent it is much less palatable than most associated grasses and withstands grazing well. As a consequence the sage usually remains long after the grasses have been driven out. Stands with the amount of grass shown here are rare.
Black sage—poor condition, showing usual size and typical growth habit.

Reasons for a poor condition rating on this range:

Most of the grasses that were formerly abundant here have been killed out. Erosion is severe and runoff losses are heavy.

Comments:

Although black sage has some value as forage, ranges that support little or nothing except this species are producing too little feed to rate higher than poor in a condition classification.
SALT'BUSHES

Although chamise and shadscale are the principal saltbushes that occur in this three-county area, three others are rather common on certain soils. All of the species are restricted to alkaline or saline soils; shadscale to soils derived from shales. These shaly soils are fine textured and erode rapidly when the plant cover is inadequate.

All the saltbushes are valuable as forage, partly because they usually grow intermixed with such grasses as blue grama, galleta, or sacaton and provide green feed when the grasses are dry. Most of the saltbushes are extremely drought resistant and withstand close grazing for long periods. Annual rings on several shadscale bushes from near Keams Canyon indicated an age of at least 75 years.

Chamise grows on a wider variety of soils and thrives under less alkalinity than the other saltbushes found in the area. Chamise occurs naturally intermixed with blue grama and sand dropseed on much of the best grassland in Coconino County. It is abundant also in Apache and Navajo counties but on lower-condition ranges.
Shadscale—excellent condition, Navajo Indian Reservation between Round Rock and Lukachukai.

Reasons for an excellent condition rating on this range:

There is a good stand of such valuable grasses as galleta and blue grama in addition to the shadscale. The grasses are vigorous and are adequately protecting the soil from erosion.

Comments:

Although there is more grass than shadscale here, the soil and climate are typical of shadscale ranges. Because the shadscale is more resistant to grazing than the grasses, heavy use on areas of this sort ultimately results in depletion of the grasses and their replacement by shadscale.
Shadscale—good condition, Navajo Indian Reservation between Round Rock and Lukachukai.

Reasons for a good condition rating on this range:

There is enough grass here, in addition to the shadscale, to provide a moderate amount of forage. Although the perennial grasses are fairly vigorous they are not as large or producing the volume of forage they should. Russian thistle and prickly pear are beginning to invade where the grass cover has broken down.

Comments:

Shadscale ranges in good condition support a mixture of grasses such as blue grama and galleta. Although these furnish the bulk of the forage, minor amounts are obtained from the shadscale and from annual weeds such as Russian thistle.
Shadscale—fair condition, Navajo Indian Reservation near Lukachukai.

Reasons for a fair condition rating on this range:

There is a scattered stand of perennial grasses, largely galleta, intermixed with the shadscale. The grass plants are weak and are producing a small volume of feed. When rains have been adequate Russian thistle is usually abundant. The plant cover is too sparse to prevent either wind or water erosion.

Comments:

Fair-condition shadscale ranges are often invaded by snakeweed, a somewhat poisonous half-shrub that uses up moisture that should be producing grasses. When drought strikes ranges where the grasses are as weak as they are here, they may be completely wiped out. The cost and difficulty of reseeding such depleted areas makes it particularly important to so manage fair-condition ranges as to improve them.
Shadscale—poor condition, Navajo Indian Reservation near Navajo Bridge.

Reasons for a poor condition rating on this range:

Little vegetation remains except shadscale and cacti. The vegetation that remains is inadequate to protect the soil against erosion or to hold rain where it falls.

Comments:

Most of the original topsoil has been washed away, reducing the ability of this range to produce. Although shadscale areas are usually less productive than many other ranges, most of them should produce a moderately thick stand of grasses intermixed with the shadscale.
BLACKBRUSH

Blackbrush is found only in the northern portion of the area under discussion. Much of it is restricted to rough canyon areas that are difficult for livestock to reach or that are poorly watered. Most blackbrush ranges produce very little feed from either grasses or other browse species. As the blackbrush itself is almost worthless as forage, this type is usually largely waste from a stockman's point of view.

Ranges where there are dense stands of blackbrush never produced much more forage than they do today. Until effective control methods are developed any attempts to improve them largely represent wasted effort.

Blackbrush range—Navajo Indian Reservation near Cameron.

Comments:
Blackbrush range does not lend itself well to range condition classification. Even those stands that have not been modified by grazing may contain little except blackbrush. Because the plants have little palatability the composition or productivity of these stands change little under grazing pressure.

The boundaries of the blackbrush type are often extremely abrupt indicating apparently either a specific soil or soil-moisture requirement. This is particularly true where the type borders on grassland. Where the adjoining vegetation is largely brush, on the other hand, blackbrush may mingle with a variety of species including some grasses. Common shrubs in this transition zone may include shrubby buckwheat, Mormon tea, cacti and Joshua tree. The principal grasses will usually be galleta, black grama and three awns.
CONIFER-ASPEN FOREST

Extensive portions of Coconino, Navajo and Apache counties are covered with coniferous timber or aspen. At the lower elevations, ponderosa pine is the principal tree. Intermixed with this species at its upper range and often forming pure stands, especially on north-facing slopes, is Douglas fir. At still higher elevations these give way to the true firs such as white fir and corkbark fir. Aspen is intermixed with the firs and usually marks sites of old fires.

Although timbered areas frequently produce little forage, the idea held by many that a site cannot produce both timber and grass is untrue. Ponderosa pine sites, in particular, are capable of producing forage if they are properly managed. The evidence indicates overwhelmingly that the pine forests of the Southwest were at one time open, parklike areas and that the forest floor was carpeted with grasses. Man in his attempt to "manage" these forests has reduced or destroyed their present potential for producing forage. In doing this he has vastly increased the fire hazard they represent and has greatly reduced the amount of moisture that gets into the soil.
Ponderosa Pine—Excellent condition, San Francisco Mountains; Arizona fescue, mountain muhly dominant grasses.

Reasons for an excellent condition rating on this range:

There is a good ground cover of such high-quality perennial grasses as Arizona fescue and mountain muhly with fescue the better of these two, predominating. The plants are vigorous, there is a good ground cover of litter and there is no erosion.

Comments:

Maximum forage production in timbered areas such as this can be obtained only by timber management practices that result in an open stand of trees that permit moisture and sunlight to reach the ground.
Ponderosa Pine—Good condition, Mogollon plateau north of Young; Arizona fescue, mountain muhly dominant grasses.

Reasons for a good condition rating on this range:

Although the same grasses are dominant here as on excellent condition Ponderosa pine range, they are somewhat scattered and do not form as dense a ground cover as they should. Sites of this sort in good condition will have little or no erosion.

Comments:

Although this is second-growth pine, whether or not an area has been logged does not of itself affect forage production. Openness of stand, either virgin or cutover, is the chief timber factor that determines the amount of forage produced.
Ponderosa Pine—Fair condition, Mogollon Plateau near Alder Lake; Arizona fescue the dominant grass.

Reasons for a fair condition rating on this range:

The area is producing only about 30 per cent as much forage as it should. Although the fescue, which is dominant, is an excellent grass, the plants are weak and thinly scattered. In some parts of the area bracken fern, sneezeweed and other worthless or poisonous plants are abundant.

Comments:

Although there is no erosion here because of the flat topography and the litter of pine needles and cones, fair condition pine ranges frequently show a moderate degree of erosion.
Ponderosa Pine—Poor condition; southern Coconino County near Young.

Reasons for a poor condition rating on this range:

Most of the forage plants have been killed by heavy grazing. As a result, the area has almost no grazing capacity. Most of the plants that do remain are weeds such as mullein, pussytoes, sheep sorrel and pingue. Remnants of good forage grasses such as mountain muhly, Arizona fescue and blue grama may occur.

Comments:

On moderate to steep slopes erosion in this condition class will range from moderate to severe. When most of the grass cover has been destroyed artificial revegetation is the most practical improvement method. Where a thin cover of the original grasses remains, improvement may be effected by livestock management.
Reasons for a poor condition rating on this range:

Almost no forage is being produced.

Comments:

A low condition rating may result from several factors. In this case the dense stand of young trees uses so much soil moisture and shades the ground so heavily that few other plants can grow. The stockman, the lumberman and the water user all lose when conditions of this sort prevail. Before pine reproduction gets this large it should be thinned by controlled burning during the cool days of late fall or early winter.
Aspen type—Excellent condition, North Kaibab near Park headquarters.

Reasons for an excellent condition rating on this range:

There is an abundance of such valuable forage grasses as mountain muhly, mountain brome and junegrass. There are almost no low-value grasses or weeds. There is abundant litter and no erosion.

Comments:

Aspen is primarily a fire type that comes in after severe fires that destroy the conifer timber. In time the conifers will return and replace the aspen. Because most aspen stands are open, they generally provide an abundance of forage when in good or excellent condition.
Reasons for a good condition rating on this range:

There is a good cover of some of the best forage species that will grow here. These include such grasses as mountain muhly, mountain brome, junegrass and Kentucky bluegrass. These grasses are rather vigorous; there is no erosion.

Comments:

Although areas of this sort are often heavily grazed by deer, they usually make little use of the grasses. They may, however, severely damage the young aspen or other browse species.
Aspen type—Fair condition, Mogollon Plateau north of Young.

Reasons for a fair condition rating on this range:

Although there are few of the grasses present that normally occur in this type when in excellent condition, it is still producing a fair amount of feed and there is no erosion. There is a rather good cover of such valuable forage species as Kentucky bluegrass, clover and aspen reproduction.

Comments:

Because aspen ranges generally occur at high elevations, they are usually well supplied with stock water. For this reason, few of them are in excellent condition.
Aspen type—Poor condition, Apache County near Alpine.

Reasons for a poor condition rating on this range:

Although the ground is well covered by vegetation and erosion-controlling litter, most of the plants provide no feed. In the example shown here, not only are the plants worthless as forage; the two dominants, bracken and sneezeweed, may be poisonous to livestock.

Comments:

In order for a range to receive a favorable condition rating it must not only produce vegetation within reach of livestock; it must produce palatable vegetation. Under continued heavy use, unpalatable species such as those shown here will gradually replace the desirable grasses or weeds that are valuable forage producers. In spite of the abundance of vegetation, therefore, these areas will rate low in a condition scale.
Aspen type—Poor condition, Mogollon Plateau north of Young.

Reasons for a poor condition rating on this range:

Most of the valuable forage-producing perennial grasses have been grazed out. These have been replaced in part by low-value annual grasses and by weeds that have little use as forage. There is little aspen reproduction and even the young conifers have been trampled and grazed.

Comments:

Most aspen stands are small in area and are surrounded by extensive pine-fir rangelands. Their small size combined with a tendency to produce an abundance of palatable feed, and to be well watered, makes them difficult to manage without overgrazing.
MAINTAINING A HIGH LEVEL OF FORAGE PRODUCTION

A range-condition classification serves three primary purposes: (1) It is an aid in improving run-down ranges, (2) it facilitates maintenance of ranges already in top condition, and (3) it aids in preventing range deterioration. Since the degree to which a range has deteriorated (as indicated by its condition class) determines the steps needed to restore it, a knowledge of range condition is basic to recommendation of the improvement measures needed.

The greater the degree of deterioration, the more difficult it is to bring a range back to excellent condition and the more drastic the measures that must be taken. A range in good condition can usually be improved by a slight reduction in stocking or better distribution of stock. A range in poor condition is usually not materially benefited by these practices. The grass remnants are not sufficient to revegetate the range, and it is usually necessary to remove the brush, reseed, or use mechanical treatments such as pitting, subsoiling, or contour furrowing.

Except for occasional short periods when drought or other unfavorable conditions prevail, a range in excellent condition can be kept that way permanently. Maintaining a range at this high production level will not require stocking at a reduced rate since an excellent-condition range will support more livestock than one in any other condition.

It may be necessary in emergencies to hold over more stock than the range or a portion of it will support continuously. When such overstocking happens frequently, this is generally a sign of mismanagement; when it happens only occasionally, mismanagement is not necessarily indicated. When overstocking of this sort is infrequent, the range will suffer little or no permanent damage. There may, however, be inadequate forage to carry the stock through in good shape.

Drought may cause a temporary drop in range condition by killing or weakening the forage-producing plants on a range. A drought may last a season, a year, or several years. Because of the consequent reduction in forage production it is frequently necessary to reduce the number of stock grazing the drought-stricken area.

On timbered ranges, logging may be very destructive of forage. Even on excellent-condition range the effects of logging may be long-lasting unless local artificial reseeding is resorted to. When such reseeding is necessary, care should be taken to reseed to species that are shade-tolerant and that will do well on forest soils.

Fire may temporarily destroy forage. This does not mean that fires are always harmful from a forage-production viewpoint. An occasional fire in grassland is natural and many grass species seem to have become adjusted to burning as a result of fires that apparently occurred from time to time down through the centuries. Many shrubs and trees, on the other hand, are killed by fire and it is probable that periodic burning originally maintained extensive areas as grassland that are not grassland today.
MANAGEMENT OF THE RANGE

Research and experience have shown that a high level of forage production can best be obtained on most range lands by applying certain time-tested management practices. These practices favor the production of forage, the greatest gains in livestock and the best calf, lamb, or wool crops.

DEGREE OF GRAZING USE

The first concern of the rancher over a long period should be to maintain a degree of grazing use that will maintain or increase his better forage plants.

On grass ranges grazed during the growing season, about one-third of the seed stalks should be left at the end of the grazing season. If grazed during the dormant period, grazing can be closer and only enough vegetation needs to be left to prevent erosion.

On chaparral ranges that contain no grass, at least one-fourth of the growth on the current year’s twigs should be left at the end of the season.

Degree of use cannot be gauged exactly. For this reason, the condition of the range should be checked occasionally, even though every attempt has been made to prevent overgrazing. If this check indicates a downward trend, grazing has been too heavy for the amount of forage produced, and the need for lighter use is indicated.

DEFERRED GRAZING

Run-down ranges require a rest period during which the grasses can set seed and new seedlings can become established. This deferment or rest period must come during the growing season and must allow time for seed development. After seed formation the grasses may again be grazed. Care must be exercised not to overgraze one portion of the range in order to rest another part.

The poorer the condition of the range the more frequently it should be deferred. Poor-condition areas should be deferred every summer until they improve at least one condition class. Fair-condition ranges should be deferred every other year. Ranges in good condition will benefit from deferment once in three years. Although excellent-condition areas do not require deferment, a rest during the growing season once every three to five years will help them keep in top condition.

Defeference benefits forage plants in two ways. It permits them to set seed and to produce new plants, and it allows the old plants to become larger and more vigorous. These effects add up to greater forage production and, consequently, better range condition.

DISTRIBUTION OF STOCK

Distribution of livestock over the range to make the best use of forage may be a major problem with cattle; it is generally a minor one with sheep. Certain basic methods of distributing livestock have been successful. These include herding, relocation of fences, providing additional temporary and permanent water, and distributing salt grounds to pull the livestock out from water. When using salt
to get better distribution, it is essential to place all salt away from water. Otherwise, stock will use those salt grounds close to water, and will not be drawn out to the other locations.

**KIND OF LIVESTOCK**

All ranges are not equally usable either by all kinds or all classes of livestock. Topography, kind of forage, climate, and adequacy of water are all factors that affect the kind of stock that should be run. A well-watered range with adequate feed available most of the year, for example, is generally well suited to a cow-calf operation. A desert range, on the other hand, where both feed and water may be in short supply for extended periods, or abundantly available for a short time, is best suited to a buying and selling beef operation.

Ranges where the finer perennial grasses or where annual grasses and weeds predominate are usually well suited to use by sheep. Cattle and horses will make better use than sheep of range where coarse grasses are abundant. This does not mean that cattle and horses are not adapted to fine-grass ranges. Some of the largest cattle ranches in the West operate in blue grama or other fine-grass areas.

Extremely rough topography is best suited to goats or sheep. Areas of heavy brush usually can be utilized best by goats. Brahmas or similar type cattle are generally conceded to be better adapted to rough, inadequately watered and desert range than are Herefords or other breeds.

**RESEEDING**

Artificial reseeding should be resorted to only where few or none of the better native species are left to produce seed. Although cost of reseeding is high and chances of success are sometimes low, seeding is often desirable and may be employed to advantage.

Areas with a high potential for forage production should be seeded before less productive areas. Range that formerly grew abundant forage usually has a high potential.

Depleted areas where erosion is a problem should be reseeded. Benefits from erosion control added to increased forage production should soon offset the cost of seeding. Burns in timber, juniper, or chaparral that have destroyed most of the forage plants fall into this class.

Several precautions should be observed to minimize the possibility of failure: (1) Use plant species adapted to the site and climate; (2) prepare a clean seedbed if at all possible, thus eliminating competition from weeds; (3) seed at the right season of the year; (4) seed at the proper rate, with particular care not to overseed; (5) seed at the correct depth, with special care not to seed too deeply; (6) cover the seed and pack the soil wherever possible; (7) protect the new seeding from grazing for two growing seasons after the seeds germinate; (8) graze at a proper rate after the plants have become established.

The best results in seeding tests have been obtained by using an eccentric or cutaway disc in combination with a cultipacker seeder. This equipment prepares a seedbed that catches and holds rainfall, plants the seed properly, and packs the soil. Good stands have been obtained with this equipment where other methods have failed.
JUNIPER AND BRUSH CONTROL

Juniper and most brush species produce less forage than grass and make it difficult to work livestock. They also use much more moisture than grasses, thus reducing the amount that otherwise might be available for springs and streams. For these reasons, primarily, control of both juniper and brush is often desirable.

Juniper. The juniper invasion of some of northeastern Arizona’s best grassland is one of the area’s most pressing range problems. Carrying capacities and land values have decreased wherever this tree has invaded grassland. All of the reasons for this invasion are not known, but there is little doubt that juniper was originally prevented from spreading to grassland by fires set by lightning or Indians. Breakdown of the grass cover by domestic livestock grazing has helped to make it harder for fire to run and easier for the young trees to get started.

Several methods of juniper control are economically feasible. Hand grubbing when the young plants first appear is probably the cheapest and most effective. This method can be used to prevent further spread, but has little use on old stands. Hand chopping is a slow but thorough method of eradication that may be combined very well with hand grubbing. Small trees and limbs may be piled around the larger trees and burned.

Cabling or chaining has given effective control on even-age stands where the trees are of moderate size. This method does tend to leave many trees alive, however, and affects young trees and seedlings only slightly or not at all.

Removal of juniper with a bulldozer has been effective in many places in Arizona. Some of the best results have been obtained when a so-called “stinger” was welded to the center of the dozer blade. Even more effective control has resulted when a stinger has been combined with a push-bar on the front of the “cat” that bends the tree away before uprooting it with the stinger blade.

Chaparral. Unlike many brush ranges where shrubs have invaded grasslands, the greater part of the chaparral is a natural shrub area. No economical control methods have yet been developed. Until such methods are available the chaparral range should be handled to make the best possible use of the brush and grasses now growing there.

Snakeweed. Snakeweed has invaded most of northeastern Arizona below an elevation of about 8,000 feet. This half-shrub usually occurs on run-down ranges where the grass cover is thin. Results of attempts to kill this plant with 2,4-D have been variable. When enough grass remains to carry a fire, snakeweed may be killed effectively by burning during the driest part of the year. It can be kept under control by maintaining a good stand of grass.

Sagebrush. Sagebrush may be controlled by spraying with 2,4-D. It is also killed readily by fire. When sagebrush areas are to be reseeded, plowing with a heavy disk-type plow is an effective control method. This operation also prepares a seedbed in which seed may be broadcast or drilled. Other effective cultural treatments include
use of some form of the Australian stump-jump plow or self-clearing log or pipe harrows. These implements have proved very useful on land too rough or rocky for the usual disk-type plows. The principal disadvantage of any type of harrow is that only the older more brittle bushes are usually killed. Harrows do, however, kill less grass than instruments that tear up more soil.

**FIRE AS A FACTOR IN RANGE MANAGEMENT**

Fire appears to have been the principal factor that originally kept junipers from spreading to grassland areas. It was also highly effective in preventing the invasion of forested areas by "jack pines" and brush. As the forests were swept by fires at rather frequent intervals there was little opportunity for inflammable material to accumulate and lay the ground for excessively destructive fires such as we have today.

Some shrubs are killed by fire; others are killed to the ground but sprout from the stumps. Plants common in northeastern Arizona that are killed and do not stump-sprout include: one-seed and Utah juniper, manzanita, sagebrush and snakeweed. Stands of these plants that support enough grass or weeds to carry a fire may be largely eradicated by broadcast burning. Some of the more vigorous "sprouters" include scrub oak and most other chaparral shrubs, rabbitbrush, catclaw and mesquite. Alligator-bark juniper, as mentioned earlier, is also a "sprouter."

Juniper, most Arizona species of which are killed by fire, has taken over many thousand acres in the three northeastern counties that were formerly grassland. This juniper invasion probably could have been prevented by an occasional fire. Today, because of grazing and competition from juniper, the ground cover over much of this area is too thin to carry fire and more expensive means of control must be used. Where there is enough grass to carry a fire, however, this method of control may still be used to advantage. Where fire will not carry, it is sometimes possible, by closing an area to grazing for a season, to build the cover up to a point where it will burn. In all such controlled burns, care should be taken to see that the fire does not escape to adjacent areas.

It is not known whether fire in most chaparral ranges is beneficial. Except in openings, the grass cover, even in the best chaparral, is thin and the shrubs are large and often dense. Fires in such areas are usually extremely hot and most of the grasses may be destroyed.

Most chaparral areas that have burned should be seeded at once to grasses or other adapted forage species. The cheapest and usually the most effective reseeding is obtained by airplane seeding directly in the ashes. This technique has proved to be particularly effective at about the beginning of the summer rainy season.

Control by burning of non-sprouting shrubs is cheap and can be used on large, relatively inaccessible range areas. Fire is hazardous, however, and must be used with care to prevent its spread to adjacent areas. If allowed to run wild, it can cause widespread destruction of fences, buildings, timber or reserve forage. Burning at any time destroys the current season's crop of forage.
Grazing Value of Some Common Plants Growing in Coconino, Apache, and Navajo Counties

(Additional information on many of these plants may be obtained by referring to publications listed at the end of this bulletin under “References.”)

**GRASSES**

Bluegrass, Kentucky  
(*Poa pratensis*) (L.)

Although Kentucky bluegrass is not native to Coconino, Apache or Navajo counties it is well acclimated at the higher elevations and may be one of the principal forage species in meadows or in Douglas fir, pine or aspen. This bluegrass is highly palatable but because of its low growth habit does not produce a very large volume of feed. It also tends to go dormant in late summer. Both of these features — low volume production and a tendency toward seasonal dormancy — make it less desirable than some other grasses such as bromes and wheatgrasses that might grow in these same sites.

Brome, mountain  
(*Bromus marginatus*) Nees.

Mountain brome is one of a small number of grasses in the state that is highly shade tolerant. It grows best on rather moist sites in Douglas fir or ponderosa pine timber. Although the grass is rather tall, commonly from 2 to 3 feet, the plants are not particularly leafy. They are, however, highly palatable and, for this reason and because they are able to grow in shade that few other grasses can tolerate, they are classed as highly desirable.

Dropseed, pine  
(*Blepharoneuron tricholepis*) (Torr.) Nash.

Pine dropseed is one of the dominant and most widespread grasses in the timbered areas of Coconino, Apache, and Navajo counties. It is moderately shade tolerant and has better than average palatability. The plants are usually one to two feet tall and produce a moderate volume of forage. Pine dropseed

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1 Drawings by Lucretia Breazeale Hamilton
Brome, mountain (*Bromus marginatus*) Nees. (x$\frac{1}{2}$)
Dropseed, pine (*Blepharoneuron tricholepsis*) (Torr.) Nash. (x1/4)
is one of the better forage producers in the timbered areas where it is adapted.

Dropseed, sand (*Sporobolus cryptandrus*)
(Torr.) A. Gray.
Sand dropseed is widespread in the open grassland, particularly on sandy soils. When the plants are green they provide fair to good feed for cattle and horses and fair for sheep. When dry, they rate as poor forage for all classes of livestock.

Fescue, Arizona
(*Festuca arizonica*) Vasey
Arizona fescue is perhaps the most valuable perennial grass at the higher elevations included in this bulletin. Because of its hard, somewhat wiry leaves it is only moderately palatable. The plants are densely tufted with a large number of leaves and stems, however, and produce an abundance of feed.

Fescue, sheep (*Festuca ovina*) L.
Sheep fescue resembles Arizona fescue in having stiff, somewhat wiry leaves that are only moderately palatable after they have stopped growing. Although the plants are rather short they are very leafy and produce abundant forage.

Galleta (*Hilaria jamesii*) (Torr.) Benth.
Galleta grass is often confused with tobosa, a closely related but less palatable species. Galleta is moderately palatable when green but is much less readily taken after it has dried. In spite of these palatability qualities, because of its abundance it is one of the most valuable grasses in the open grasslands of Coconino, Apache, and Navajo counties. Although protein content of the green grass is lower than that of blue grama, it is still high enough to rate as average quality feed. When dry the protein content is low.

Grama, black (*Bouteloua eriopoda*)
Torr.
Black grama is one of our best and most nutritious grasses. It produces an abundance of forage that remains palatable and nutritious throughout the year. Although less palatable than most gramas during the summer growing season, it cures well and provides excellent fall, winter, and spring feed. The stems are usually green even when the plants are not actively growing, a feature that makes this grass particularly valuable as winter forage.
Dropseed, sand (*Sporobolus cryptandrus*) (Torr.) A. Gray. ($x^{1/3}$)
Fescue, Arizona (*Festuca arizonica*) Vasey (x\(1/3\))
Black grama is readily damaged by heavy grazing during the summer growing season. During the fall, winter, and spring, when it is most valuable as forage, it is less easily harmed. Ranges on which black grama is a major component of the vegetation should be reserved for winter range if possible.

Grama, blue (Bouteloua gracilis) (H.B.K.) Lag.

Blue grama is probably the best known Arizona range grass and is one of our most valuable forage plants. The fine, palatable leaves are low in fiber and high in protein when green. Blue grama cures well and may retain up to 50 per cent of its nutritive value when dormant. It is thus an excellent winter, as well as summer, feed.

Under favorable conditions, blue grama produces abundant forage. Many Arizona ranges, however, even where this grass is abundant, do not provide these conditions. On some the soil is compacted, on others, as in the higher mountains, temperatures are low, and blue grama produces very little feed. Under these conditions, it is an inferior forage plant, not because of reduced palatability or nutritious-
ness, but because it produces less forage than other grasses would under the same conditions.

Junegrass (Koeleria cristata) (L.) Pers.

Junegrass is rated as good forage for all classes of livestock. It greens up earlier in the spring than most grasses and is often overgrazed early in the season. It grows most actively and produces the bulk of its feed during the summer after the rains begin.

Care must be taken not to overgraze Junegrass in the spring when it first greens up. When the plants are grazed during the growing season at least a third of the seed stalks should be left for seed production and to make certain that the vegetative parts of the plants will not be grazed too closely.

Muhly, mountain (Muhlenbergia montana) (Nutt.) Hitchc.

Mountain muhly is a valuable forage plant because of its abundance rather than because of high palatability. Although it produces large amounts of herbage it is one of the least palatable of the high-altitude grasses in the state. It is grazed most readily during the early summer when the plants are actively growing.

Mountain muhly is usually the principal grass in the dry forested range between mountain meadows, and is less palatable than the mea-
dow plants. This, and the natural concentration of stock around water, almost always results in overuse of the meadows and much lighter use of the upland areas between. Most efficient use of many of our high mountain ranges could be obtained by fencing off the meadows. In this way stock would be forced to make fuller use of the dry upland areas and the meadows would have a chance to recover from their usual depleted condition. This would permit an increase in the number of stock that could be run on both meadows and upland.

Muhly, sandhill
(*Muhlenbergia pungens*) Thurb.

Sandhill muhly occurs typically on sandy soils, particularly on those that tend to be windblown. Although the plants are large the leaves and stems are harsh and wiry and produce low-quality forage.

Muhly, spike
(*Muhlenbergia wrightii*) Vasey

Spike muhly occurs scattered in woodland and forest types and in many open dry meadows throughout much of northeastern Arizona. Although the plants rarely occur extensively in pure stands, they are abundant enough to provide a rather large amount of forage. Spike muhly is highly palatable to all classes of livestock and has
Muhly, sandhill (Muhlenbergia pungens) Thurb. (x1/3)

proved to be well adapted to reseeding in the juniper-pinyon and ponderosa pine zones.

Needlegrass (Stipa comata) Trin. & Rupr.

Needlegrass (needle-and-thread grass) is widespread, though usually not abundant on much of the light-soil, open grassland or juniper ranges of Coconino, Apache, and Navajo counties. Although somewhat less palatable than blue grama, needlegrass is deeper rooted and tends to stay green longer than blue grama or other short-rooted species. For this reason it rates high as a forage producer. When the seeds first ripen they are sharp pointed with long twisted awns. The sharp points bury themselves in the mouth tissues and eyes of grazing animals or in the wool of sheep. As soon as the seeds are shed, however, the plants are no longer objectionable and provide good late-season grazing.
Needlegrass (*Stipa comata*) Trin & Rupr. (Plant $\times \frac{1}{3}$; seed $x1$)

**Nutgrass (Cyperus esculentus) L.**

Although nutgrass is grazed to some extent the leaves and stems are hard and produce little feed. Because of their low palatability and aggressive seeding habits the plants are an aggressive weed in open pastures that tend to stay damp late in the spring.

**Ricegrass, Indian (Oryzopsis hymenoides) (Roem and Schult.) Ricker**

Indian ricegrass is common at elevations of 3,500 to 6,500 feet in Apache, Navajo and Coconino counties. Although well adapted to sandy soils, Indian ricegrass is by no means restricted to such
areas. It frequently grows associated with shadscale and winterfat and is able to withstand moderate amounts of alkali.

This grass is highly palatable to all classes of livestock. It cures exceptionally well and is valued as winter feed for cattle, sheep, and horses. The seeds, which stay on the plants for long periods, are large and high in protein. They are responsible to a considerable degree for the value of the grass as winter feed.

Indian ricegrass should be lightly grazed during the spring to give the nutritious seeds a chance to develop. Close grazing early in the season reduces seed production as well as general vigor of the plants.

Areas supporting an abundance of this grass should be reserved for winter use. Grazing during
Ricegrass, Indian (*Oryzopsis hymenoides*) (Roem and Shult.)
Ricker (Plant x1/3; spikelet x10)

Even when ringgrass is young and growing rapidly the plants have little value as forage. As the plants mature palatability drops almost to zero. Because of their low palatability and small size, ringgrass plants are almost worthless as feed.

Ranges that have an abundance of ringgrass should be managed to restore the better grasses. Continued attempts to obtain even a moderate amount of feed from
Ringgrass (*Muhlenbergia torreyi*) (Kunth.) Hitchc. (x\(\frac{1}{3}\))

ringgrass will in time drive out the more desirable species and result in consistent weight losses in the animals being grazed. Ranges with an abundance of this grass should be rested during the summer rainy season at least every other year until the vigor and density of the better species has clearly improved.

Sacaton (*Sporobolus wrightii*) Munro

Sacaton generally occurs on alluvial flats and bottomlands subject to flooding. On sites of this sort it has been found in Arizona at elevations of 2,000 to 6,500 feet in Coconino and Navajo counties.

The tender early spring growth is eaten readily by cattle and horses. As the plants mature, the leaves and stems become coarse and tough and are eaten only sparingly. If cut before seed has set and while the plants are still growing sacaton makes fairly good hay.

Because sacaton is a coarse grass that grows rapidly, it should be managed carefully to make full use of the forage and to maintain the stand in a highly productive condition. These areas can be used most effectively by grazing them heavily in the early spring. After the grasses on the higher ranges have begun to grow, livestock should be moved from the sacaton flats and kept off until fall.

The coarse, unpalatable old growth may be removed by burning every three or four years. It is advisable to divide a flat into three or four parts and burn one part each year. The plants will suffer the least fire injury if they are burned during the late winter or early spring months before growth begins.

Sacaton, alkali (*Sporobolus airoides*) Torr.

Alkali sacaton is common in Coconino, Apache, and Navajo counties on fine-textured alkaline soils of bottomlands and flats and on sandy mesas and along washes. While this grass is growing vigorously it generally rates as fair to rather good forage for cattle and horses and poor to fair for sheep. When dry, it provides poor forage for all classes of livestock. It makes fair quality hay when cut during the bloom stage.

Solid stands of alkali sacaton should be grazed during the spring and summer when growth is most...
Sacaton (*Sporobolus wrightii*) Munro (Plant x\(\frac{1}{3}\); spikelet x10)

active. Where it grows as scattered plants intermixed with more palatable perennials management should be aimed at maintaining the better species. As this species of sacaton is less palatable than most of the grasses with which it grows, these grasses will be overgrazed if full use is made of the sacaton. In order to obtain proper use of the more desirable grasses, therefore, the sacaton should usually be somewhat under-used.

Sedges (See nutgrass)

Squirreltail (*Sitanion hystrix*) (Nutt.) J. G. Smith

Although nowhere very important in these three counties as a forage species, squirreltail is widespread. It occurs chiefly where the better grasses have been thinned out or on abandoned cropland that is beginning to come back to perennial grasses.

Squirreltail rates as a fair forage
Sacaton, alkali (*Sporobolus airoides*) Torr. (Plant x1/3; spikelet x10)
Squirreltail (*Sitanion hystrix*) (Nutt.) J. G. Smith
(Plant $x_{1/2}$; spikelet $x_{10}$)
Three-awn (Aristida divaricata) L. (x\(\frac{1}{4}\))

species, particularly before the seeds with their long awns have matured or after they have been shed.

Three-awn (Aristida) L.

There are several species of three-awn in northeastern Arizona, most of which do not rate very high as forage. Perhaps the most common is red three-awn. This species is restricted largely to open grassland or to open brushy ranges and is almost worthless as feed. It usually indicates a run-down range.

Another species common in the area is Fendler’s three-awn. This is generally rated as fair to good feed even though the leaves tend to be rather narrow and wiry. An abundance of this grass is a good indication of a range in better than average condition. It occurs commonly in juniper-pinyon or chaparral-covered areas more typically than in open grassland.

Wheatgrass, intermediate (Agropyron intermedium) (Host) Beauv.

Intermediate wheatgrass is not native to Arizona but has proved well adapted for reseeding at many moderately high-altitude sites. Although not well adapted to shade this grass is rather easy to establish in many areas that have been cleared of sagebrush, juniper and pinyon or ponderosa pine. It is not as drought resistant as crested wheatgrass but is a highly productive palatable grass that should be widely used in areas where it is adapted.

Wheatgrass, crested (Agropyron desertorum) (Fisch.) Schult.

Crested wheatgrass may be seeded successfully in northeastern Arizona on sites cleared of sagebrush, juniper and pinyon pine or ponderosa pine. It may also be established on open grassland areas of less than average aridity.

Although there has been some dissatisfaction with crested wheatgrass as a grazing species this has resulted largely from attempts to graze at the wrong season. The stems and leaves of this grass are rather coarse and lose much of their palatability when dry. They should, therefore, be grazed primarily while green and actively growing. As the plants green up early in the spring when other species are still largely dormant, they provide green feed at a time when it is usually greatly needed. After the onset of summer rains they again start to grow and produce a second crop of grazable forage.
Aspen (Populus tremuloides) Michx.

Aspen (quaking or trembling aspen) is restricted to the higher elevations in Coconino, Apache, and Navajo counties. This tree occurs where fire or some other major destructive agent has killed the conifers and made an opening in the timber. The tendency of aspen to sprout abundantly from the roots often results in a large number of young shoots within reach of grazing animals. As long as these young plants can be reached they are readily grazed, particularly by deer and elk but also by all kinds of domestic livestock.
Blackbrush (*Coleogyne ramosissima*) Torr.

Blackbrush (sometimes called burrobrush) is locally abundant in the northern parts of Coconino, Navajo, and Apache counties. It tends to form dense stands that permit the growth of little other vegetation.

Blackbrush provides poor forage during the spring, summer, and fall for cattle, horses, or sheep. Goats make fair use of it during these seasons. During the winter when other feed is scarce it sometimes rates as fair for cattle and sheep. At best, however, the plant is a poor forage species.

Chamiso (*Atriplex canescens*) (Pursh) Nutt.

Chamiso (chamise, four-wing saltbush) is one of the most valuable and palatable shrubs in northeastern Arizona. Its range extends from the lowest elevations in the area upward through the chaparral, grassland and juniper-pinyon.

The leaves, young twigs, and seed pods are highly relished by all classes of domestic livestock. Because of the high palatability and the preference that livestock show for the seed pods the plants are often grazed to a point where their reproduction is restricted.

Juniper (*Juniperus*)

All five species of juniper known to occur in Arizona are found in the northeastern three counties. None of them has any value as forage for cattle and little for sheep. They may be browsed rather heavily by deer, particularly when other feed is scarce.

Mormon tea (*Ephedra*)

There are several species of Mormon tea (also known as Brigham tea and joint-fir) in this area. One or more of the species occur from the lowest elevations up through
Mormon tea (*Ephedra*)

the chaparral, grassland, juniper-pinyon and ponderosa pine. During the summer, when better forage is usually available, Mormon tea is lightly grazed by domestic stock. During the winter when other feed is relatively scarce, it may be a valuable feed source.

Pine, pinyon (*Pinus*)

Pinyon pines occur commonly in northeastern Arizona in the juniper-pinyon woodland. The trees have no value as forage for either domestic livestock or game animals.

Pine, ponderosa (*Pinus ponderosa*)

Ponderosa pine occurs commonly in all three northeastern counties, generally at elevations from 5,500 to 8,000 feet. Except on heavily overstocked ranges the plants have no value as forage and are usually not grazed.

Rabbitbrush (*Chrysothamnus*)

Several species of rabbitbrush are abundant in northeastern Ari-

Rabbitbrush (*Chrysothamnus*)

Sagebrush, big (*Artemisia tri-dentata*) Nutt.
Sagebrush, black (*Artemisia nova*)
A. Nels. (x½)

Sagebrush, sand (*Artemisia filifolia*) Torr. (x½)
Shadscale (*Atriplex confertifolia*) (Torr. & Frem.) Wats. (*x* 1/2)
zona, being particularly common in and below the ponderosa pine zone. Although much still remains to be learned about the toxicity of these plants, they are generally considered to be poisonous to livestock. Fortunately, however, the common species have little or no palatability and are rarely eaten.

Sagebrush, big (*Artemisia tridentata*) Nutt.

Big sagebrush occurs abundantly in Apache, Navajo, and Coconino counties between elevations of 5,000 and 8,000 feet. Although grazed by domestic livestock to some extent, sagebrush usually receives little use and has little value as forage. During the winter, on the other hand, the plants may be grazed rather heavily if snow covers the more palatable grasses. Sheep, in particular, tend to use sagebrush in this manner.

Sagebrush, black (*Artemisia nova*) A. Nels.

Black sagebrush is a low-growing, dark-colored shrub common on fine-textured soils. It usually does not grow in extensive, open-grassland types, but is commonly associated rather closely with either juniper-pinyon woodland, ponderosa pine timber or big sagebrush. Black sagebrush has a low palatability for all classes of livestock, but is taken somewhat more readily than big sagebrush.

Sagebrush, sand (*Artemisia filifolia*) Torr.

Sand sagebrush grows on loose sandy soils in Coconino, Apache,
Bracken fern (*Pteridium aquilinum*) (L.) Kuhn. (x½)

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and Navajo counties. The plants have little value as forage and are grazed heavily only on severely depleted range. Their chief value is in providing a plant cover on sandy soils subject to wind erosion.

Saltbush (See chamiso, shadscale.)

Shadscale (*Atriplex confertifolia*) (Torr. & Frem.) Wats.

Shadscale (sheep-fat, spiny saltbush) is rather common on heavy soils derived from shales in Coconino, Apache, and Navajo counties. Although the young stems and leaves are highly palatable to cattle, horses and sheep the plants are extremely hardy and are often very long lived. Shadscale is particularly valuable as winter sheep feed. The fruits and leaves drop to the ground in the fall and accumulate in hollows or under the bushes where they are picked up by grazing animals and serve as a highly nutritious source of feed.

Snakeweed (*Gutierrezia sarothrae*) (Pursh) Britt. & Rusby.

Snakeweed (broomweed, matchweed) occurs on open rangeland in northeastern Arizona at elevations of 3,000 to 8,000 feet. The plants are not well adapted to shade, hence are not abundant in timbered areas. They are worthless as forage but may be lightly grazed when stock are on a starvation diet. Under these conditions livestock losses from poisoning are reported occasionally.

**WEEDS**

Bracken fern (*Pteridium aquilinum*) (L.) Kuhn.

Bracken is common in open pine and aspen forests in Coconino, Navajo, and Apache counties. Commonly classed as an undesirable weed, bracken has no value as feed. When livestock get sufficiently hungry they may be forced to eat the leaves. When taken in large quantities the plants are toxic to cattle and horses.
Clover (*Trifolium repens*)

Cinquefoil (*Potentilla*)

There are several weedy species of cinquefoil in northeastern Arizona. Most of these come in on run-down meadows or moister-than-average open grassland areas. Although they provide a little feed, they produce much less than the grasses or sedges they have replaced.

Clover (*Trifolium*)

The low-growing, creeping clovers growing in the higher timbered portions or meadows of Coconino, Navajo, and Apache counties provide excellent forage. Their principal shortcoming is that they are usually not particularly abundant. Because of the high palatability of these clovers they are heavily grazed and tend to be killed out under the grazing pressure that most of the forested areas receive. It is possible that the native species or similar introductions might benefit markedly by the use of phosphate fertilizer.

Dandelion
(*Taraxacum laevigatum*)
(Willd.) DC.

This is not the common roadside dandelion but one that usually occurs in aspen or other wooded areas of rather high rainfall. In these locations it is a rather valuable forage plant. Although the leaves grow rather close to the ground sheep, in particular, are able to make rather complete use of them.

The common garden dandelion, which also occurs in all three counties covered by this bulletin, is equally palatable. It shows a preference for open, rather than timbered areas in high precipitation or sub-irrigated areas.

Flag, blue (See Iris)

Fleabane (*Erigeron*)

A rather large number of species of fleabane or wild daisy occur throughout the area covered by this bulletin. Although most of them are grazed lightly, particularly by sheep, none of them has any great value as forage.

Groundsel, threadleaf
(*Senecio longilobus*) Benth.

Threadleaf groundsel is locally common in Coconino, Navajo, and Apache counties, particularly along washes, roadsides, or other areas supporting little other vegetation. The plants not only have no value
Dandelion (Taraxacum laevigatum) (Willd.) DC. (x\(\frac{1}{2}\))

as forage; they are rather highly toxic on those infrequent occasions when they may be eaten. As is true with most poisonous plants groundsel will not be grazed unless there is little other feed available. Prevention of poisoning can be most easily accomplished, therefore, by managing so as to prevent severe range deterioration or depletion.

Iris (Iris missouriensis) Nutt.
This plant is variously known as iris, Rocky Mountain iris or blue flag. It is common in meadows or other wet-soil areas in Coconino, Navajo, and Apache counties at elevations between 6,000 and 9,500 feet. The plants are grazed only lightly and provide poor-quality forage. When abundant they usually indicate a high potential area that has deteriorated to a relatively small fraction of its original carrying capacity.

Loco-weed (Astragalus)
The various loco-weeds probably occur more commonly and are more widespread in northeastern Arizona than any other poisonous plant. The locos are found largely on open ranges though they may be rather abundant in chaparral or juniper and pinyon. Although all of the so-called locos are often believed to be poisonous, many of them apparently are not and a few may even be rather palatable. Until more is known about the toxic and forage values of the individual species, however, they all should be regarded with suspicion.
Fleabane (Erigeron divergens) Torr. & Gray (x1/3)

Mullein (Verbascum thapsus) L.
Mullein has not been reported from Apache or Navajo counties but does occur locally along roadsides, old bedgrounds, or other areas that support little or no ground cover of vegetation. The plants have no value as forage and apparently are never grazed.

Pingue (Hymenoxys richardsoni) Hook.
This is the commonest of several species of pingue that are rather widespread in northeastern Arizona. Although the plant is highly toxic and unpalatable, livestock will eat it if forced to by semi-starvation. Losses generally occur when stock are turned on summer ranges too early or when left on too long in the fall. Unless feed is short, however, pingue is rarely eaten and losses from it are rare.

Pussytoes (Antennaria)
Five species of this plant are known to occur in northeastern Arizona. None of them has any value as forage, nor are any of them known to be toxic. They grow as mats or rosettes close to the ground which is doubtless one reason why they are not grazed.
Mullein \textit{(Verbascum thapsus)} L. \((x^{\frac{1}{2}})\)
Russian thistle
(Salsola kali tenuifolia) Tausch

Russian thistle or tumbleweed is one of the commonest weeds in northeastern Arizona. It is most abundant at moderate elevations in the grassland, chaparral, and juniper-pinyon belts. When the plants are green they provide fair to good forage, particularly when growing with grasses or other good forage. After dying they are grazed little or not at all except when dampened by rain or snow. This moisture softens the dry prickly leaves and restores a fair degree of their palatability. On winter sheep ranges, in particular, this softening may be of considerable value.

Sneezeweed (Helenium hoopesii) Gray

Sneezeweed is locally common in timbered areas of northeastern Arizona at elevations of 7,000 to 11,000 feet. It normally has no forage value but may be grazed when desirable forage plants have been closely grazed or ranges are overstocked. Under these conditions it may cause serious losses to sheep.
Sneezeweed is rated as the most dangerous summer-range sheep poison in Utah. The toxic element is cumulative and even when only small quantities are taken continually, the affected animals may eventually die. In order to keep sheep losses at a minimum Stoddart et al (12) recommend "grazing lightly on sneezeweed areas and avoiding dense patches, avoiding sneezeweed ranges early in the summer, removing sheep from sneezeweed range when good forage begins to dry, practicing open herding and not hurrying the animals, allowing a maximum of natural movement, using bed grounds for one night only and being sure the bed ground is free from sneezeweed and employing a good herder and instructing him properly."

Sorrel, sheep (Rumex acetosella) L.
Sheep sorrel is common in Coconino, Navajo, and Apache counties
Sneezeweed (*Helenium hoopesii*) Gray ($\times\frac{1}{2}$)
Sorrel, sheep (*Rumex acetosella* L. (x1/2)) along roadsides, and in old fields and other areas denuded of vegetation. The plants are lightly grazed but have no particular value as forage. Sheep make more use of them than cattle.

Yarrow (*Achillea lanulosa*) Nutt.
Yarrow occurs rather widely in Coconino, Navajo, and Apache counties between elevations of 5,500 to 11,500 feet. Although shade tolerant and well adapted to growing in timbered areas, yarrow also flourishes on the open range. It is lightly to moderately grazed by cattle, horses, and sheep but, because of its rather low palatability and sparseness of occurrence, is not an important forage plant.
BIBLIOGRAPHY


