

The Rangelands of Colorado

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To understand the rangelands of Colorado, one should first look at its physiography. Colorado can rightfully be called the "zenith" of the United States; on average, it is the highest state in elevation with more than 50 peaks exceeding 14,000 ft. Mountain passes crossing the Continental Divide in Colorado frequently are above 11,000 ft. The lowest point in the state, along the Arkansas River where it enters Kansas, is only slightly below 3,400 ft., while about 95% of Colorado's land area is more than "a mile high!" The headwaters of four major rivers can be found in the Colorado mountains—the Colorado, North and South Platte, Arkansas, and Rio Grande. The watersheds of these rivers and their tributaries account for 20% of the area of the 48 conterminous states.

Although Colorado is high in elevation, it tends to be relatively low in precipitation except for a few high-elevation peaks along the Continental Divide. The Sierra Madre Range near Steamboat Springs is the only mountainous area with annual precipitation exceeding 50 in. In general, precipitation in the mountains ranges between 20 and 50 in./year, distributed fairly even throughout all seasons.

On the eastern plains, precipitation is sparse, falling mostly during the spring and summer months from convective thunderstorms. Along the Arkansas River valley east of Pueblo, annual rainfall is less than 12 in. It ranges from 12 to 16 in. throughout most of the high plains, but approaches 20 in. in the sandhills region of northeastern Colorado. The state's driest climate, with an annual precipitation of less than 7 in., is found in the San Luis Valley. The Grand Valley between Grand Junction and the

Utah border also receives very little precipitation. [Note: It is not commonly known that the stretch of the Colorado River between Grand Lake and its confluence with the Green River in eastern Utah was called the Grand River by early pioneers (Stanton 1965).]

Like other western states, Colorado is predominantly rangeland. The 1979 Assessment of the U.S. Forest and Rangeland Situation, mandated by the Renewable Resources Planning Act of 1974, estimated that 47.5 million ac., or 72% of the state's lands are grazed. About 55% of this acreage is in private ownership. Of the 22 million acres under Federal control, a little more than one-third is managed by the Bureau of Land Management while 63% is on National Forests. Rangelands under the control of the Defense Department, such as the Army's Pinon Canyon Maneuver Site, comprise most of the remaining Federal land.

Physiographic Regions

Physiographers have divided Colorado into three major provinces: the Great Plains, Rocky Mountains, and Colorado Plateaus (Fig. 1). From a perspective of geological time, these landforms are quite young. The present Rocky Mountains were uplifted only 60 million years ago. The Great Plains are composed of alluvial material that eroded from these uplifting mountains and were deposited over thick mantles of ancient gravels worn away from ancestral Rockies formed during the Paleozoic Era (Chronic and Chronic 1972). The Colorado Plateau is dominated by sedimentary shales and sandstones laid down during the Cretaceous Period, from 70 to 135 million years ago, and carved by the Colorado River and its tributaries since that time.

The rangelands of Colorado are linked inexorably to its physical geography and the underlying differences

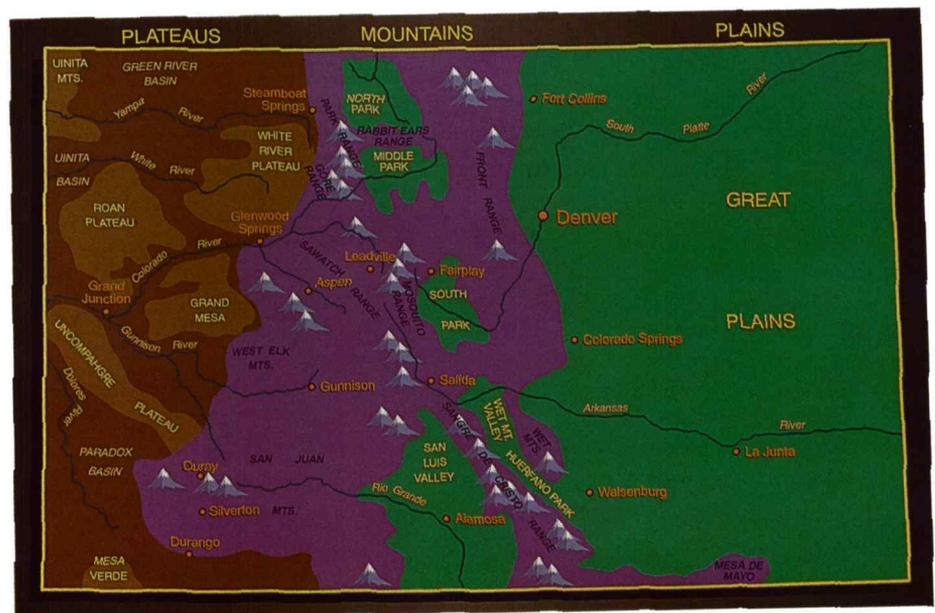


Fig. 1. Three major physiographic provinces in Colorado (adapted from Chronic and Chronic 1972).

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in climate and soils. The three prominent provinces and their attendant ecosystems contain a rich diversity of vegetation, wildlife, and other fauna.

Vegetation of the Plains

The grasslands of the Great Plains are classified into three well-known divisions: the tall-grass prairie, the mid-grass prairie, and the short-grass steppe. Two of the three have fundamentally changed since European settlement. In the tall-grass prairie, native species have been largely replaced by the introduced tall grass, corn. At the same time, native mid-grass prairie species have been extensively supplanted by a group of agronomic mid-grasses, wheat. Only the short-grass plains remains largely under native sod.

James A. Michener, in his classic novel, *Centennial*, adroitly captured a period in history when man attempted to supplant the native short-grasses with wheat and milo. Farmers, predominately immigrants, were enticed to Colorado during the early 20th century by the railroads and other interest groups with the promise that wheat could be grown on 12 in. of rain per year. The Dust Bowl years of the 1930's burst that balloon, and the Federal government purchased large amounts of land that



Fig. 3. The shortgrass steppe was considered a wasteland by travellers in the early 19th century, suitable only for Indians and buffalo. Today it is the principal rangeland vegetation zone in Colorado.

had been abandoned and gone into default. These lands were to become the Pawnee and Comanche National Grasslands, now managed by the U.S. Forest Service.

During World War II, much of the short-grass plains were again plowed to grow small grains. This time, however, the government did not buy the land when times later became tough. Rather, in the 1960's it contracted with farmers to seed their eroding lands back into grass under conser-

vation provisions of the Soil Bank. When the Soil Bank payments ended, nearly all of the acreage involved reverted to grain production because of economic considerations.

This process is essentially repeating itself as a result of the Conservation Reserve Program (CRP) of the 1985 Food Security Act. In Colorado, almost 2 million ac. of cropland have been placed into the CRP. These lands comprise a major, if temporary, increment to Colorado's rangelands (Fig. 2). One of the goals of the Society for Range Management is to minimize the amount of CRP land with highly erodible soils that will be plowed out for row crop production at the end of the program.

The tall-grass prairie is dominated by the genera *Andropogon*, *Schizachyrium*, *Sorghastrum*, and *Panicum*. Only remnants of this prairie are found in Colorado. However, it may have occupied much larger areas within the Colorado Piedmont, a gentle valley running north-south between the Rockies and high plains, prior to European settlement. This depressed area tends to concentrate soil water, thereby providing suitable conditions for tall-grass communities. Numerous reservoirs and wetlands may be found within the Colorado Piedmont today, nearly all which is under irrigated agriculture or devoted to urban use. An excellent example of a

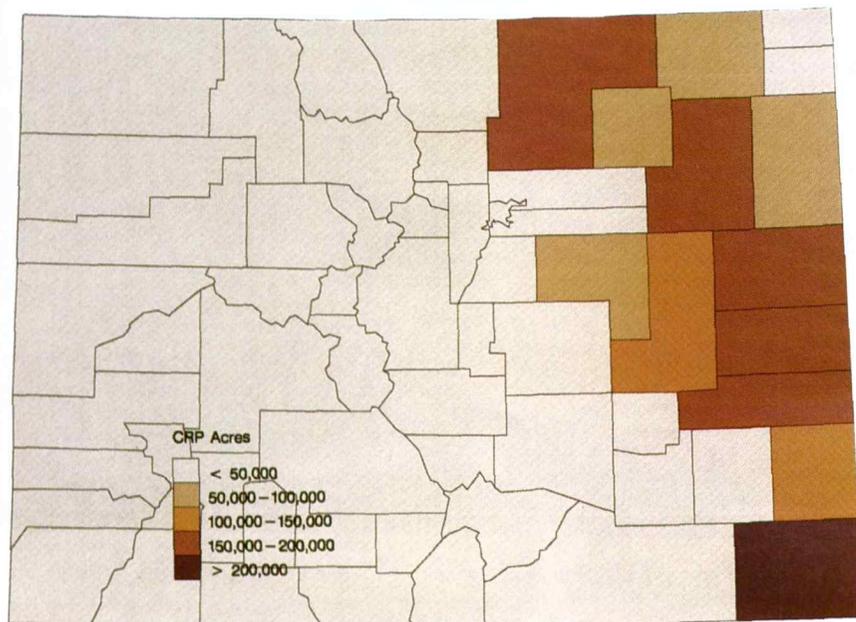


Fig. 2. Extent and distribution of lands in Colorado enrolled in the Conservation Reserve Program of the 1985 Food Security Act.



Fig. 4. Subalpine meadow in north central Colorado. These meadows provide much of the available livestock forage in the lodgepole pine and spruce-fir zones and are also valuable to elk.

true tall-grass relict area is located within the City of Boulder Open Space.

On deep, sandy soils covering the uplands of extreme eastern Colorado, a tall-grass prairie, represented by grasses such as sand bluestem, switchgrass, prairie sandreed and side-oats grama, occurs on nearly 1.7 million ac. Annual precipitation is 12–16 in., 75% of which is received between May and October. This prairie provides excellent habitat for small mammals, upland game birds and other animals. The dominant shrub, sand sagebrush, also gives good cover and protection to wildlife. Endangered species in this region include the American peregrine falcon. In higher rainfall zones much of the deep sand prairie is planted to wheat and milo.

The true mid-grass prairie, as represented by different species of *Agropyron* and *Stipa*, is not prevalent within Colorado, and is not addressed in this report.

The primary ecosystem on Colorado's eastern plains, occupying at least 15 million ac., is the short-grass

steppe, dominated by blue grama and buffalo grass (Fig. 3). Blue grama was designated the state grass of Colorado in 1987. Other major species include western wheatgrass, sand dropseed, prickly-pear cactus, and scarlet globemallow. The most common shrub is four-wing saltbush. Prior to the mid-19th Century, the short-grass steppe was home to countless bison, antelope, prairie dogs and other herbivores. The vegetation present has, consequently, evolved under unmitigated grazing, and is highly resistant to grazing pressure by domestic herbivores (Klippel and Costello 1960). Short-grass communities also provide good protection from wind erosion.

Typical riparian zones in the eastern plains occupy flood plains and adjacent bottomlands along braided streams and rivers. Prior to dam and reservoir construction for irrigation, as well as water diversions from west of the Continental Divide, even major waterways were intermittent during the late summer and early fall (Crouch

1961). Today, rivers traversing the Great Plains flow year-round, providing a different water regime for riparian ecosystems. Before water development, trees were widely scattered along the South Platte River (Conklin 1928), but, by 1900, plains cottonwoods had become increasingly established (Crouch 1961). Willows are found with cottonwood in riparian zones that are not heavily grazed during the summer growing season (Sedgwick and Knopf 1991).

Understory species in plains riparian areas include prairie cordgrass, panicum, common reed, sedges, Canada wildrye, woods rose, golden currant, and snowberry. A profusion of other grasses, forbs and shrubs may also be encountered in these riparian zones.

Wildlife are numerous on the short-grass steppe. Although the bison has been eliminated as a free-roaming animal, thousands of antelope may still be seen by travellers passing through the area. Colorado's state bird, the lark bunting, is a familiar inhabitant. Other plains animals in-

clude the coyote, black-tailed prairie dog, golden eagle, and curlew. An endangered species, the mountain plover, appears to do best in areas that have been grazed. In riparian zones, selected wildlife species comprise birds and mammals like the great blue heron, bald eagle, white-tailed deer, and many waterfowl.

Vegetation of the Rockies

The mountain ranges in Colorado are a subset of the Southern Rocky Mountains (Fenneman 1931). Rangelands in the Colorado Rockies extend from shrubby foothills communities to the subalpine zone found above timberline (Peet 1981). In general terms, they fall into five major ecosystems; foothills brush, pine/Douglas-fir forests, aspen, mountain grasslands/alpine meadows and riparian areas.

The foothills brush ecosystem has broad contrasts in species composition, depending upon location. Along the Front Range, the mountains adjoining western edge of the Great Plains, it is dominated by mountain mahogany, skunkbrush, and wax currant. On the foothills and mesas of the western slope, the ecosystem is typified by a Gambel oak and serviceberry overstory. Understory species are quite diverse. Big bluestem, side-oats grama, and needle-and-thread are common grasses along the Front Range, while Indian ricegrass, western wheatgrass, and elk sedge appear on the western slope.

The pine/Douglas-fir zone is the lowest of the true montane forests in the Southern Rockies. From a classification perspective, it can be divided into communities having only graminoid species in the understory and those with browse species, also (Alexander 1985). The dominant tree is easily ponderosa pine. Douglas-fir predominates in mesic areas within the zone, such as on north-facing slopes.

Primary herbaceous understory species in the pine/Douglas-fir zone include mountain muhly, sedge, June-grass, Arizona fescue and King spike-fescue. Woody understory species include mountain mahogany, bitterbrush, wax currant, sumac and woods rose.



Fig. 5. Willow-dominated riparian community near Woodland Park, Colorado. The U.S. Forest Service's Manitou Experimental Forest, site of many grazing studies in the ponderosa pine zone, is nearby.

The pine/Douglas-fir zone is characterized by low timber productivity and moderate forage yields. However, these sites are valuable as late spring or summer range for cattle and winter and early spring range for big game. The communities with shrub-dominated understories can be particularly important for deer and elk. Rangelands in Colorado support more elk ($\approx 200,000$ head) than any other state, and nearly 600,000 deer reside there, too (Unpublished report, Colorado Division of Wildlife).

Aspen communities occur throughout the Southern Rocky Mountains, but are most abundant west of the Front Range and Sangre de Cristos (DeByle and Winokur 1985). Stands of aspen traditionally have been categorized as seral following fire, which is often the case; however, some authors believe that aspen can be considered climax in a few habitats (Langenheim 1962).

Aspen community types range from warm dry sites in southwestern Colorado with understories of pachistima and whortleberry, to moist sites with understories of grasses such as blue wildrye and Thurber fescue, to wet sites distinguished by rich forb/grass understories containing meadowrue, cowparsnip and tall larkspur.

The value of aspen stands for wildlife needs and as a source of summer forage for livestock are broadly acknowledged (Ellison and Houston 1958). They produce widely varying amounts of forage, depending upon habitat type, however, ranging from more than 4,500 lb./ac. to less than 500 lb/ac.

The extensive lodgepole pine and spruce-fir forests that grow at mid-elevations (around 8,000–10,000 ft.) only provide forage where disturbances, such as fire and logging, create openings or in natural meadows (Moir 1969). Riparian ecosystems, although not expansive in area, are extremely important in the montane zone for both wildlife habitat and livestock grazing.

Grasslands and mountain meadows can be found within all montane and subalpine zones above 8,000 ft. in the Colorado Rockies. In the ponderosa pine zone, species like Parry oatgrass and sun sedge are common. On more mesic habitats, graminoid species include tufted hairgrass, bluejoint reedgrass, and alpine timothy. Wet meadows tend to be dominated by sedges such as Nebraska sedge and rushes like millet woodrush. Numerous forbs are common on wetter mountain meadows,



Fig. 6. Oakbrush vista in southern Colorado.

including solomonplume, blue-eyed grass, groundsel, and Rocky Mountain iris (Fig. 4).

Riparian areas in the Southern Rockies typically have overstories of narrowleaf cottonwood, often with blue spruce as a co-dominant at higher elevations. Blue spruce, of course, is Colorado's state tree. The shrub layer is controlled by willow communities unless they have been overgrazed. Willows, themselves, form the overstory in habitats too cold or wet for tree survival (Fig. 5). Alder and honeysuckle are two other familiar shrubs in the riparian zone. Understories in montane riparian areas include solomonplume, baneberry, bedstraw, field horsetail, and many of the grasses associated with wet meadows.

Besides deer and elk, montane rangelands in Colorado are home to

black bear, mountain lion, bobcat, bighorn sheep, and numerous smaller mammals. Common birds include blue grouse, Swainson's hawk, and golden eagle.

Three large mountain parks, named North, Middle, and South, are a prominent part of the Rocky Mountain Province in Colorado. Each is unique in its representative vegetation. North Park, which lies between the Park Range to its west and the Front Range to its east, forms the headwaters of the North Platte River. Situated at an elevation of 8,200 ft., North Park is epitomized by large expanses of sub-irrigated grasslands that are well-suited for haying operations. The native plant community was composed primarily of the cool-season bunchgrasses Arizona fescue, mountain muhly, and Parry oatgrass.

For nearly 100 years, much of North Park has been irrigated for increased hay production, resulting in a change in species composition to sedges, along with seeded cultivars like timothy, orchard grass, and clover.

North Park has high value as wildlife habitat because of the luxuriant cover of grasses on the uplands and willow-dominated riparian communities along its many streams and small rivers. The Arapaho National Wildlife Refuge occupies several thousand acres along the Illinois River in the center of the park. In addition to waterfowl, upland game birds, mule deer, and elk, more than 600 moose now live in North Park after a small number were introduced a decade ago.

Middle Park, located just below the headwaters of the Colorado River, is

the only park of the three found west of the Continental Divide. It is surrounded on the north by the Rabbit Ears Range, and on the west and southwest by the Gore Range. Lower in elevation than the other two parks (i.e., approximately 7,500 ft.), Middle Park is dominated by Wyoming big sagebrush at lower elevations, basin big sagebrush in upland swales and alluvial terraces and mountain big sagebrush at higher elevations and on north-facing slopes (Tiedeman et al. 1987). Herbaceous species in Middle Park include western wheatgrass, bluebunch wheatgrass, bottlebrush squirreltail, and elk sedge. Much of Middle Park is classified as critical winter range for mule deer and elk in addition to providing valuable grazing for domestic livestock.

South Park is a unique ecosystem because of its high elevation and extremely flat topography. It is situated between the Mosquito Range and Front Range, about 55 mi. west-northwest of Colorado Springs. It is the highest of the three parks, with a mean elevation of 9,200 ft. The headwaters of the South Platte River drain the park, flowing from northwest to southeast before turning back to the north and cutting through the Front Range towards Denver. Because of its level terrain, runoff is extremely slow compared to evaporation; therefore, soils tend to be highly calcareous and caliche layers are common.

South Park's vegetation is primarily sparse grassland with interspersed islands of ponderosa pine on isolated small mountains. Principal species consist of Indian ricegrass, blue grama, western wheatgrass, bottlebrush squirreltail, and winterfat. Production averages only 500 lb/ac. Both cattle and sheep make extensive use of South Park during the late spring and summer months.

Salt meadows occur where water accumulates in the park. Their plant communities are dominated by various mixtures of alkali sacaton, alkali cordgrass, and western wheatgrass. Other species often present include foxtail barley, alkali muhly, and saltgrass.

The San Luis Valley is similar to South Park, except it is 1,600 ft. lower in elevation and has an annual rainfall that is only two-thirds of the park's 10–12 in. This valley, situated in the rain shadow of the San Juan Mountains on its west and bounded by the Sangre de Cristos on the east, is found in south-central Colorado, opening south into New Mexico. The Rio Grande River passes through on its way to the Gulf of Mexico.

Most of the dominant species in the San Luis Valley are the same as found in South Park. The valley contains many deep sand sites, dominated by Indian ricegrass and needle-and-thread. Greasewood, rubber rabbitbrush and four-winged saltbush are found on salt flats in the valley. Because of a high water table, irrigated agriculture is a major land use where salinity is not a problem (USDA Soil Conservation Service 1981).

Vegetation of the Western Plateaus

As previously described, the western one-third of Colorado is a region of fairly level sedimentary rocks. Because the area has been uplifted so far above sea level, the rivers emanating from its higher terrain towards the west, including the Yampa, White, Colorado, Dolores, Gunnison, and San Juan, have dissected it, thereby separating the province into large, isolated plateaus. These substantial, and often abrupt, changes in topography, soils, and elevation have created a diverse landscape with numerous rangeland ecosystems.

Vegetation on top of the highest plateau, the White River, about 11,000 ft. mean sea level, closely approximates upper montane and subalpine vegetation of the Rocky Mountains to its immediate east. The other plateaus are lower, and the montane zone is predominantly covered by ponderosa pine forests (Alexander 1985). A widespread rangeland community in this zone is the ponderosa pine/Arizona fescue habitat type. On rockier sites, the understory is often woody because of the presence of

gambel oak. Mountain muhly and blue grama may also be found beneath ponderosa pine overstories.

Fire is an important ecological factor in southwestern ponderosa pine ecosystems, particularly in relation to the abundance of gambel oak (Brown 1958). For example, following destructive fires, gambel oak can regenerate asexually from adventitious buds, forming dense undergrowths that will preclude pine regeneration.

A foothills shrub transition zone, dominated by gambel oak and mountain mahogany, is positioned below the ponderosa pine forest. Gambel oak has diverse growth forms in Colorado (Harper et al. 1985). In some areas it takes a tree form, while in others it establishes compact, shrub-like patches that are impenetrable to man and other larger animals. Few research results are at hand to explain the reasons for such morphological variability; however, authorities have speculated that it is a combination of environmental factors and genetic hybridization with species formerly inhabiting the area (Clary and Tiedemann 1992).

Gambel oak stands are not extensively grazed because of a lack of available water and their dense vegetation; nonetheless, they frequently serve as valuable habitat for many wildlife species, including deer (Reynolds et al. 1970). Some oak stands have a high recreational amenity value during the fall when their tree foliage turns bright shades of red (Fig. 6).

Below 6,900 ft., pinyon-juniper communities become prevalent throughout the Colorado Plateau. Their understories are primarily grasses: blue grama, tobosa, side-oats grama, and western wheatgrass. Pinyon-juniper woodland occupies about 4.4 million ac. in Colorado, substantially less than in New Mexico, Utah, Arizona, and Nevada (unpublished data). It is, regardless, an important component of the Colorado Plateau country.

Nearly all of the pinyon-juniper zone has been grazed by livestock, especially during the period between



Fig. 7. Big sagebrush community near Great Divide, an expansive plateau in northwestern Colorado. The individual in the picture is Clint Wasser, a pioneering range ecologist and teacher at Colorado State University.

1880 and the end of World War I (West 1984). Grazing, coupled with unquantified (in Colorado) effects of fire, have undoubtedly contributed to shifts in geographical distribution and community structure of this type (Jameson 1987).

Great Basin sagebrush ecosystems (Kuchler 1964) are another important foothills component of the Colorado plateau. The three primary subspecies of big sagebrush, mountain, basin and Wyoming, are all present. Soil factors, fire, and grazing appear to control the relative distribution of pinyon-juniper and the 3 sagebrush subspecies (Bonham et al. 1991). The watersheds of the White and Yampa Rivers in northwestern Colorado, known for their large reserves of coal, natural gas, and oil shale, are occupied by sagebrush across nearly 5 million acres (Fig. 7).

One encounters salt desert shrub ecosystems, dominated by members of the family Chenopodiaceae, at the lowest elevations within the Colorado plateau province. The salt desert shrub can be considered as a high, cold desert, typified by high evapo-

transpiration-to-precipitation ratios, a comparatively short growing season and poorly-drained alkaline soils.

The most common species in Colorado's salt desert shrub are shadscale and greasewood, the former on adobe hills and benches and the latter on alkaline flats. Other shrubby species include mat saltbush, spiny hop-sage, and Wyoming big sagebrush on better-drained sites. Grasses make up approximately one-half of the foliar cover under conditions of favorable precipitation and proper grazing. They include bottlebrush squirrel tail, Indian ricegrass, wildrye, and alkali sacaton.

Wildlife species in the salt desert shrub have adapted to little free water and extremely hot and cold temperatures (that can fluctuate as much as 80°F during 24 hours). Black-tailed jackrabbit, kangaroo rat, coyote, desert kit fox and numerous reptiles inhabit these desert areas.

So, there you have it. From the vastness of the Great Plains to her rampart-like mountains and colorful western plateaus, the rangelands of Colorado are a broad representation of the diversity and vistas of western North America. They provide a means of livelihood to some, a source of clean air, water and food to many, and a sense of enjoyment to us all. Our job is to work towards the enhancement of all these benefits.

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