A Comparison of Seeded Grasses Under Grazing and Protection on a Mountain Brush Burn

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Extensive areas in the mountain brush zone, once supporting luxuriant stands of herbaceous plants, are now dominated by big sagebrush (*Artemisia tridentata*) and other brushy species. This change resulted mainly from severe livestock overgrazing in earlier years which weakened or killed the palatable herbaceous plants and opened the way for increase of the less palatable brush. With the increase of brush, many areas were bypassed by livestock. However, it has been found that by reducing the brush and seeding adapted grasses, these areas can again be made highly productive grazing lands with the browse then forming an important part of the total forage.

Artificial seeding trials show that many grasses are adapted within the mountain brush zone. Full evaluation of their suitability for range plantings, however, must include some information on their performance under grazing and aggressiveness in competition with other species. This paper reports the relative persistence of 22 grasses, each seeded with smooth brome (*Bromus inermis*), under heavy grazing and protection on the Manti-LaSal National Forest in central Utah. These were selected because of superior showing from a much larger number undergoing preliminary trial. Smooth brome provides a standard for judging values of newer species because it has demonstrated persistence under a wide range of use and site conditions over a long period on mountain lands. Some information is also given relative to response of several shrubs following burning as well as their performance in competition with seeded grasses under protection and grazing.

Description of the Area

The study site lies within the midmountain brush zone at an elevation of about 8,100 feet in Ephraim Canyon. It is part of a 45-acre area from which brushy vegetation was burned in late September 1944. Prior to treatment, brush produced an estimated 1,500 pounds of air-dry herbage per acre, 80 percent of which was big sagebrush. Mountain snowberry (*Symphoricarpos oreophilus*), the next most abundant species, occurred generally over the area. Scattered patches of Gambel oak (*Quercus gambelii*) and chokecherry (*Prunus virginiana melanocarpa*) were present along with occasional serviceberry bushes (*Amelanchier alnifolia*) and a few clumps of bigtooth maple (*Acer grandidentatum*). Letterman needlegrass (*Stipa lettermani*), slender wheatgrass (*Agropyron trachycaulum*), mountain brome (*Bromus carinatus*), western yarrow (*Achillea lanulosa*), penstemon (*Penstemon spp.*), and annual weeds formed a sparse understory amounting to less than 100 pounds of air-dry herbage per acre.

Based on long-time records at similar elevations in Ephraim Canyon, the average annual precipitation was calculated to be 23 inches (Lull and Ellison, 1950). The exposure is northwesterly, with a slope of about 20 percent on the immediate study area. The soil is a deep clay loam of good fertility.

Methods and Procedures

Following burning, seed of 22 grasses was broadcast individually on contour strips approximately 400 feet long and 8 feet wide at a rate of about 14 pounds per acre. Seed of smooth brome was then broadcast over these plots at the rate of 5 pounds per acre. Overcasting with smooth brome had a two-fold purpose: first, to insure a stand if some species failed, and second, to provide a test for the aggressiveness of each species in competition with smooth brome. The remainder of the burned area was broadcast to a mixture. Seed was covered by disk-harrowing following broadcasting.

Following early summer grazing in 1946, two belt transects, each 3 feet wide, were established across all plots. On these, estimates were made of the amount remaining, in pounds per acre, and percentage utilization of each grass and the associated smooth brome, from which total yields were calculated (Frischknecht and Plummer, 1949). Yield estimates of brush species were also made and numbers of plants were counted. At this time an enclosure 32 feet wide and 265 feet long was erected across the plots to include one transect plus an additional area on each end that had been seeded to the grass mixture. Cattle broke into the enclosure in late summer of both 1948 and 1949 and utilized the grasses to around 80 percent. The fence was then strengthened and cattle have since been totally excluded.

With elimination of the brush and seeding to grasses, this site became a natural concentration area for cattle, beginning in 1946. Sheep also grazed the area for four years, but when it became apparent that use was too heavy, sheep were excluded. Elimination of sheep contributed to more moderate early use, but cattle spent more time on the area so that total use continued heavy, approaching 90 percent by the end of each summer season. In 1952 utilization averaged about 50 percent on the grazed transect when it, too, was fenced for a com-

parison of the persistence and yield of the various grasses following six years of heavy grazing.

Yield estimates of each grass and the associated smooth brome have been made on the protected transect, and the amount left and the percentage utilization have been estimated on the grazed transect, each year. The final data presented are for 1953 when both transects were protected.

Response of Grasses

Initial seedling stands (1945) were rated good to excellent for all grasses except beardless bluebunch wheatgrass (*Agropyron inerme*), bearded bluebunch wheatgrass (*A. spicatum*), and reed canarygrass (*Phalaris arundinacea*), all of which showed medium to poor initial establishment. Seedlings of smooth brome were present on all plots in about equal numbers but were somewhat suppressed on plots where the more aggressive species had been planted. Most grasses made good growth the first year; several species such as mountain rye (*Secale montanum*) matured seed.

When initial yield data were taken in 1946, 10 of the 22 grasses were more prominent than smooth brome on both transects; another four were superior to smooth brome on one transect only; and smooth brome was superior to the other eight species on both transects. By 1953 this situation had changed considerably.

Based on comparative production with smooth brome, the 22 grasses have been divided into three groups as follows: (1) those dominant to smooth brome in 1946 and also in 1953, (2) those dominant to smooth brome in 1946 that have since given way to smooth brome, and (3) those largely suppressed by smooth brome in both 1946 and 1953. Although wide variations in yield exist, this grouping facilitates comparison of grasses that performed somewhat similarly.

Intermediate wheatgrass (*Agropyron intermedium*), pubescent wheatgrass (*A. trichophorum*), quackgrass (*A. repens*), and meadow brome (*Bromus erectus*) were the only grasses that were dominant to smooth brome in 1946 and also in 1953 (Fig. 1). Of this group, only meadow brome is a bunchgrass. It demonstrates unusual persistence for a nonsod-former, especially under severe use. The persistence of the three wheatgrasses is undoubtedly related to their marked ability to propagate vegetatively, a quality likewise possessed by smooth brome.

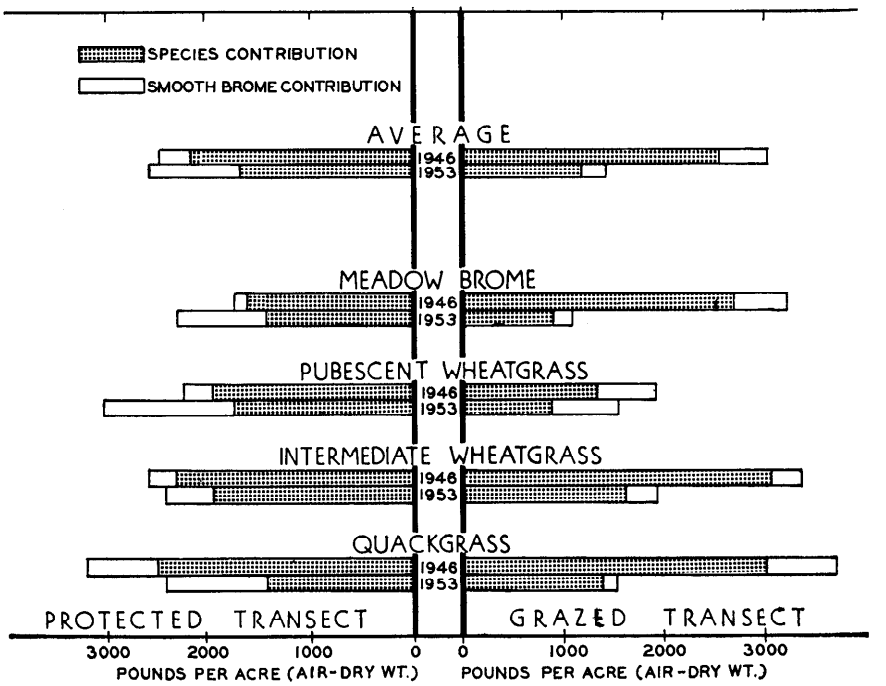

FIGURE 1. Yields of grasses dominant to smooth brome under both grazing and protection.

Although smooth brome has increased to some extent in each of these plots, these grasses have made invasions of adjacent plots in which smooth brome was present. Because changes are still in progress, it will be of interest to see which grasses will eventually become dominant.

Their qualities of rapid establishment and persistence make the grasses in Figure 1 outstanding for seeding on mountain rangelands. Like smooth brome, they have particular usefulness on areas where livestock concentrate and a good cover is needed for watershed protection. Intermediate and pubescent wheatgrasses, in particular, have vigorous seedlings which contribute to rapid stand establishment.

Quackgrass forms a tougher sod than the other species and shows a more marked decline in yields, which is probably associated with quicker sod-binding. Observations show it to be one of the most palatable grasses to livestock and big game. Pocket gophers relish the rootstocks and frequently destroy small plots completely. The aggressive sod-forming habit of quackgrass makes it valuable for erosion control, but this same habit causes it to become a pest on agricultural land, so that it cannot be recommended for seeding except at high elevations where it does not mature seed.

Tall oatgrass (*Arrhenatherum elatius*), mountain rye, mountain brome, Canada wildrye (*Elymus canadensis*), blue wildrye (*E. glaucus*), bearded wheatgrass (*Agropyron subsecundum*), slender wheatgrass, tall wheatgrass (*A. elongatum*), and standard crested wheatgrass (*A. desertorum*) became readily established and gave relatively high yields for about four years, but are now suppressed by smooth brome under both protection and heavy grazing (Fig. 2).

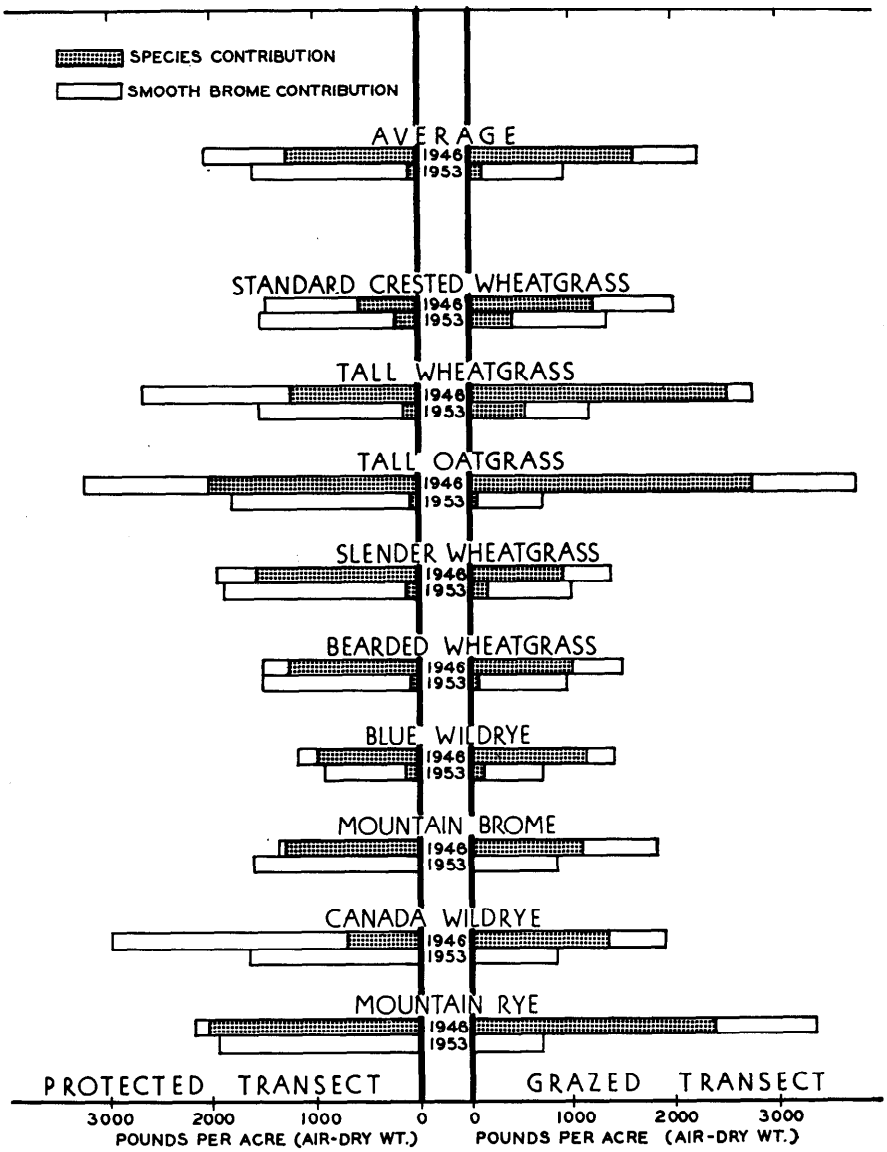

FIGURE 2. Comparative yields of grasses dominant to smooth brome in 1946 that have been largely replaced by brome.

All are bunchgrasses; most of them tend to be short-lived, and are dependent upon self-reseeding for perpetuation. In the present study they failed to reestablish themselves in competition with improving stands of smooth brome. However, they are useful in mixtures with slower developing grasses such as smooth brome to insure rapid establishment of a grass cover following seeding. They maintain themselves on spots where sod grasses fail to become established as well as on disturbed areas created by pocket gophers, mice and ground squirrels. All except standard crested and tall wheatgrasses and mountain rye have been found to grow very well in shade of shrubs and aspen.

Standard crested and tall wheatgrass, two of the longer lived bunchgrasses in this group, have shown greater persistence than the others, but they, too, have been suppressed. They have maintained stands better on drier sites and at slightly lower elevations. Both are valuable for seeding sunny openings throughout most of the mountain brush zone. Although Fairway crested wheatgrass (*Agropyron cristatum*) was not used in these trials, other observations show it to be more persistent at this elevation than standard.

Creeping wildrye (*Elymus triticoides*), Great Basin wildrye (*E. cinereus*), thickspike wheatgrass (*Agropyron dasystachyum*), bluestem wheatgrass (*A. smithii*), beardless bluebunch wheatgrass, bearded bluebunch wheatgrass, big bluegrass (*Poa ampla*), subalpine needlegrass (*Stipa columbiana*), and reed canarygrass were inferior to smooth brome in establishment at the outset and for the most part have remained so (Fig. 3). It is notable that beardless bluebunch wheatgrass and big bluegrass, two bunchgrasses, increased on the protected transect but not on the grazed transect. Conversely, three sod-formers, thickspike wheatgrass, creeping wildrye, and bluestem wheatgrass, increased in yield and ground spread under grazing but changed very little under protection, suggesting again the superiority of sod-formers under heavy grazing. The primary weakness of the grasses in Figure 3 was their slowness to become established. Other studies (Plummer, 1943) have shown this disadvantage to be primarily associated with weak or slow developing seedlings. Experience with various strains within species indicates that much of this disadvantage can be overcome through selection and breeding.

Repeated heavy grazing has been damaging to the seeded grasses as shown by the fact that in 1953, total production on the heavily grazed transect was only 56 percent of that on the protected transect; at the outset yield was slightly higher on the grazed transect. However, it is probable that after a year's protection, yield on the grazed transect will increase. Data from four 10- x 15-foot enclosures on the adjoining mixture planting showed that, following five years' heavy use, grasses regained much, if not all, their vigor in the second year of protection. Yields in the second year (1952) were comparable to yields on the mixture planting protected since 1946. These

results show a need for occasionally providing a year of rest for areas where livestock tend to concentrate on seeded range.

Reinvasion of Brush Following Burning

Big Sagebrush

A uniform stand of big sagebrush seedlings became established with the grasses. The seed was probably transported to the area by wind and to some extent by animals from adjacent unburned areas. It is possible, but unlikely, that a few sagebrush plants had matured seed on the area before burning; inspection prior to burning showed very immature seed. The possibility that seed from prior years had lain dormant in the ground and germinated the spring following burning is discounted on the basis of experience with seeding sagebrush artificially where after the first year no new plants have been found. Finally, it is doubtful whether any sagebrush seed on the area prior to burning would have survived the very hot fire which consumed all litter as well as brush.

When the two transects were established in 1946, sagebrush seedlings averaged 1.03 and 0.83 plants per square foot on the fenced and unfenced transects, respectively (Fig. 4). The trend in numbers of these original plants has been downward until in 1953 there were only 0.30 and 0.35 plant per square foot on the respective transects.

Aside from the original plants, it is important to note that new sagebrush seedlings appeared on the grazed transect, beginning in 1951, and that numbers increased during the next two years. Despite possible high mortality, it is likely that a considerable number of these plants will survive to maturity. Only two small sagebrush seedlings have been found on the protected transect, both in 1953. In addition to keener competition from the grass, the heavy grass litter inside the enclosure, which amounts to about 2,500 pounds per acre, makes it difficult for brush seedlings to become established.

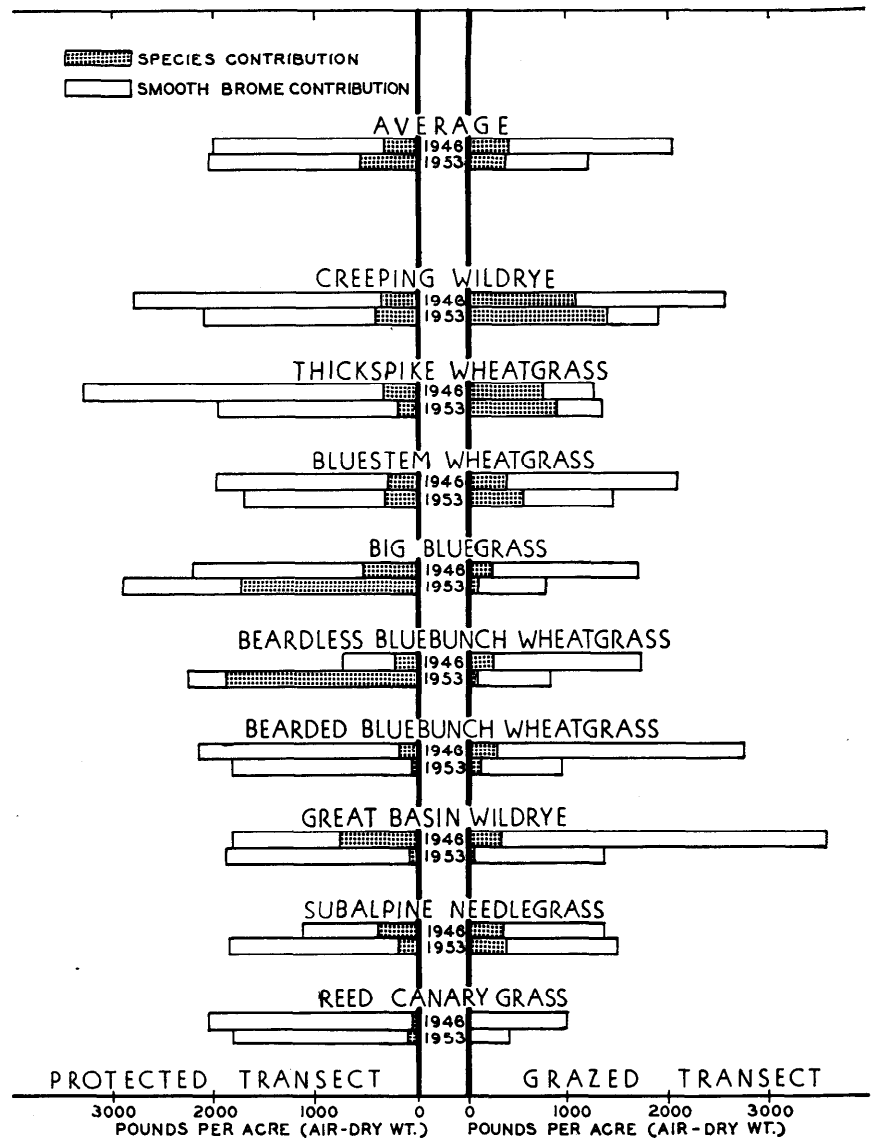

FIGURE 3. Yields of grasses mostly inferior to smooth brome throughout the study.

Figure 4 shows that although mortality of brush plants was only slightly higher on the grazed transect than on the protected transect after 1947, differences in herbage production were much more pronounced. Yield of big sagebrush increased on both transects each year up to 1950, when an infestation of aphids damaged the foliage considerably. Apparently the effect of this infestation carried over to the following year because brush yields did not increase in 1951. During the next two years, brush yield was much higher on the grazed transect but changed very little on the protected. In 1953, plants on the grazed transect averaged 18.2 inches in height and 10.3 inches in crown diameter compared to 15.8 inches in height and 8.3 inches in crown diameter on the protected transect. Figure 5 shows vigorous sagebrush outside the enclosure compared to its lack of prominence inside. No important differences were noted in the numbers of plants or yield of sagebrush on the different grass strips.

The larger plants and much higher yield of brush on the grazed transect are further evidences of reduced grass vigor from prolonged heavy grazing. There has been virtually no grazing of sagebrush, so this is not a factor. These results support findings on the

Snake River Plains (Blaisdell, 1947, 1953) that sagebrush and grass, established at the same time, grow and develop together even under complete protection. However, growth is retarded and yield of sagebrush is reduced by a thrifty grass cover, and fewer new plants become established.

Mountain Snowberry

None of the mountain snowberry bushes were killed by the fire. In fact subsequent growth of burned and unburned bushes showed that burning stimulated sprouting. Aldous (1934) and Pelton (1953) found that burning of other species of *Symphoricarpos* likewise increased the number of stems.

While there were no new snowberry plants, herbage yield from the old plants almost doubled on the grazed transect, increasing from 539 pounds per acre (green weight) in 1946 to 1,023 pounds per acre in 1953. In contrast, yield of snowberry on the protected transect showed essentially no change, being 479 and 477 pounds per acre in the two years. This points to a suppressive effect of the grass inside the enclosure, or to a stimulative effect from grazing of snowberry outside, probably both. Utilization of snowberry has varied from 10 to 60 percent in different years on the outside transect. It was noted that the higher use occurred in years when sheep grazed the area.

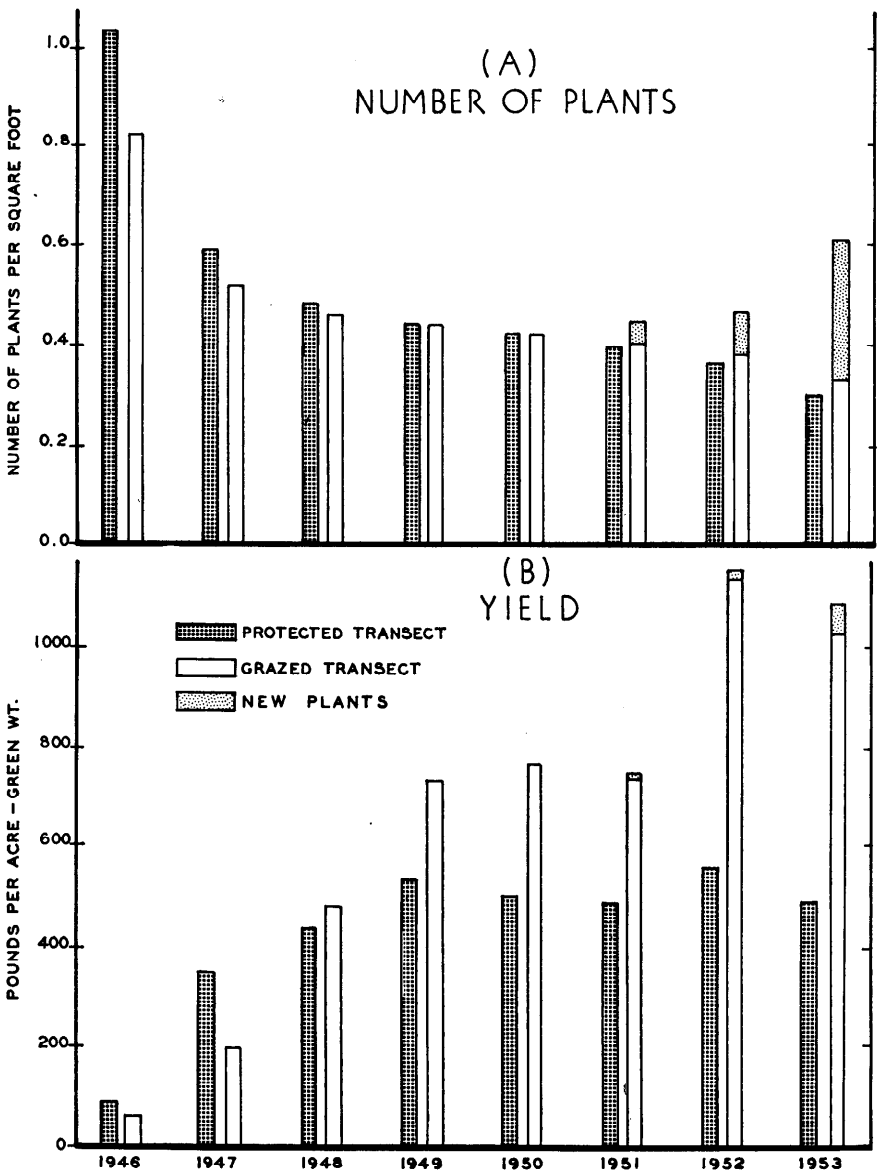

FIGURE 4. (A) Numbers of plants, and (B) yield of big sagebrush on protected and grazed transects.

Chokecherry

Very heavy use of chokecherry (90 percent) has been notably detrimental to the few patches of chokecherry which occurred on the area and which were killed back only to the crown by fire. A total of 177 sprouts on the grazed transect in 1946 decreased to only 24 sprouts in 1953. In contrast, on the protected transect, the decrease was only from 46 to 40 sprouts. At the same time herbage yield of chokecherry decreased from 22 to 9 pounds per acre on the grazed transect, but increased from 24 to 43 pounds on the protected. Further effects of heavy grazing were noted on sprout heights which averaged 14 and 7 inches in 1953 on the protected and grazed transects, respectively, whereas the 1946 height was 8 inches on both transects. Quite likely there is considerable suppression of the chokecherry by the grass on the protected transect, which emphasizes further the damage to this browse by grazing.

Other Browse

Gambel oak, serviceberry and bigtooth maple did not occur on either transect but were present on the adjoining area. There was no observed mortality of these species following burning. All sprouted v i g o r o u s l y from the crowns, but new growth has been largely held in check by grazing and competition of the grass. One patch of horsebrush (*Tetradymia glabrata*) was apparently uninjured by burning. There has been no grazing of this brush and also no increase from new plants.

Summary

Twenty-two grasses were seeded on contour strips with smooth brome on a mountain brush site in the fall of 1944. Two transects were established across all strips

in 1946; one was fenced to exclude livestock grazing whereas the other has been grazed heavily by livestock each year since establishment until 1952. Except for two years when cattle broke through the fence, livestock have been excluded from the protected transect. Final inventories were made in 1953.

Only intermediate wheatgrass, pubescent wheatgrass, quackgrass and meadow brome maintained dominance to smooth brome under both heavy grazing and protection throughout the study. Mountain rye, mountain brome, bearded wheatgrass, slender wheatgrass, tall oatgrass, blue wildrye and Canada wildrye, which are relatively short-lived bunchgrasses, were dominant early, but were later suppressed by smooth brome. Two longer lived bunchgrasses, standard crested and tall wheatgrass, were not so totally replaced but are gradually giving way to smooth brome. These two grasses compete more successfully with smooth brome on drier sites and at lower elevations in the mountain brush zone.

Beardless bluebunch wheatgrass and big bluegrass, two bunchgrasses, tended to suppress smooth brome on the protected transect but not on the grazed transect. In contrast, thickspike wheatgrass, creeping wildrye and bluestem wheatgrass, all sod-formers, tended to dominate smooth brome on the grazed transect but not under protection. The primary weakness of this group, along with bearded bluebunch wheatgrass, Great Basin wildrye, subalpine needlegrass and reed canarygrass, was their initially weak stand establishment, an undesirable quality which greatly limits their usefulness in range seedings.

Prolonged heavy grazing has been damaging to the seeded grasses in that total yield on the heavily grazed transect was only 56 percent of the yield under protection.

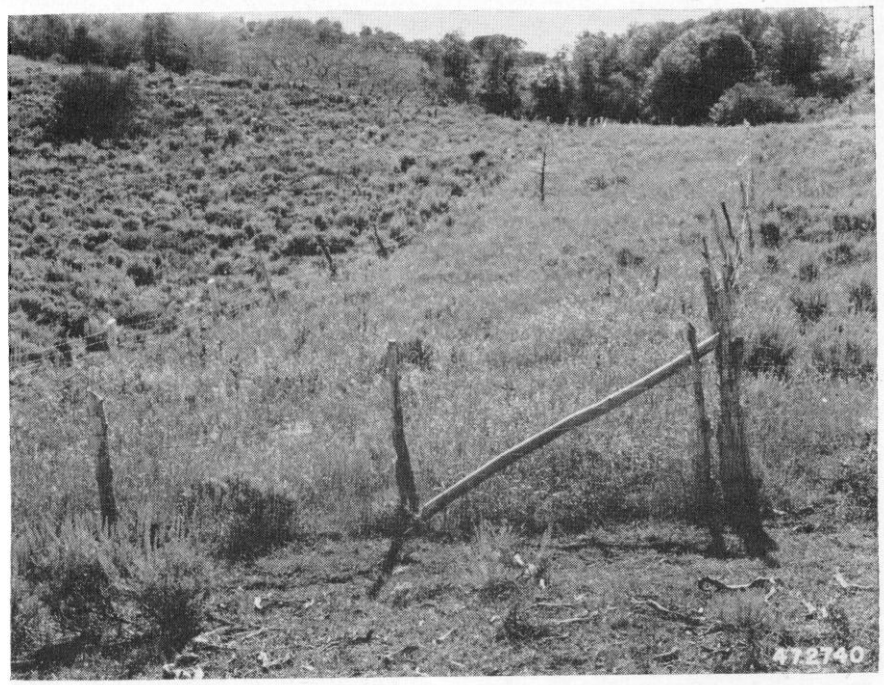

FIGURE 5. Big sagebrush became established and developed simultaneously with the grass, both inside and outside the enclosure, but is now more prominent outside where grasses are heavily grazed.

However, results from small enclosures showed virtually complete recovery of high grass yields in the second year of protection. Thus, it would appear that where grazing must ordinarily be heavy on seeded ranges, giving complete rest occasionally would assist in maintaining grasses in a high state of productivity.

The increased yields of big sagebrush and snowberry on the grazed transect are associated with reduced grass vigor, and in the case of snowberry, perhaps with an added stimulative effect of grazing. In addition, many sagebrush seedlings have appeared on the grazed transect beginning in 1951 but only two on the protected. Chokecherry, present only in minor amounts, was greatly reduced by heavy grazing. Of the seven browse species on the burned area, only big sagebrush was killed by fire. Snowberry, gambel oak, chokecherry, serviceberry, bigtooth maple and horsebrush sprouted readily from the crowns. Except for horsebrush, all provide good browse.

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