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A comparison of vegetation changes in a mountain brush type after grazing and protection from grazing during thirty-seven years

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A COMPARISON OF VEGETATION CHANGES IN A MOUNTAIN BRUSH TYPE AFTER GRAZING AND PROTECTION FROM GRAZING DURING THIRTY-SEVEN YEARS

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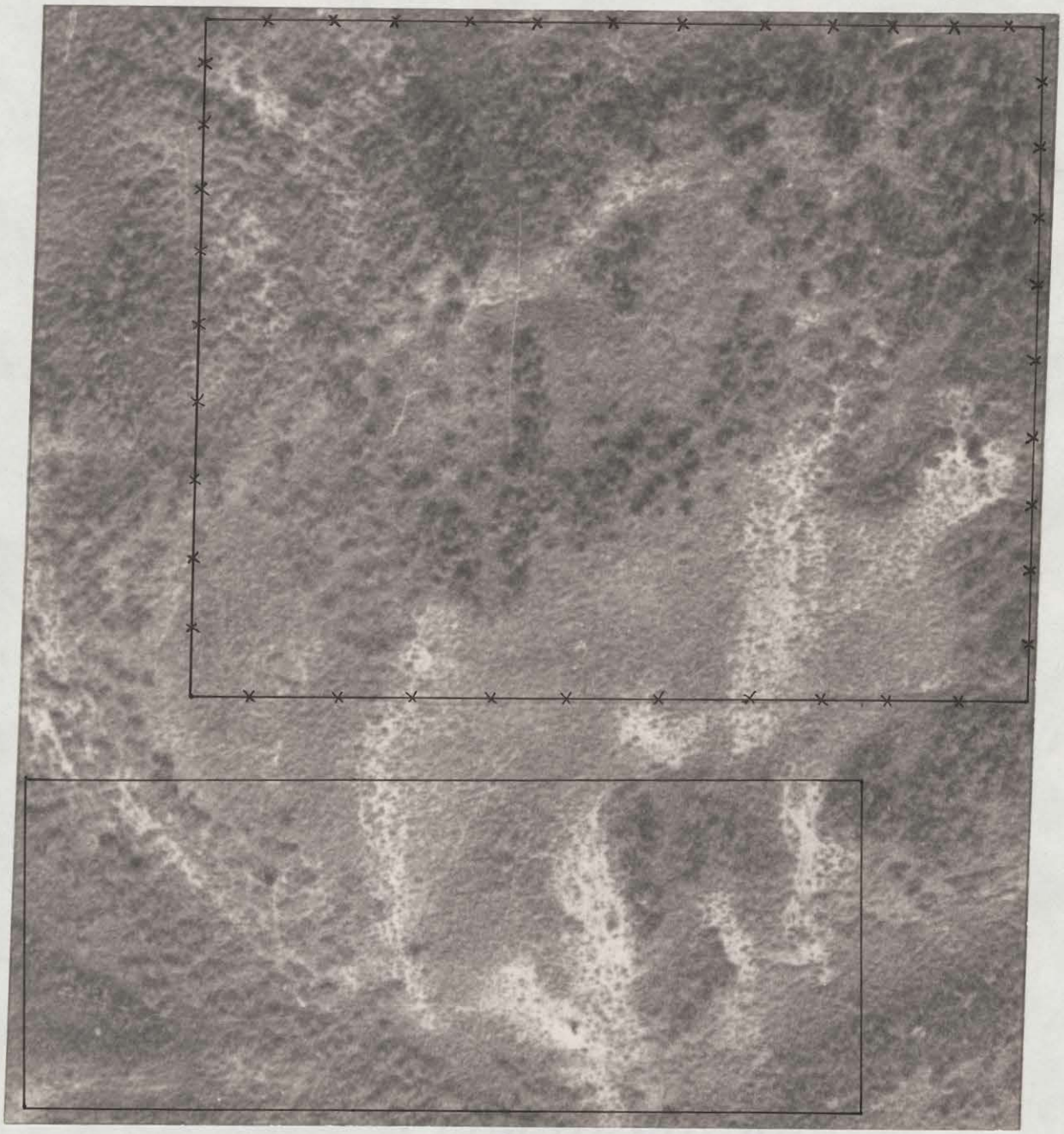
INTRODUCTION

The mountain brush vegetation type is extensive and important throughout the central and southern Rocky Mountains. It extends from the eastern Sierras to the eastern Colorado Rockies and south of a latitude from Denver, Colorado to northern New Mexico (Shelford, 1963; Oosting, 1956). This type is important as spring and fall range for livestock grazing. Daubenmire (1943) indicated that this type attains its maximum development in the southern Rockies where it has a vertical range of 1,800 feet. Hayward (1948) in reporting on this type in Utah indicated that it occurs on slopes at elevations of 5,100 ft. to 7,500 ft. depending on the steepness of the slope and exposure. Numerous studies have been made in mountain brush types in Utah, but few have been made to correlate vegetation changes that have taken place under grazed and ungrazed conditions.

Personnel from the Intermountain Forest and Range Experiment Station, in 1931, established study exclosures in major vegetation types throughout Utah. The purposes of these exclosures were to study the effects of grazing on the various vegetation types and to determine what the changes or trends would be. Such an exclosure was established in the mountain brush type along the Castilla-West Portal Road one mile northeast of the Springville Crossing on Diamond Fork Creek in section 31 township 7 south, range 6 east, Salt Lake meridian (Fig. 1).

Range trends are often difficult to evaluate and can only be projected and inferred from past records (Ellison, 1949). This study



scale 1" = 132'
-x-x- = exclosure
——— = grazed

Fig. 1. An aerial view of the study areas showing the relationship of ungrazed and grazed areas.

was concerned with the correlation of the vegetation trends that have taken place over 37 years inside the exclosure and the grazed area adjacent to it. With such long intervals of time between the studies, 10 and 27 years, there are periods of fluctuation and conditions that were not observed that may have influenced the vegetation and consequently do not appear in the current data. Without knowing all of the factors that may have influenced changes during this time the trends have been based on major species, good and poor, that have indicated the most apparent changes in grazed and ungrazed plots.

STUDY AREA AND METHODS

The mountain brush area in the Uinta National Forest covers approximately 80,600 acres located on moderate to steep topography at near 7,400 ft. in elevation. The greenriver formation is the major geologic type in the area (U.S.G.S., 1948). The soil varies from a sandy loam and sandy clay loam on the benches and steep slopes to a clay loam in the bottom with some limestone-shale exposed on steeper slopes and eroded areas. The climate is semi-arid with annual precipitation averaging 22.55 inches for 1948 to 1962 (S.C.S., 1968) of which 62 percent falls during the winter season (October 1 to April 30) (Price, 1938). Measurements on precipitation were made at the Hobble Creek Summit Station which lies approximately four miles north and west of the study site at approximately the same elevation. Temperature extremes range from -30° F to 97° F with a mean annual temperature of 43° F (Price, 1938).

The area has been used in late spring and early fall by sheep and cattle since early settlement in the 1850's and the common-use by both classes of livestock continued until 1963, after which time the sheep were not allowed to graze the area. Patterns of grazing determined from early records show that sheep use was probably light as most of them grazed to the east and north of the study area. The number of livestock prior to 1963 has varied greatly. The number of sheep ranged from 3,054 to 30,000 head grazing on the area jointly with from 500 to 9,900 head of cattle and horses. Since 1963 the area has been

used strictly as a cattle allotment and placed under management plans to improve the area. Since 1963 the number of cattle has been cut to 40 percent of the original number. There are approximately 3,000 cattle on the allotment now. Cattle have not grazed the area adjacent to the exclosure for the past two years (U.S.D.A., 1968).

A ten-acre exclosure was established in 1931 by Pechanec, Hutchings, Pickford, Stewart and other Intermountain Experiment Station personnel to determing the effects of grazing on the area. In 1932 they selected a five-acre area that was grazed south of and adjacent to the exclosure. The exclosure and grazed area were marked off and plots were established one chain apart and 33 feet from the exclosure and grazed area boundaries. One hundred plots were established in the exclosure and 50 plots in the grazed area. Cover was determined by mapping four, meter-square quadrats established in the southern half of the exclosure and four in the grazed area (Fig. 2). They were mapped by using a meter-square frame with straps or strings dividing it into ten strips vertically and horizontally. With the points of intersection as reference points the crown cover of the vegetation was drawn to scale.

Species composition and cover percentages were determined by the point-observation-plot (square-foot density) method (Stewart and Hutchings, 1936) and weight estimates as outlined by Pechanec and Pickford (1937) were made on the 50 grazed and 100 ungrazed plots. Dry weight production for the plots was determined by the Forest Service range analysis procedure used in their range handbook (U.S.D.A., 1969). The meter-square quadrats were mapped, as previously indicated, and species lists made.

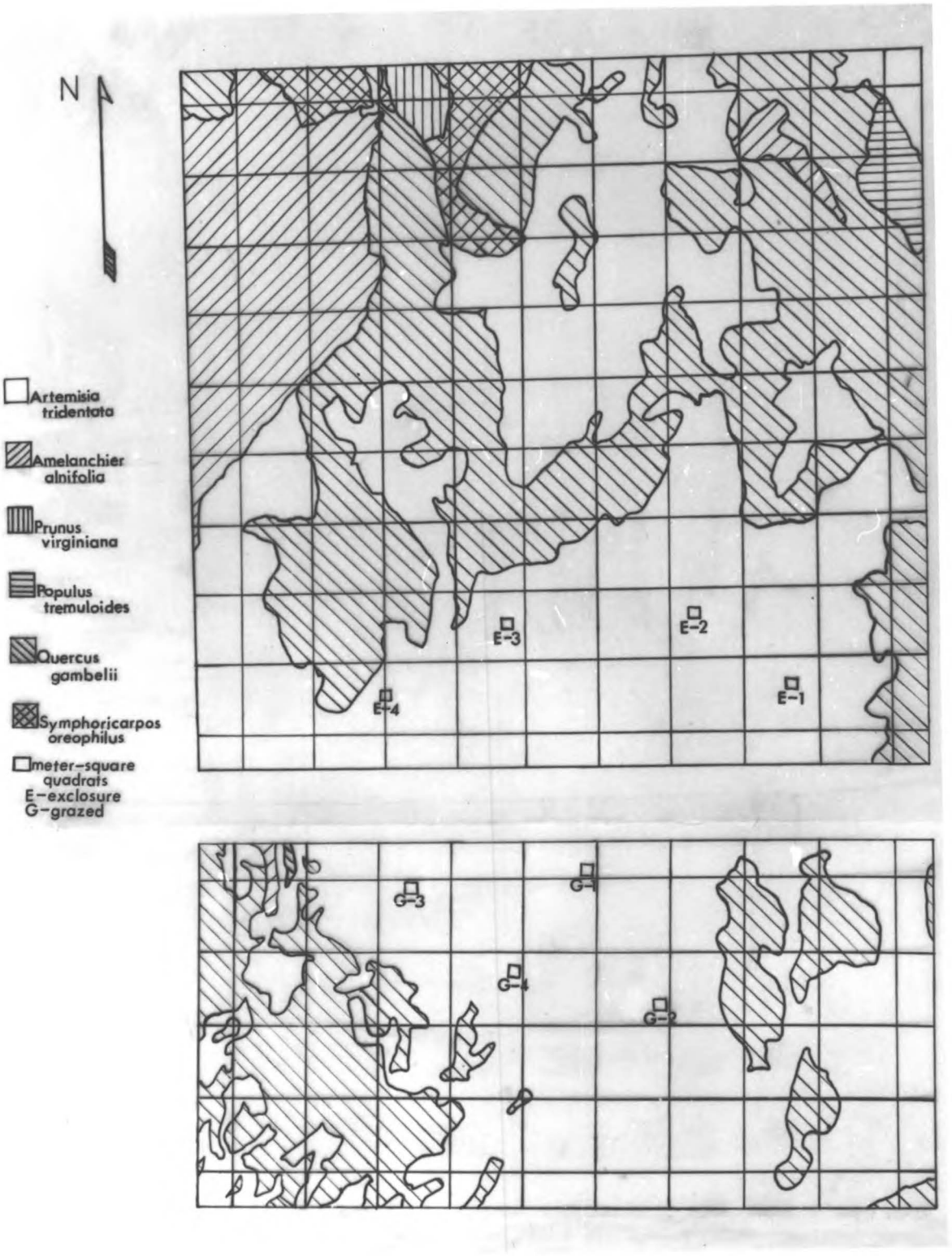


Fig. 2. Grazed and ungrazed area illustrating the location of plots, browse types, and meter-square mapping quadrats.

In 1942 and 1969 the study was repeated in the same manner as in 1932. Plants were counted and included in the studies of 1942 and 1969, on mature, dead and seedling browse plants. Some perennial forbs were also counted to see if any changes would be evident after a period of 27 years.

In the 1969 study a mechanical analysis was made on soils (Bouyoucos, 1936) from the different exposures to determine the types of soils and their extent in the study area. Soil samples were taken from the gentle sloping sage-grass, moderate sloping oak, steep oak, and in drainage bottom areas in the exclosures and in the grazed area except for the drainage bottom. The soils were collected at depths of 0-1", 1-3", 3-6", 6-9", 9-12", and deeper than 12". From these collections the textures of the soil were determined.

Voucher specimens of the plant species were collected in 1969, verified and deposited in the Brigham Young University Herbarium and Range Plant Herbarium.

Thus with early 1932, 1942 and late 1969 determinations of cover, composition, production of available forage, soils, and grazing history it is possible to determine the vegetation trends related to grazing.

RESULTS AND DISCUSSION

The overall general trend for the more palatable forage species of grasses and browse has been a decrease in cover, composition, and production in the grazed area and an increase in the exclosure or ungrazed area with the exception of bluebunch wheatgrass (Agropyron spicatum). The species selected to illustrate the trends under grazing pressures were those that showed the most evident changes. Forbs have responded differently than the grasses and browse in that they have increased in the grazed as well as in the ungrazed plots. The species of forbs were numerous but only a few showed changes that were large enough to be considered indicators of trend.

Dry weight production information on the grasses, forbs, and browse was available for 1942 and 1969. As indicated in Table 1 the production of the grass species shows a decrease in the grazed and ungrazed plots with the exception of bluebunch wheatgrass which has increased slightly on the grazed plots. The slight increase in production for wheatgrass may be because livestock have not grazed the area for two years which would give most plants a chance to produce more forage than they normally would if grazed in late spring and early fall each year. Letterman's needlegrass (Stipa lettermannii) has remained relatively stable in the grazed plots but appears to be decreasing in the ungrazed plots. Reduced production in the ungrazed plots is probably due to competition with other species while the stable condition in the

Table 1. Dry weight production (pounds per acre) of major species in grazed and ungrazed plots.

Species	Grazed		Ungrazed	
	1942	1969	1942	1969
Grasses				
Agropyron spicatum	3	4	13	5
Carex geyeri	24	9	58	14
Poa longiligula	15	6	19	11
Stipa lettermannii	1	1	3	3
	43	20	93	33
Forbs				
Balsamorhiza sagittata	125	236	43	94
Frasera speciosa		6	5	50
Helianthella uniflora	6	11	29	45
Penstemon watsonii	7	4	8	4
Senecio integerrimus	70	26	71	38
	208	283	156	231
Browse				
Amelanchier alnifolia	114	44	43	33
Artemisia tridentata	151	114	193	98
Chrysothamnus viscidiflorus	17	12	15	19
Quercus gambelii	13	49	5	41
Symphoricarpos oreophilus	82	36	101	64
	377	255	357	255
Total production	628	606	558	519

grazed plots is because cattle do not readily graze letterman's needlegrass when other forage is available. Elk sedge (Carex geyeri) and longtongue muttongrass (Poa longiligula) have the greatest decrease in production in grazed and ungrazed plots. Reduction of these two species is probably due to competition in the ungrazed plots and grazing pressures in the grazed plots.

Crown cover for the grasses follows the same pattern as dry weight production with the exception of bluebunch wheatgrass and longtongue muttongrass. Longtongue muttongrass has shown a greater increase in the ungrazed plots than the other grasses (Fig. 3). The increase is probably because this species matures early and sets seed before the other species, thus allowing it to become established in the late fall or early spring.

Composition percentages of the grasses (Fig. 4) indicates trends similar to those of production and crown cover. The majority of species have shown a decrease in the grazed and ungrazed plots while some have remained relatively stable or increased in the ungrazed plots.

Five new species of native grasses, giant wildrye (Elymus cinereus), junegrass (Koeleria cristata), oniongrass (Melica bulbosa), Indian ricegrass (Oryzopsis hymenoides), and columbia needlegrass (Stipa columbiana), have appeared in the grazed and ungrazed plots that were not reported in either the 1932 or 1942 studies. This supports the fact pointed out by Cottam and Evans (1945) that under protection and reduced grazing pressures more native grasses will appear. The increase of these species has been greater in the ungrazed plots than in the grazed plots. Giant wildrye is found only in the ungrazed area

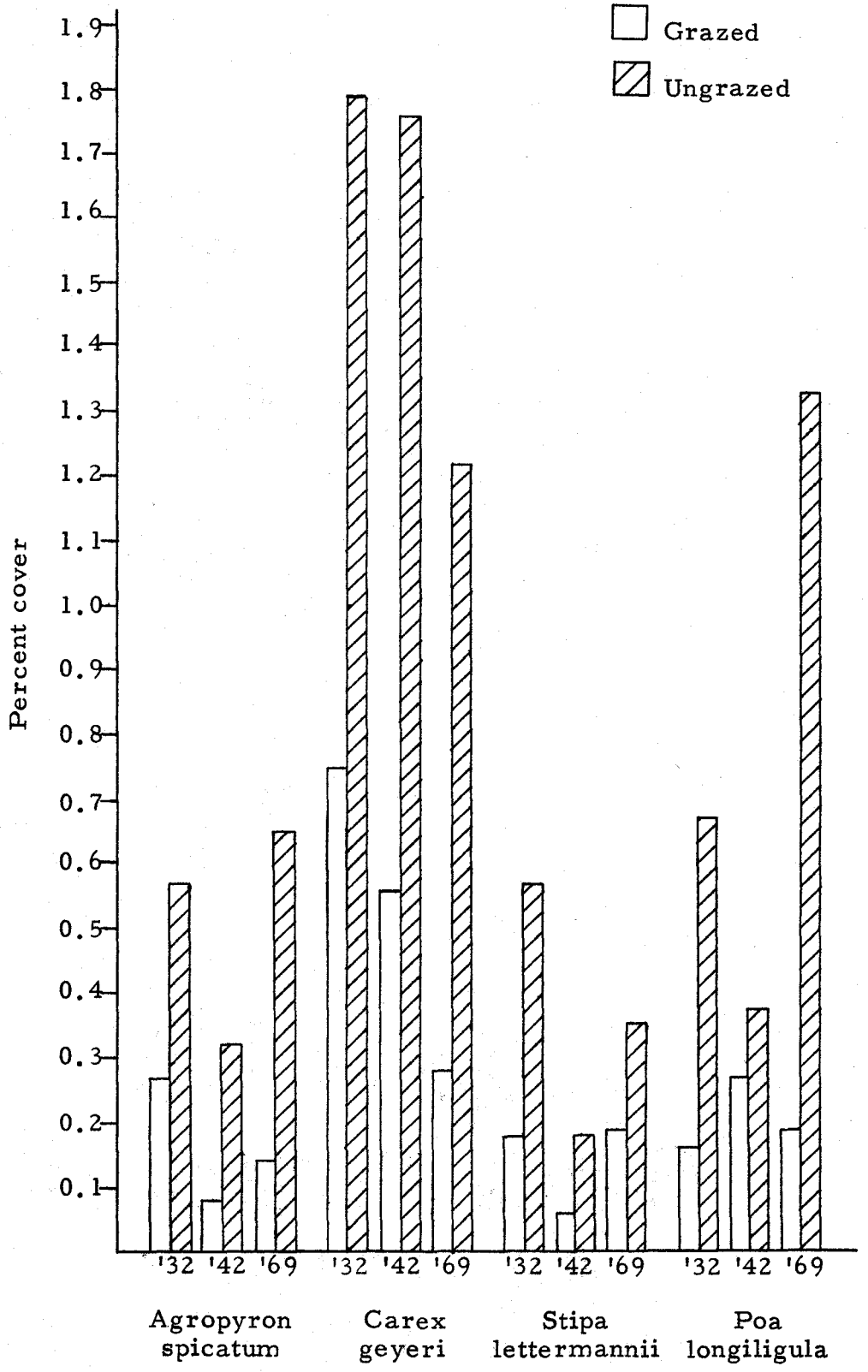


Fig. 3. Cover percentages of grass species in grazed and ungrazed plots for 1932, 1942, and 1969.

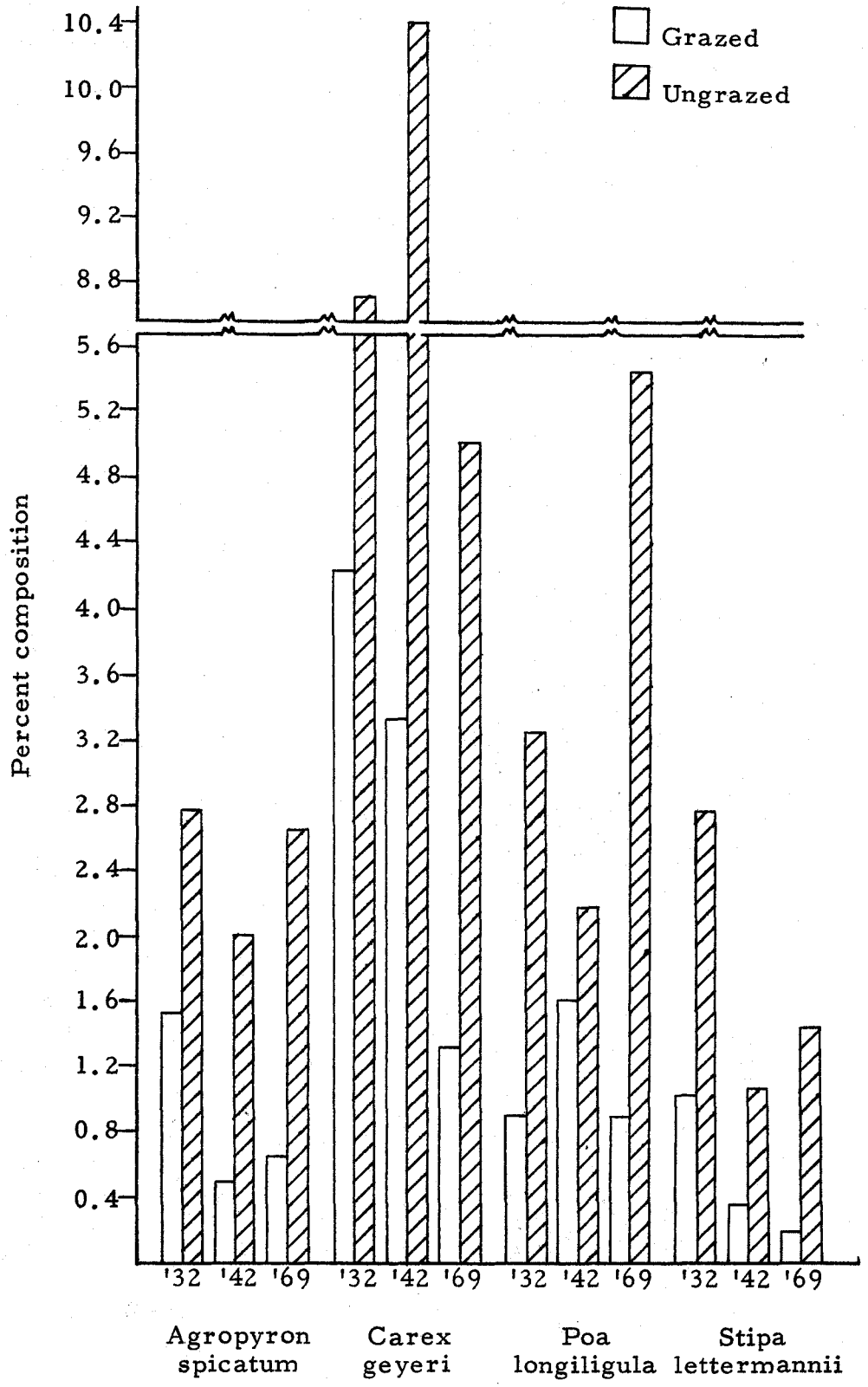


Fig. 4. Percent composition for grasses in grazed and ungrazed plots for 1932, 1942, and 1969.

growing near the aspen while Indian ricegrass was found only in the grazed area where the conditions are drier.

Forbs, with the exception of groundsel (Senecio integerrimus), have shown a trend opposite that of grasses and browse. In general they have increased in production. Arrowleaf balsamroot (Balsamorhiza sagittata) has doubled in production along with other forbs (Table 1). There are numerous forbs that have not been listed because of small changes but show the same trends as those listed. Groundsel has shown a decrease in production in both grazed and ungrazed plots of about one-half that of 1942, this reduction could be due to competition with other species.

Crown cover for forbs shows an increase in both grazed and ungrazed areas with the exception of groundsel which has decreased in the grazed area and only slightly in the ungrazed area. Beardtongue (Penstemon watsonii) has remained relatively stable in both areas. Little sunflower (Helianthella uniflora) and arrowleaf balsamroot have shown the greatest changes in the forbs. They have both increased, particularly in the exclosure, to three and four times as much cover in 1969 as compared to 1942 (Fig. 5). Weedy perennials and annuals such as onion (Allium spp.), green-gentian (Frasera speciosa), bedstraw (Galium boreale), owlclover (Orthocarpus tolmei) and chickweed (Stellaria jamesiana) have increased in cover percentages and production in both grazed and ungrazed plots. A few of the forb species have remained somewhat stable with little fluctuation either way. There have been several new species of forbs, aster (Aster spp.), milkvetch (Astragalus argophyllus, A. cibarius, A. convallarius), fleabane (Erigeron spp.), stickseed (Hackelia floribunda), alumroot (Heuchera

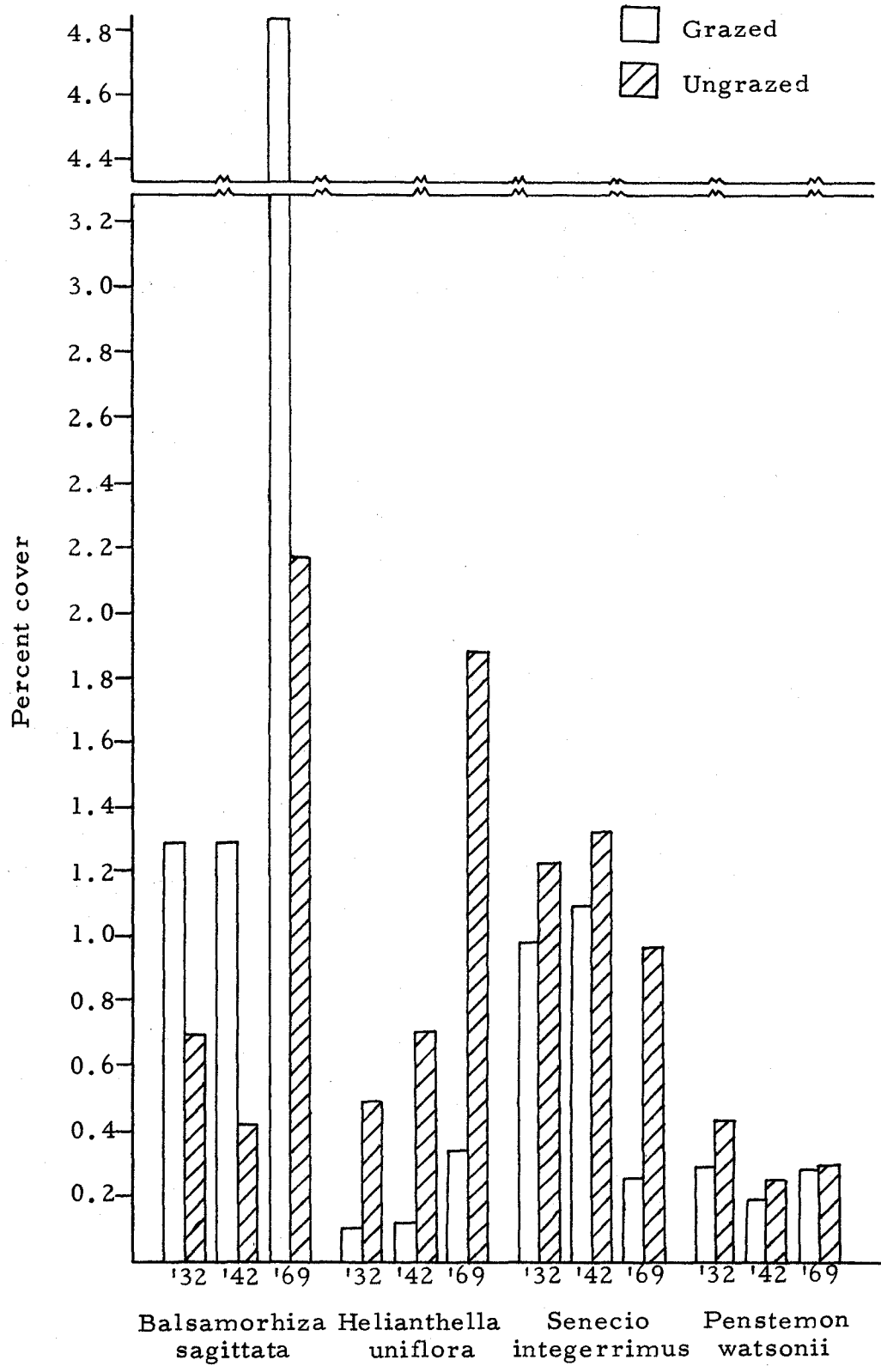


Fig. 5. Cover percentages of forb species in grazed and ungrazed plots for 1932, 1942, and 1969.

spp.), wild sweet pea (Lathyrus pauciflorus), stoneseed (Lithospermum ruderale), desert parsley (Lomatium spp.), phlox (Phlox longifolia), cinquefoil (Potentilla diversifolia), false solomonsseal (Smilacina racemosa and stellata), and vetch (Vicia americana), all of intermediate forage value added that were not previously recorded. Some of these species appear in both grazed and ungrazed plots. Although they are not very abundant they may be sensitive indicators that have come back under protection and release of grazing pressure.

Some species present in 1932 and 1942 were not found in the 1969 study, this may be due to misinterpretation of the early data, grazing pressures, climatic factors, or some physiological factors that have forced them out. The trend for total crown cover was relatively stable from 1932 to 1942 at about two percent. An increase in cover of two to three percent from 1942 to 1969 occurred in both the grazed and ungrazed plots. The increase in 1969 can apparently be attributed to reduced grazing pressure in the grazed area and more favorable growing conditions in both areas.

Composition percentages for the forbs (Fig. 6) indicates an increase for arrowleaf balsamroot and little sunflower which have increased from two to three times in both grazed and ungrazed plots. Penstemon and groundsel have decreased in the ungrazed plots but have remained somewhat stable and decreased respectively in the grazed plots. Forbs have increased in greater numbers than the grasses; apparently at the expense of some grasses.

The dry weight production of the browse species (Table 1) shows a decrease in the better forage species. Serviceberry (Amelanchier alnifolia) decreased by one-third in grazed but much less in

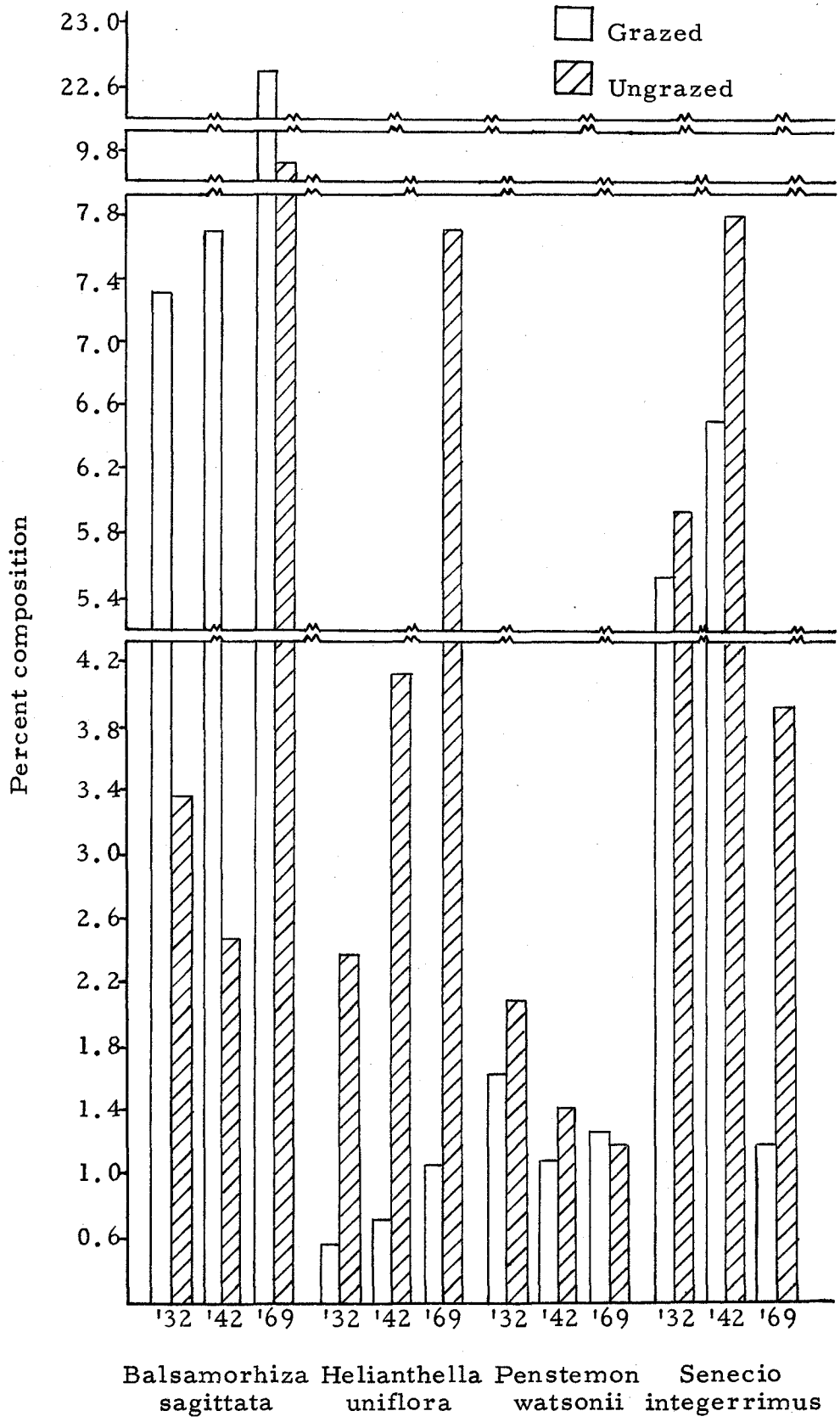


Fig. 6. Percent composition for forbs in grazed and ungrazed plots for 1932, 1942, and 1969.

ungrazed plots. Snowberry (Symphoricarpos oreophilus) decreased by one-half in both grazed and ungrazed plots. With the decrease of these two species there has been an increase of gambel oak (Quercus gambelii), a poor forage species, in both grazed and ungrazed plots by as much as four and eight times in production respectively. Big sagebrush (Artemisia tridentata) has decreased in both grazed and ungrazed areas with a decrease of one-third in the grazed and one-half in the ungrazed plots. The decrease in the grazed area may be due to some past heavy deer use as many shrubs have apparently been heavily grazed. Competition with other species in the ungrazed area has limited big sagebrush in its expansion and thus in productivity. Rabbitbrush (Chrysothamnus viscidiflorus var. lanceolatus) has decreased slightly in the grazed plots and increased about the same amount in the ungrazed plots indicating that it is often grazed by livestock and deer.

Cover percentages (Fig. 7) for the browse species follow a similar pattern as in production. The better forage species, serviceberry and bitterbrush (Purshia tridentata), and snowberry, an intermediate species, have decreased in cover percentage in the grazed plots from one to three percent and remained relatively stable or increased slightly in the ungrazed plots. Two low forage value species, big sagebrush and gambel oak, show an increase of about one percent in the grazed plots. Rabbitbrush has remained relatively constant between 1932 and 1969 but had a decrease of one percent in 1942. The reason for the decrease is not readily known but may be due to weather or other factors not recorded. Bitterbrush and snowberry increased in the ungrazed plots, illustrating the principle that under protection

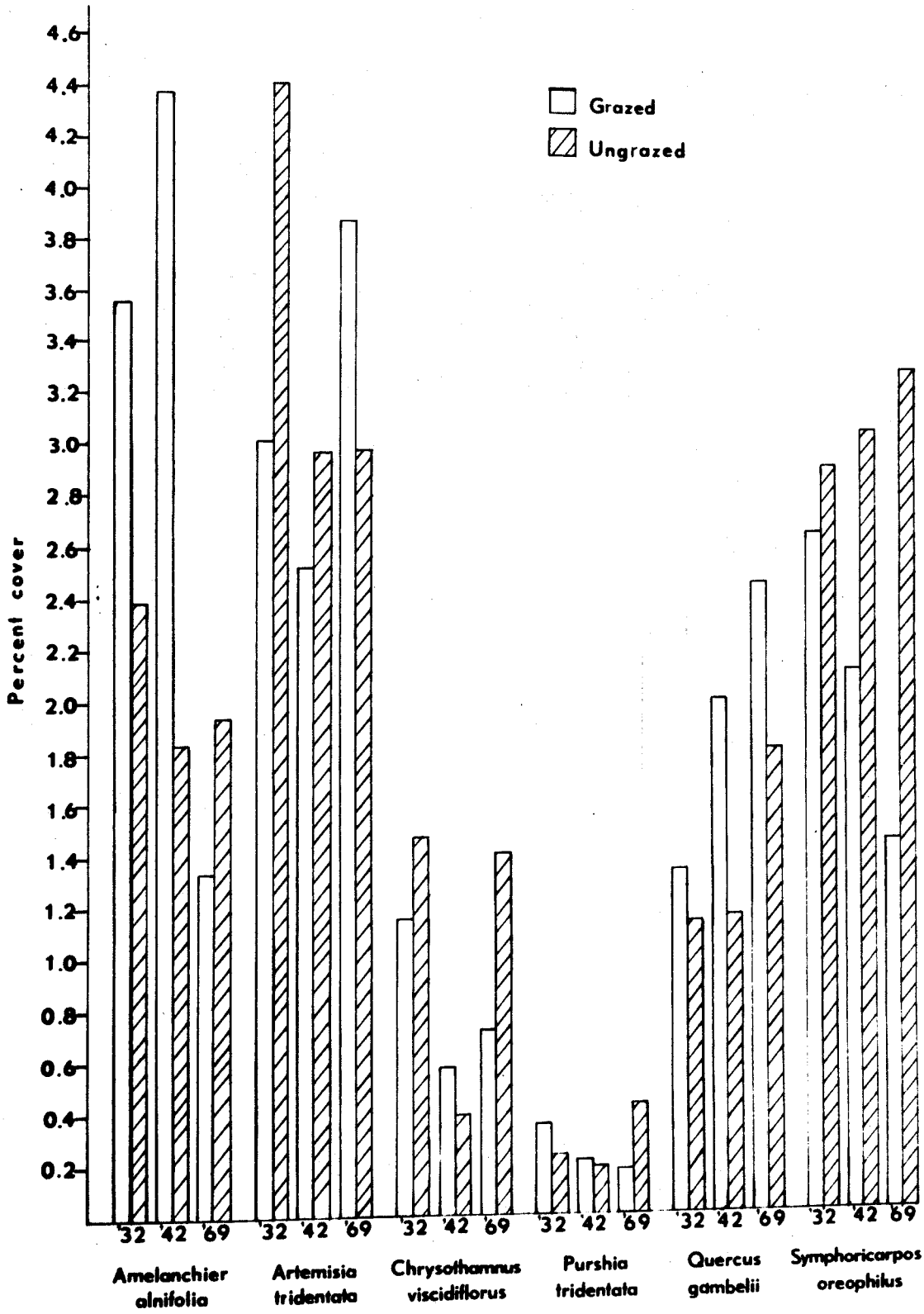


Fig. 7. Cover percentages of browse species in grazed and ungrazed plots for 1932, 1942, and 1969.

better forage species will increase while poor forage species increase with excessive grazing.

Composition percentages of browse (Fig. 8) show that serviceberry and snowberry have decreased in composition in both the ungrazed and grazed plots by from three to fourteen percent indicating that they have been unsuccessful in producing and maintaining themselves. Big sagebrush shows a decrease in the ungrazed area probably due to competition and a relatively stable condition in the grazed area. The decrease from 1932 to 1969 has been approximately ten percent where the composition in the grazed area has fluctuated from one to three percent. Bitterbrush has decreased in the grazed plots under grazing pressure to less than one percent in composition but has increased to about two percent in composition in the ungrazed plots. Gambel oak shows a steady increase in composition in the ungrazed plots indicating that it is reproducing and becoming more widely distributed. It has increased in the grazed plots from 1932 to 1942 by about four percent but has remained somewhat constant between 1942 and 1969 fluctuating only a fraction of a percent. Rabbitbrush has decreased in percentage composition in the grazed area but appears to have increased in 1969 from a drop in 1942 in the ungrazed plots.

Reproduction and mortality data on some browse species are indicated in Figure 9. In both the grazed and ungrazed plots all species have increased in number with the exception of big sagebrush which has decreased in both areas. From these figures it is evident that although shrubs do not expand their perimeters as readily as grasses and forbs they are successful in reproduction and gradually expand over the area. Some species have increased in greater numbers than others while

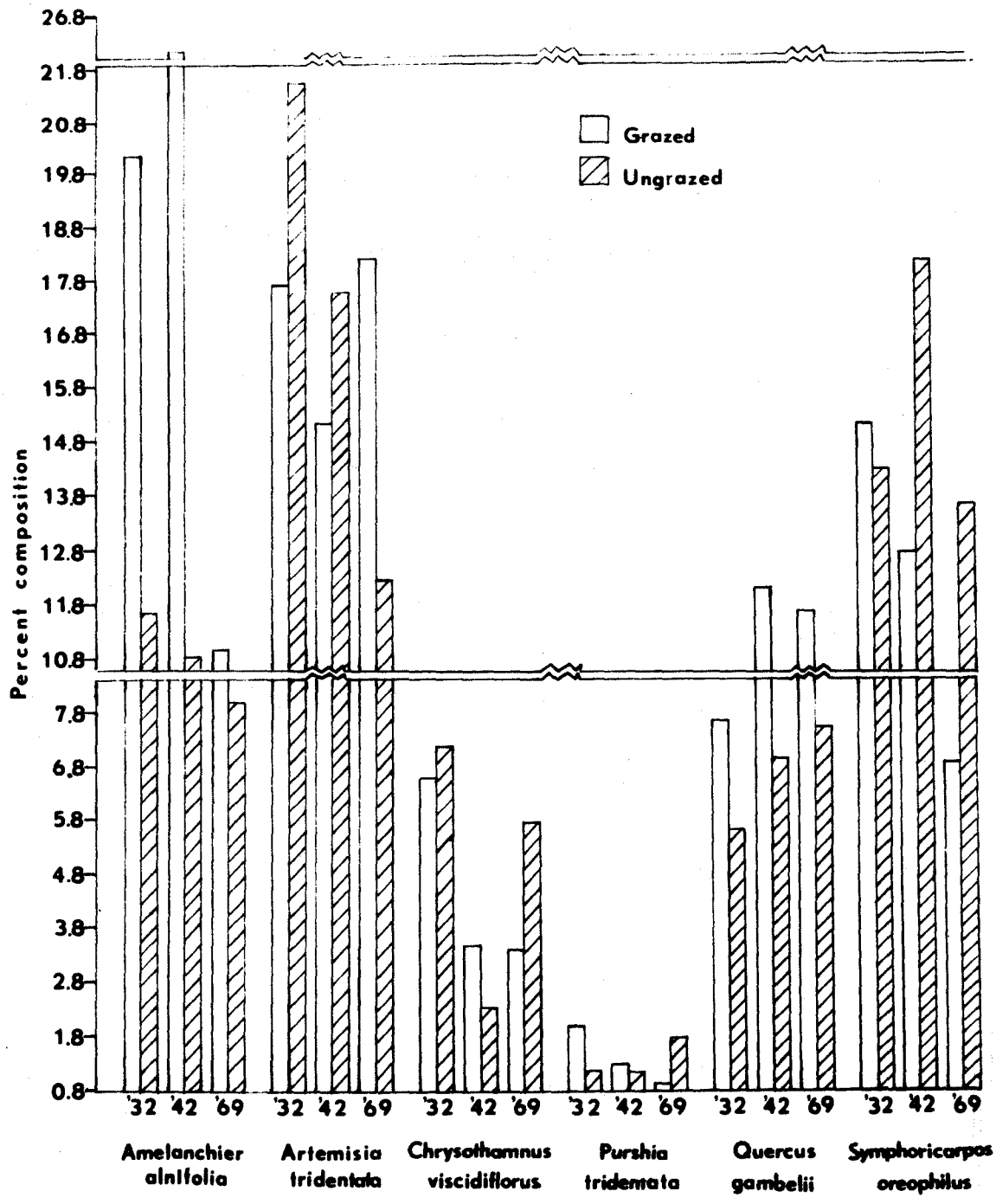


Fig. 8. Percent composition for browse in grazed and ungrazed plots for 1932, 1942, and 1969.

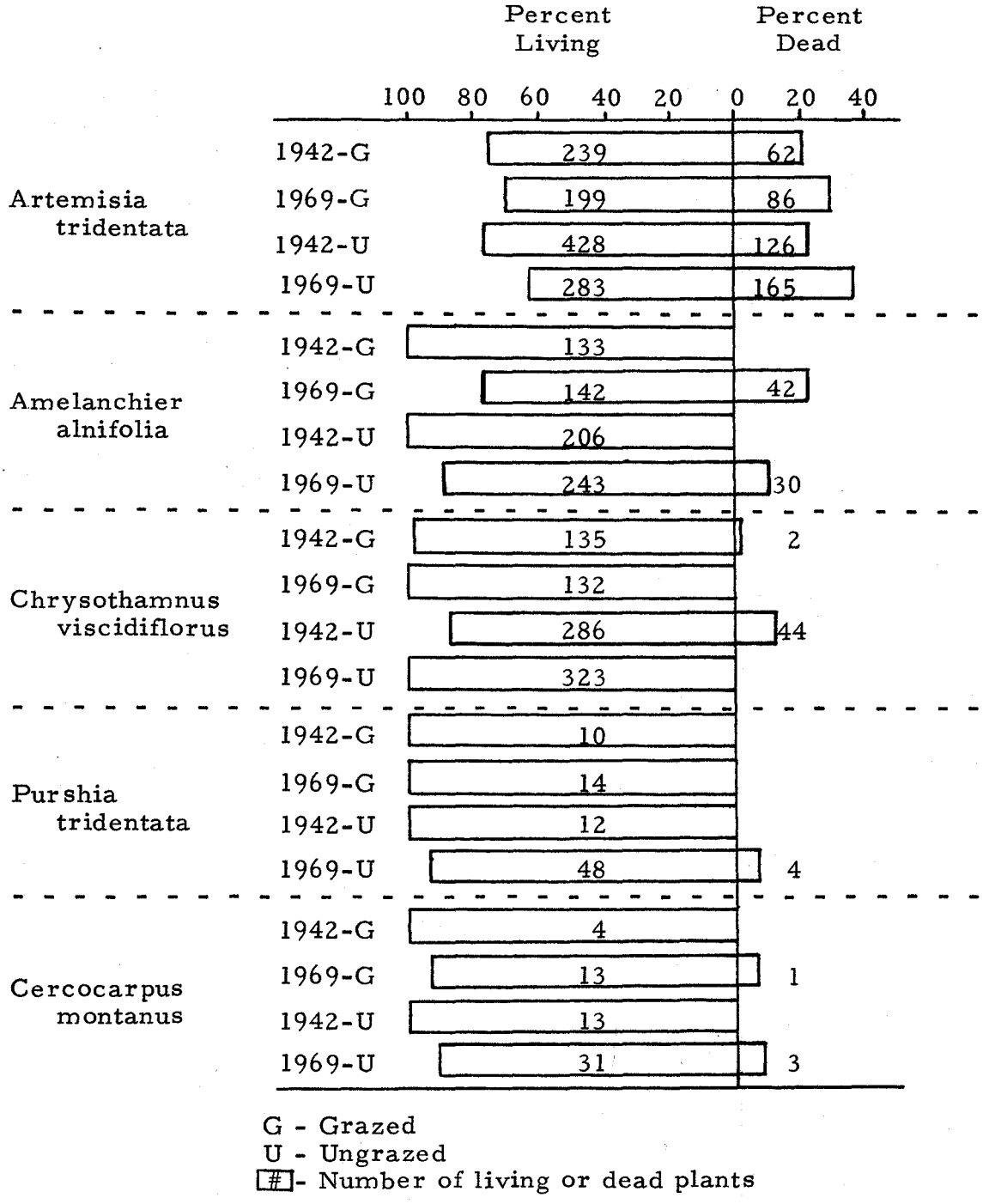


Fig. 9. Comparison of browse species, their numbers and percentages of living and dead plants in grazed and ungrazed plots for 1942 and 1969.

some have remained relatively stable or only increased from three to six plants. The increase in percent of dead and living big sagebrush in the grazed and ungrazed areas may be due to competition and poor shallow soils. Although production and crown cover show decreases for the less desirable species of browse, plant counts indicate that the trend for the better forage species in both the grazed and ungrazed plots is upward in production and cover. Apparently the maturing of seedlings that have become established contribute to this upward trend.

Frequency data of the grasses, forbs, and browse (Fig. 10) indicate an increase of five percent in the occurrence of browse in the ungrazed plots with little change in the grazed plots. Grasses show an upward trend in both grazed and ungrazed plots by from three to four percent. Forbs show a decrease of five to six percent in the grazed and ungrazed plots from 1932 to 1942 but remain stable from 1942 to 1969. From these data it is apparent that the grasses and browse are reproducing successfully and maintaining themselves while spreading more widely over the area. The forbs appear to remain stable with little or no spread from established locations in either the grazed or ungrazed plots.

The meter-square mapping quadrats show a general upward trend in crown cover of grasses in both grazed and ungrazed quadrats from 1932 to 1942 but with little change between 1942 and 1969 in the ungrazed quadrats. Bluebunch wheatgrass, longtongue muttongrass, and letterman's needlegrass have all expanded their perimeters on both the grazed and ungrazed quadrats showing the upward trend. The cover percent of forbs increased from one to twenty percent in the grazed and ungrazed quadrats from 1932 to 1942 but showed less increase in the

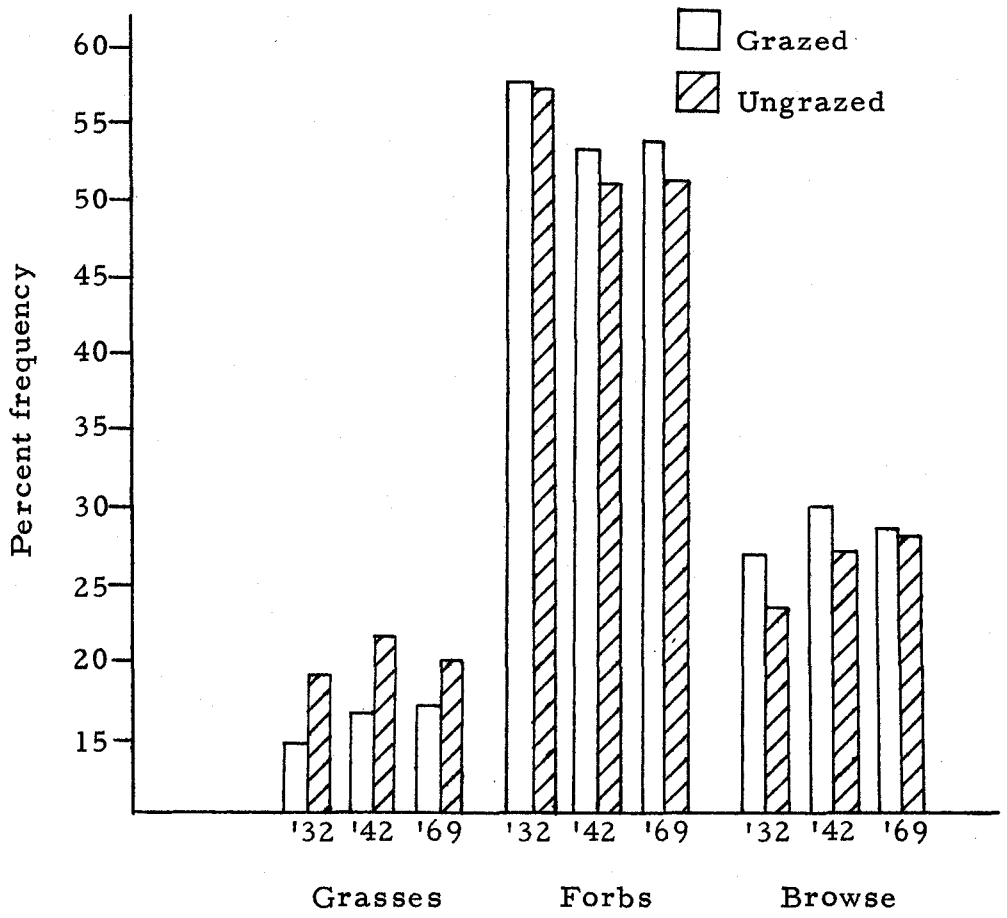


Fig. 10. Total percent frequency for grasses, forbs, and browse plants in grazed and ungrazed plots for 1932, 1942, and 1969.

quadrats between 1942 and 1969. Arrowleaf balsamroot and little sunflower have shown the greatest increases with other species appearing in 1969 that were not present in the earlier studies. Browse cover increased steadily in the ungrazed quadrats but fluctuated a great deal in the grazed quadrats. Big sagebrush, rabbitbrush, snowberry, and serviceberry have shown the fluctuations in the grazed quadrats being present in 1932, dropping in 1942, and increasing slightly in 1969. Big sagebrush and snowberry have died out of some of the quadrats and have not re-established themselves. Figures 11 and 12 show the changes that have occurred in the grazed and ungrazed quadrats. Total cover of all meter-square quadrats indicates an increase in cover in both grazed and ungrazed quadrats with the greatest increase shown in the grazed quadrats. The meter-square quadrats reinforce the data of the 100 square-foot plots in that they show similar trends on a smaller more accurate basis through mapping. Trends for the grasses, forbs, and browse in the meter-square quadrats were very similar to those of the 100 square-foot plots.

Analysis of the soils (Table 2) shows the range of textures according to vegetation type and exposure. The depth of the soil varies with exposure and vegetation type. The big sagebrush types on the gentle north exposures have a shallow soil with limestone-shale outcrops in them. The textures here vary from a sandy loam to a sandy clay loam. In the gambel oak types on the gentle north slopes the texture is the same in both grazed and ungrazed with the soil depths being approximately the same. The steep slopes of the north exposures containing oak varied in soil depth as well as texture. The west exposure of the steep slopes containing oak in the grazed area have deeper soils

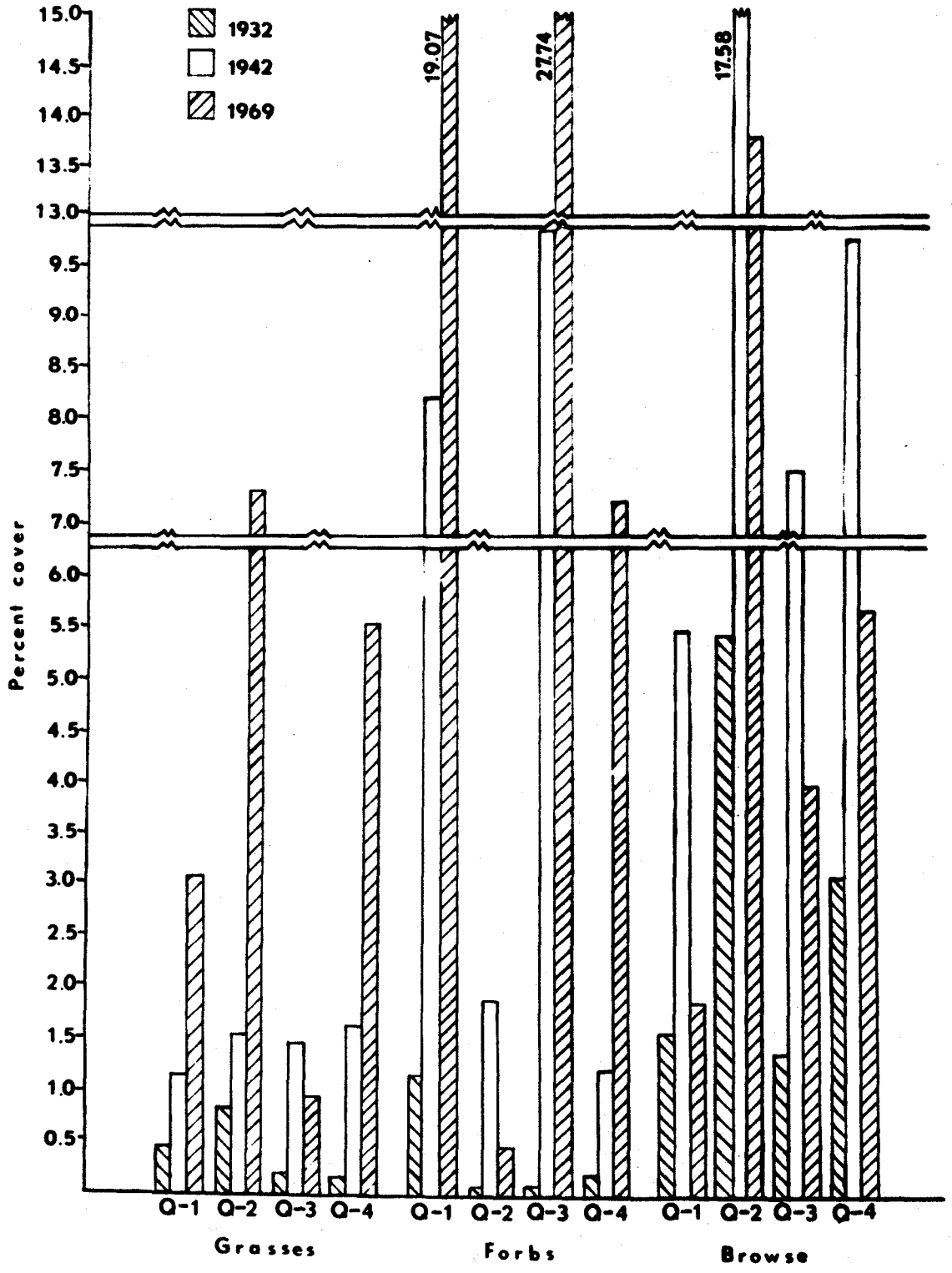


Fig. 11. Percent cover of grasses, forbs, and browse in the grazed meter-square mapping quadrats.

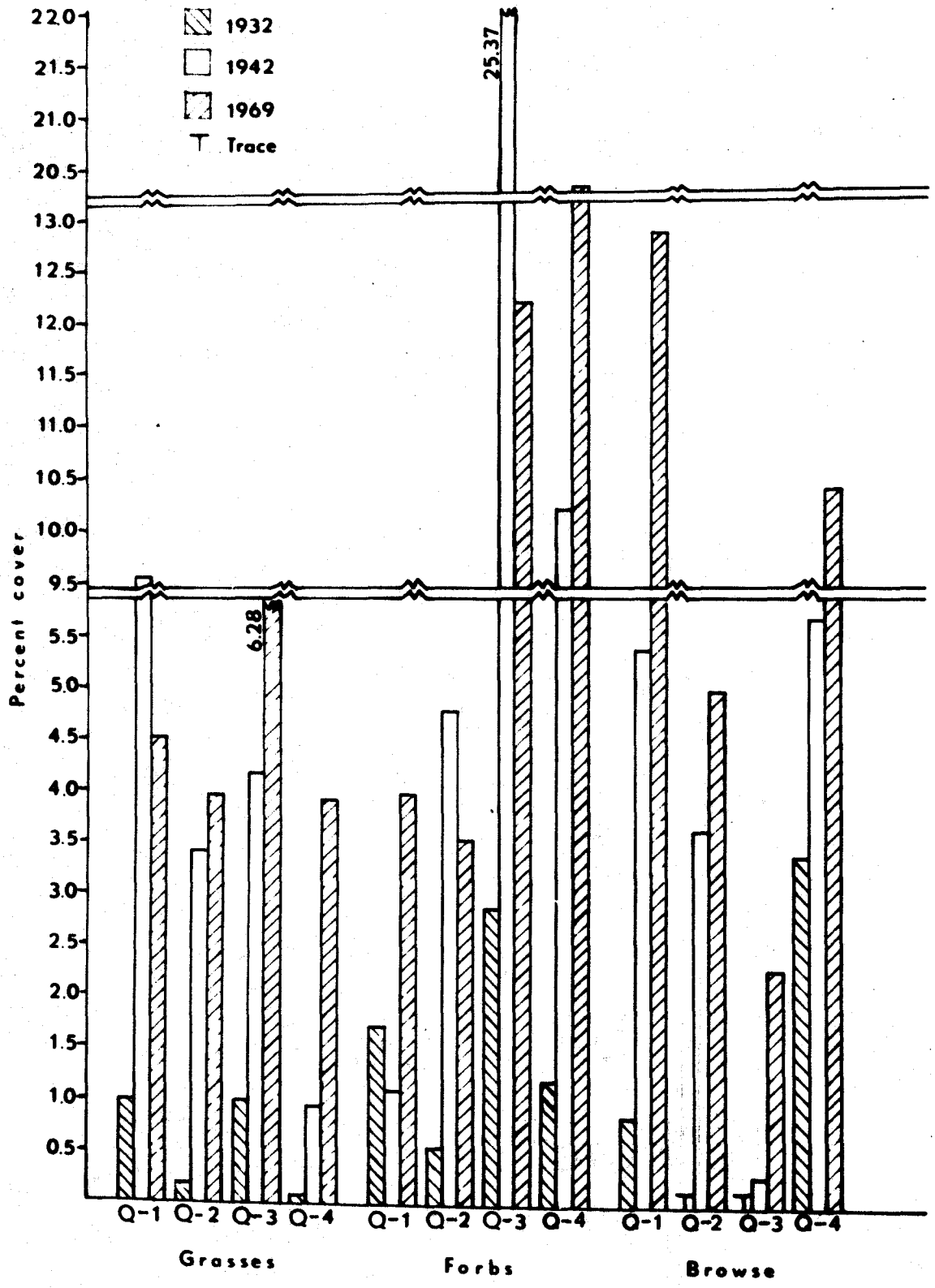


Fig. 12. Percent cover of grasses, forbs, and browse in the ungrazed meter-square mapping quadrats.

Table 2. Soil texture in relation to vegetation type, exposure, and depth in grazed and ungrazed areas.

Area	Vegetation type	Exposure	Depth	Texture
Grazed	big sagebrush	gentle north	0-10" 10"	sandy clay loam limestone rock
	big sagebrush	steep west	0-22" 22" +	sandy loam loam
	gambel oak	steep west	0-26" 26" +	sandy clay loam limestone rock
	gambel oak	gentle north	0-16" 16"	sandy clay loam limestone rock
Ungrazed	big sagebrush	gentle south	0-9" 9"	sandy loam limestone rock
	gambel oak	steep north and northeast	0-9" 9" +	sandy loam sandy clay loam with large limestone rocks
	gambel oak	gentle north	0-11" 11"+	sandy clay loam sandy loam with limestone rocks
	aspen	bottom facing north	0-7" 7-26" 26" +	clay loam sandy clay loam clay loam

than the north exposure in the ungrazed area. The aspen type in the northeast corner of the ungrazed area has the deepest and richest soil in the study area. This soil is over 26 inches in depth and has a clay loam texture. The texture and depth of the soils in the grazed and ungrazed areas play a role in the production and development of the species there. Those species found in grazed and ungrazed plots that lie in the shallow soils of the big sagebrush type are in relatively poor soil and compete for available soil moisture. Where the soils are deeper there is less competition for moisture between the herbaceous species and the woody species thus allowing better establishment of herbaceous species. In the ungrazed area the litter and duff are building faster and giving better ground cover which has slowed down and stopped surface erosion in most areas whereas surface erosion and small gully erosion is quite evident in the grazed area. The type of soil in the study area erodes quite readily when not protected by cover during and after moderate to heavy storms. With soil erosion varying from light to moderate in the grazed area this may account for poor establishment of seedlings in comparison to the ungrazed area where the litter and duff afford more protection.

CONCLUSIONS

The apparent overall trend for the plants in the grazed and ungrazed plots has been a decrease in production, cover and composition percentages of the better forage species and an increase in the poorer forage species with the exception of bluebunch wheatgrass, longtongue muttongrass, and big sagebrush. Although they have not followed the general trend of the other species this may be due to unrecorded influences that have occurred during the periods between studies. Grazing pressures have been reduced by 20 percent in each of the years from 1963 to 1965 and presently there are only 40 percent (3,000 head) of the original number of cattle grazing the area. They have also been withheld from the study area for the past two years because revegetation work has been in progress nearby. The reduction in the number of cattle would release grazing pressures in the open area and allow species to respond more readily in their production and vigor over the last seven years.

Intensity of game use is not known for the area but general observations indicate that there is some deer use in spring and fall into the winter months when there is light snowfall. Deer reached a peak in numbers throughout Utah about 1940 to 1942 at which time many ranges were severely overbrowsed. It is likely that the deer herd in the study area has fluctuated in numbers during the years and increased to a point where heavy game use occurred along with intensive livestock grazing. This would account for the decrease in certain browse and

forbs. The apparent decrease in big sagebrush may be from deer use as many shrubs appear to have been grazed heavily. Deer use is evident on the bitterbrush in the exclosures as well as in the grazed area as many of the shrubs show that moderate to heavy hedging has occurred.

The small variation in cover percentages for most species from 1932 to 1942 may have been due to differences in individuals reading the plots. The below normal precipitation that occurred in 1934 and 1935 may have had some influence on the vegetation. Precipitation data for early periods were not available from surrounding stations as most of them were established after the first study in 1932 and then were not recorded each year. The average annual precipitation from 1948 until 1962 was 22.55 inches for the general area (S.C.S., 1968).

In comparing the ungrazed with the grazed plots only 50 plots in the southern portion of the exclosure were used as on these plots the browse types, soils, and exposure were all similar and gave a more meaningful comparison than the total plots could have given. The other 50 plots of the exclosure have a steeper north and northeast exposure than those used, with gambel oak, serviceberry, and snowberry as the dominant browse species. This portion of the exclosure not used in the comparison has followed a similar pattern as the plots used in the comparison. Grasses have decreased in production and cover where most forbs and browse have increased. The litter and duff in this portion of the exclosure have developed more than in the southern portion giving better protection to seeds and seedlings that are developing.

Those species of browse and forbs that have decreased in cover percent and production may have been influenced by climatic

factors during the periods between the studies. One influencing factor for grazed and ungrazed plots may have been the heavy frost that occurred in the latter part of June and first part of July in 1968. This frost damaged and set back many species in their flowering and seed development. The oak during the 1969 study did not have many leaves on it but the leaves that were present were much larger than usual. This may have been an effect from the frost which has cut down the cover percent and production for this period. These same effects, although not too apparent, may have influenced the other species in regards to cover percent and production.

SUMMARY

1. The mountain brush type was studied in 1932, 1942, and 1969 to determine the vegetation changes and trends after grazing and protection from grazing for 37 years. With 10 and 27 years between the studies it has been difficult to interpret the fluctuations that may have occurred between studies and to apply influencing factors that may have affected the plants.

2. The effect of intensive livestock grazing on the mountain brush type in Utah has been to reduce the proportion of herbaceous vegetation and the better forage shrubs and to increase the proportion of poorer forage species as pointed out in studies by Cottam and Evans (1945) and Ellison (1960).

3. Production, cover and composition percentages for good and fair forage species of grasses and browse decreased on the grazed plots whereas they generally increased in the ungrazed plots.

4. Forbs increased in production, cover and composition percentages in both grazed and ungrazed plots but most of these species are of low forage value.

5. Annual species have increased in number in both grazed and ungrazed plots but are more abundant in the grazed plots.

6. Arrowleaf balsamroot has shown the greatest increase of all species, with production and cover increasing by a factor of four, in grazed and ungrazed plots. It was observed that during 1969 there was an increased amount of this species in many places throughout its

range indicating that it had an above normal year for production.

7. New species have appeared in the ungrazed plots that were not present in previous studies. They may be indicators of conditions prior to heavy grazing pressures.

8. From the study it is evident that the changes in the mountain brush type take place slowly but a gradual improvement of the ungrazed range is indicated.

LITERATURE CITED

Bouyoucus, George John. 1936. Directions for making mechanical analyses of soils by the hydrometer method. Soil Science 42(3):225-229.

Cottam, Walter P. and Frederick R. Evans. 1945. A comparative study of the vegetation of grazed and ungrazed canyons of the Wasatch Range, Utah. Ecol. 26:171-181.

Daubenmire, R. 1943. Vegetational zonation in the Rocky Mountains. Bot. Rev. 9:325-393.

Ellison, Lincoln. 1949. The ecological basis for judging condition and trend on mountain range land. Jour. of Forestry 47(10):786-795.

_____. 1960. Influence of grazing on plant succession of rangelands. Bot. Rev. 26(1):1-78.

Hayward, C. Lynn. 1948. Biotic communities of the Wasatch Chaparral, Utah. Ecol. Mono. 18:473-506.

Oosting, Henry J. 1956. The study of plant communities. W. H. Freeman and Company, San Francisco.

Pechanec, Joseph F. and G. D. Pickford. 1937. A weight estimate method for the determination of range or pasture production. Agronomy Jour. 29:894-904.

Price, Raymond. 1938. Artificial reseeding on oak-brush range in central Utah. U. S. Dept. Agr. Circ. 458:1-18.

Shelford, Victor E. 1963. The ecology of North America. University of Illinois Press, Urbana, Illinois.

S. C. S. 1968. Water supply outlook for Utah. Soil Conservation Service. June 1.

Stewart, George and Selar S. Hutchings. 1936. The point-observation-plot (square-foot density) method of vegetation survey. Agronomy Jour. 28:714-722.

U. S. D. A. Forest Service. 1968. Unpublished allotment records on file at the Spanish Fork Ranger Station, and Forest Supervisor's office in Provo, Utah.

_____. 1969. Range environmental analysis handbook. Intermountain Region. Forest Service Handbook 2209.21.

U. S. G. S. 1948. Geologic map of eastern and southern Utah.

APPENDIX

PLANT SPECIES OF STUDY AREA

Abies concolor
Achillea millefolium
Agoseris glauca
Agropyron spicatum
Agropyron subsecundum
Allium companulatum
Amelanchier alnifolia (utahensis)
Antennaria parvifolia
Apocynum androsaemifolium
Arabis holboellii
Artemisia tridentata
Aster spp.
Astragalus argophyllus
Astragalus cibarius
Astragalus convallarius
Balsamorhiza sagittata
Bromus inermis
Bromus marginatus
Calochortus nuttallii
Carex geyeri
Carex filifolia
Castilleja linariaefolia
Ceanothus fendleri
Cercocarpus montanus
Chaenactis douglasii
Chrysothamnus nauseosus
Chrysothamnus viscidiflorus var. lanceolatus
Cirsium arvense
Comandra umbellata
Crepis acuminata
Cynoglossum officinalis
Delphinium nelsonii
Elymus cinereus
Erigeron spp.
Eriogonum brevicaule var. laxifolium
Eriogonum heracleoides var. angustifolium
Eriogonum umbellatum var. majus
Erysimum asperum
Frasera speciosa
Galium boreale
Geranium fremontii
Gilia aggregata
Hackelia floribunda
Helianthella uniflora
Heuchera parvifolia
Juniperus scopulorum
Koeleria cristata
Lathyrus pauciflorus
Lithospermum ruderale
Lomatium spp.
Lupinus sericeus
Mahonia repens
Melica bulbosa
Mertensia brevistyla
Orthocarpus tolmei
Oryzopsis hymenoides
Pachystima myrsinites
Penstemon leonardii
Penstemon watsonii
Phlox longifolia
Poa compressa
Poa longiligula
Poa pratensis
Populus tremuloides
Potentilla glandulosa
Prunus virginiana
Purshia tridentata
Quercus gambelii
Ribes cereum
Rosa woodsii
Rumex spp.
Sambucus coerulea
Senecio integerrimus
Senecio uintahensis
Smilacina racemosa
Smilacina stellata
Stellaria jamesiana
Stipa columbiana

Stipa lettermannii
Symphoricarpos oreophilus
Taraxacum officinale
Thalictrum fendleri
Tragopogon dubius
Vicia americana
Viguiera multiflora
Viola spp.
Zygadenus paniculatus