

South Entrance Exclosure Study

"The Effects of Browsing on the Growth of Cowanla mexicana
and Quercus gambelii"

by

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Grand Canyon National Park

South Entrance Exclosure

Abstract:

The South Entrance Exclosure, located approximately 100 yards northwest of the Grand Canyon Clinic, was created in 1935 in a moderately overgrazed area to study the effects of herbivore browsing on the growth of several plant species, primarily Cowania mexicana (Cliffrose) and Quercus gambelii (Gambel Oak). Fifty years later, a comparison of plant numbers and crown cover of these plant species growing on the 40'x 80' fenced plot versus the 40'x 80' unfenced plot (directly south of the exclosure) reveals a definite inhibition of growth of Cliffrose and oak on the unprotected plot and a rampant overgrowth on the enclosed plot, suggesting that moderate browsing acts as a growth-controlling agent in this forest ecosystem.

Introduction:

Cowania mexicana and Quercus gambelii are two species highly browsed upon by deer and other herbivores. In many areas on the South Rim the deer population is numerous and these plant species are not very abundant. Likewise in these grazed areas the plant growth appears to be stunted. To determine if browsing is the main inhibitor of growth, the South Entrance Exclosure was designed. Two plots of identical length and width, situated side by side and receiving the same amount of sunlight and experiencing the same weather conditions (but differing in that the northern-most plot is enclosed by a fence to deter herbivore grazing) were established. Numbers and heights of the individual plants of Cowania mexicana, Quercus gambelii, Artemisia tridentata (Big Sagebrush), Juniperus osteosperma (Utah Juniper), Chrysothamnus nauseosus (Rabbitbrush), Pinus edulis (Rocky Mountain Pinyon), and Pinus ponderosa (Ponderosa Pine) were recorded, and vegetation locations were plotted on a grid map. Three years later a check study was performed; the plots were then left undisturbed for forty-seven years. The question after fifty years, upon reexamination in 1985, is: Will there be a significant difference in the vegetation growth on the enclosed plot as opposed to the unfenced plot? If there is no difference, one must assume that the sparcity of these two species in the grazed areas is due to some factor other than browsing. However, if there is a marked increase in height, canopy area, and number of plants within the exclosure and not outside, then one must conclude that the grazing has a definite inhibitory or controlling effect on the growth of the species in study (Cliffrose and Gambel Oak). One must also examine the type of forest community present inside versus outside the fence to discover if in the absence of browsing, other species of plants (eg. pines) experience severe competition, hindering their growth.

Methods:

* Because the procedures performed by the scientists in 1935 and 1938 are not recorded anywhere, the following is a description of the methods used in the 1985 study.*

First, the location of the 40'x 80' unfenced plot was determined to lay directly south of the exclosure by comparing the positions of the oldest existing trees with the vegetation maps from the 1935 and 1938 plots. This plot was then divided into 10'x 10' transects and each unit was labeled with a letter and a

number according to its east/west and north/south geographical location (diagram 2). Beginning with the most northeast quadrant (A-1), each individual plant (members of one of the seven species in study) was measured for height (feet), dbh (inches), and canopy cover (inches). The position of the plant within the plot unit was placed on a grid map. This procedure was repeated for each unit traveling southwest from A-1 to A-8, then southeast from B-8 to B-1, then southwest from C-1 to C-8, and finally back southeast again from D-8 to D-1. For trees taller than 5' a clinometer was used to calculate tree height. The entire procedure was repeated for the 40'x 80' fenced plot (diagram 1).

The data from all three studies was placed separately onto a data spreadsheet into the IBM computer using the program LOTUS 123. Because only the height of each plant was recorded in the earlier studies the more valuable crown cover measurements are only available for the 1985 study. Using the graphic picture program of LOTUS, comparisons of the number of plants of each species within the enclosure and outside the enclosure over the fifty years were made to explore the change in relative plant density over the years (diagrams 3-9). This comparison was followed by the comparison of crown area of each species (fenced versus unfenced 1985) to study the obvious results of grazing on the plants after fifty years (diagram 10). Percent cover of each species on fenced versus unfenced plots in 1985 was graphed to reveal the dominant vegetation on each plot (diagram 11). The seedlings versus mature plants comparison was performed to examine the dynamic nature of each plot (diagram 12).

Results:

Diagrams 1 & 2 are the grid map representations of the vegetation on the enclosed plot and the unfenced plot in 1985.

Diagrams 1a & 2a are the grid map representations from the 1938 study.

Diagrams 1b & 2b are the grid map representations from the 1935 study.

* At this point please note that it appears that the studies done in 1935 and 1985 present observations and measurements made painstakingly, while the data from the 1938 check study are obviously incomplete and should not be regarded as totally valid.*

Charts 1 & 2 represent summary tables of all the data located in appendices 1 & 2 located at the rear of the report.

Diagrams 3-12 are the graphic results of the comparisons explained in the methods section.

Photo set 1 shows two pictures of the fenced plot taken in April 1985.

Photo set 2 shows two pictures of the unfenced plot taken in April 1985.

Discussion:

Upon reviewing the data, it becomes apparent that browsing definitely affects the growth of certain plant species. In the study of the numbers of Cowania mexicana (Cliffrose) plants on the fenced versus unfenced plots for 1935 to 1985, a dramatic change resulting from grazing is evident. A marked increase in size and numbers of Cliffrose within the enclosure vividly exemplifies the possible growth potential of this species in the absence of browsing (diagram 4).

Exploring the actual percentage of the area of each plot covered by the canopy of the individual species of plants in 1985 (diagram 11), one sees that the dominant vegetation within the fence is undoubtedly Cowania mexicana and Quercus gambelii (Gambel Oak), while the pine trees, Pinus edulis (Rocky Mountain Pinyon) and Pinus ponderosa (Ponderosa Pine), constitute the majority of the canopy of the unfenced plot. It is quite striking to observe that the open plot browsed upon by deer and other herbivores contains very little oak and Cliffrose. Without the dense thickets of Cliffrose and clusters of oak prominent on the protected plot, competition for water and light outside the fence is not as intense. Trees such as the pines which require a greater amount of nutrients and are a "light-demanding species, unable to regenerate under low light intensity and which cannot tolerate heavy root competition"(1), are more abundant.

Although at first it appears that browsing is detrimental to the ability of the Cliffrose and oak to reach maximum growth, the grazing occurring is actually a positive growth-controlling factor. By keeping the number and size of these species down, intraspecific and interspecific competition is tempered, and other species such as rabbitbrush, juniper and especially pines are allowed to flourish. It actually seems that the herbivorous grazing allows the forest to continue through its natural pattern of succession, impeding rampant overpopulation of underbrush and encouraging the formation of a climax forest. Results of the examination of the number of seedlings versus mature trees in both plots in 1985 (diagram 12), reveal a greater number of younger trees on the unprotected plot supporting the notion that this land is in a dynamic, changing state. These figures nicely coincide with the increase in the number of pines on the unfenced plot over the fifty years (diagram 9).

(1) Shubert, Gilbert H., Silvicultural Systems for Major Forest Types of the United States (U.S. Department of Agriculture, Washington D.C.) p.45.

Conclusion:

Moderate grazing on Cowania mexicana and Quercus gambelii by deer and other herbivores has a definite impact on the type of forest community in existence. When these species are protected from browsing, they successfully dominate the area by creating dense thickets and out-competing high light and nutrient demanding plant species. When the untamed growth of the Cliffrose and oak is impeded by frequent grazing their populations are controlled, and a more balanced and diverse ecosystem is the result.

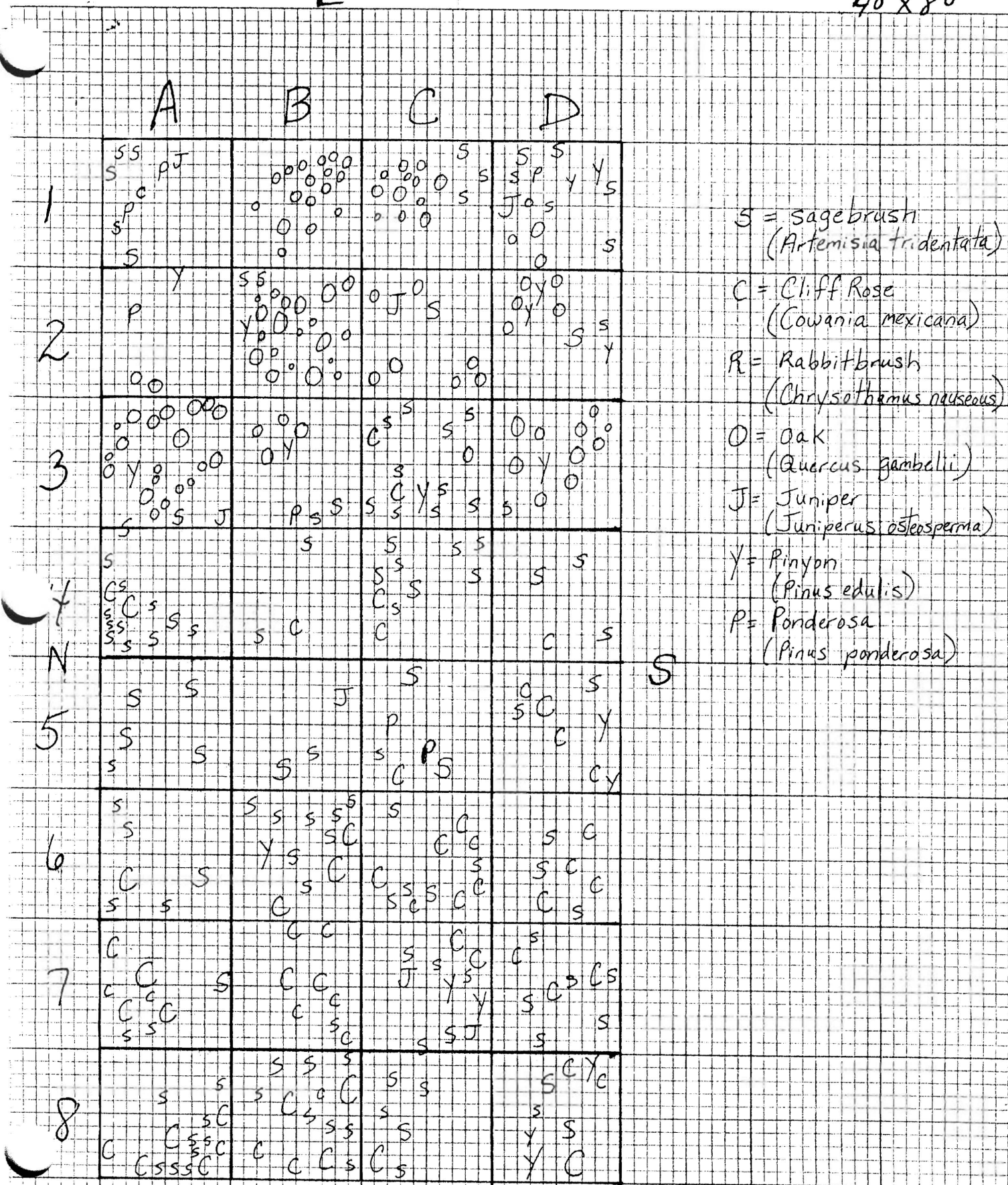
Note:

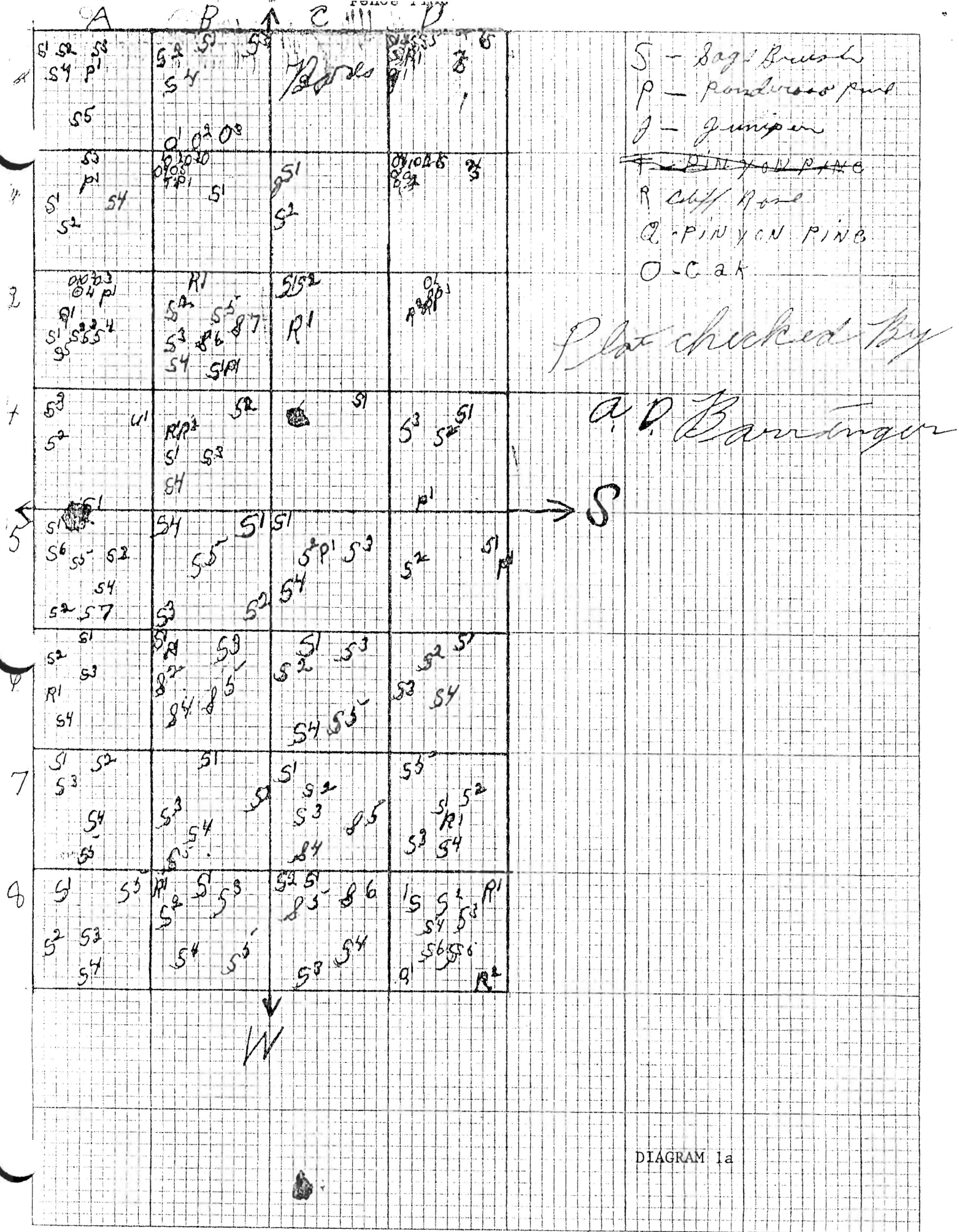
In a highly grazed area; however, where browsing is almost incessant and these plants are literally stripped, grazing may no longer be just a positive growth controlling factor, and if examined using a similar study, may prove to be extremely destructive and a serious problem.

South Entrance Exclosure
Fenced Plot

John Kay
Lenore Grover
April 3, 1985
40' x 80'

E





Plot---South Entrance
y 22, 1935
Grater.

Fenced Plot
(80'x40'ft)

CROSS SECTION 10 X 10
101 X 01 NO1135 550803

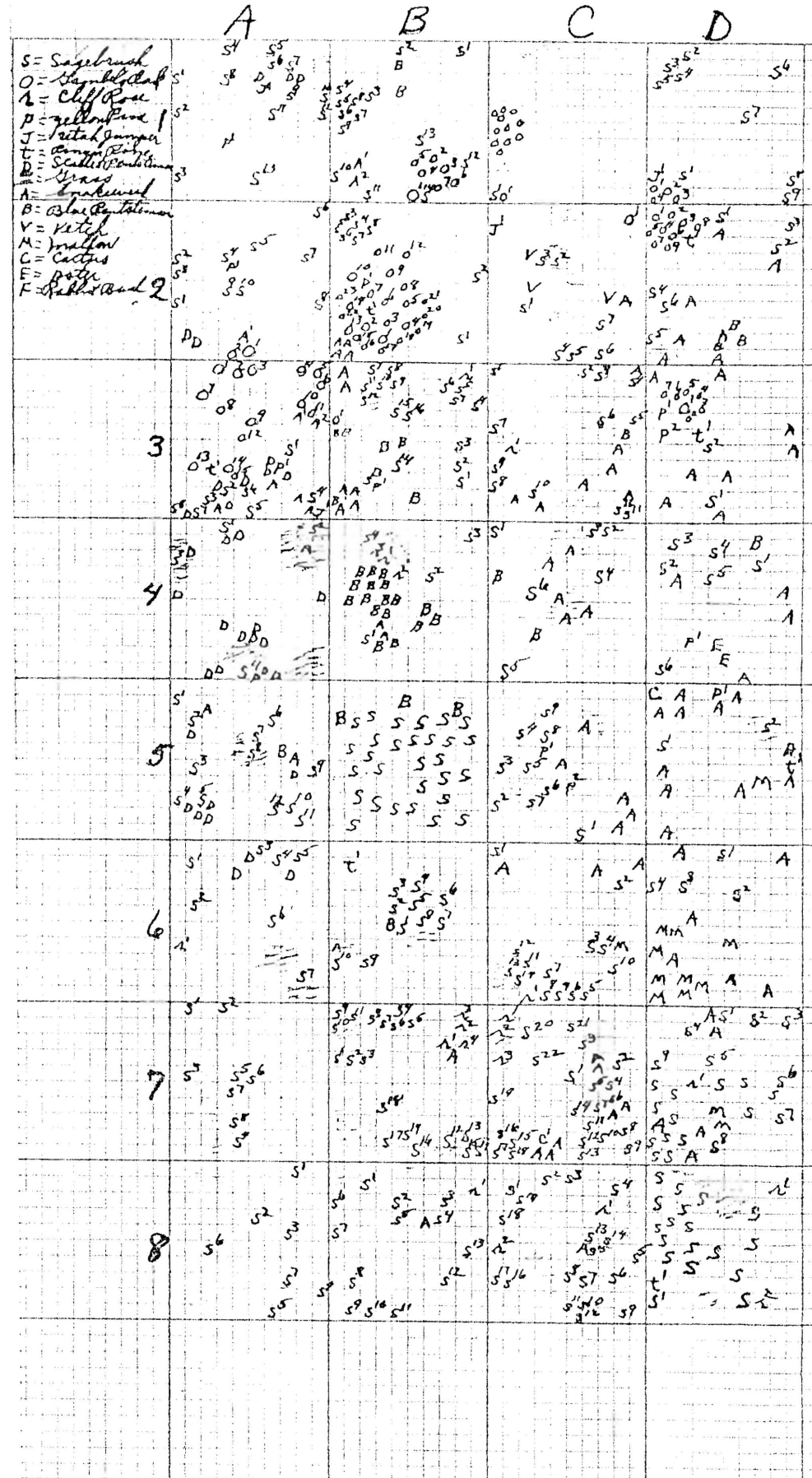


DIAGRAM 1b

South Entrance Exclosure
Unfenced Plot

John Ray
Lenore Grover
April 1, 1985
40' x 80'

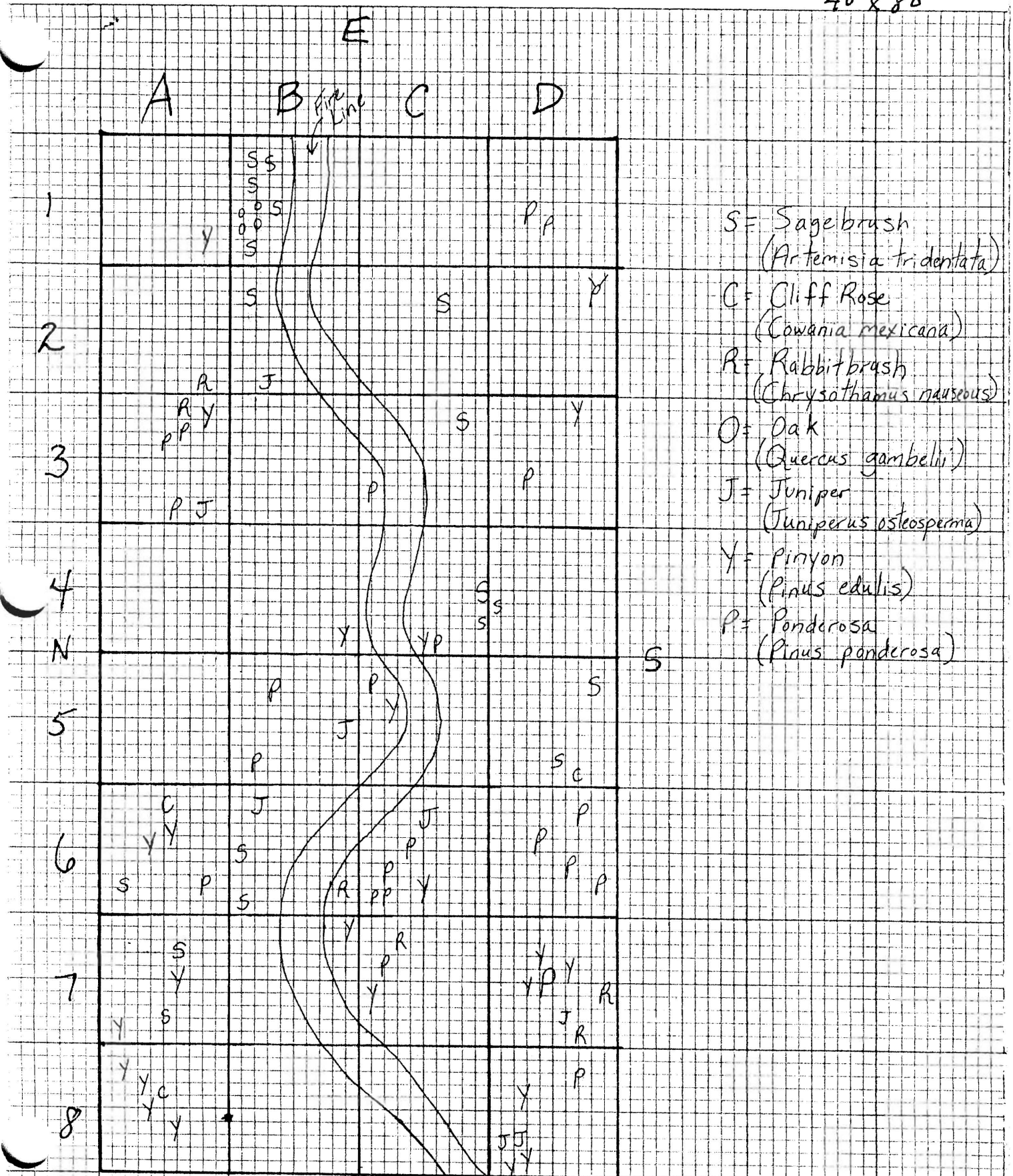


DIAGRAM 2

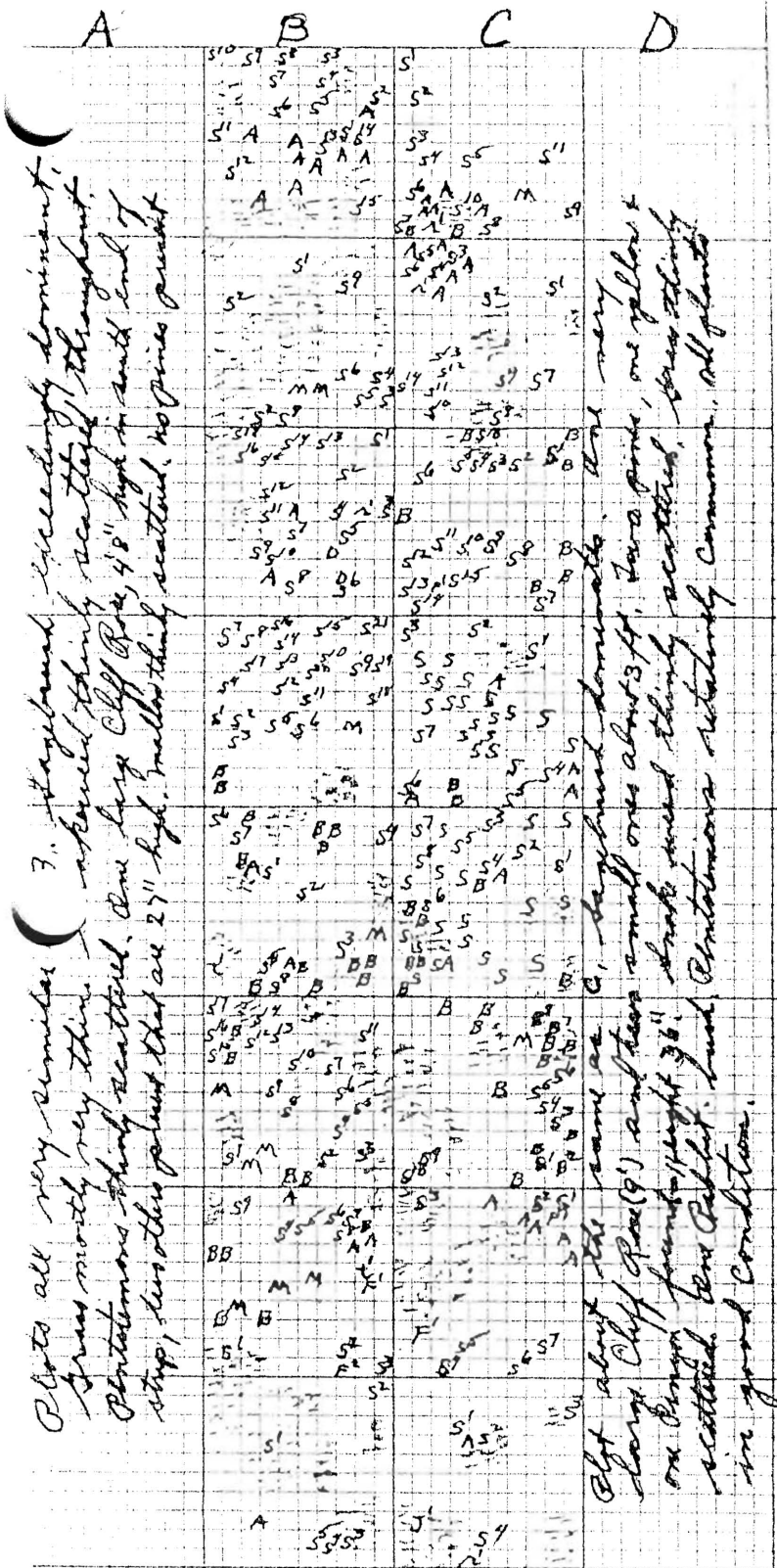
Un Fence Plot

S. - Sage Brush
C.R. - Cliff Rose
Pi. - Yellow Pines
R.W. - Rabbit Brush
S.W. - Snake Weeds

Plot Checked 12/15/38 by A.D. Barringer

Check Plot (unfenced)
(80' x 40' ft)

Experimental
Checked Jul
Russell K.



Summary of Data
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FENCED PLOT	Number of Plants 1935	Number of Plants 1938	Number of Plants 1985
Artemisia tridentata	340	125	129
Cowania mexicana	20	9	63
Chrysothamnus nauseous	0	0	0
Juniperus osteosperma	4	2	7
Quercus gambelii	81	18	102
Pinus edulis	7	3	19
Pinus ponderosa	11	8	7

UNFENCED PLOT	Number of Plants 1935	Number of Plants 1938	Number of Plants 1985
Artemisia tridentata	418	157	18
Cowania mexicana	10	7	3
Chrysothamnus nauseous	4	4	6
Juniperus osteosperma	1	0	8
Quercus gambelii	0	0	4
Pinus edulis	3	0	23
Pinus ponderosa	3	12	24

Summary of Data
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FENCED PLOT	Average Height feet 1935	Average Height feet 1938	Average Height feet 1985	Total Crown Diam feet 1985	Total Crown Area sq. feet 1985
Artemisia tridentata	1.17	1.93	---	172	249.69
Cowania mexicana	1.59	3.98	5.79	234.58	982.57
Chrysothamnus nauseous	0	0	0	0	0
Juniperus osteosperma	3.69	7.29	9.4	29.58	112.06
Quercus gambelii	3.8	6.07	5.47	276.67	789.12
Pinus edulis	1.92	2.28	7.07	64.33	350.92
Pinus ponderosa	1.01	2.27	12.01	37.58	224

UNFENCED PLOT	Average Height feet 1935	Average Height feet 1938	Average Height feet 1985	Total Crown Diam feet 1985	Total Crown Area sq. feet 1985
Artemisia tridentata	1.32	1.99	---	20.08	19.37
Cowania mexicana	4.38	5.01	5.81	6.17	14.51
Chrysothamnus nauseous	1.19	0.6	---	10.75	18.62
Juniperus osteosperma	0.42	0	2.31	11.92	34.17
Quercus gambelii	0	0	1.46	4.58	4.75
Pinus edulis	1.72	0	4.71	59.58	273.71
Pinus ponderosa	1.28	1.44	8.69	97.42	819.26

Artemisia tridentata

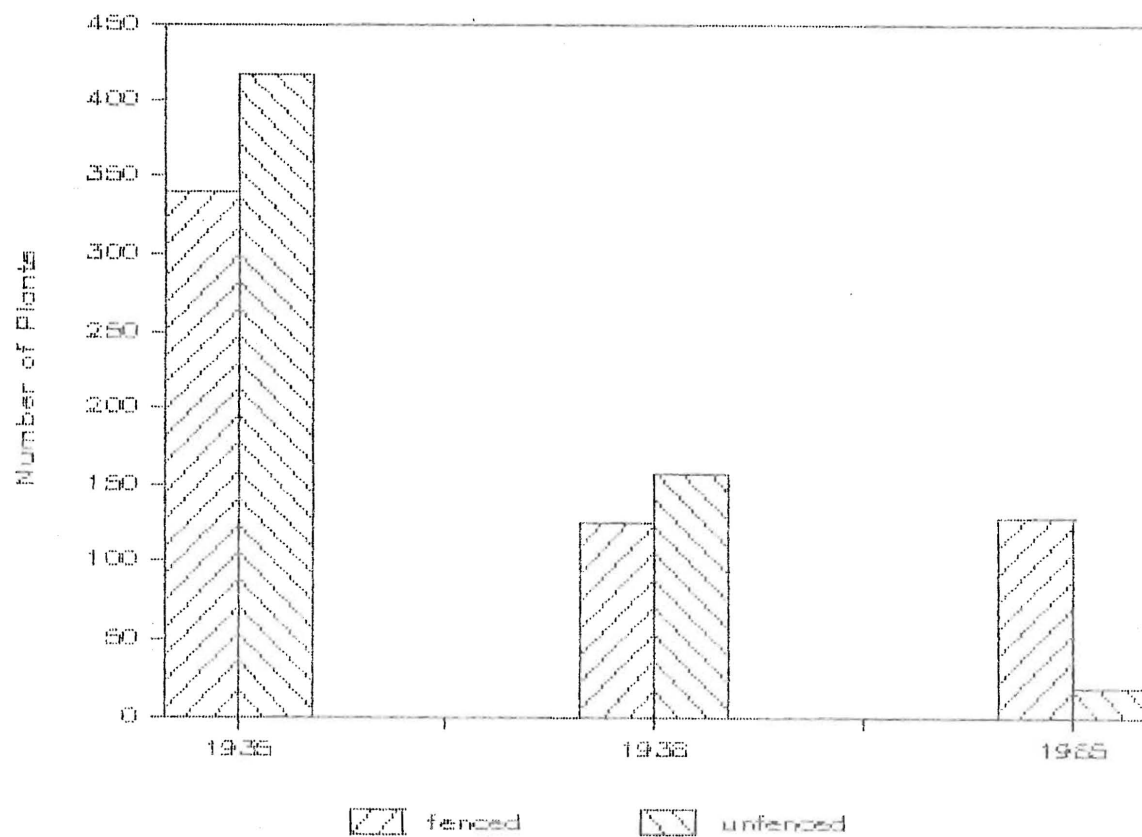


DIAGRAM 3

Cowania mexicana

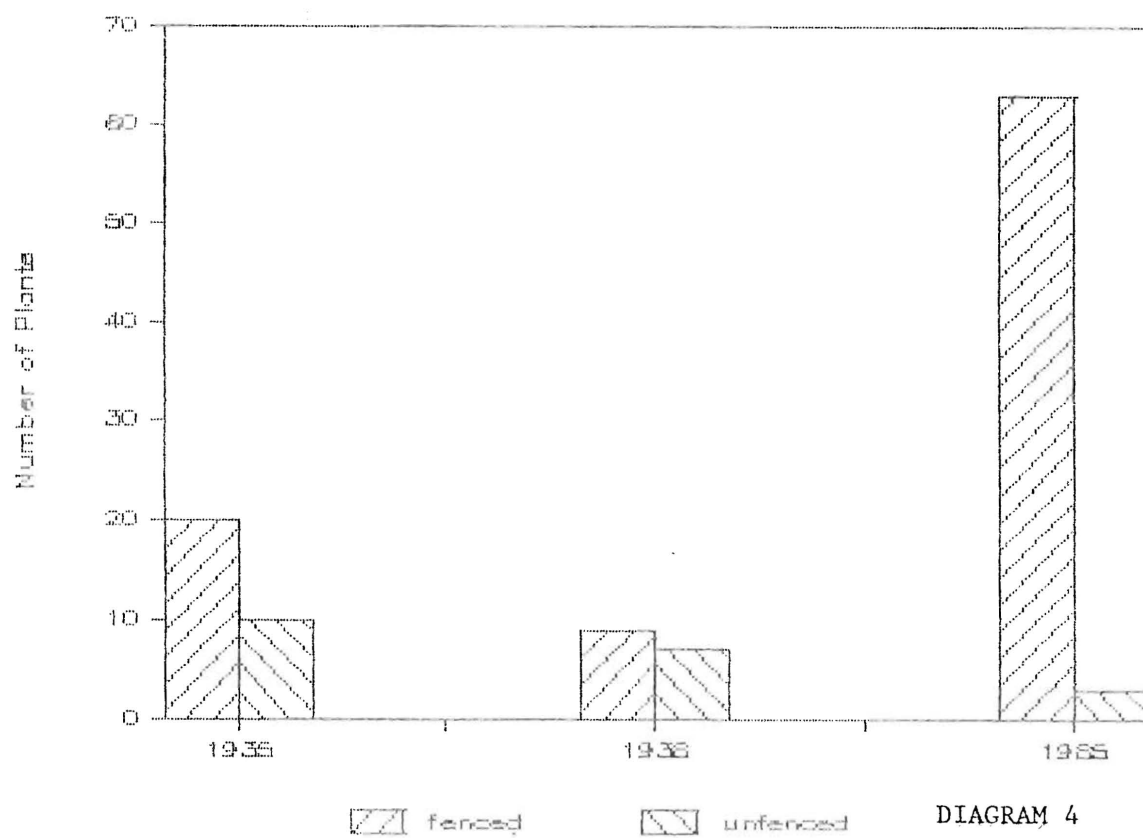


DIAGRAM 4

Chrysothamnus nauseosus

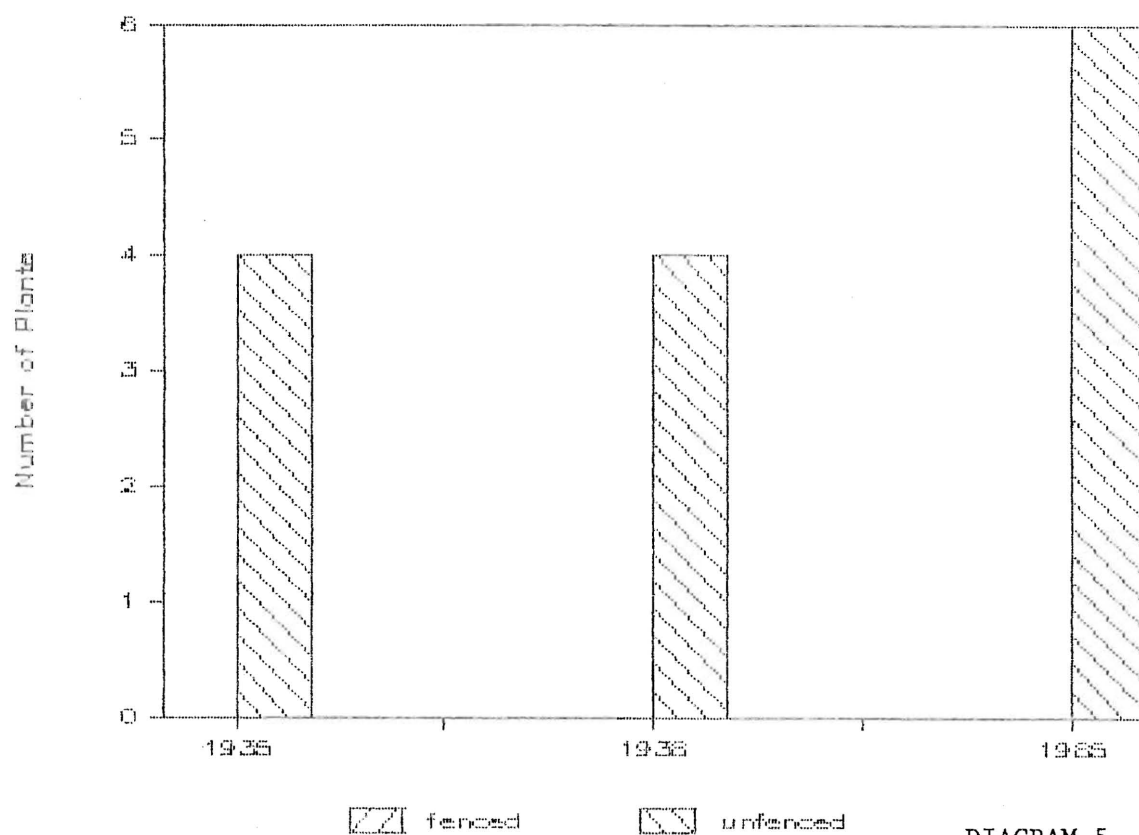


DIAGRAM 5

Juniperus osteosperma

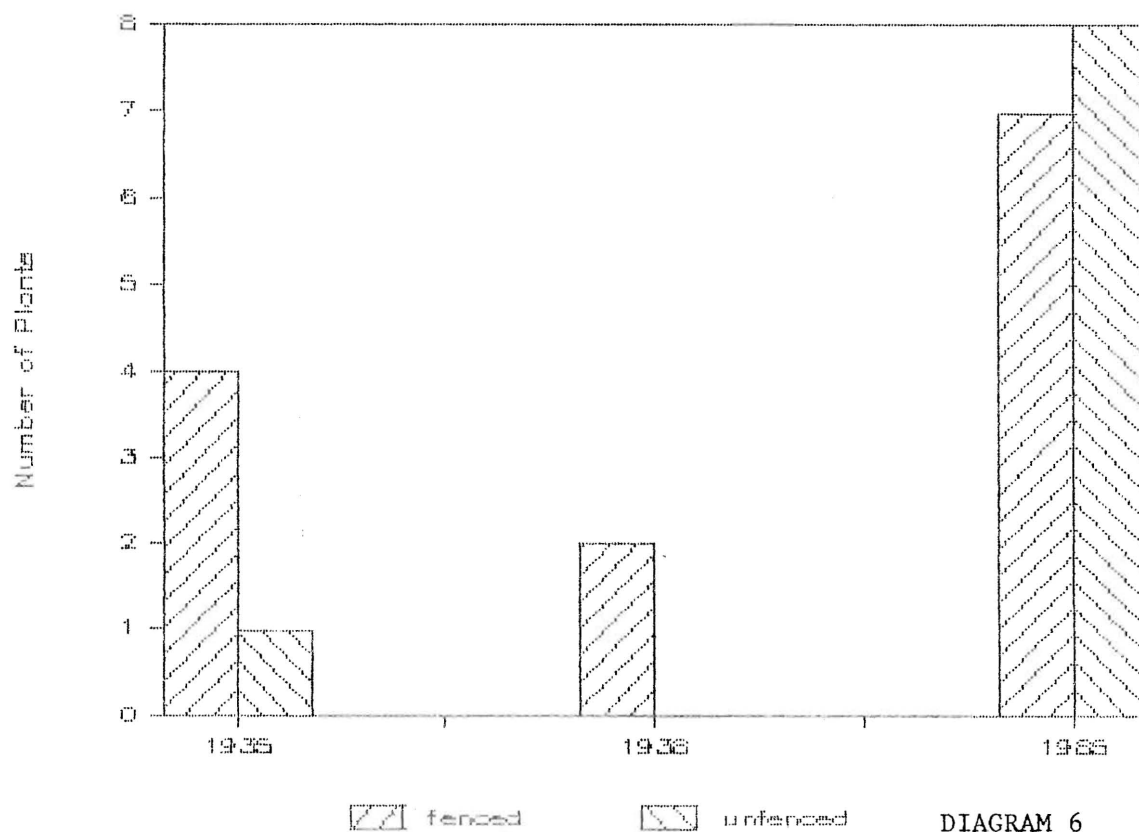
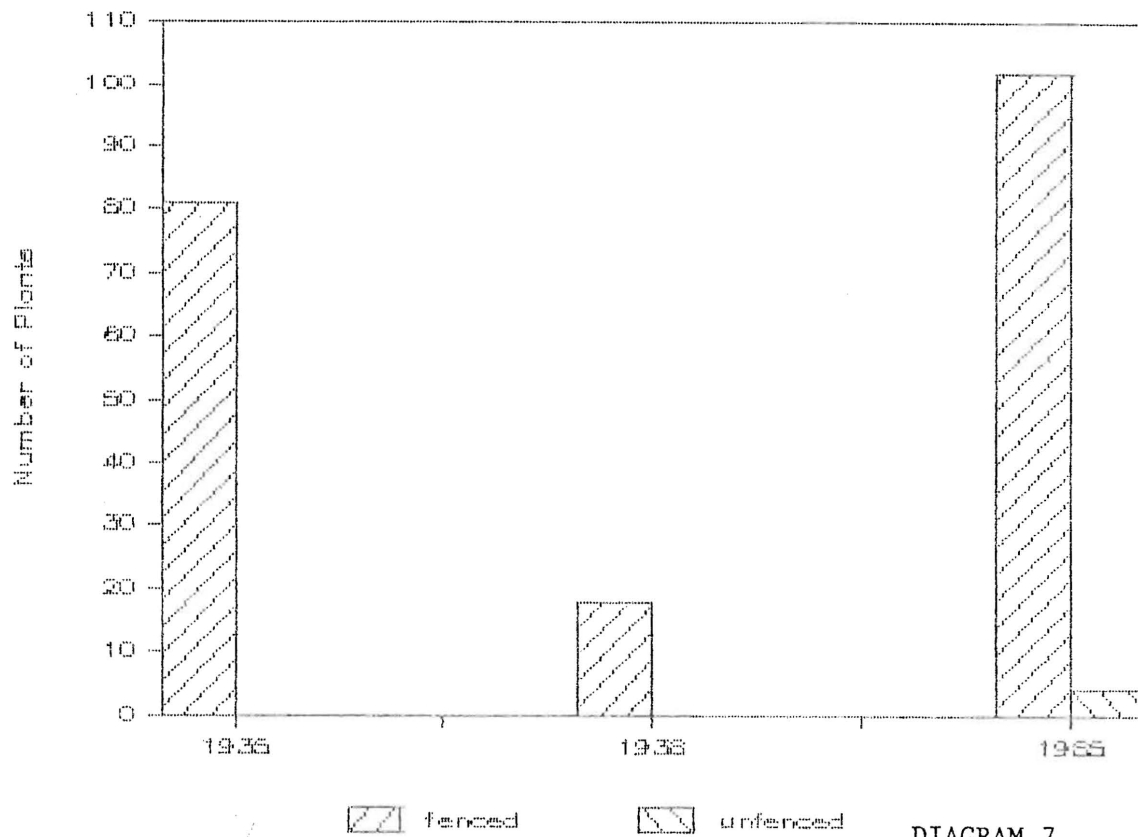
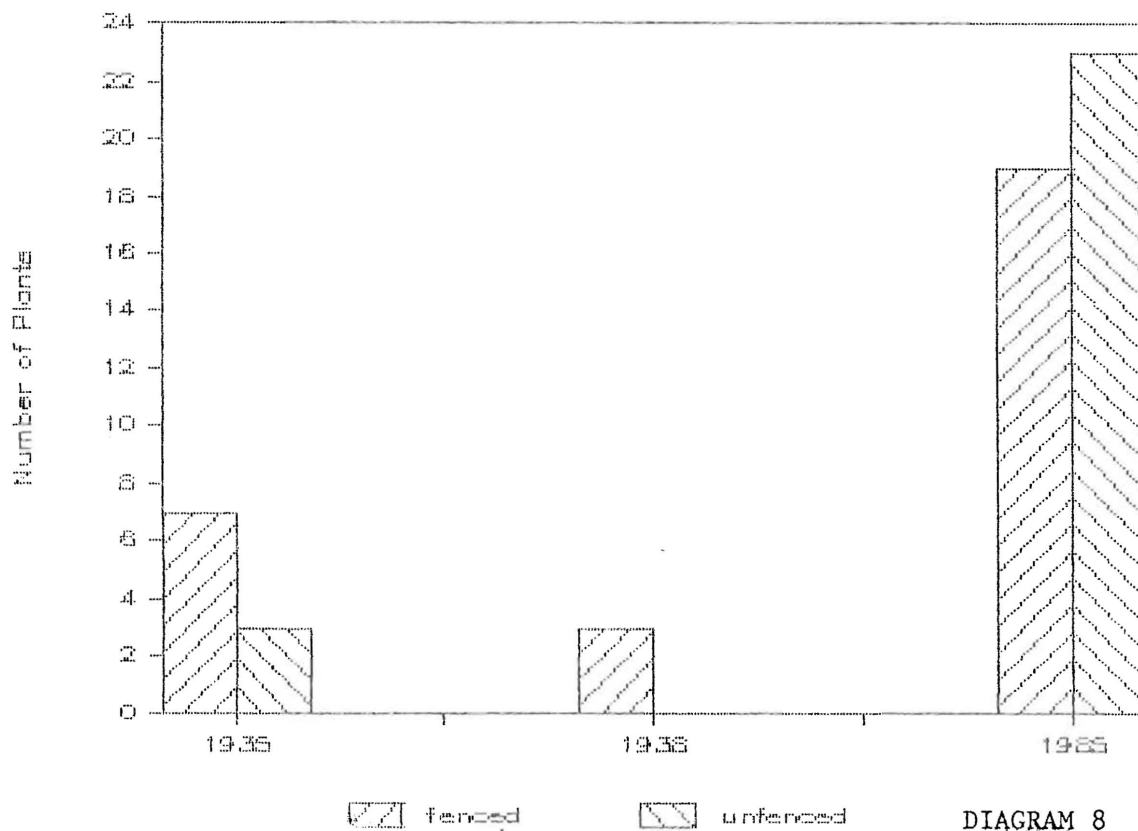


DIAGRAM 6

Quercus gambelii



Pinus edulis



Pinus ponderosa

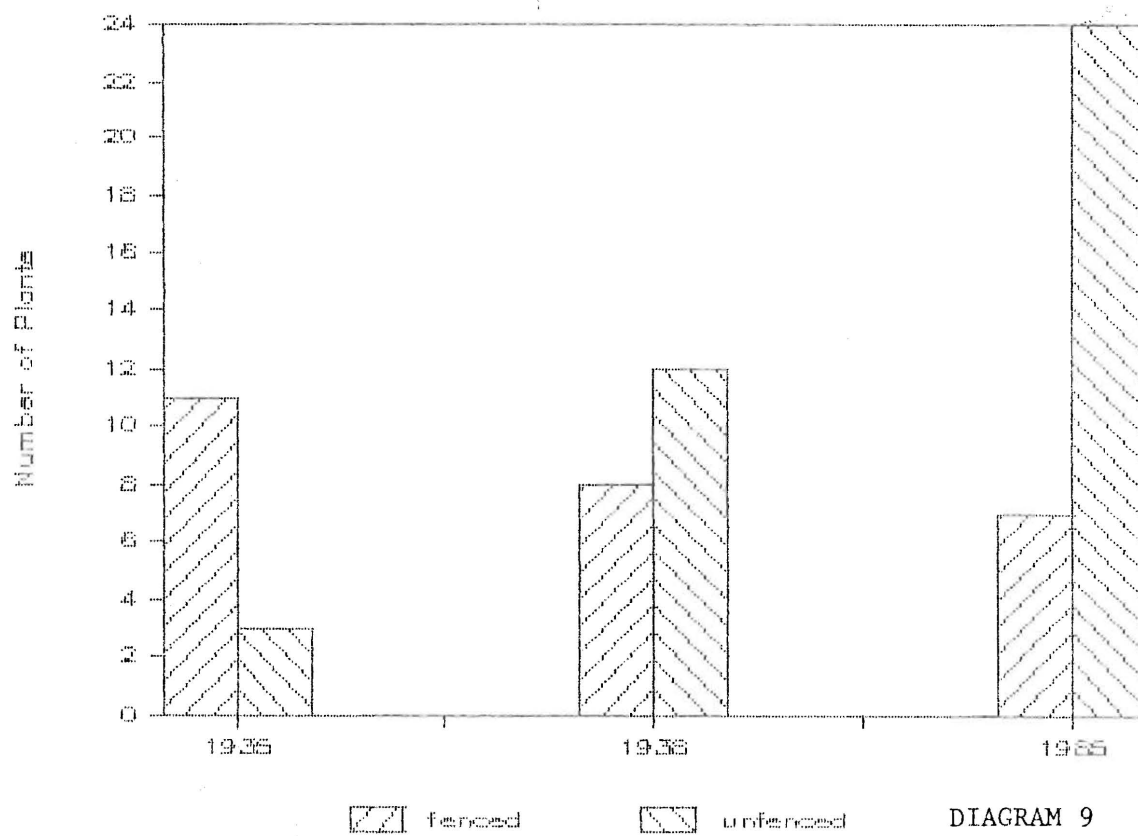
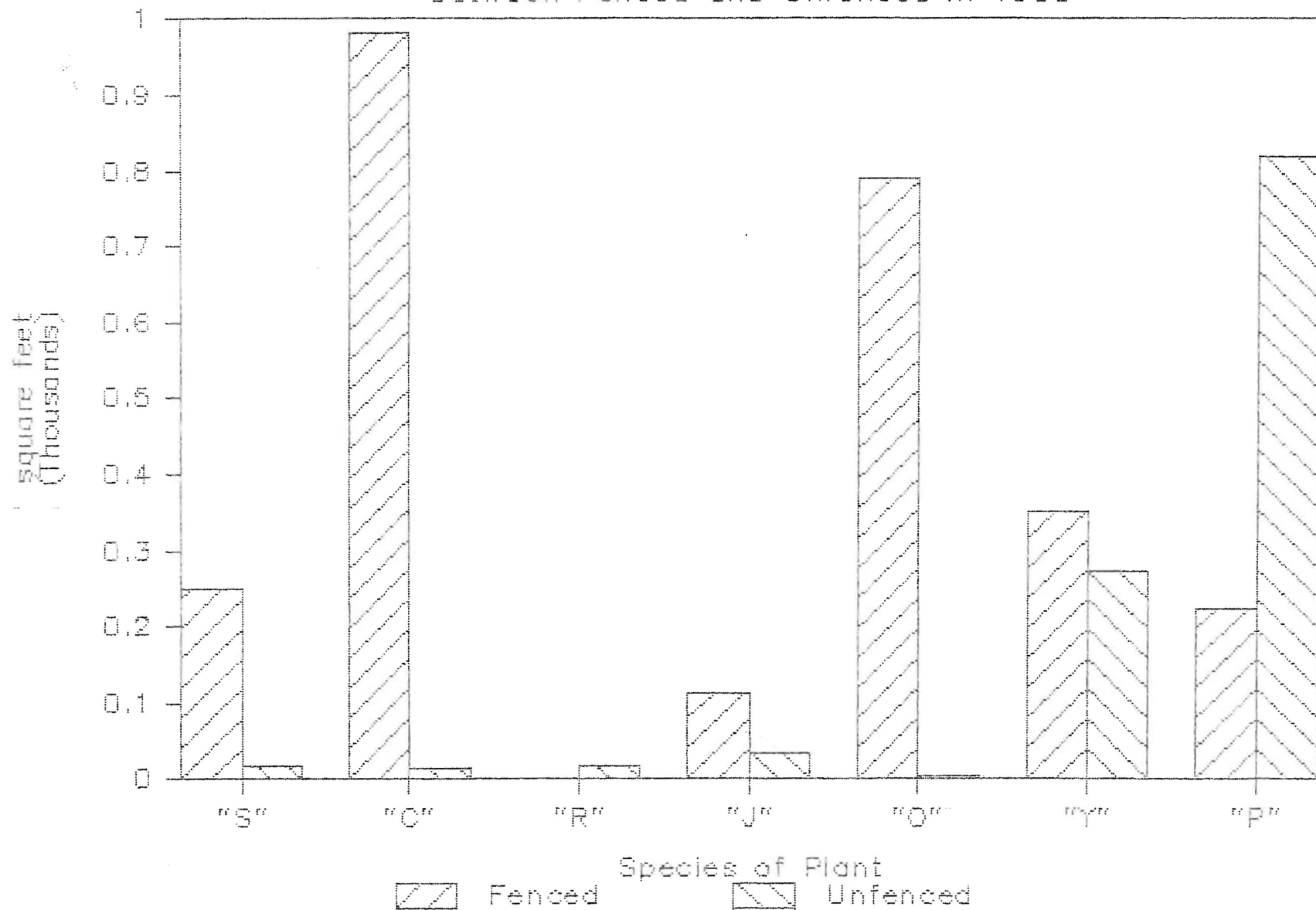


DIAGRAM 9

Difference in Crown Area

between Fenced and Unfenced in 1985



"S"-A. tridentata

"C"-C. mexicana

"R"-C. nauseous

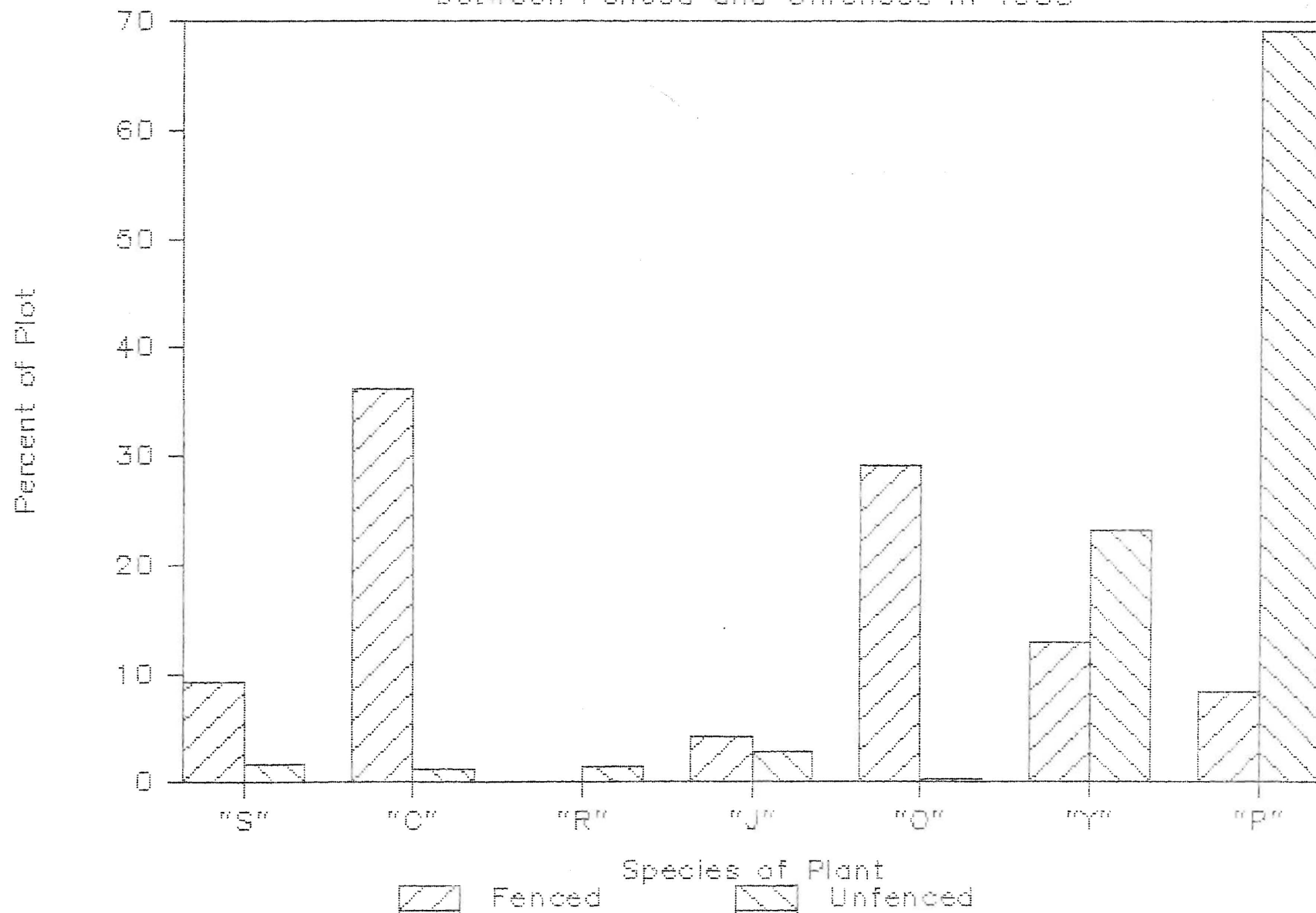
"J"-J. osteosperma

"O"-Q. gambelii

"Y"-P. edulis

"P"-P. ponderosa

Difference in % Crown Cover between Fenced and Unfenced in 1985



"S"-A. tridentata

"C"-C. mexicana

"R"-C. nauseous

"J"-J. osteosperma

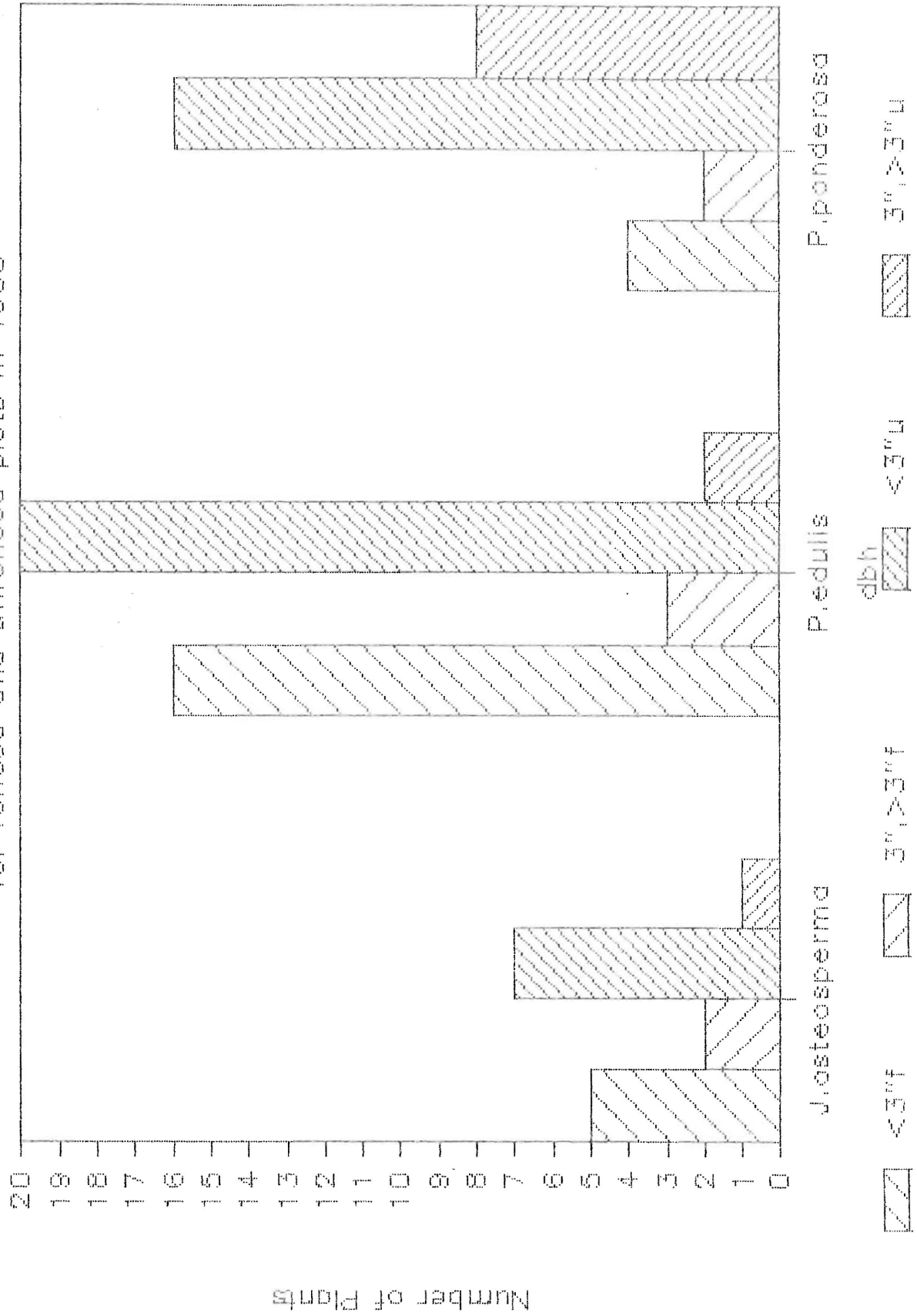
"O"-Q. gambelii

"Y"-P. edulis

"P"-P. ponderosa

Seedlings vs. Mature Trees

for fenced and unfenced plots in 1985



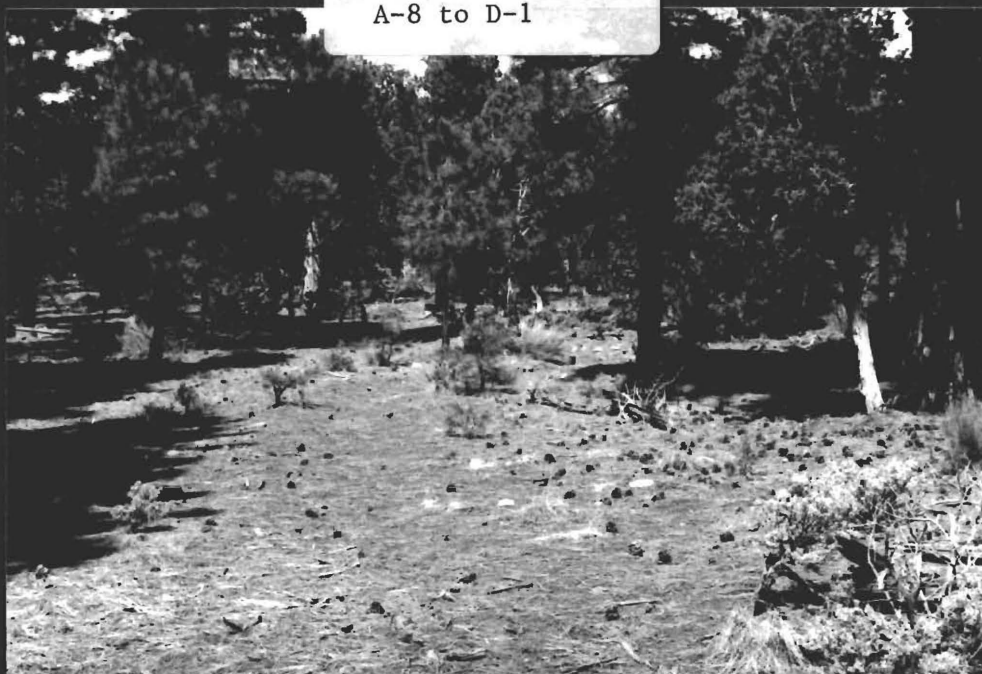
1a- Fenced Plot
A-1 to D-8



1b- Fenced Plot
C-8 to A-1



2a- Unfenced Plot
A-8 to D-1



2b- Unfenced Plot
A-1 to D-8

