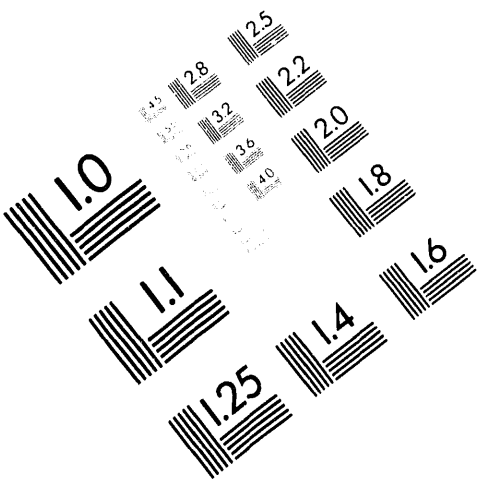

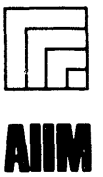

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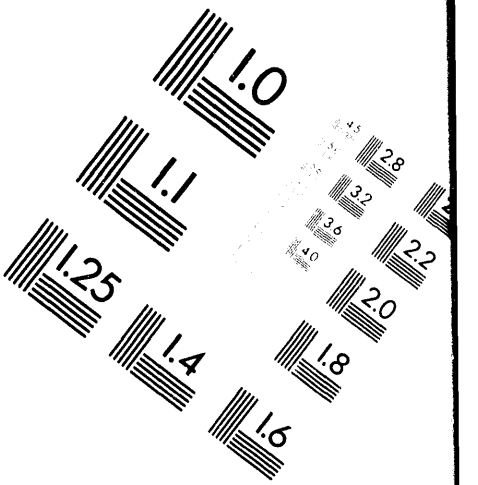

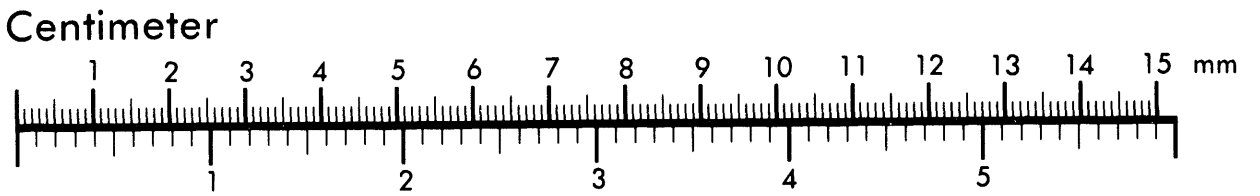

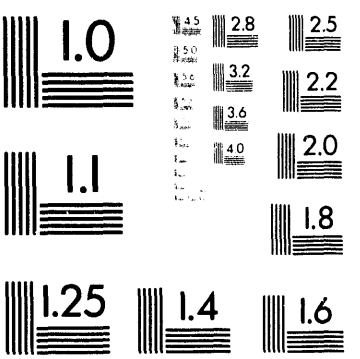

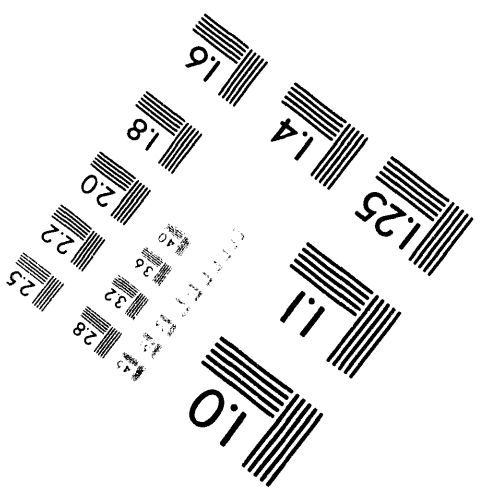

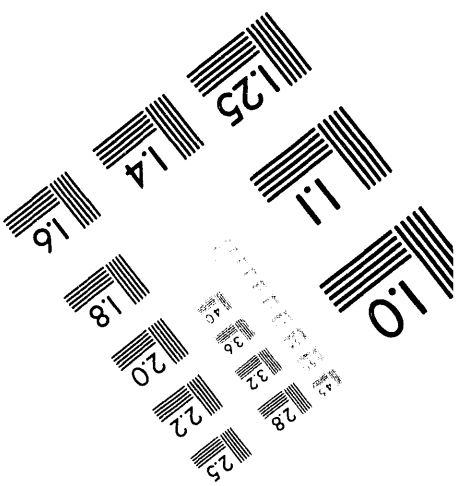

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Species and Community Response to Above Normal Precipitation Following Prolonged Drought in the Northern Mojave Desert.

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INTRODUCTION

Little information is available on how desert plant communities that are dominated by perennial species respond to normal and above normal precipitation following prolonged drought. Intuitively, one would expect total canopy cover to increase. Whether a concomitant increase in the density of perennial species also occurs is unknown. Even less is known about how individual species respond to above normal precipitation following drought. From 1987 through 1991 a prolonged drought occurred in much of the western United States, including the northern Mojave Desert. In March 1991 the northern Mojave Desert received well above normal precipitation. The following two winters (December-March) also had above normal precipitation (150 to 200 % of normal, unpublished data). Ongoing vegetation characterization studies by the U. S. Department of Energy (DOE) at Yucca Mountain, Nevada, allowed EG&G Energy Measurements to collect data that could be used to infer how both vegetation associations and individual species respond to above normal precipitation following prolonged drought. This paper reports the preliminary results.

OBJECTIVES

1. To determine if the collective perennial species component in the four vegetation associations present at Yucca Mountain, Nevada, responded similarly to above normal precipitation following prolonged drought.

2. To determine how individual perennial plant species responded to above normal precipitation following prolonged drought.

3. To determine if the plant species that occurred in two or more vegetation associations responded similarly in each vegetation association.

STUDY SITE DESCRIPTION

Four primary vegetation associations occur in the Yucca Mountain Project area: *Larrea tridentata-Ambrosia dumosa* (LA), *Larrea tridentata-Lycium andersonii-Grayia spinosa* (LLG), *Coleogyne ramissisimma* (COL), and *Lycium andersonii-Grayia spinosa* (LG) (Figures 1a-1e).

Table 1 provides a relative description of each vegetation association, and the elevation and precipitation gradient that

occurs at Yucca Mountain.

METHODS

Twelve, 200 x 200-m ecological study plots (ESPs) were established in each vegetation association.

Canopy cover measurements occurred on eight or ten, 50-m line transects in each ESP in 1991, 1992, and 1993.

Density measurements occurred for established perennial plants (plants $\geq$ 1 year of age) in eight or ten, 2 x 50-m belt transects. Data collection occurred during 1991 and 1992.

COVER AND DENSITY DATA SUMMARIZATION

The mean perennial species canopy cover (%) was calculated for each vegetation association, for each year that data collection occurred (1991-1993).

The mean canopy cover (%) and density (#/900 m^2) were calculated, for the 17 most common perennial species present. Mean values were obtained for each year that data collection occurred.

The percent change in mean canopy cover, between 1991 and 1993, for each of the 17 species analyzed was calculated.

The percent change in mean density of established perennial plants between 1991 and 1992 was determined.

RESULTS

Cover

The vegetation cover of the perennial species increased in each vegetation association, except the *Lycium-Grayia*, during each year (Figure 2). Cover in the *Lycium-Grayia* vegetation association increased over 4 % from 1991 to 1992, but was similar in both 1992 and 1993.

The mean cover of most species increased substantially between 1991 and 1993 (Figures 3a-3d).

The three species that had the greatest percentage increase in cover were *Atriplex confertifolia* (Figure 3c), *Grayia Spinosa* (Figure 3a), and *Oryzopsis hymenoides* (Figure 3a). The increase in the total cover of these species, however, was small. The large increase in the cover of *Atriplex* occurred only in the *Coleogyne* association, and the increase in the mean cover of *Grayia* and *Oryzopsis* occurred only in the *Larrea-Ambrosia* vegetation association.

Ambrosia dumosa, Ephedra nevadensis, Grayia spinosa, Larrea tridentata, Lycium andersonii, and *Lycium pallidum* were the only

species that had an increase in their total cover of 0.5 % or more [(e.g., from 2.5% to 3.1%) (Figures 3a-3d)]. None of these species increased their total cover by at least 0.5 % in every vegetation association.

The percent change in the cover of a species between vegetation associations was not always similar in magnitude or direction *Atriplex confertifolia* and *Oryzopsis hymenoides* are two examples (Figures 3a-3d).

Density

The mean density of most species changed little in each vegetation association (Figures 4a-4d).

Substantial increases in density occurred for only two species: *Atriplex confertifolia* and *Oryzopsis hymenoides*. The increase in *Atriplex* density, however, was largely limited to the *Coleogyne* vegetation association, and the increase in *Oryzopsis* density to the *Larrea-Ambrosia* vegetation association.

DISCUSSION AND CONCLUSIONS

An increase in canopy cover was the primary response that each vegetation association had to above normal precipitation (Figures 2 and 4a-4d). Percentage wise several species saw a substantial change in the density; however, the change in total numbers was usually small (Figures 4a-4d).

Only two species, *Atriplex confertifolia* and *Oryzopsis hymenoides*, had large percentage increases in both cover and density; however, this response was not consistent across vegetation associations (Figures 3 and 4). *Atriplex* only showed the increase in the *Coleogyne* vegetation association, and *Oryzopsis* only in the *Larrea-Ambrosia* association. Schultz and Ostler (this session) have shown that *Atriplex* and *Oryzopsis* both appeared to suffer substantial mortality in *Coleogyne* and *Larrea-Ambrosia* vegetation associations, respectively. Other research (Hall and others, this session) showed that only *Oryzopsis* had good seedling survival (43 %) between years (1992 and 1993). The large increase in the density of *Atriplex* in the *Coleogyne* association indicates that this species may have had reasonably good seedling survival in the *Coleogyne* association from 1991 to 1992.

This study showed that the change in canopy cover of an individual species (Figures 3a-3d) in a plant community was often quite different than the general response of the vegetation association in which the species occurred (Figure 2). Many species in each vegetation association showed a large increase in relative cover between years; however, only a few species also had a large increase in total cover.

A species that occurs in two or more vegetation associations does not always experience a change in canopy cover or density of the

same direction or magnitude, in each association (Figures 3 and 4).

The increase in vegetation cover (Figure 2 and Figures 3a-3d), of both individual species and vegetation associations, did not follow the elevation and precipitation gradient present (Table 1). During the duration of this study the *Larrea-Ambrosia* association, which is the driest vegetation association in the Yucca Mountain area, had both the greatest relative and absolute increases in perennial species cover.

Because the changes in cover and density exhibited by both individual species and vegetation associations in this study did not follow the elevation and precipitation gradient present, and were not consistent across vegetation associations, factors other than precipitation must control how both species and communities respond to above normal precipitation following drought. One observed difference between each association was soil. Not only were differences in soil depth and landform position present (Table 1), but also texture, structure, pH, and the presence of carbonates (unpublished data and personal observation).

The composition of the annual species community may also limit the recruitment of perennial seedlings (Hall and others 1993). Competitive interactions in the Mojave Desert between both native and introduced annual species, and native perennial species have not been studied in detail.

REFERENCES

Hall, P. F., Schultz. B. W., Angerer, J. P., and W. K. Ostler. 1993. The Influence of Annual Species Composition and Density on Perennial Seedling Density in Four Plant Communities in the Northern Mojave Desert. In: Wildland Shrub and Arid Land Restoration Symposium: October 19-21, 1993; Las Vegas, NV.

Schultz, B. W. and W. K. Ostler. 1993. The Affect of Prolonged Drought on Four Vegetation Associations in the Northern Mojave Desert. In: Wildland Shrub and Arid Land Restoration Symposium: October 19-21, 1993; Las Vegas, NV.

DISCLAIMER

Table 1. General physiographic and abiotic characteristics of the five vegetation primary vegetation associations at Yucca Mountain.

Vegetation Association	Elevation Range (m)	Landform	Relative Precipitation (1992 ave.)	Average Soil Depth (cm)†
Larrea-Ambrosia	900-1050	Sandy alluvial plain	Lowest (166 mm)	80+
Larrea-Lycium-Grayia	1000-1200	Young gravelly alluvial outwash	Intermediate (219 mm)	60-100
Low elevation *Coleogyne*	1100-1300	Old alluvial fans	Intermediate (212 mm)	15-45
High Elevation *Coleogyne*	1400-1700	Flat mountain tops and mesas	Highest (260 mm)	30-45
Lycium-Grayia	1150-1500	Ridge tops and mountain sideslopes	Intermediate (220 mm)	30-45

† Personal observation of the authors.

Appendix 1. Definitions of species codes used in figures.

Ambrosia dumosa	AMDU
Atriplex confertifolia	ATCO
Acamptopappus shockleyi	ACSH
Chrysothamnus teretifolius	CHTE
Coleogyne ramosissima	CORA
Encelia virginensis	ENVI
Ephedra nevadensis	EPNE
Ephedra viridis	EPVI
Eriogonum fasiculatum	ERFA
Grayia spinosa	GRSP
Haplopappus cooperi	HACO
Hymenochlea salsola	HYSA
Lycium andersonii	LYAN
Lycium pallidum	LYPA
Larrea tridentata	LATR
Menodora spinescens	MESP
Oryzopsis hymenoides	ORHY

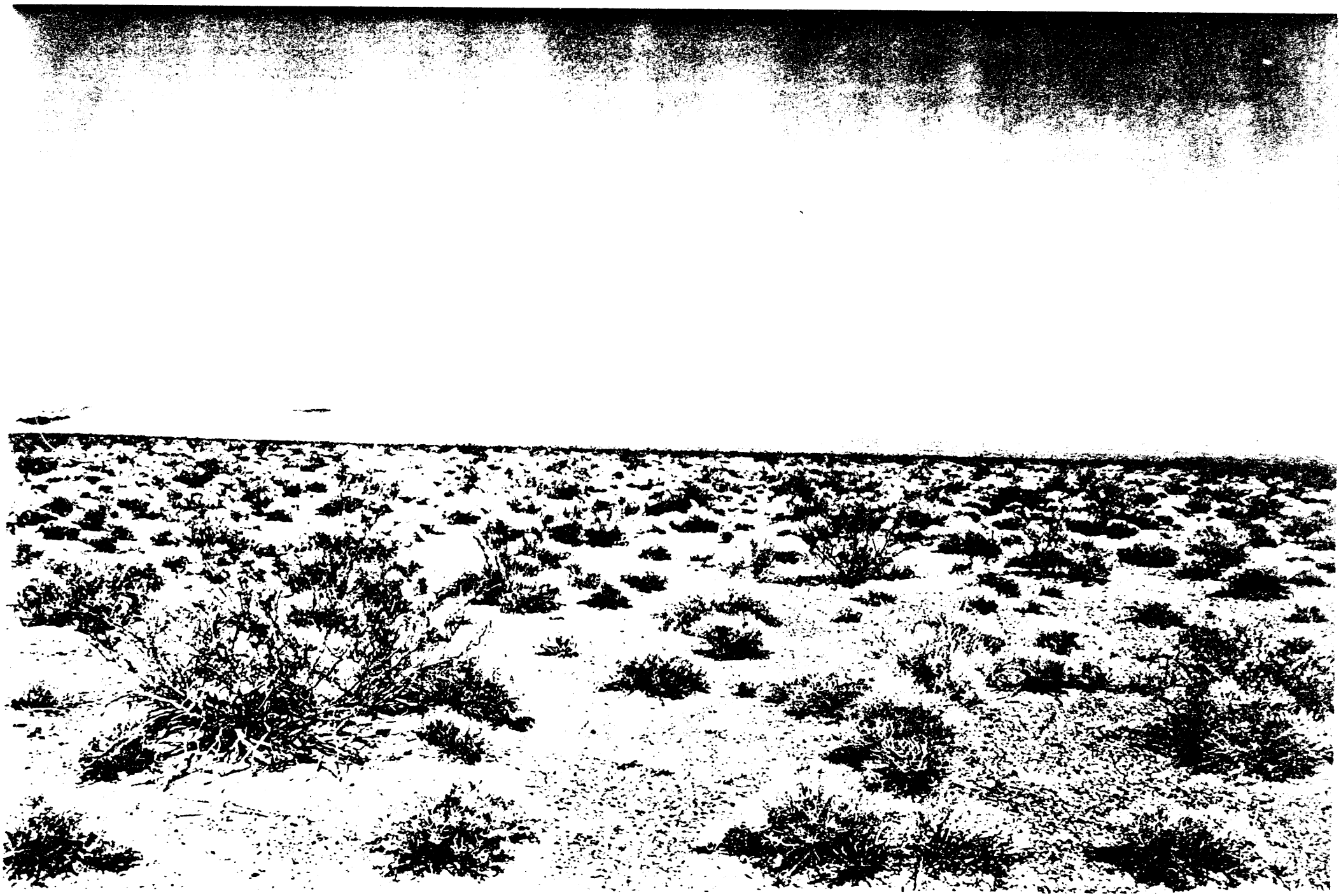
Titles to Figures.

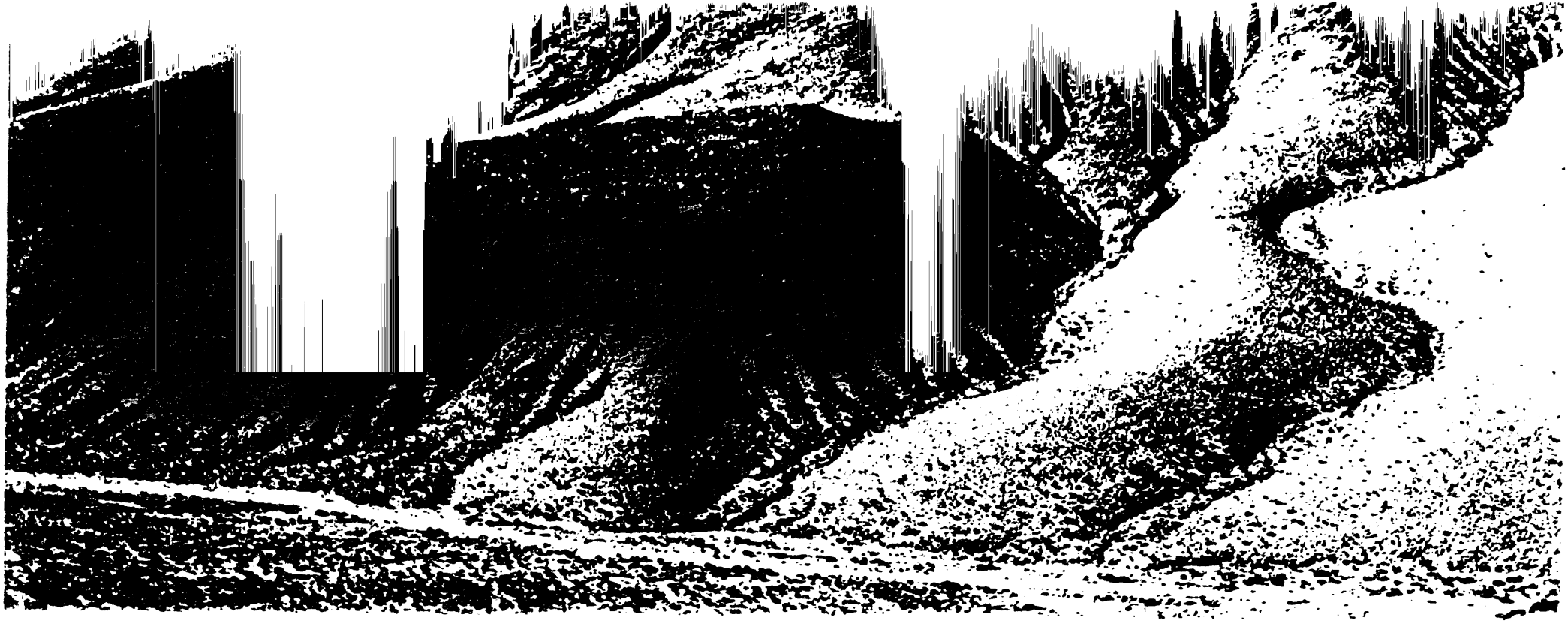
Figures 1a-1e. a) Larrea-Ambrosia association, b) Larrea-Lycium-Grayia association, c) low elevation Coleogyne association, d) high elevation Coleogyne association, and e) the Lycium-Grayia association.

Figure 2. The mean canopy cover in 1991, 1992, and 1993 of all perennial species present in four vegetation associations present in the Northern Mojave Desert. Values above each bar are the percent change in cover between 1991 and 1993.

Figures 3a-3d. The mean canopy cover, in each of three years, of the 17 most common perennial plant species in four vegetation associations, in the Northern Mojave Desert. Values above each group of bars is the percent change in total cover between 1991 and 1993.

Figures 4a-4d. The mean density, in 1991 and 1992, of the 17 most common species in four vegetation associations in the northern Mojave Desert. Values above each group of bars is the percent change in density from 1991 to 1992.





Vegetation Cover by Vegetation Association and Year

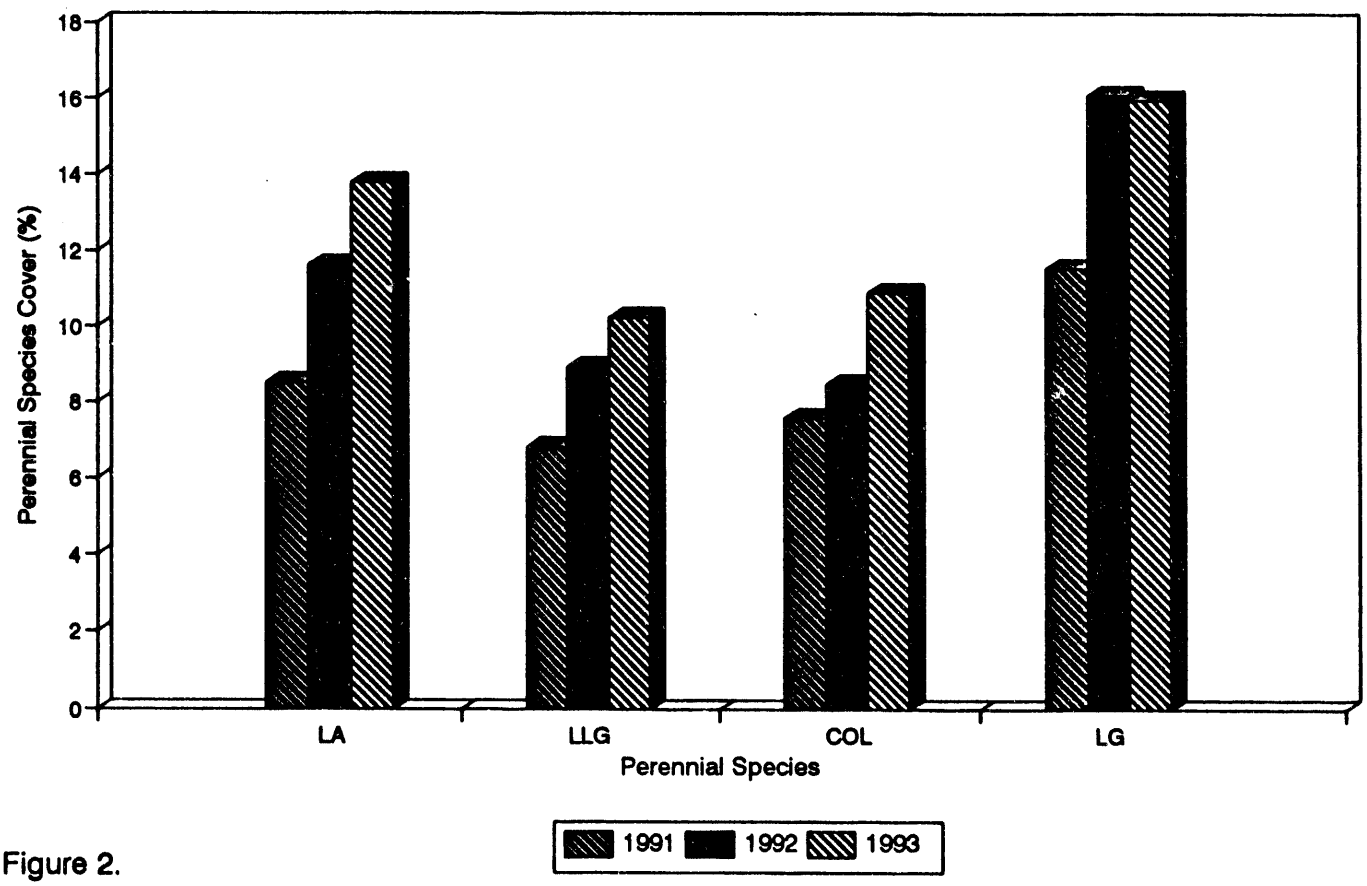


Figure 2.

Larrea-Ambrosia Association

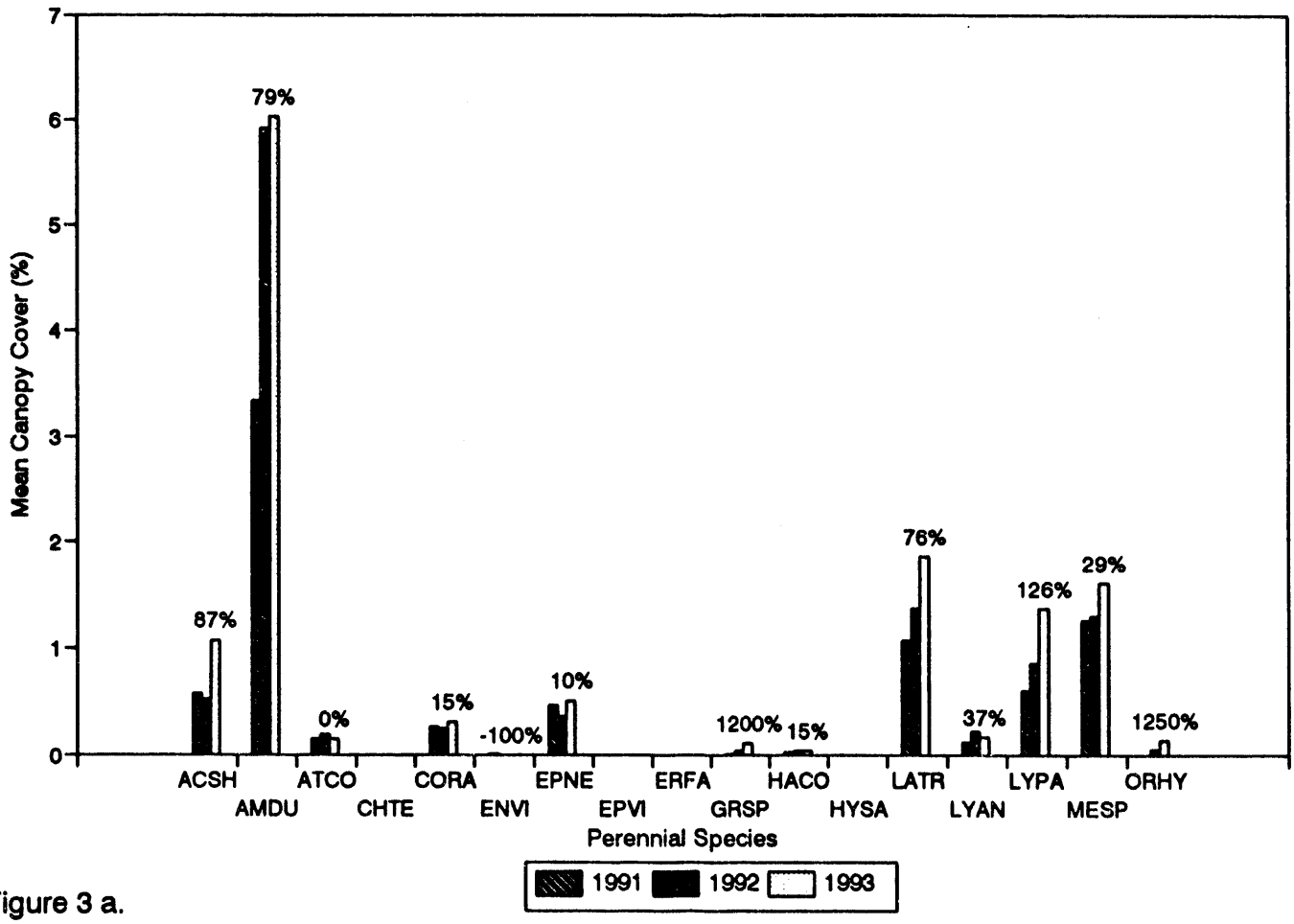


Figure 3 a.

Larrea-Lycium-Grayia Association

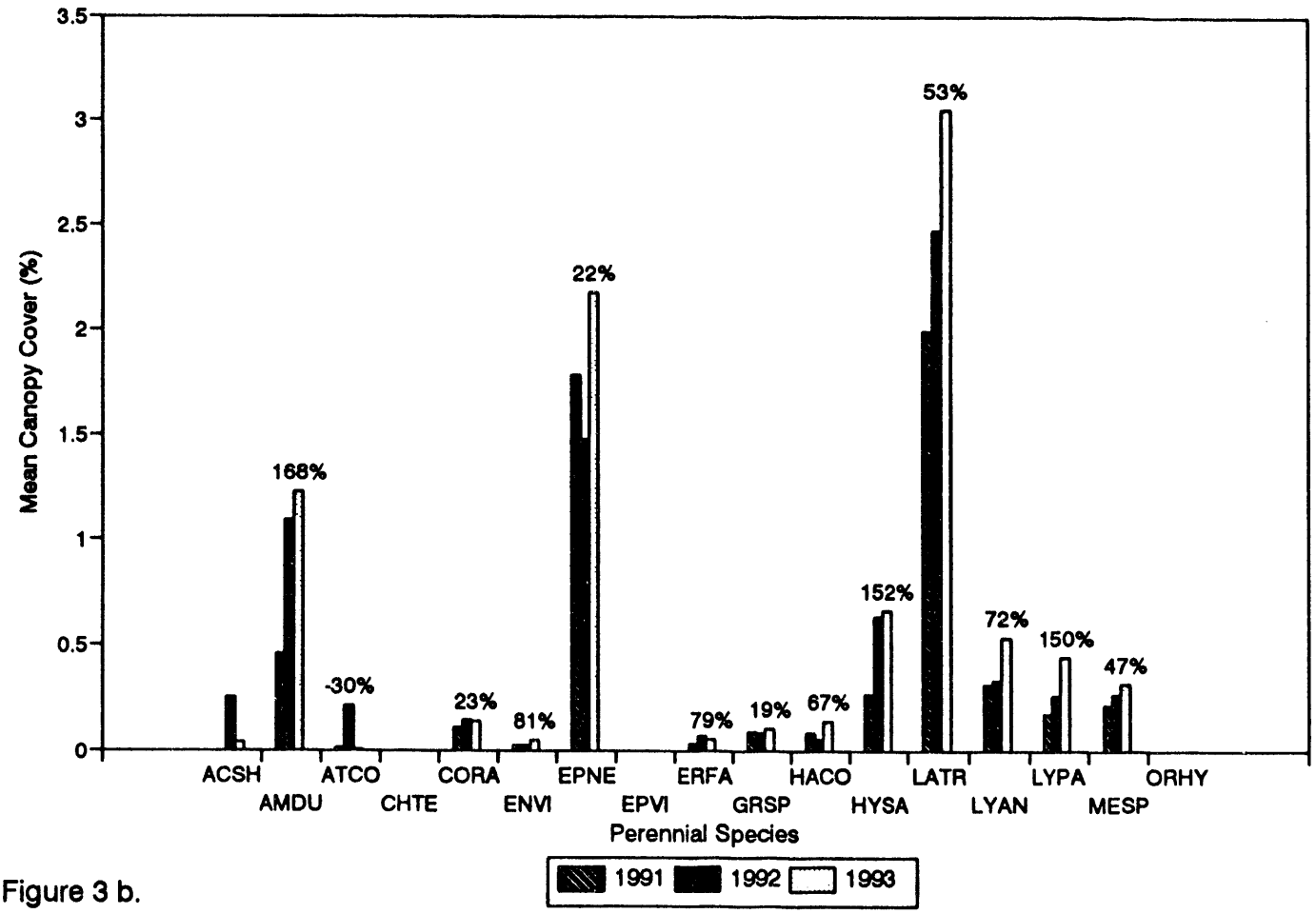


Figure 3 b.

Coleogyne Association

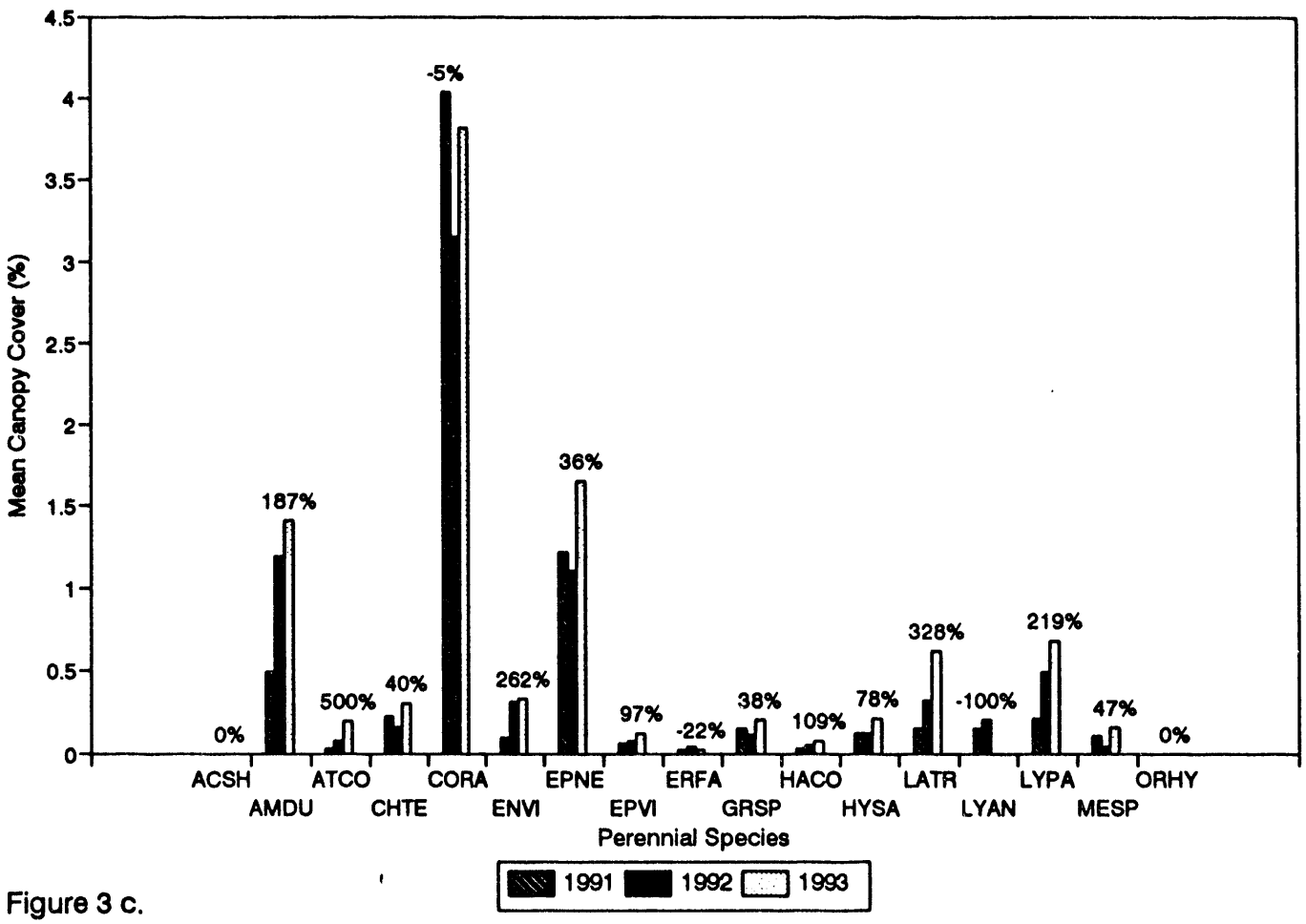


Figure 3 c.

Lycium-Grayia Association

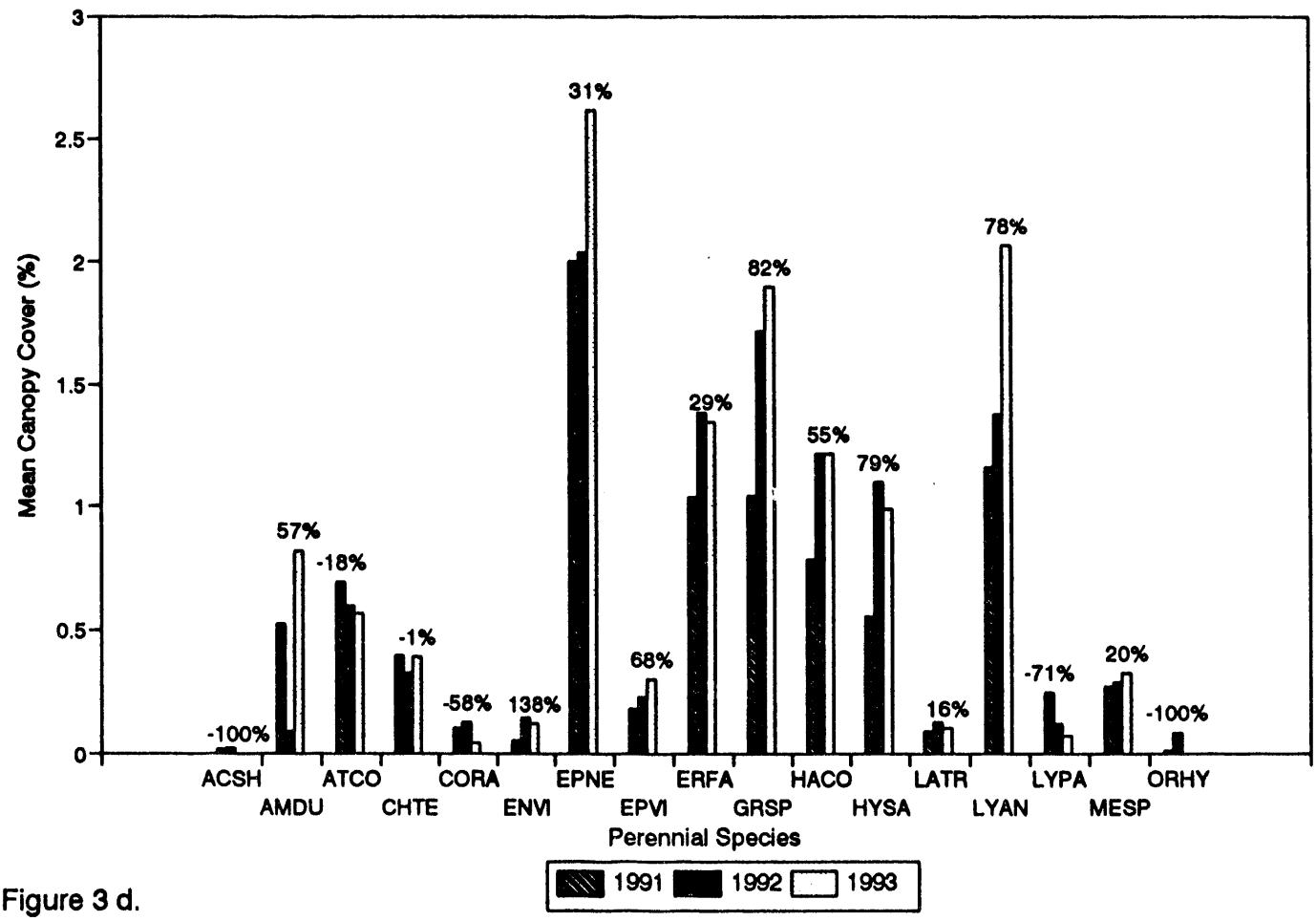


Figure 3 d.

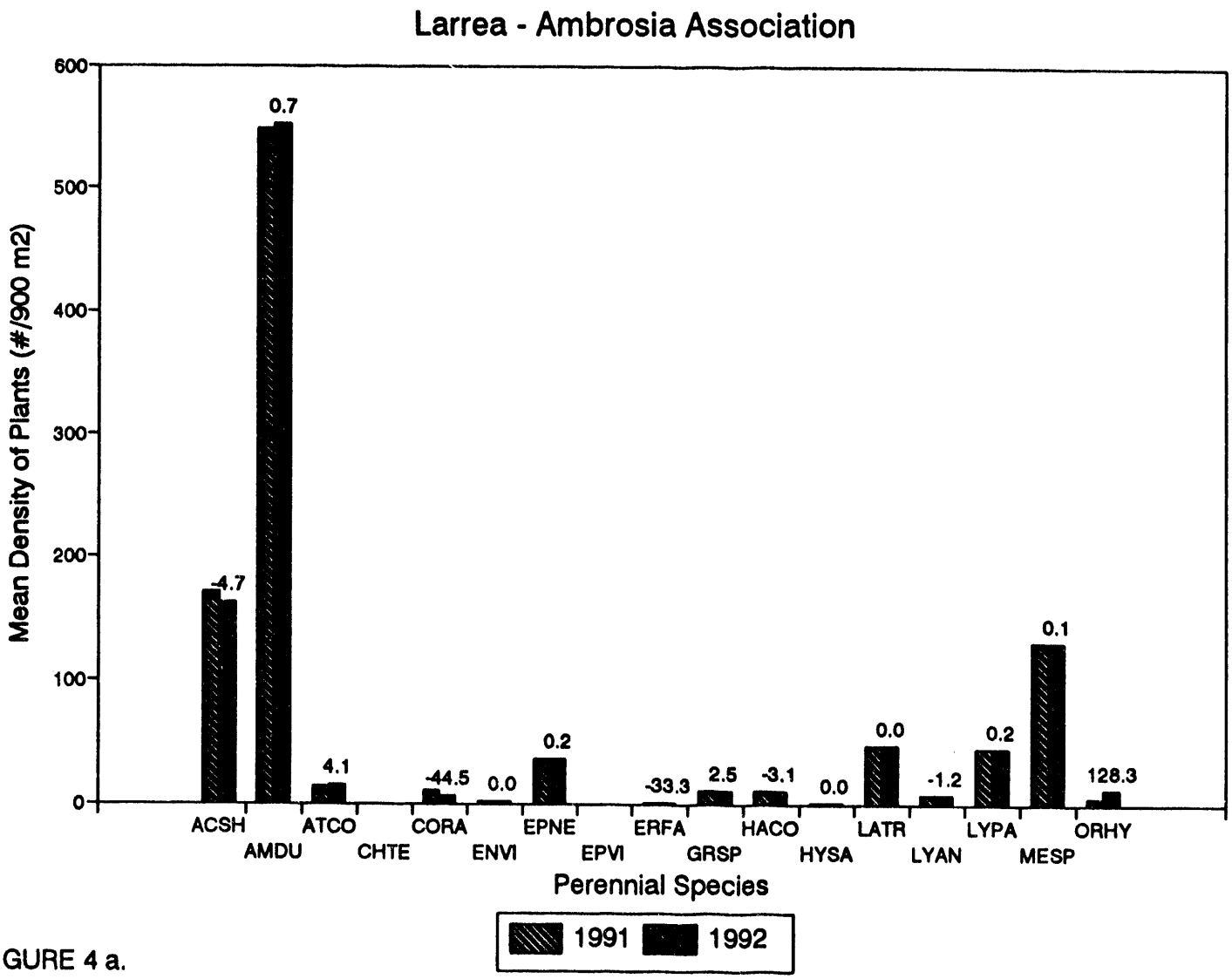
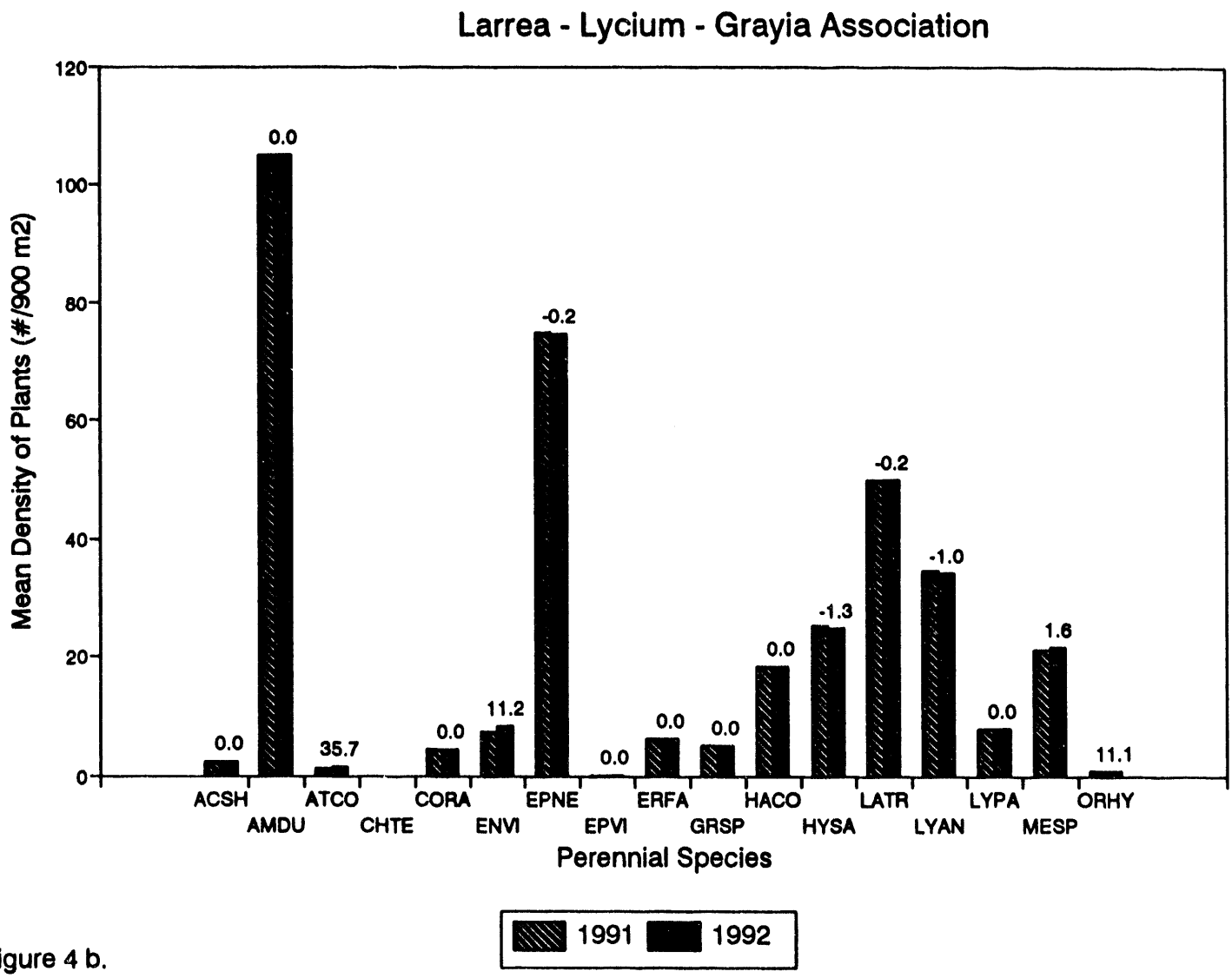

Larrea - Ambrosia Association
Mean Density of Plants (#/900 m2)
600
500
400
300
200
100
0
-4.7
0.7
4.1
-44.5
0.0
0.2
-33.3
2.5
-3.1
0.0
0.0
-1.2
0.2
0.1
128.3
ACSH
AMDU
ATCO
CHTE
CORA
ENVI
EPNE
EPVI
ERFA
GRSP
HACO
HYSA
LATR
LYAN
LYPA
MESP
ORHY
Perennial Species
1991
1992

FIGURE 4 a.


Larrea - Lycium - Grayia Association
Mean Density of Plants (#/900 m2)
120
100
80
60
40
20
0
0.0
0.0
35.7
0.0
11.2
-0.2
0.0
0.0
0.0
0.0
-1.3
-0.2
-1.0
0.0
1.6
11.1
ACSH
AMDU
ATCO
CHTE
CORA
ENVI
EPNE
EPVI
ERFA
GRSP
HACO
HYSA
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LYAN
LYPA
MESP
ORHY
Perennial Species
1991
1992

Figure 4 b.

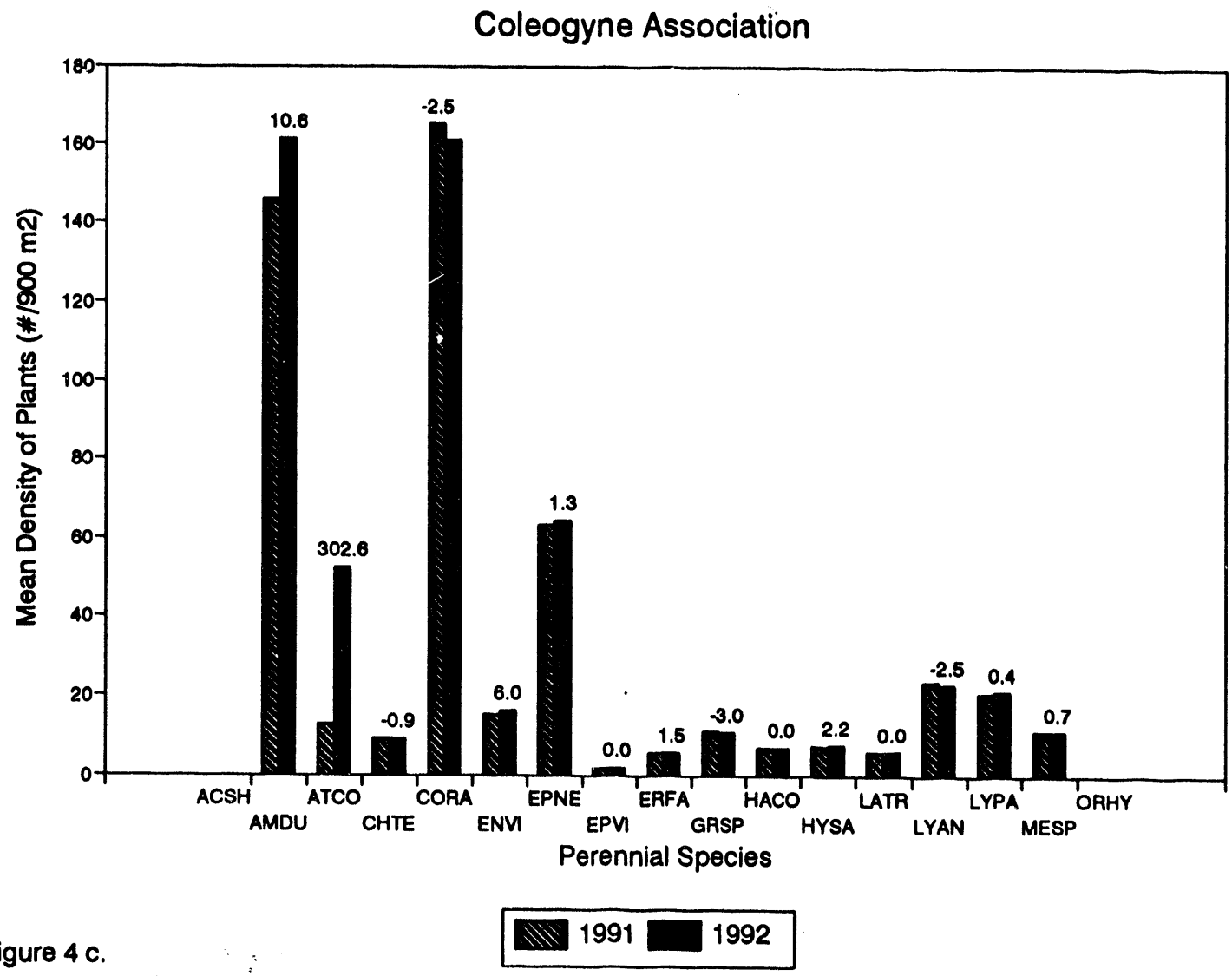
Coleogyne Association
Mean Density of Plants (#/900 m2)
180
160
140
120
100
80
60
40
20
0
10.6
-2.5
302.6
-0.9
6.0
1.3
0.0
1.5
-3.0
0.0
2.2
0.0
-2.5
0.4
0.7
ACSH
AMDU
ATCO
CHTE
CORA
ENVI
EPNE
EPVI
ERFA
GRSP
HACO
HYSA
LATR
LYAN
LYPA
MESP
ORHY
Perennial Species
1991
1992

Figure 4 c.

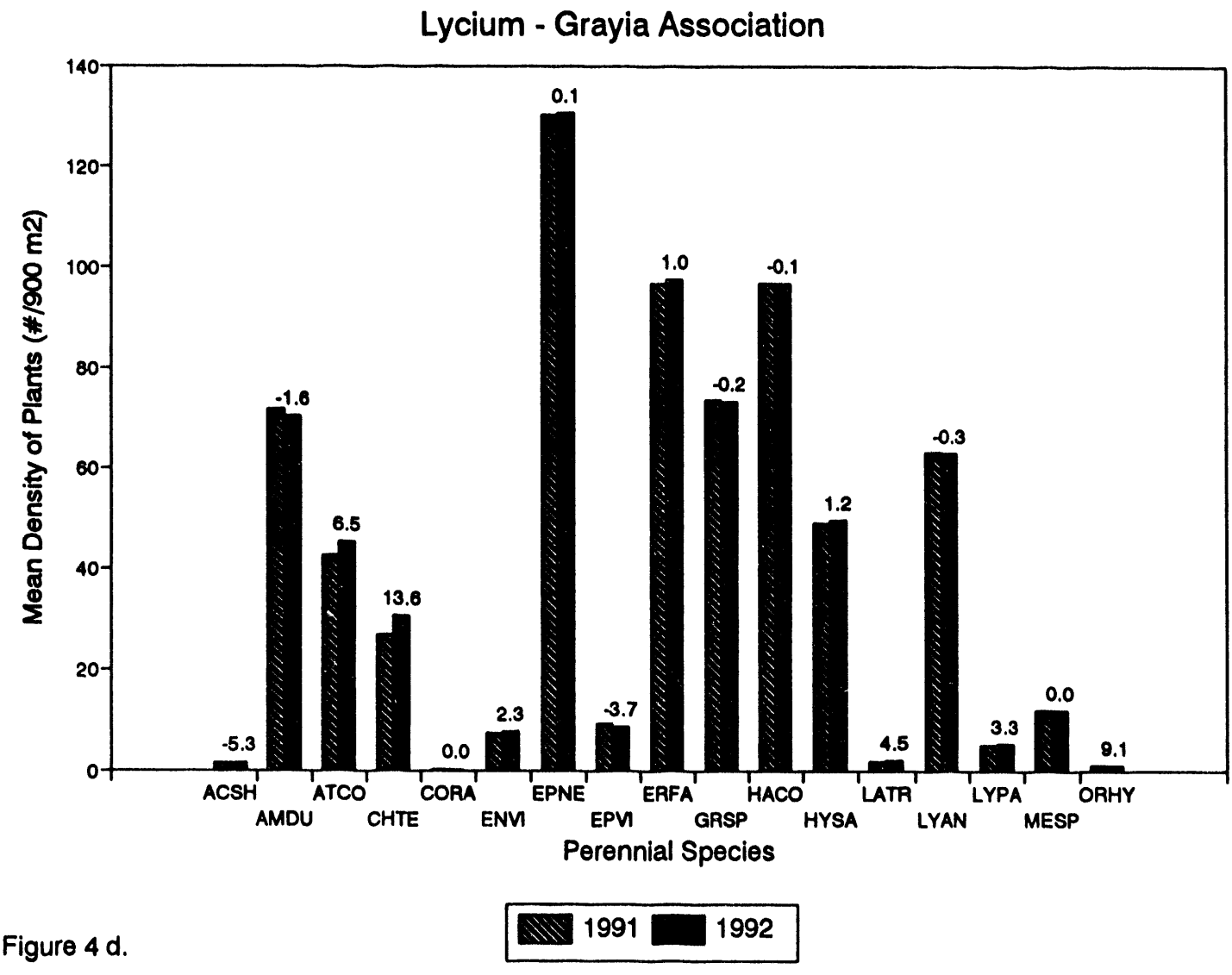
Lycium - Grayia Association
Mean Density of Plants (#/900 m2)
140
120
100
80
60
40
20
0
-5.3
-1.6
6.5
13.6
0.0
2.3
0.1
-3.7
1.0
-0.2
-0.1
1.2
4.5
-0.3
3.3
0.0
9.1
ACSH
AMDU
ATCO
CHTE
CORA
ENVI
EPNE
EPVI
ERFA
GRSP
HACO
HYSA
LATR
LYAN
LYPA
MESP
ORHY
Perennial Species
1991
1992

Figure 4 d.

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