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PLANT SUCCESSION ON DISTURBED SITES IN FOUR PLANT ASSOCIATIONS IN THE NORTHERN MOJAVE DESERT.

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ABSTRACT

The U.S. Department of Energy (DOE) is characterizing Yucca Mountain, Nevada, as a potential site for long-term underground storage of high-level nuclear waste. DOE is committed to reclaim all lands disturbed by the project, and return them to a stable ecological state, with a composition and productivity similar to predisturbance conditions. A study was implemented to assess plant species which naturally invade disturbed sites in the Yucca Mountain Project Area. In 1991 and 1992 study plots were established on disturbed sites. Sites were characterized by disturbance type (i.e., road, drill pad, etc.), disturbance severity, vegetation association, time since abandonment, and topographic placement. Density of all perennial plant species was measured on disturbed and undisturbed plots. The species with the highest density in disturbed sites was *Chrysothamnus teretifolia*. This species was not a major contributor in undisturbed sites. In the undisturbed sites *Ambrosia dumosa* had the highest density of perennial plant species but was also high in density in the disturbance sites. Total species density was higher in undisturbed sites compared to disturbed sites. Plant species density analysis compared disturbed and undisturbed vegetation associations. Results will be used to design reclamation field trials and to finalize the Yucca Mountain Project Reclamation Implementation Plan.

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INTRODUCTION

In 1979, Yucca Mountain, Nevada, was identified as a potential site for long-term underground storage of high-level nuclear waste. Initial exploration of the suitability of Yucca Mountain began in 1979. Disturbances resulting from exploration included drilling, road construction, soil excavation for drill pad construction, and other construction activities. The U. S. Department of Energy-Yucca Mountain Project is committed to reclaiming all lands disturbed by site-characterization activities.

Yucca Mountain is located in the Northern Mojave Desert with elevations ranging from 944 to 1,789 m above sea level (Figure 1). Four major vegetation associations identified in the Yucca Mountain area by EG&G Energy Measurements-Environmental Sciences Department (EG&G) are: *Coleogyne* (COL), *Larrea-Ambrosia* (LA), *Lycium-Grayia* (LG), and *Larrea-Lycium-Grayia* (LLG). Site characterization activities for the Yucca Mountain Project will disturb approximately 180 ha of vegetation and soils within these four vegetation associations. Since little is known about reclamation in the Mojave Desert a research program was initiated. One portion of that program was to inventory past disturbances and assess the rate of natural succession on these sites. Specific objectives were: 1) to identify the dominant plant species present in disturbed habitats within the four vegetation associations in the Yucca Mountain area, 2) to compare dominant plant species in disturbed areas with undisturbed areas, 3) to evaluate the succession rate of disturbed areas. Information from this study will be used to determine species which can be used in reclamation trials and aid in the development of site specific reclamation plans.

METHODS

In 1991 and 1992, study plots were established on 57 disturbed sites. At

each disturbed site, three to six, 2 x 20-m belt transects were established randomly, parallel to an undisturbed seed source. All perennial plant species rooted within the belt transects were identified and counted. In the undisturbed habitats 48 study plots were established randomly with eight to ten, 2 x 100-m belt transects, these study plots were sampled similarly for density. Perennial plant species densities of disturbed sites were compared to those of undisturbed sites with the same vegetation association. Plant species densities for both disturbed and undisturbed plots were reported on a per square meter basis, and data from plots of the same vegetation association were combined for an average species density. Species diversity and richness were calculated as the number of species, per the proportion of individuals, to a log base within the same vegetation associations. (Kent and Coker, 1992)

RESULTS

Species Density-Disturbed Sites.

- The plant species with the highest average density across all disturbances of the four vegetation associations was *Chrysothamnus teretifolia* (CHTE). CHTE contributed over 30% of the total density of all dominant species (Figure 2).

- The next four species with the highest average density in disturbed plots were two forbs: *Stephanomeria pauciflora* (STPA), *Eriogonum inflatum* (ERIN) and two shrubs: *Ambrosia dumosa* (AMDU), and *Gutierrezia sarothrae* (GUSA). These species each made up approximately 8% of the total species density. The remaining species comprised less than 5% each of the total species (Figure 2).

Species Density-Undisturbed Sites.

- In contrast to the disturbed habitats, CHTE contributed only 1% of the relative density on undisturbed sites (Figure 3).

- The species with the highest density in undisturbed sites of the four vegetation associations was AMDU comprising 27% of the total number of species (Figure 3).

- Two other species with high densities from undisturbed sites were:

Ephedra nevadensis (EPNE) and *Krameria parvifolia* (KRPA), which made up approximately 9 and 8% of the total number of species within the four vegetation associations in undisturbed habitats, respectively (Figure 3).

- Only three of the ten highest density species in the disturbance plots were also found in the ten highest density species of the undisturbed plots. These species were: AMDU, *Erioneuron pulchellum* (ERPU) and *Sphaeralcea ambigua* (SPAM) (Figures 2 and 3).

Common Species-Disturbed Areas

- CHTE contributed a large proportion of the disturbance species in the COL, LG and LLG vegetation associations ranging from 20 - 27% relative density. With the exception of the LA vegetation association, CHTE may be an important secondary successional species (Figure 4).

- AMDU is an important secondary successional species in the LA vegetation association.

- Only AMDU and *Stephanomeria pauciflora* (STPA) are found consistently in all vegetation associations (Figure 4).

- Of the other species that were not common among the four vegetation associations relative densities ranged from 9 - 62%. The low percentage of these other species in the LA habitat (9%) was due to the high relative density of AMDU (78%) (Figure 4).

Species Diversity-Disturbed vs. Undisturbed Habitats

- A comparison of the four vegetation associations shows that species diversity, and richness, of the disturbed and undisturbed LG habitats was greater than the other vegetation associations (Table 1).

- Species diversity and species richness is lowest in both disturbed and undisturbed LA vegetation association. The LLG and COL vegetation associations have comparable species diversity and species richness (Table 1).

Disturbed vs. Undisturbed: *Larrea-Ambrosia*

- In the LA vegetation association, AMDU had the greatest species density in both disturbed and undisturbed sites with 79% and 51% relative density (Figure 5).

- Although STPA and ERIN did not comprise a large component of the undisturbed LA vegetation association they contribute 10% of the relative density on disturbances (Figure 5).

- *Larrea tridentata* (LATR) had similar relative densities between disturbed and undisturbed habitats at 5 and 4% respectively (Figure 5).

- *Acamptopappus shockleyi* (ACSH), LATR, EPNE, and KRPA comprised a large proportion of species in the undisturbed LA vegetation association with a combined relative density of 25%. Although these species had low proportions in disturbed sites, they were present in the disturbed sites (Figure 5).

Disturbed vs. Undisturbed: *Coleogyne*

- CHTE was the dominant species with 36% relative density in the disturbed *Coleogyne* habitats. In undisturbed habitats, CHTE constitutes only 2% of the relative density (Figure 6).

- CHTE, *Chrysothamnus nauseosus* (CHNA), SPAM, *Atriplex canescens* (ATCA), and *Coleogyne ramosissima* (CORA) contributes 67% of the total numbers of species in COL disturbed habitats. In the undisturbed COL plots these same species contribute only 25% relative density, 23% of that density being CORA. It would appear that the successional species on the disturbances in this vegetation association were not the dominant species in the undisturbed plots (Figure 6).

- CORA and AMDU were the dominant species of undisturbed Coleogyne habitats each with 23% relative density. In the disturbed Coleogyne habitats CORA and AMDU were proportionally lower relative densities 5% and 3% respectively. Species reestablishing in disturbed sites on this vegetation association were unlike those of the LA vegetation association where AMDU is a dominant species in both

disturbed and undisturbed sites (Figure 6 and 3).

Disturbed vs. Undisturbed: *Larrea-Lycium-Grayia*

- CHTE had the highest species density in disturbed *Larrea-Lycium-Grayia* habitats with a relative density of 25%. Density surveys on undisturbed sites showed that CHTE was not a significant component in the undisturbed habitat (Figure 7).

- CHTE, ERIN, STPA, AMDU, and *Erioneuron pulchellum* (ERPU) make up 77% of the species composition in LLG disturbances. Each contributes 9 - 25% of the total disturbance density. Of these species, only AMDU was a major component of the undisturbed habitats (Figure 7).

- AMDU represents 18% of the species in undisturbed habitats. AMDU, EPNE, LATR, and *Lycium andersonii* (LYAN) collectively represent 46% of the undisturbed species. EPNE, LATR and LYAN were present within the disturbed habitats but in very low density (Figure 7).

- *Hymenoclea salsola* (HYSA) was equal in relative density in both disturbed and undisturbed LLG habitats at 4%. This may have obtained an equilibrium with that of other species present in both disturbed and undisturbed areas (Figure 7).

Disturbed vs. Undisturbed: *Lycium-Grayia*

- CHTE was the dominant species of disturbed LG habitats with a relative density of 34%, and a relative density of only 2% in the undisturbed LG habitats (Figure 8).

- CHTE, GUSA, *Atriplex confertifolia* (ATCO), CHNA, and STPA contribute 67% of the relative density of disturbed LG habitats (Figure 8).

- The dominant species of the undisturbed LG habitat EPNE, represents 11% of the relative density. The major species of the undisturbed LG habitat (EPNE, *Stipa speciosa* (STSP), SPAM, ERPU, *Eriogonum fasciculatum* (ERFA) and *Haplopappus cooperii* (HACO)) comprised

53% of the relative density. These same species provided only 10% of the relative density in the disturbed LG habitat (Figure 8).

CONCLUSION

The species with higher densities in disturbed vegetation associations were: CHTE, STPA, AMDU, GUSA, ERIN, ATCO, and CHNA respectively. Except for AMDU, these species were present at low densities, within undisturbed sites. AMDU was a contributing species for both disturbed and undisturbed habitats at 8% and 27% respectively. From a succession perspective, AMDU may be best suited for reestablishment on disturbances located in the LA vegetation association.

Although CHTE comprises 32% of the disturbance species it is not significant in the undisturbed habitats at 1%. CHTE was a dominant species in the disturbances in all vegetation associations except the LA. CHTE may be best suited to reestablish on disturbances of the other vegetation associations, however the LLG association had two other species, ERIN and STPA, which also had high densities. In the disturbed LG vegetation association two other contributing species were present in relatively high densities GUSA and ATCO. Although they appear in low densities in the undisturbed habitats they are part of the composition of the LG vegetation association. Within the disturbed COL habitat CHNA and SPAM each contributed 10% of the species density. However, they do not contribute to the undisturbed COL vegetation association and may be valuable as short-term soil stabilizing species.

The success of CHTE on the disturbed sites may suggest that this species would be an excellent choice for reclaiming disturbed areas within the three vegetation associations. This species may act to stabilize soils on disturbed areas and allow other species to become established. The high density of AMDU on disturbed sites and its part as a major component of the undisturbed sites suggests its use as a reclamation species. The other species that did reestablish best on disturbances were quite often not the species that had the highest densities in the undisturbed plots. Many major species found in the undisturbed sites of each of the vegetation associations are present in low densities in the disturbed sites. Although their numbers were generally low, the presence of these species may indicate that these disturbed sites are eventually returning to the form and productivity of the undisturbed habitat.

	UNDISTURBED	DISTURBED
COLEOGYNE		
SHANNON DIVERSITY INDEX	2.38	2.44
SHANNON EVENESS	0.63	0.71
SHANNON SPECIES RICHNESS	43	31
LARREA-AMBROSIA		
SHANNON DIVERSITY INDEX	1.81	0.92
SHANNON EVENESS	0.51	0.37
SHANNON SPECIES RICHNESS	35	12
LYCIUM-GRAYIA		
SHANNON DIVERSITY INDEX	2.98	2.51
SHANNON EVENESS	0.74	0.66
SHANNON SPECIES RICHNESS	56	44
LARREA-LYCIUM-GRAYIA		
SHANNON DIVERSITY INDEX	2.48	2.36
SHANNON EVENESS	0.67	0.68
SHANNON SPECIES RICHNESS	40	33

Table 1.

PLANT SPECIES OF DISTURBANCE STUDY

4-LETTER CODE	SPECIES
ACSH	*Acamptopappus shockleyi*
AMDU	*Ambrosia dumosa*
ARPU	*Aristida purpurea*
ARTR	*Artemisia tridentata*
ATCA	*Atriplex canescens*
ATCO	*Atriplex confertifolia*
BRWA	*Brickellia watsonii*
CELA	*Ceratoides lanata*
CHNA	*Chrysothamnus nauseosus*
CHPA	*Chrysothamnus paniculatus*
CHTE	*Chrysothamnus teretifolia*
CHVI	*Chrysothamnus viscidiflorus*
CORA	*Coleogyne ramosissima*
ENVI	*Encilia virginensis*
EPNE	*Ephedra nevadensis*
ERFA	*Eriogonun fasciculatum*
ERIN	*Eriogonum inflatum*
ERPU	*Erioneuron pulchellum*
EUAL	*Euphorbia albamarginata*
GUSA	*Gutierrizia sarothrae*
HACO	*Haplopappus cooperii*
HALI	*Haplopappus linearifolius*
HIJA	*Hilaria jamesii*
HYSA	*Hymenoclea salsola*
KRPA	*Krameria parvifolia*
LATR	*Larrea tridentata*
LYAN	*Lycium andersonii*
LYPA	*Lycium pallidum*
MATO	*Machaeranthera tortifolia*
MESP	*Menodora spiniscens*
ORHY	*Oryzopsis hymenoides*
SIJU	*Sitanion jubatum*
SPAM	*Sphaeralcea ambigua*
STPA	*Stephanomeria pauciflora*
STSP	*Stipa speciosa*

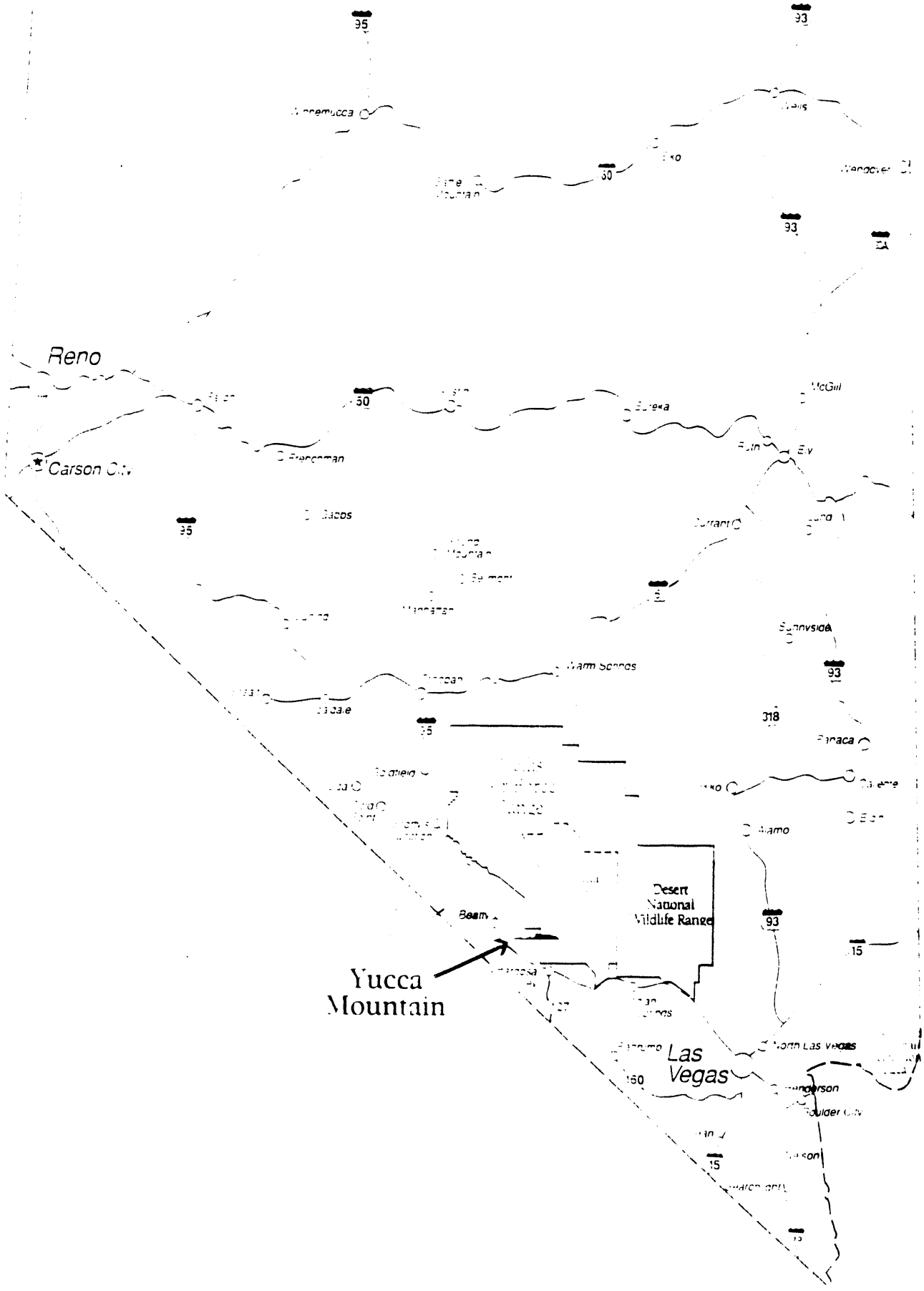


Figure 1. Location of Yucca Mountain, Nevada.

PLANT DENSITY IN DISTURBED SITES IN FOUR VEGETATION ASSOCIATIONS

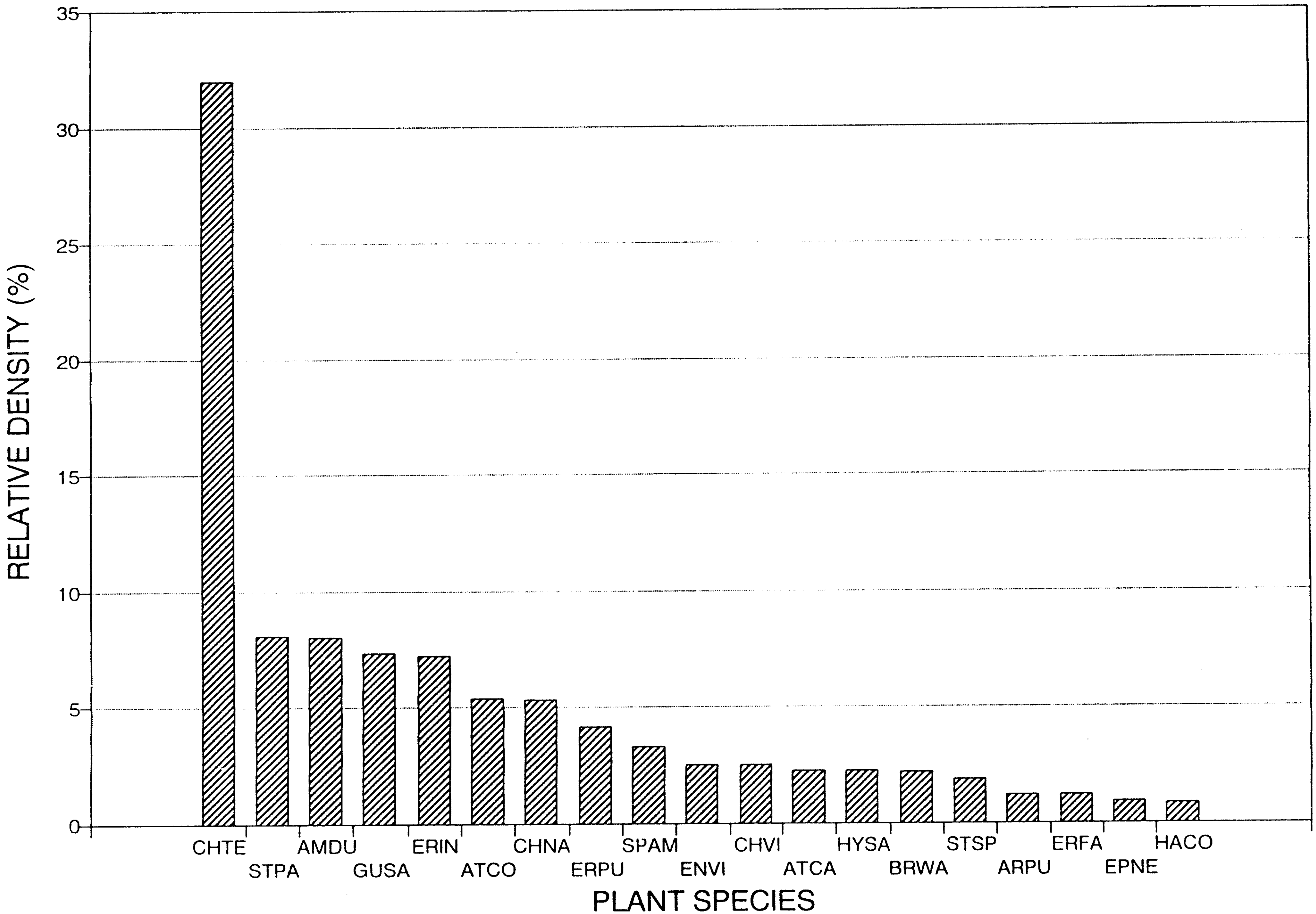


Figure 2.

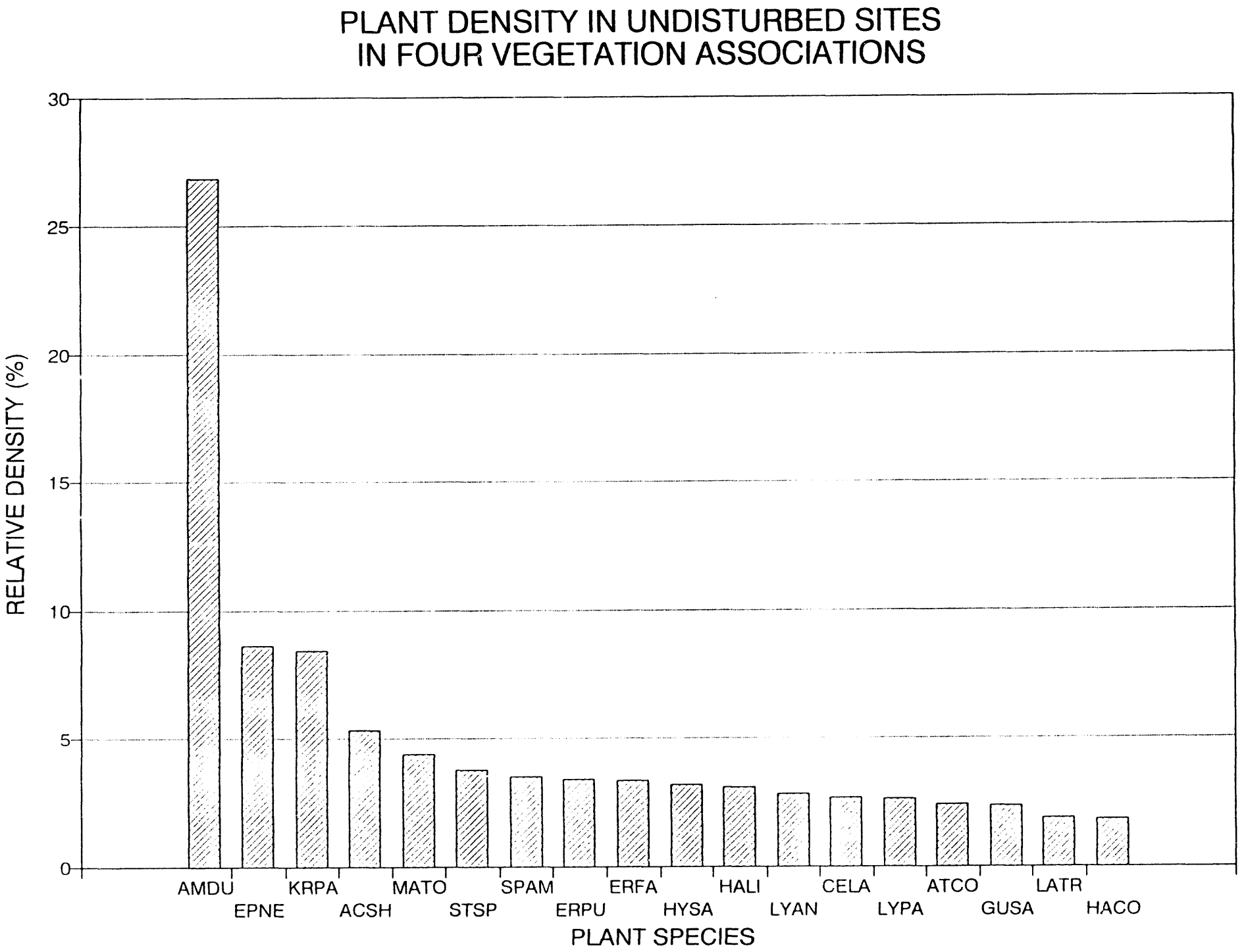

PLANT DENSITY IN UNDISTURBED SITES
IN FOUR VEGETATION ASSOCIATIONS
RELATIVE DENSITY (%)
30
25
20
15
10
5
0
AMDU
EPNE
KRPA
ACSH
MATO
STSP
SPAM
ERPU
ERFA
HYSA
HALI
LYAN
CELA
LYPA
ATCO
GUSA
LATR
HACO
PLANT SPECIES

Figure 3.

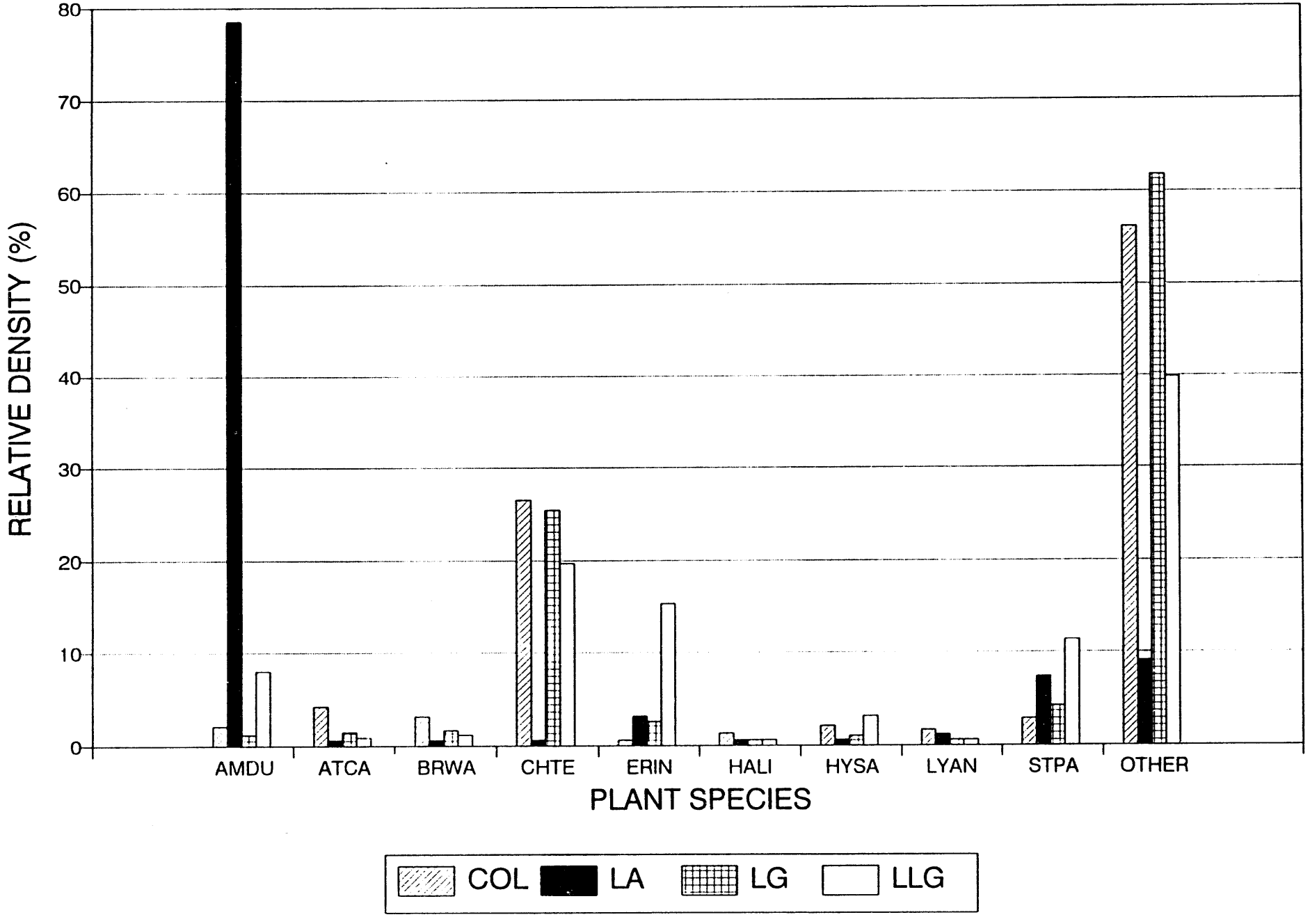

COMMON SPECIES FOUND IN DISTURBED
HABITATS OF 4 VEGETATION ASSOCIATIONS
RELATIVE DENSITY (%)
80
70
60
50
40
30
20
10
0
AMDU
ATCA
BRWA
CHTE
ERIN
HALI
HYSA
LYAN
STPA
OTHER
PLANT SPECIES
COL
LA
LG
LLG

Figure 4.

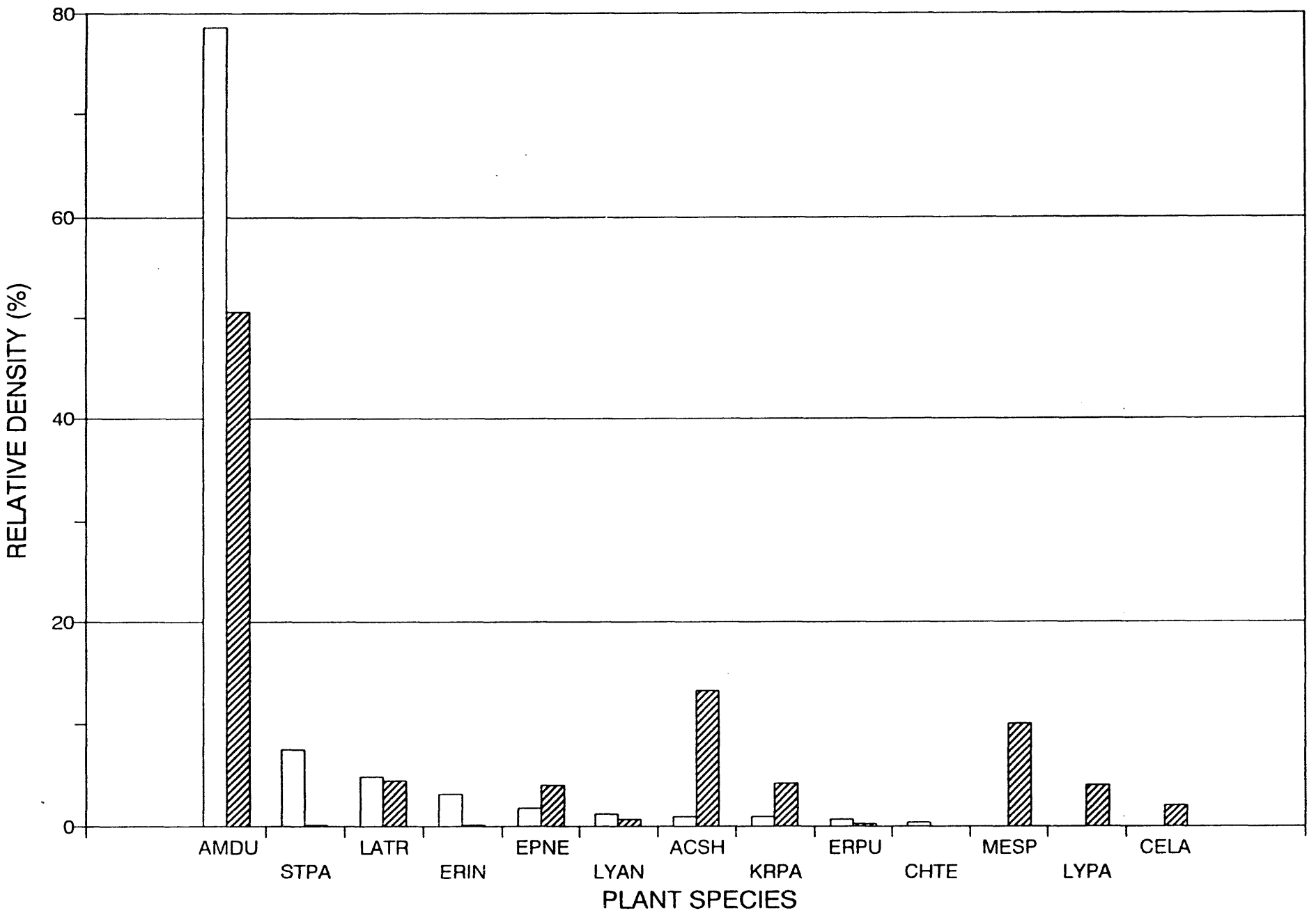

DOMINANT SPECIES OF
LARREA-AMBROSIA HABITATS
RELATIVE DENSITY (%)
80
60
40
20
0
AMDU
STPA
LATR
ERIN
EPNE
LYAN
ACSH
KRPA
ERPU
CHTE
MESP
LYPA
CELA
PLANT SPECIES

Figure 5.

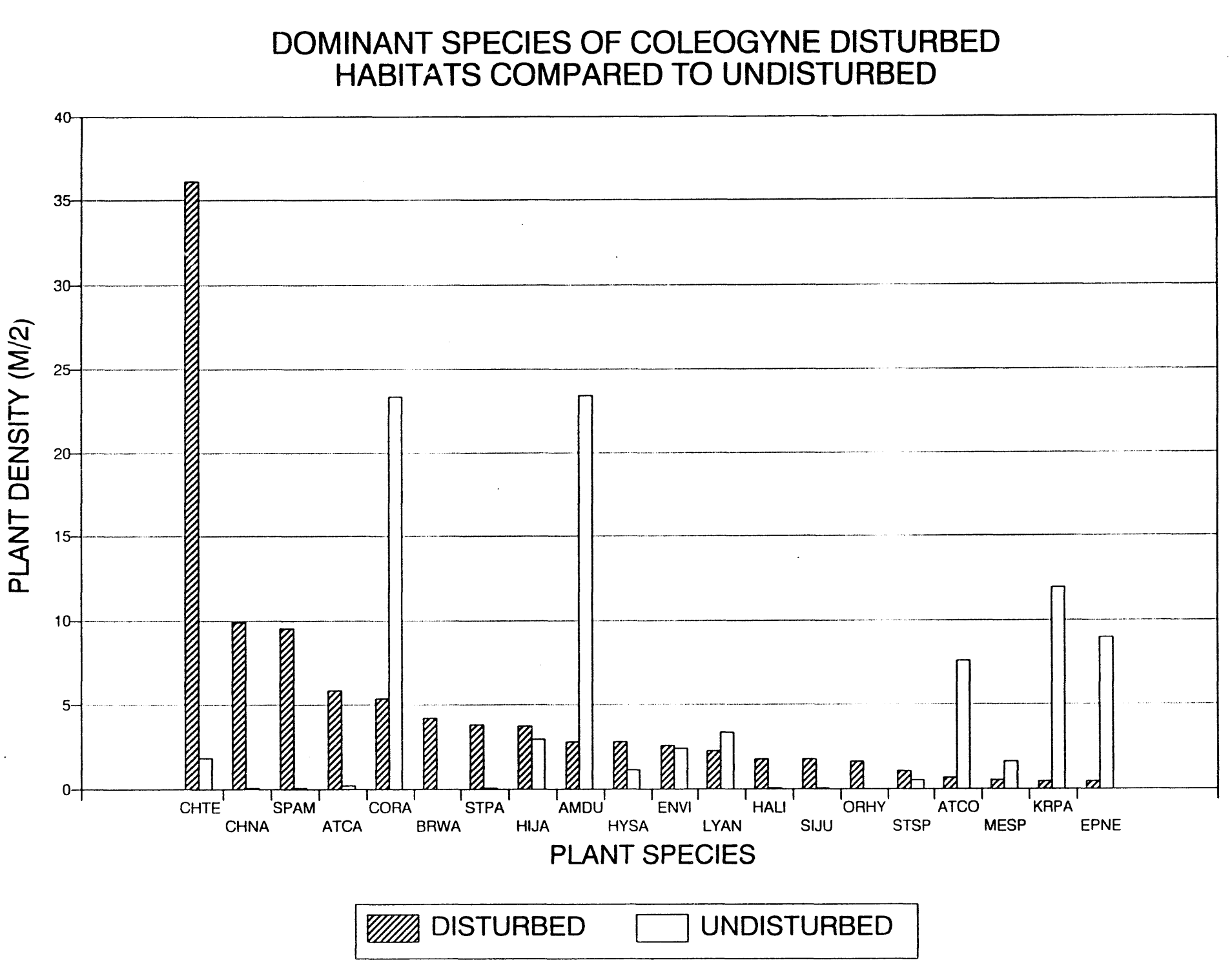

DOMINANT SPECIES OF COLEOGYNE DISTURBED HABITATS COMPARED TO UNDISTURBED
PLANT DENSITY (M/2)
40
35
30
25
20
15
10
5
0
CHTE
CHNA
SPAM
ATCA
CORA
BRWA
STPA
HIJA
AMDU
HYSA
ENVI
LYAN
HALI
SIJU
ORHY
STSP
ATCO
MESP
KRPA
EPNE
PLANT SPECIES
DISTURBED
UNDISTURBED

Figure 6.

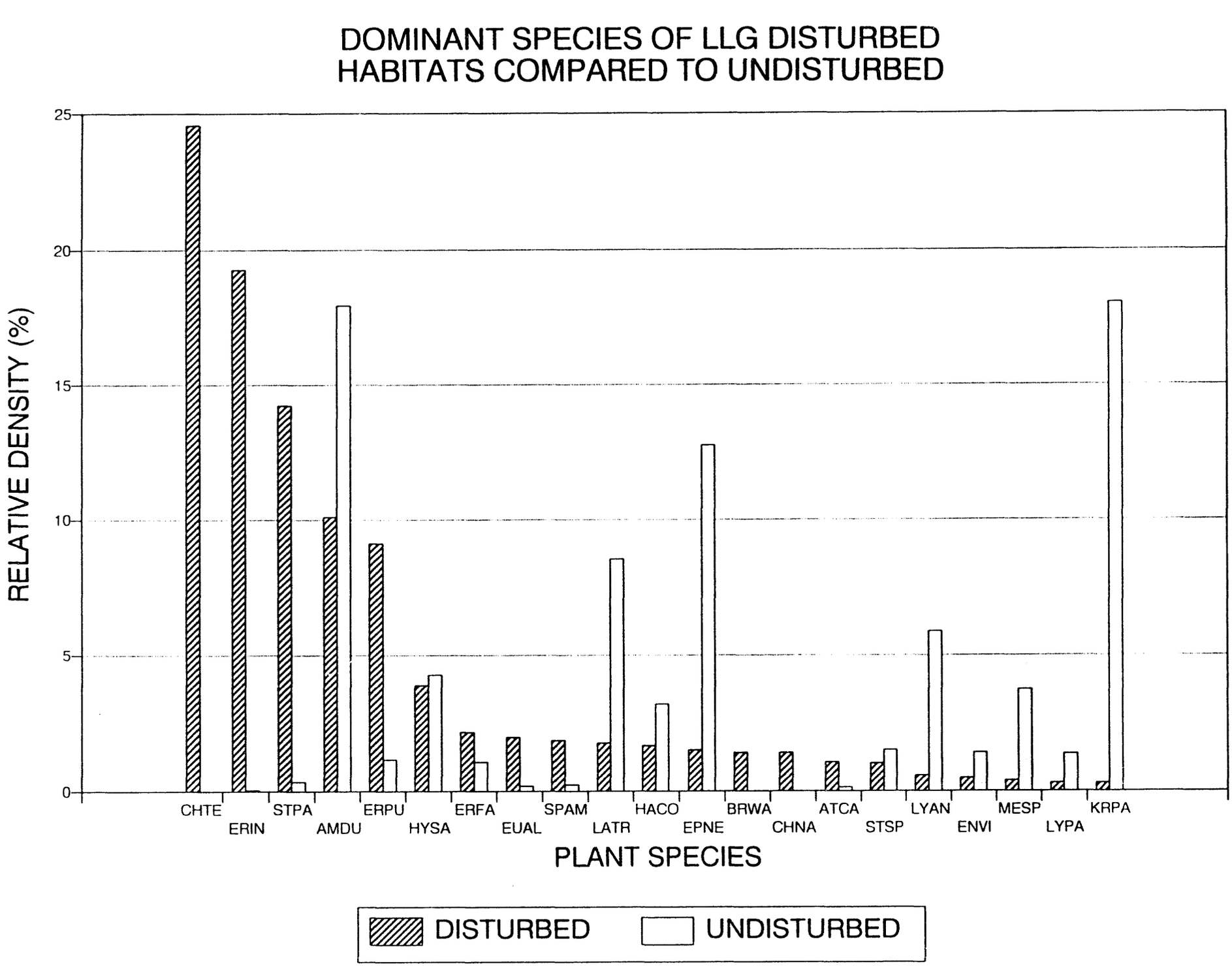

DOMINANT SPECIES OF LLG DISTURBED HABITATS COMPARED TO UNDISTURBED
RELATIVE DENSITY (%)
25
20
15
10
5
0
CHTE
ERIN
STPA
AMDU
ERPU
HYSA
ERFA
EUAL
SPAM
LATR
HACO
EPNE
BRWA
CHNA
ATCA
STSP
LYAN
ENVI
MESP
LYPA
KRPA
PLANT SPECIES
DISTURBED
UNDISTURBED

Figure 7.

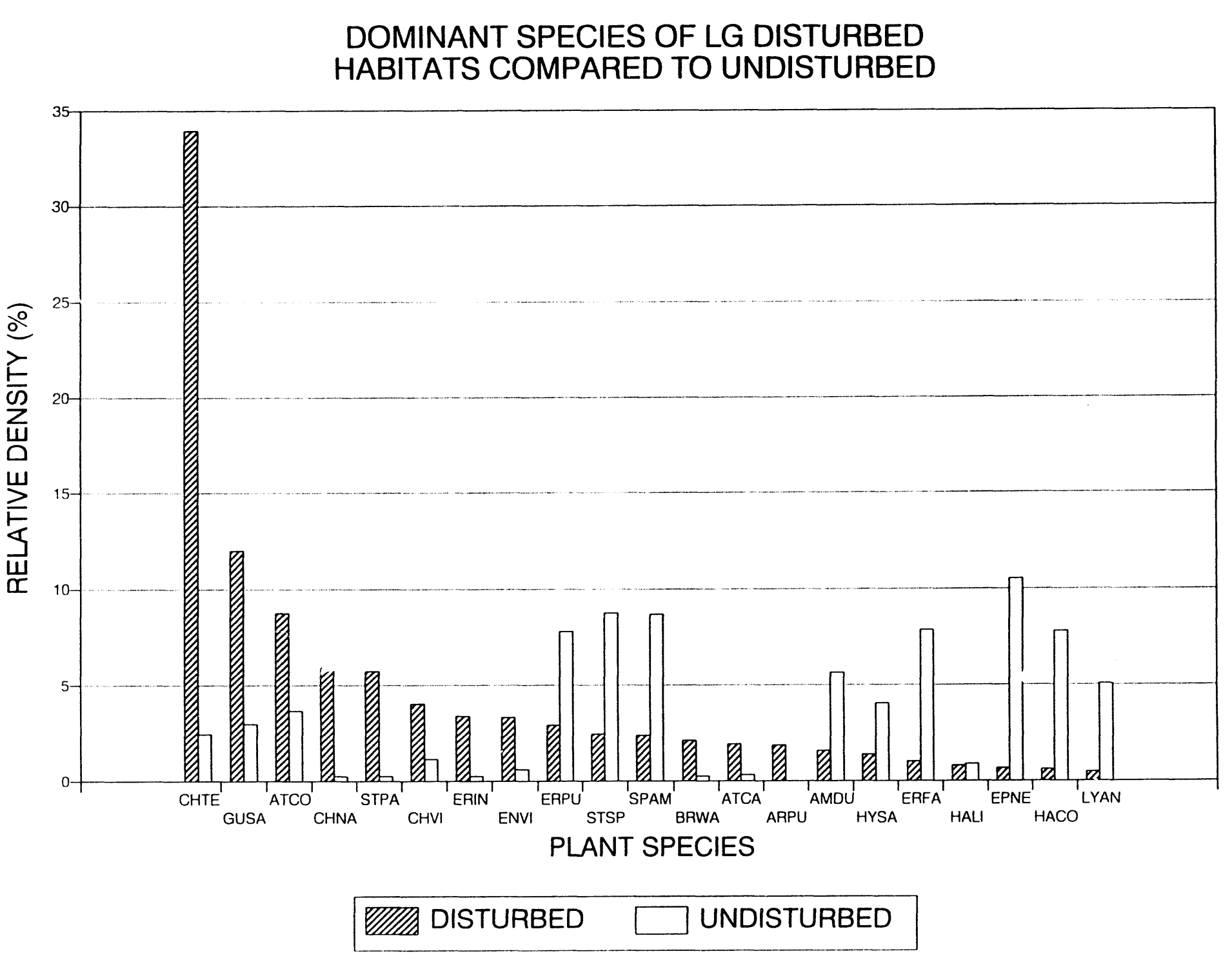
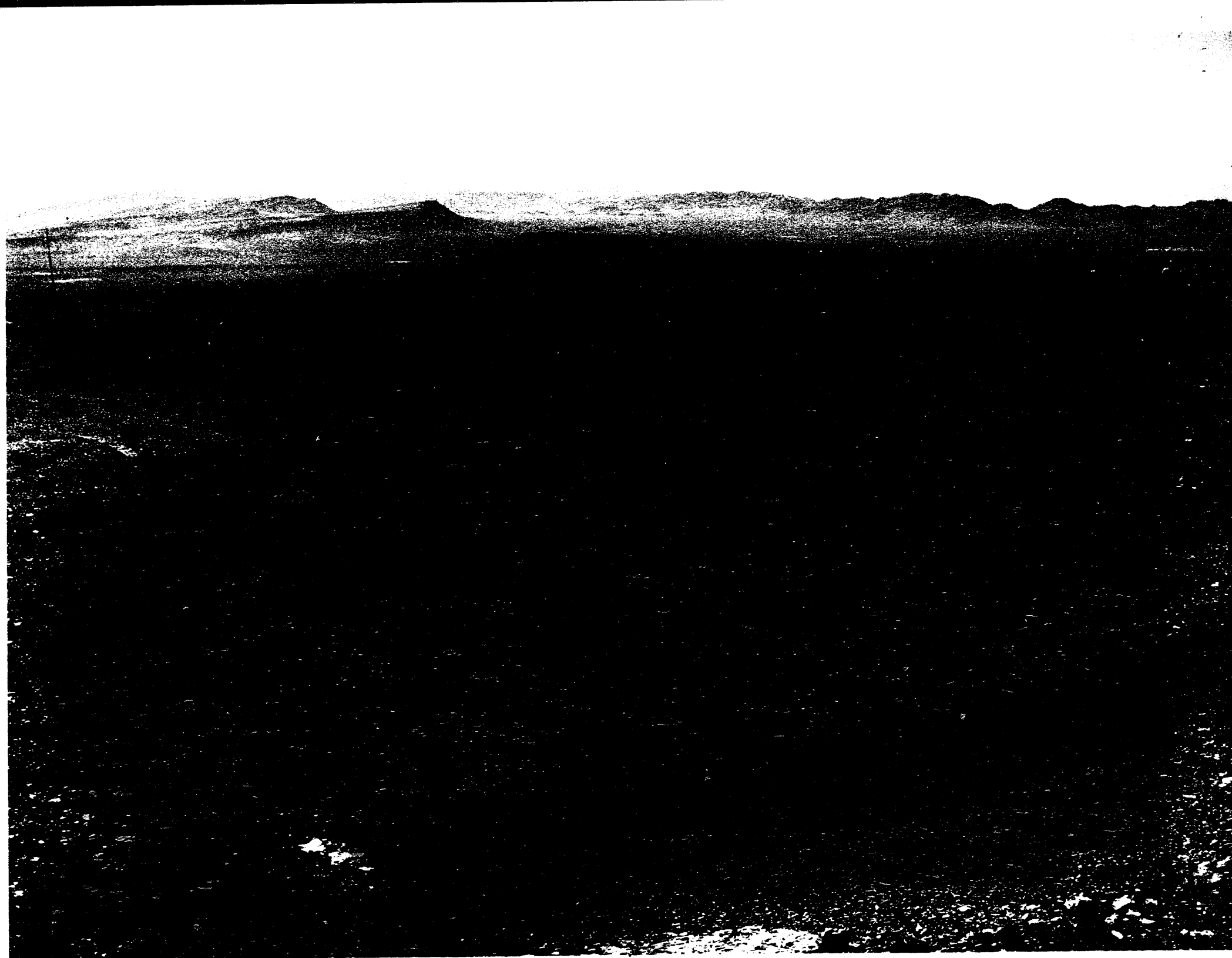
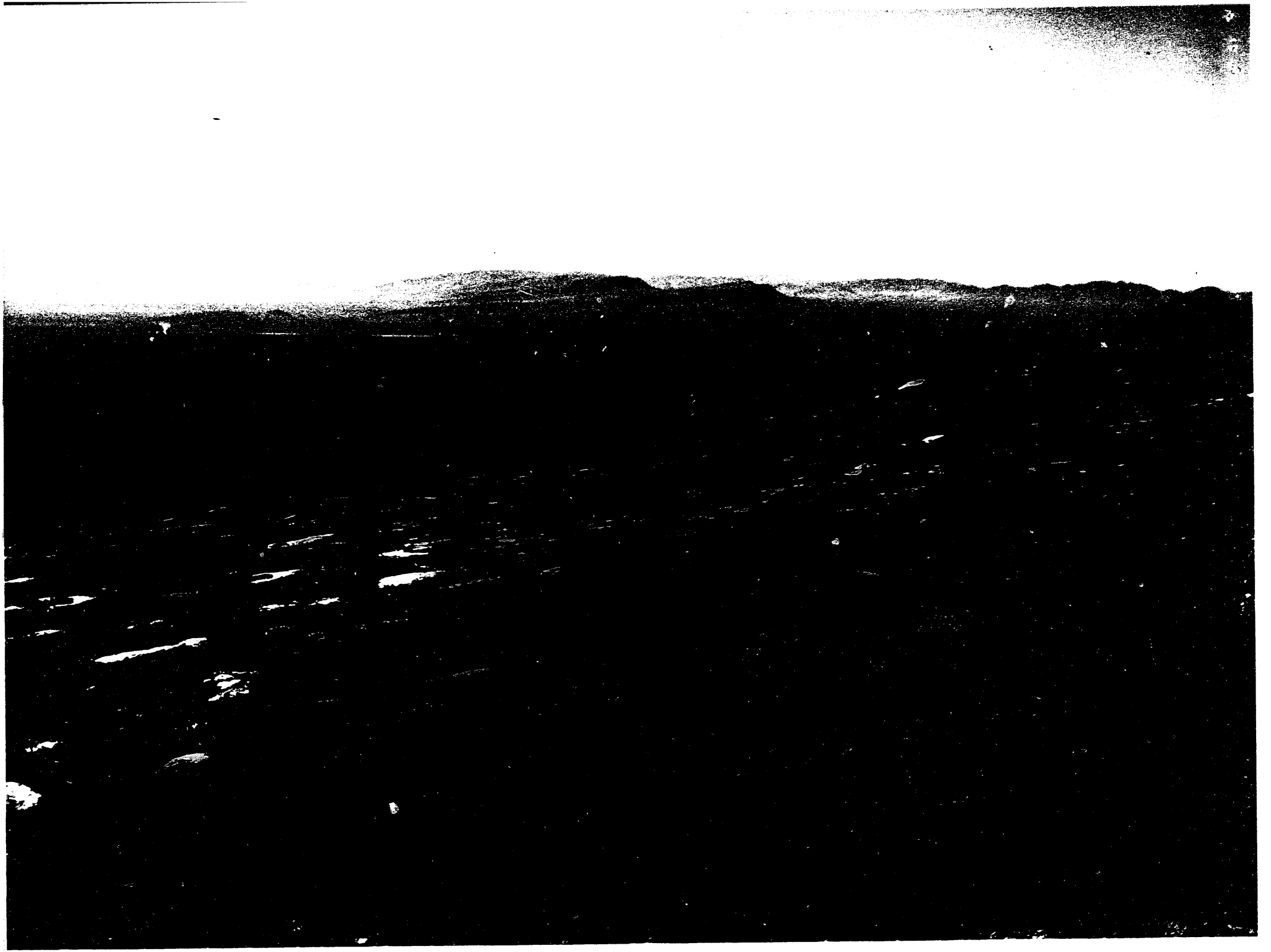
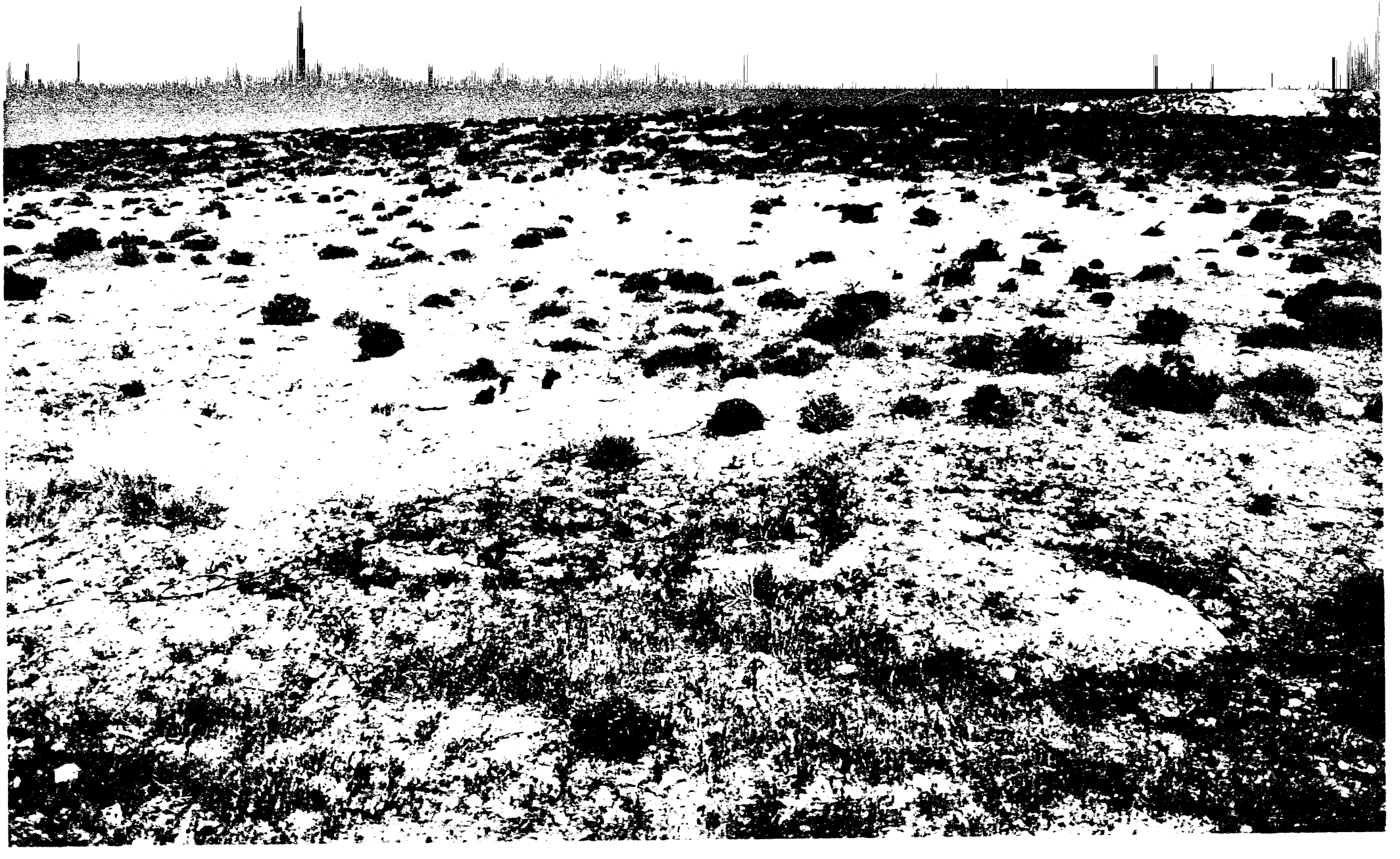

DOMINANT SPECIES OF LG DISTURBED HABITATS COMPARED TO UNDISTURBED
RELATIVE DENSITY (%)
35
30
25
20
15
10
5
0
CHTE
GUSA
ATCO
CHNA
STPA
CHVI
ERIN
ENVI
ERPU
STSP
SPAM
BRWA
ATCA
ARPU
AMDU
HYSA
ERFA
HALI
EPNE
HACO
LYAN
PLANT SPECIES
DISTURBED
UNDISTURBED

Figure 8.







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