NOTES ON VEGETATION OF DESERT SLOPES OF THE EASTERN MOJAVE *

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An investigator will search in vain through available literature for detailed descriptions of plant communities and for quantitative data on plant cover in the eastern Mojave Desert. Descriptive data from published sources may be summarized as follows: (1) a widespread distribution of the creosote bush-burroweed association dominating low-lying sloping plains and rolling surfaces to an elevation of 3,700 feet; (2) dominance of black bush or occasionally black bush and hop sage from 3,700 to 4, 000 feet, and (3) general increase in numbers of species, plant cover, and plant heights with increases in elevation.

For those with little more than the spring-flower interest in the vegetation of desert areas, the description given above may suffice, but for those interested in comparisons of desert areas, quantitative expressions of plant communities are desirable. What differences in numbers of species and in plant cover occur with differences in elevation? What variations in dominance of species and in associated species develop with increasing elevations? Plant manuals contain generalized data on the gross distributions of species but provide no quantitative data. It will be a long time before sufficient vegetative and other habitat data are available for a thorough understanding of variations in desert environments.

The purpose of this report is to provide some fragmentary data both on numbers and relative abundance of perennial species and on measurements of foliage area and complete cover of vegetation along two series of sample plots in the eastern Mojave Desert.

FIELD RESEARCH AND TREATMENT OF DATA

In order to make an appraisal of quantitative changes in vegetation with increases in elevation, two series of plots spaced at intervals of 200 feet in elevation were measured in detail. Each of a total of twenty-eight plots contained 1,000 square feet. Locations of these plots are shown in Figure 1.

A series of eleven plots along the route from Essex, California, to the base of the Providence Mountains (Figure 1), referred to hereafter as the Essex series, extended from 2,100 to 4,100 feet in elevation. The lowest plot was located about one mile northwest of Essex, and the series extended about twenty-one miles northwestward to Mitchell Caverns State Park. All plots were on alluvial fan materials, which differed from plot to plot in texture, lithologic composition, and current effects of gradational forces. In all plots exposures were either south or southeast. Below 3,500 feet the slopes of all plots were 5 per cent or less; at and above 3,500 feet, ranged from 15 to 19 per cent.

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In the Bristol Dry Lakes-Granite Mountains series of seventeen plots (Figure 1), hereafter referred to as the Bristol series, the lowest plot at 700 feet was located five and one-half miles east of Amboy. The series extended north-northwest for fourteen miles between the Bristol and Marble mountains and thence north-northeast about six miles to the base of Granite Mountains at an elevation of 3,900 feet. Exposures along the north-northeast leg were south-facing and those along the lower leg were either south or southeast-facing. Plots below 2,700 feet were developed on deep alluvial materials washed from the Granite, Old Dad, Bristol,

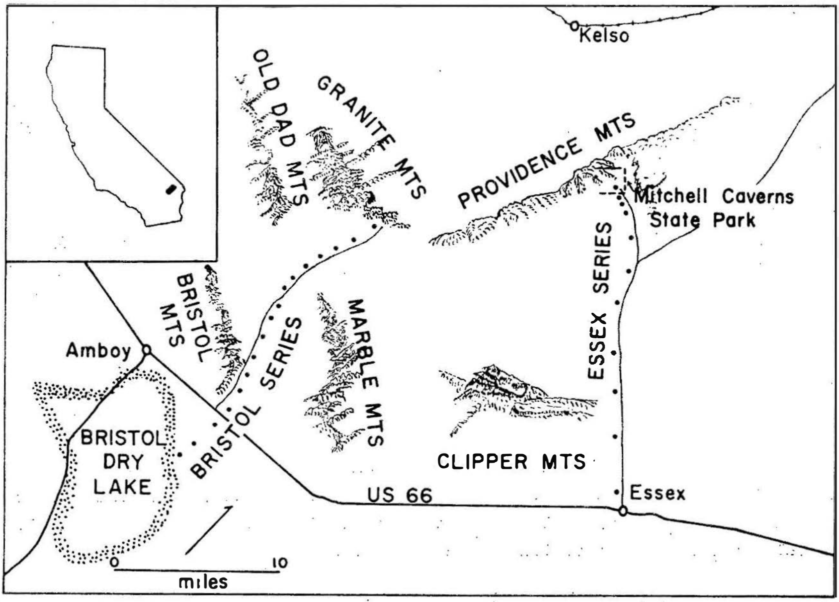

FIG. I. LOCATION OF THE BRISTOL AND ESSEX SERIES.
Positions of plots indicated by large dots.

and Marble mountains. The surfaces of the four highest plots were within a few feet of bedrock. The gradients, ranging from 3 to 7 per cent, were more uniform than those of the Essex series.

The intervals of two hundred feet in elevation were determined in the fields by means of an altimeter and an automobile odometer. Immediately after the altimeter had been set at the nearest point of known elevation, the route of a series was traversed as rapidly as possible by automobile, and odometer readings were recorded for each change of two hundred feet noted on the altimeter. Rapid traverse of the route made possible the location of desired altitudinal levels in such a short period of time that changes in atmosphere pressure from one station point to another were negligible.

Within each plot of 1,000 square feet, each perennial plant species was identified, and its foliage area and complete cover were determined.

Foliage area is defined as the area covered planimetrically by connecting visually the terminal points of branches and leaves of a plant. *Complete cover* is the term used for the area covered—not just outlined—by the stems, branches, and leaves of a plant.

Foliage areas were determined in the field by means of listing rulers and linear scales. A listing ruler was used if plants were nearly circular in outline or if they could be broken visually into two or more component circles. A number of desert shrubs, growing singly and hence not hampered by growth of other shrubs, are nearly circular in planimetric outline. So are many clumps of bunch grass. To determine approximately the foliage area of somewhat circular plants, a listing ruler was used by which one measured the diameter of a plant, but instead of reading a linear measurement from the ruler, one read instead the area of a circle having the same diameter as that of the plant which he had measured. In a few instances foliage areas were determined by approximating the rectangular area which a plant might cover, in which case the foliage area was the product of two linear measurements.

Foliage area may be used as a rough measure of vegetation cover of an area, but when the two dominants of the creosote bush-burroweed association are compared, it is apparent that another measurement, complete cover, is needed. For example, creosote bush with its widely flaring, sparsely branched stems bearing a few small leaves often covers much less than 10 per cent of its foliage area. On the other hand, burroweed, scarcely 15 inches in height, forms a dense cluster of leaves and branches, frequently covering 70 to 90 per cent and occasionally 100 per cent of its foliage area.

Complete cover was determined from the measurements of foilage area by estimating the percentage of foliage area actually covered planimetrically by vegetation, and then multiplying the foilage area by the estimated percentage. Thus, for a creosote bush with a foliage area of ten square feet and an estimated cover of 20 per cent, a figure of two square feet was recorded for complete cover.

Data for foliage area and complete cover recorded in Figure 3 and Figure 4 and stated elsewhere in this report are expressed as percentages of the total area of each plot. Although admittedly a statement that the foliage area of a species is 10 per cent is audibly somewhat awkward, percentage comparisons are usually readily comprehended, and several steps in mathematical computation are eliminated for considering data for comparative purposes. For example, if the data for burroweed in a plot were: foliage area 7.9 per cent and complete cover 6.4 per cent, the reader immediately has the general impression that far less than one-tenth of the area measured was required for the foliage area or complete cover of burroweed, or if interested in more specific impressions, he may easily determine that the foilage area measurements for burroweed in a 1,000-square-foot plot totaled seventy-nine square feet and that the total computed complete cover was sixty-four square feet.

In the vicinity of each 200-foot point along the routes a representative sample plot was selected after an area of two to three acres had been surveyed, and component species, approximate foliage areas, and estimated complete cover had been noted. Areas of active stream erosion and of desert pavement were avoided in the selections of sites of plots.

The selection of a sampling area of 1,000 square feet appears to be defensible on the basis of species-area curves and similar curves for foliage area and complete cover which were prepared for the areas of investigation. In communities with no more than five perennial species, plots of 300 to 400 square feet were large enough to provide satisfactory coverage from

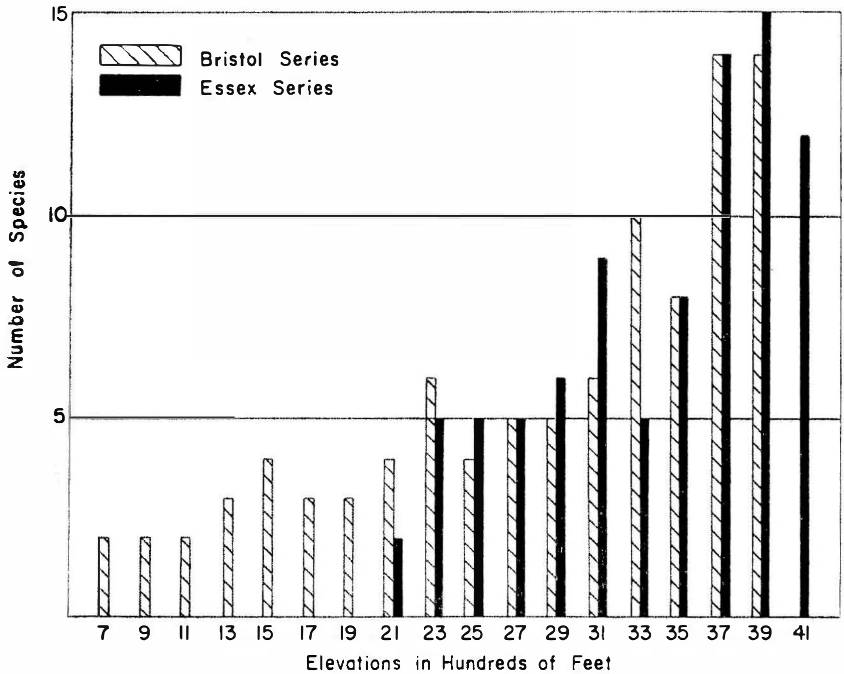

FIG. 2. PERENNIAL SPECIES PER PLOT OF 1000 SQUARE FEET AT VERTICAL INTERVALS OF 200 FEET IN THE BRISTOL AND ESSEX SERIES

the standpoint of component species, and areas of 600 to 700 square feet were sufficient for communities with ten or more perennial species. Similar curves in which foliage area and complete cover were plotted against the size of plot-areas indicated that changes of less than 10 per cent in any of the measurements would be obtained for any increase of 10 per cent in plot-area of plots larger than 700 square feet.

There is no defense for the arbitrary selection of only one plot of 1,000 square feet at each altitudinal interval. The decision was based on time and expediency. However, measurements obtained for this report compare favorably with those of a more extensive study in the Providence Mountains area in which several plots of 2,500 square feet were mapped in each of the two associations reported herein.

Numbers of Species

Both sets of bars in Figure 2 show a fluctuation in numbers of perennial species with increasing elevation but indicate an overall increase from two at the lowest station in each series to fourteen in the highest plot in the Bristol series and to fifteen at 3,900 feet in the Essex series. From 2,100 to 2,300 feet in elevation in the Essex series there was a marked increase in perennial species from two to five, and in the Bristol series the number of perennials increased from four to six at corresponding elevations but fluctuated from four to six through the plot at 2,900 feet. An increase from six to nine perennials was recorded between elevations of 2,900 and 3,100 feet in the Essex series, along with an increase from six to ten in the 3,100 to 3,300 interval in the Bristol series. Numbers decreased slightly at the 3,500-foot plot but a marked increase from eight to fourteen perennial species occurred in both series between 3,500 and 3,700 feet.

Plant Composition

An association of creosote bush (*Larrea divaricata*) and burroweed (*Franseria dumosa*) dominated the lower portions of the Essex series to 3,500 feet and the Bristol series to 3,700 feet. The only species of areal importance below 2,300 feet in both series were the dominants of the association. At 2,300 feet in both series other species became areally significant, chiefly galleta grass (*Hilaria rigida*) in the Essex series and Nevada ephedra (*Ephedra nevadensis*), desert cassia (*Cassia armata*), and desert thorn (*Lycium fermontii*) in the Bristol series.

In both series an association of perennial buckwheat became dominant immediately above the creosote bush-burroweed association. Within the elevations considered in this study, the dominant buckwheat species was *Eriogonum polifolium.* At 3,100 feet in each series, perennial buckwheat was insignificant, but at 3,500 in the Essex series and at 3,700 in the Bristol series, buckwheat had become a dominant of the association. The dominance of buckwheat extended several hundred feet above the upper limits of this study, with dominance shifting to other buckwheat species, chiefly *Eriogonum heermannii, E. wrightii,* and *E. umbellatum.* Buckwheat seldom occurred as a single dominant but was usually associated with one or several co-dominant species.

Mojave yucca (*Yucca schidigera*=*Yucca mohavensis*), although seldom covering more than 2 per cent of the desert area, is a conspicuous element of the high areas of the Mojave Desert. Yucca appears above 3,700 feet in the Bristol series and above 3,500 feet in the Essex series.

Contrary to the opinion of laymen that our deserts are profusely covered with numerous species of cacti, the Bristol series with no areas of conspicuous development of cactus is representative of hundreds of square miles of the Mojave Desert. The highest measurement of cactus in the series was 0.8 per cent foliage area at 3,900 feet. The low measurements for cacti in the area may be attributed in part to repeated grazing in the area because of proximity to watering places. Also in times of depleted ranges, ranchers often burn the needles from cacti after which the remaining stems are eaten by hungry cattle. Young cacti are also subject to damage by trampling.

On the other hand, plots above 3,500 feet in the Essex series contain some of the richest developments of cacti to be found in the Mojave Desert. The predominant species are deerhorn cholla (*Opuntia acanthocarpa*), Engelmann cereus (*Cereus engelmannii*), and barrel cactus (*Echinocactus acanthodes*). Locally these may form from 10 to 30 per cent of the total foliage cover. Actual measurements of foliage area varied from

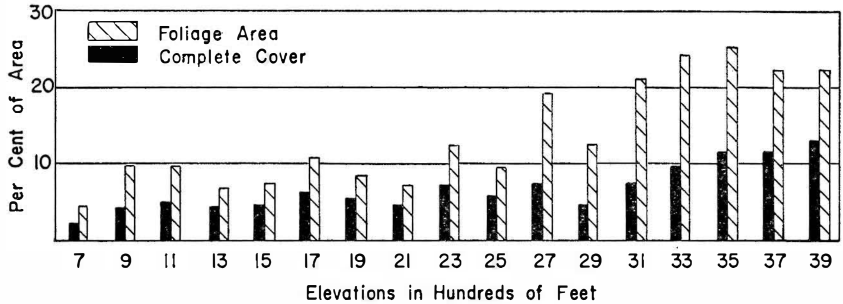

FIG. 3. FOLIAGE AREA AND COMPLETE COVER IN THE BRISTOL SERIES

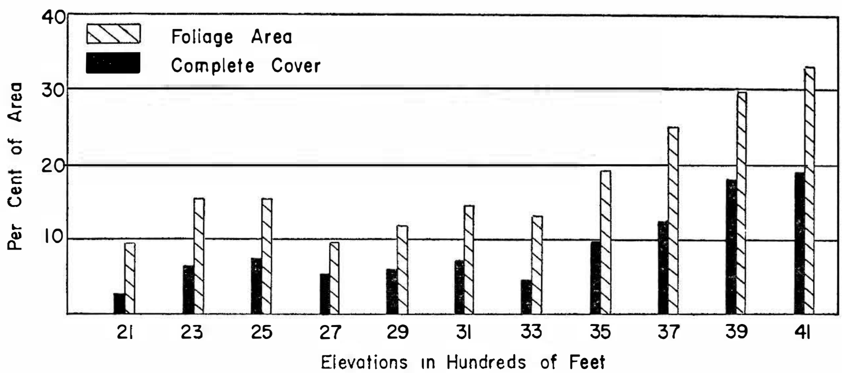

FIG. 4. FOLIAGE AREA AND COMPLETE COVER IN THE ESSEX SERIES

2.4 to 9.1 per cent in plots above 3,500 feet in the Essex series. The plots of this series also are occasionally grazed, but being far from watering places, the grazing pressure is far less than that in the highest plots of the Bristol series.

Foliage Area

Results of measurements of foliage in each of the plots in both series are shown graphically in Figure 3 and Figure 4.

A gross indication of differences in percentage of foliage area developing with differences in elevation may be indicated by comparing two groups of plots in each series: the three plots at lowest elevations and the three plots at highest elevations. In the Bristol series there was an increase of 291 per cent from the lowest to the highest group. The corresponding increase in the Essex series was 218 per cent.

With minor exceptions in both series, the foliage areas in plots below 2,900 feet was 7 to 9 per cent of each plot. Foliage areas of most of the stations above 2,500 feet or above were 12 per cent or more.

Measurements of foliage areas in both series reflect the increase in numbers of perennial species above 2,300 feet (Figure 2). Below 2,300 feet, creosote bush and burroweed formed 91 per cent of the total vegetation in the Bristol series and 100 per cent in the Essex series. At 2,300 feet these two species comprised no more than 54 per cent of the total perennial vegetation in either series.

Although nothing significant appeared at 3,100 feet in the Essex series, all plots at or above 3,100 feet in the Bristol series yielded foliage areas of 20 per cent or more, almost twice the measurements of most of the lower stations, in spite of the relatively high frequency of grazing at elevations above 3,000 feet in the Granite Mountains area.

A significant increase from 19.4 to 25.4 per cent in foliage area occurred in the Essex series between 3,500 and 3,700 feet. All other plots above 3,700 feet in the Essex series had foliage areas of more than 25 per cent.

Complete Cover

Again comparing the averages of the three highest and the three lowest plots in each series, the increases in complete cover were approximately three-fold: 310 per cent in the Bristol series (Figure 3) and 286 per cent in the Essex series (Figure 4). In the Bristol series the complete cover at 700 feet was only 2.3 per cent, and although there was not always an increase in cover at consecutively higher plots, the percentage of complete cover increased to 12.8 at 3,900 feet with all stations at 3,100 feet or above being markedly higher than those below. In the Essex series there were significant increases in complete cover at 2,300, 3,500, 3,700 and 3,900 feet. The lowest complete cover, 3 per cent, in the Essex series was recorded at 2,100 feet; the highest, 18.6 per cent, at 4,100 feet.

Habitat Data

Practically no meaningful habitat data are available for the areas in which these plots were measured. In the absence of precise environmental data, one may readily suggest that precipitation may be slightly higher on the upper slopes; that snow falls more often and in greater quantities above 3,500 feet than below; that temperatures are slightly lower, evapotranspiration rates less, and soil moisture availability greater on the upper slopes than on the lower, but suppositions do not explain vegetative distributions.

Summary

On the basis of this preliminary survey of the vegetation of a portion of the eastern Mojave Desert, the results may be summarized as follows: (1) A recognizable and statistically defensible association of buckwheat (*Eriogonum polifolium*) occurs on all but the north-facing exposures of fan surfaces above 3,700 feet—not a black bush or black bush and hop sage community as commonly recorded in literature. (2) In the two areas where quantitative measurements were taken, elevations of 2,300, 3,100 and the interval 3,500 to 3,700 feet are significant from the viewpoint of vegetative distribution. Some marked increases in numbers of perennial species were shown for all three levels. Foliage area increased noticeably in both series at 2,300 feet, in the Bristol series at 3,100 feet, in the Essex series at 3,500 and 3,700 feet. In the Essex series pronounced increases in plant cover were recorded at 2,300, 3,500, and 3,700 feet. *Yucca schidigera* was recorded above 3,500 feet in the Essex series and above 3,700 feet in the Bristol series. (3) Since vegetation is in part a response to environment and is presumably an indicator of habitat, the elevations noted above may have some significance for delimiting climate subdivisions of this portion of the Mojave Desert. Most effective utilization of our desert lands in the future requires a full evaluation of all desert plant communities and all desert habitats. In the absence of specific habitat data, a vast array of environment measurements must be accumulated before the true climatic and economic significance of these levels can be ascertained.