A Comparison of Vegetation Structure and Composition in Modified and Natural Chaparral

John A. Rosario

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A COMPARISON OF VEGETATION STRUCTURE AND COMPOSITION
IN MODIFIED AND NATURAL CHAPARRAL

by

John A. Rosario

A Thesis in Partial Fulfillment
of the Requirements for the Degree
Master of Arts in the Field of Biology

October, 1973
Each person whose signature appears below certifies that he has read this thesis and that in his opinion it is adequate in scope and quality as a thesis for the degree of Master of Arts.

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Dedicated to my loving and understanding wife Carolann.
Grateful acknowledgment is made to the committee members for their guidance and suggestions in this study. Special thanks go to Dr. Earl W. Lathrop, whose encouragement pulled me through many difficult periods.

Special thanks go also to the Department of Biology, Loma Linda University, for the use of their field vehicle, which made accessibility to the project area possible.

Several people in the San Bernardino National Forest, U. S. Forest Service, Department of Agriculture, gave helpful suggestions in the original planning of this project and my appreciation is extended to them. Particular thanks go to Mr. Donald Bauer, Forest Supervisor, and Mr. Jerome T. Light, Wildlife Biologist.
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INTRODUCTION

Type conversion of chaparral to grassland has been practiced by the San Bernardino National Forest, California, for the purposes of wildlife habitat improvement, fire control, increased water yields, and improved grazeland, as outlined by the United States Forest Service (1972).

Type conversion of a 12 acre plot of chaparral to grassland in the Mud Flat region of the San Bernardino National Forest, San Gorgonio District, was completed in 1967. The chaparral site was the chamise (Adenostoma fasciculatum H. & A.) chaparral association as described by Cooper (1922), Burcham (1957) and Horton (1960). The general study area is situated 3 miles to the south of Lake Arrowhead and approximately 8 miles northeast of the city of San Bernardino, on the West Fork of City Creek (Figure 1).

The site is on a south facing slope of approximately 5 to 10 per cent at an average elevation of 3300 feet. The soil of the study site is rocky and gravelly over a granitic base material including granodiorite and gneiss with stratification parallel to the land surface (U. S. Forest Service, 1967). According to isohyetal maps provided by the U. S. Forest Service, approximate annual precipitation is 25 inches.
Figure 1. Location map of the Mud Flat region, the San Bernardino National Forest, California.
The conversion was accomplished following standard chaparral conversion techniques for California, as outlined by Bentley (1967) and included the retention of a mosaic pattern of chaparral islands for the purpose of creating maximum "edge effect" and improving scenic quality, as discussed by the U.S. Forest Service (1972).

The chaparral islands retained in the grassland (modified) plot constituted approximately 9 per cent of the total 12 acres and averaged 3800 square feet per island with an average measurement of 96 feet between islands.

Brush removal with a brush rake attached to a D-7 caterpillar, was followed by brush pile burning and discing of the soil surface to aid residual brush decomposition. A mixture of 2 pounds per acre of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2 pounds per acre of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), applied by hand spray, was used in the herbicidal treatment of shrub stumps and burls to control top resprouting. This treatment was last performed in 1969. Replanting of the modified plot was by range land drill seeding a mixture of intermediate wheatgrass \( (Agropyron \text{ intermedium} \text{ (Host)} \text{ Beauv.}) \) and pubescent wheatgrass \( (Agropyron \text{ trichophorum} \text{ (Link)} \text{ Richt.}) \).

The purpose of this paper is to report the results of a comparison of vegetation structure and composition
of the modified plot described above with an adjacent natural (control) chaparral plot of equal area, six years after conversion.

PROCEDURES

Field studies were conducted during the winter and spring months of 1973. A natural chamise chaparral plot was selected for comparison with the modified plot. The site selected was adjacent to the modified plot but at a distance far enough away to be considered out of the zone of influence of the conversion (Figure 2). Other criteria for selection of the control plot included, lack of disturbance in a relatively homogeneous area of mature, reproducing plants, in an established site at approximately the same elevation and exposure as the modified plot. Specimens of all species were collected and identified according to Munz (1965).

The vegetation of the natural chaparral plot was sampled quantitatively with a 100 foot line intercept at 11 randomly spaced sites along a compass line and also by a one-fortieth acre quadrat (100 x 10.9 feet) at each of the line intercepts (Cox, 1972; Wilson and Vogl, 1965). The total number of feet intercepting the line at crown height was recorded for each species, including overlapping species. From this, relative dominance and absolute
Figure 2. The Mud Flat region, San Bernardino National Forest, showing the relationship of the natural plot to the modified plot and to current modification projects.

- Natural chamise chaparral
- Chamise chaparral modified in 1973 project.
- Manzanita chaparral modified in 1973 project.
- Natural chamise chaparral study plot.
- Modified chamise chaparral study plot.
per cent crown cover were calculated.

Each one-fortieth acre quadrat was placed adjacent to one of 10 of the line intercepts. This quadrat was divided into four contiguous sections, each measuring 25 ft. x 10.9 ft. The number of individuals was counted in each quadrat. An individual plant was any plant possessing a trunk or burl distinct from other trunks and burls. Relative density, relative frequency and the density of individuals per acre were calculated from the quadrat data. Values of relative density, relative dominance and relative frequency were totalled to obtain importance values (I.V.) (Wilson and Vogl, 1965; Curtis and McIntosh, 1951).

Additional measurements included elevation, exposure, per cent of slope and lists of ground cover species in the quadrats.

Vegetation characteristics of the modified plot were studied at 10 sites located 100 feet apart, along each of 10 of the transect lines. Each site was sampled by an integrated plot consisting of a 20 foot diameter circular plot superimposed over a 1 x 20 foot belt transect (Nord, 1965). Within the circular plot, which represented a one-one hundred and thirty eighth acre, all shrubs were counted to obtain density per acre.

The basal cover (area) by plant species inside the belt transect was measured by a pocket tape, to ascertain the area taken up by the plant at ground level. The
basal area of the bunch grasses was computed from the average diameters of clumps. The average diameter of stems was used for shrub and forb species (Hutchings and Pase, 1963).

The belt transect was broken into twenty contiguous sections, each 1 x 1 foot. The number of clumps of the two bunch grass species present were counted as an aggregate in each quadrat to determine per cent frequency and density per plot. Likewise, all individuals of the remaining species were counted in each quadrat but were too insignificant in number to be considered further.

RESULTS AND DISCUSSION

Characteristics of the important shrub species in the natural chaparral plot are listed in Tables 1 and 2 and give an indication of the structure and composition of the modified plot before type conversion to grassland.

Density per acre of the important species in the natural chaparral plot is shown in Table 1. Table 2 lists the relative importance of each species in the community and serves as a species present list for the control plot. Chamise is the most important species, receiving the highest values for per cent cover, relative dominance and importance value. Scrub oak (Quercus dumosa Nutt.) is next in importance in the study area. Eastwood manzanita (Arctostaphylos glandulosa Eastw.), quixote plant (Yucca whipplei Torr.) and chaparral
Table 1. Density per acre of the shrub species in modified and natural chamise chaparral plots in the San Bernardino National Forest, California. (The measurements in the modified plot exclude chaparral islands.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Natural plot</th>
<th>Modified plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamise</td>
<td>2800</td>
<td>28</td>
</tr>
<tr>
<td>Deerweed</td>
<td>--</td>
<td>721</td>
</tr>
<tr>
<td>Eastwood Manzanita</td>
<td>484</td>
<td>55</td>
</tr>
<tr>
<td>Hollyleaf Cherry</td>
<td>112</td>
<td>70</td>
</tr>
<tr>
<td>Quixote Plant</td>
<td>348</td>
<td>111</td>
</tr>
<tr>
<td>Scrub Oak</td>
<td>1152</td>
<td>55</td>
</tr>
<tr>
<td>Chaparral Whitethorn</td>
<td>104</td>
<td>--</td>
</tr>
<tr>
<td>Aggregate. Includes:</td>
<td>112</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Sage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black Sage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeysuckle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redberry</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5112</td>
<td>1040</td>
</tr>
</tbody>
</table>


Table 2. Average absolute per cent cover, relative dominance and importance value for shrub species in a chamise chaparral community in the San Bernardino National Forest, California.

<table>
<thead>
<tr>
<th>Species</th>
<th>Per Cent Cover</th>
<th>Relative Dominance</th>
<th>Importance Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamise</td>
<td>39.4</td>
<td>57.2</td>
<td>126.1</td>
</tr>
<tr>
<td>Eastwood Manzanita</td>
<td>4.8</td>
<td>6.9</td>
<td>26.1</td>
</tr>
<tr>
<td>Quixote Plant</td>
<td>2.6</td>
<td>3.8</td>
<td>23.3</td>
</tr>
<tr>
<td>Scrub Oak</td>
<td>20.9</td>
<td>30.3</td>
<td>65.6</td>
</tr>
<tr>
<td>Chaparral Whitethorn</td>
<td>.8</td>
<td>1.2</td>
<td>8.6</td>
</tr>
<tr>
<td>Aggregate. Includes:</td>
<td>.4</td>
<td>.6</td>
<td>18.7</td>
</tr>
<tr>
<td>White Sage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black Sage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeysuckle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redberry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>68.9</td>
<td>100.0</td>
<td>268.4</td>
</tr>
</tbody>
</table>
whitethorn (*Ceanothus leucodermis* Greene) follow scrub oak in importance. Other species which were of relatively little importance in the community, primarily because of their small size causing them to receive low values of cover and dominance, were listed together as an aggregate in Tables 1 and 2. The major species in the aggregate were white sage (*Salvia apiana* Jeps.), black sage (*Salvia mellifera* Greene), honeysuckle (*Lonicera subspicata* H. & A. var. *johnstonii* Keck) and red-berry (*Rhamnus crocea* Nutt.).

Holyleaf cherry (*Prunus ilicifolia* (Nutt.) Walp.) was absent from the line intercepts taken in the natural chaparral plots, but was present in the one-fortieth acre quadrats, and is listed in Table 1 as having a density about equal to that of chaparral whitethorn. Few other woody species were present in the natural chaparral plot, except for occasional individuals which were located outside of the sample plots. Among these species were knobcone pine (*Pinus attenuata* Lemmon), California wild lilac (*Ceanothus tomentosus* Parry), mountain mahogany (*Cercocarpus betuloides* Nutt.) and bigberry manzanita (*Arctostaphylos glauca* Lindl.). These occasional individuals tended to be generally more characteristic of manzanita chaparral which is found in the general vicinity of the study area but at a higher elevation (Horton, 1960; Wilson and Vogl, 1965).

There was very little herbaceous ground cover in the chaparral plot at the time of sampling (March, 1973) except
for an abundance of basal leaves of soap plant (*Chlorogalum pomeridianum* (DC.) Kunth.) and occasional early leaves of annual grasses and forbs.

The original conversion treatments in the modified chaparral plot in 1967 reduced shrub density to essentially zero, and in the subsequent years the various shrub species considered together recovered to a density of 1040 plants per acre (Table 1). Table 1 also indicates that 79.7 per cent fewer shrubs were found in the modified plot when compared to the natural plot. There was also a 40 per cent reduction in the total number of species in the modified plot, with chaparral whitethorn, white sage, black sage, and other species of the aggregate listed in Table 1 being absent. The modified plot tended to favor deerweed (*Lotus scoparius* (Nutt.) Ottley), a shrub not present in the natural plot, but present here at a density of 721 per acre after the type conversion. The species which were apparently affected the least by the conversion were the quixote plant which showed a reduction in density of 68.1 per cent and the hollyleaf cherry which was reduced by only 37.5 per cent (Table 1).

The total basal area measured accounted for 7.9 per cent of the total area of the plot. Of this, intermediate and pubescent wheatgrass comprised 7.0 per cent (Table 3), while all other plants considered as an aggregate accounted for only .9 per cent. Intermediate and pubescent wheatgrass considered together had a frequency of 87.5 per cent and a
Table 3. Basal area, per cent frequency and density per plot of perennial bunch grass species in a modified chamise chaparral plot in the San Bernardino National Forest, California.

<table>
<thead>
<tr>
<th>Species</th>
<th>Per Cent Basal Area</th>
<th>Average Area</th>
<th>Per Cent Frequency</th>
<th>Density Per Plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate of:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td>7.0</td>
<td>4.2 in.$^2$</td>
<td>87.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
density per plot of 2.7 bunches (Table 3).

Regardless of the appearance of occasional shrubs coming up from the stumps and burls left over from the natural community before type conversion, the physiognomy of the modified plot is decidedly that of a bunch grass community. The 7 per cent basal area recorded for the bunch grasses compares favorably with the 11 per cent basal area reported by White (1967) for a natural bunch grass community in California. The chaparral islands retained in the modified plot, which were not sampled, were left for the purposes of improving scenic quality within this brushland region and increasing the maximum edge, thus providing more cover for wildlife, particularly deer and quail (U. S. Forest Service, 1972).

SUMMARY

Intermediate and pubescent wheatgrass were planted following type conversion of the natural chamise chaparral community in 1967 and although not native to California are thriving and helping to form an established grassland community in the converted chamise chaparral plot in the San Bernardino National Forest.

This information provides an indication of the success of chaparral modification procedures in this area of southern California and is intended as an initial step in evaluating
the effect of chaparral type conversions on wildlife populations.
LITERATURE CITED


APPENDIX
Background of Study

The National Forests in California have for many years conducted a complex program of brushland management and modification of National Forest lands. Much of this work has been incorporated into the management program of the San Bernardino National Forest, under the direction of the U. S. Forest Service. Though work of this type has been conducted in California for almost 25 years, little quantitative or qualitative data has been submitted regarding the overall ecological effects on the modified areas and the wildlife species present. This project was undertaken in an attempt to begin bridging the vast gulf of ignorance existing in regard to the effects of the modification programs. It is hoped that this may be an initial step in determining the overall ecological effects of brushland modification, particularly in light of the stated objectives outlined at the inception of the program.

Modification of brushland areas within National Forests in California has generally followed two lines. One program is concerned with converting brushland areas to stands for commercial timber production where this is feasible. The second program has multiple objectives as follows:

1. Reduce public and private losses that result from wildfires and subsequent flooding.
2. Reduce burned acreage and the cost of suppressing wildfires.
3. Create safer areas for fire fighters and the
public.

4. Improve public access usability and the variety of landscape within the brushland zone.
5. Increase water yields.
6. Increase production of desirable forage and improve the availability for wildlife and livestock.
7. Increase the variety and abundance of wildlife.

One of the problems in southern California, in terms of brushland communities, is the fire-flood problem. History shows that attention should be directed towards this problem in light of the high fire potential of brushland communities and the possibility of subsequent flooding of burned over areas. Thus fire control planning has traditionally involved procedures to reduce the fuel volume by replacement of a particular plant species of high fire potential with one possessing a lower fire potential. This has been accomplished by altering the continuity of the community either by pre-planning fire attack or through the use of fuelbreak systems.

The preceding procedures have been combined into one type of modification which also meets the multipurpose objective. This modification is known as a "type conversion" and is defined as "a change from one of the native woody plant communities to a predominantly grassland community".

Type conversions are divided into two types, the fuelbreak and the multipurpose type conversion. The fuelbreak is a wide strip of land (usually 100 feet to 300 feet) where the native vegetation has been removed and replaced with grass so that the area is more readily accessible for fire fighters,
and so that fires burning into or near it may be more easily extinguished due to a lower burning potential of the area. One can see that the primary concern in this procedure is fire control. This procedure is most often implemented in areas that are particularly inaccessible due to the topography.

The multipurpose type conversion is usually undertaken on more productive areas on relatively flat or gentle terrain, and results in a mosaic pattern of islands consisting of the native vegetation. It is designed to provide multiple use benefits including improvement of wildlife habitat by creating a maximum amount of edge.

As previously mentioned, this project is an initial step in evaluating the effects of type conversions on wildlife species. The reasons for concern are obvious. It would be tragic if some species should suffer and possibly face extinction in an area due to mismanagement, resulting from a lack of information.

Plant and animal associations are complex and those associations present in a dense old growth stand are poorly understood. Management has been biased towards man's preferences, without full knowledge of all of the ecological implications of his actions. Much of his research has been directed towards establishing vegetation he considered more valuable or desirable.

A dense chaparral ecosystem yields few if any of the plant-animal associations common to grassland areas. Many
specific niches are formed by dense brush and affected species may either be eliminated or forced to establish new territories when the community is changed. Thus a new ecological relationship may develop between the plants and animals on the converted areas. The time required for such a change, the species composition, and the relative abundance of species are things that are not known at the present time. This project and subsequent work has been planned in the hopes of elucidating some of these problems.
Importance Value

The index of importance value (I. V.) was formulated by Curtis and McIntosh (1951) and was first introduced by them in an analysis of an upland forest in Wisconsin. This formulation is an extension of the original density-frequency-dominance index, or D. F. D. (Cottam, 1949; Whitford, 1949; Stearns, 1951).

The importance value is determined by the summation of relative per cent density, relative per cent dominance, and relative per cent frequency, providing a summation index. Since each of these parameters has a maximum value of 100 per cent, the three values taken together may have a maximum value of 300 per cent. On this basis a particular species may have an I. V. ranging from 0 to 300 and one may then determine the importance of a particular species relative to other species within that stand. This index is a good importance indicator since it is sensitive to variables within the stand, such as crown spread and excessive basal area.

The difference between importance value and the D. F. D. is the use of relative frequency in the former index and the use of simple frequency in the latter.
Literature Cited


LOMA LINDA UNIVERSITY
Graduate School

A COMPARISON OF VEGETATION STRUCTURE AND COMPOSITION
IN MODIFIED AND NATURAL CHAPARRAL
by
John A. Rosario

An Abstract of a Thesis in
Partial Fulfillment of the Requirements
for the Degree Master of Arts in
the Field of Biology

October, 1973
ABSTRACT

Type conversion of a 12 acre plot of chamise chaparral to grassland in the Mud Flat region of the San Bernardino National Forest, San Gorgonio District, California, was completed in 1967.

The conversion was accomplished following standard type conversion techniques for chaparral in California and included retention of a mosaic pattern of islands of the original chaparral for the purpose of improving scenic quality and maximizing edge effect. The islands constituted approximately 9 per cent of the total 12 acres and averaged 3800 square feet per island with an average distance measurement between islands of 96 feet.

Brush removal by a D-7 caterpillar was followed by brush pile burning and discing. The last herbicide treatment of the area was in 1969 and consisted of a mixture of 2 pounds per acre of 2,4-D and 2,4,5-T, applied by hand spray. Replanting was by range land drill seeding a mixture of intermediate wheatgrass and pubescent wheatgrass, at a rate of 6 pounds per acre.

Density per acre and number of shrubs were reduced by 79.7 per cent and 40 per cent respectively, excluding the chaparral islands in the modified plot. The only shrub which became established in the modified plot which was not present in the natural plot was deerweed with a density of 721 per acre.

The predominant physiognomy of the modified plot six
years after conversion, even considering survival of some of the shrubs from the original chaparral community, was decidedly that of a bunch grass community. A basal area of 7 per cent for intermediate and pubescent wheatgrass together was recorded, which compares favorably with the 11 per cent reported in the literature for a native bunch grass community in California. Intermediate and pubescent wheatgrass considered as an aggregate had a frequency of 87.5 per cent and a density per plot of 2.7 bunches.

Although not native to California, the intermediate and pubescent wheatgrass species are thriving and helping to form an established grassland community in the type converted chamise chaparral association within the San Bernardino National Forest.