Plant Response to the Barstow to Las Vegas Motorcycle Race of November, 1974

Candace E. Horsley

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Abstract

PLANT RESPONSE TO THE BARSTOW TO LAS VEGAS
MOTORCYCLE RACE OF NOVEMBER, 1974
by Candace E. Horsley

The purpose of this study was to determine the disturbance spectrum of the perennial plant vegetation by the Barstow to Las Vegas motorcycle race. Transects were taken at the pit area, starting line, and at various locations along the race course. Measurements were also taken in undisturbed control sites near the test areas, the topographic and biotic features being judged as equal. Methods employed consisted of aerial photograph analysis just before and after the race. On site ground measurements were taken four years after the 1974 motorcycle event. Measurements of diversity, stability, productivity, and community quality were calculated. The results indicated a general negative response of perennials to motorcycle disturbance, the vegetational cover reduced on an average of 34%. In the pit area, a positive response was held by annuals due to the edge effect. Differences in percent species composition, density, and cover indicate a change in diversity and stability of the perennial plant vegetation.
PLANT RESPONSE TO THE BARSTOW TO LAS VEGAS MOTORCYCLE RACE OF NOVEMBER, 1974

by

Candace E. Horsley

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

August 1979
Each person whose signature appears below certifies that this thesis in his opinion is adequate, in scope and quality, as a thesis for the degree Master of Arts.

Earl W. Lathrop, Chairman
Earl W. Lathrop, Professor of Biology

Norman L. Mitchell, Associate Professor of Biology

Anthony J. Zuccarelli, Assistant Professor of Biology
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Location and Topography</td>
<td>7</td>
</tr>
<tr>
<td>Historical Background</td>
<td>10</td>
</tr>
<tr>
<td>MATERIALS AND METHODS</td>
<td>14</td>
</tr>
<tr>
<td>Aerial Photographic Analysis</td>
<td>15</td>
</tr>
<tr>
<td>Ground Analysis</td>
<td>16</td>
</tr>
<tr>
<td>Statistical Methods</td>
<td>18</td>
</tr>
<tr>
<td>RESULTS</td>
<td>21</td>
</tr>
<tr>
<td>PHOTOGRAPHS</td>
<td>55</td>
</tr>
<tr>
<td>DISCUSSION</td>
<td>67</td>
</tr>
<tr>
<td>LITERATURE CITED</td>
<td>75</td>
</tr>
<tr>
<td>APPENDIX A</td>
<td>77</td>
</tr>
<tr>
<td>APPENDIX B</td>
<td>82</td>
</tr>
<tr>
<td>APPENDIX C</td>
<td>83</td>
</tr>
</tbody>
</table>
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Summary data of selected physical and biotic characteristics of the El Cajon motorcycle race</td>
<td>3</td>
</tr>
<tr>
<td>Table 2</td>
<td>Summary data of selected physical and biotic characteristics of the Barstow to Las Vegas (B to V) motorcycle race</td>
<td>11</td>
</tr>
<tr>
<td>Table 3</td>
<td>Summary data of cover using point frame samples of vegetation at site 1 and 2</td>
<td>22</td>
</tr>
<tr>
<td>Table 4</td>
<td>Relative cover and total percent cover of perennial vegetation in the race path, site 1 and 2</td>
<td>26</td>
</tr>
<tr>
<td>Table 5</td>
<td>Photo analysis of perennial vegetation before and after the B to V motorcycle race at site 3 and 4</td>
<td>28</td>
</tr>
<tr>
<td>Table 6</td>
<td>Density and cover means by ground measurements in racecourse and control of sites 4 and 5</td>
<td>37</td>
</tr>
<tr>
<td>Table 7</td>
<td>Relative cover and total percent cover at the control and race track of site 4</td>
<td>43</td>
</tr>
<tr>
<td>Table 8</td>
<td>Relative cover and total percent cover at control and racecourse of site 5</td>
<td>46</td>
</tr>
<tr>
<td>Table 9</td>
<td>Summary table of diversity index, evenness, and community quality index</td>
<td>49</td>
</tr>
<tr>
<td>Table 10</td>
<td>Summary table of Jaccard's coefficient of community similarity and percent change</td>
<td>51</td>
</tr>
<tr>
<td>Table 11</td>
<td>Mean density of perennial vegetation at El Cajon racecourse site 1 by aerial photographs</td>
<td>72</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Location map of the Barstow to Las Vegas (B to V) motorcycle race</td>
<td>8</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Bar graph showing vegetation, litter, and bare-ground cover at sites 1 and 2</td>
<td>24</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Mean density of sites 3 and 4 as taken from aerial photographs before and after the B to V race</td>
<td>30</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Mean density of sites 3 and 4 from aerial photographs, <em>Hilaria rigida</em> not included</td>
<td>32</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Mean percent cover of sites 3 and 4 as taken from aerial photographs before and after the B to V race</td>
<td>34</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Ground transect calculations of cover and mean cover at sites 4 and 5</td>
<td>39</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Density of perennial vegetation at sites 4 and 5</td>
<td>41</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Tracked pit area, site 1</td>
<td>55</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Hardened tracks visible at site 3</td>
<td>55</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Pit area showing the edge effect</td>
<td>57</td>
</tr>
<tr>
<td>Figure 11</td>
<td>Study site 5 with many tracks</td>
<td>57</td>
</tr>
<tr>
<td>Figure 12</td>
<td>Congregation of spectators in pit area</td>
<td>59</td>
</tr>
<tr>
<td>Figure 13</td>
<td>Close up of pit area and associated dust storm</td>
<td>59</td>
</tr>
<tr>
<td>Figure 14</td>
<td>View of race in session</td>
<td>61</td>
</tr>
<tr>
<td>Figure 15</td>
<td>Check and repair area of race</td>
<td>61</td>
</tr>
<tr>
<td>Figure 16</td>
<td>Rider following course of previous racers around checkpoint</td>
<td>63</td>
</tr>
</tbody>
</table>
Figure 17 Motorcycle racers following racetrack course ........ 63
Figure 18 Cyclists trying to avoid the larger bushes ............ 65
Figure 19 Concentrated pathway where a marker sets indicating
the race route ........................................... 65
The California Desert comprises roughly one-quarter the area of the state of California and contains 15 to 20% of its flora. Many of the desert plant communities are fragile due to extreme environmental conditions. Formations of soil crust or desert pavement, consisting of a coarse gravel top layer, are able to support and nurture these simple plant systems, but these can be easily and permanently altered by man. The life cycle of the desert perennials is extremely slow thus limiting the rate at which damaged or destroyed foliage can be replaced (Bureau of Land Management, 1975). In order to ensure its preservation, eleven million acres of this land have been designated as the California Desert Conservation Area (CDCA) and is managed by the Bureau of Land Management (BLM), (Bureau of Land Management, 1974a).

In recent years the delicate desert ecosystem has been challenged by increased use. Thousands of dune buggies, motorcycles and four-wheel drive vehicles flood the desert on weekends (Luckenbach, 1975). The use of motorized vehicles has greatly affected the vegetation on one million acres of California desert and has reduced the ground cover by sixty to seventy percent in some areas of regular use (Sheridan, 1979). Extensive damage can be inflicted in a few hours if use is sufficiently intense. A Kern County motorcycle race with 700 entrants destroyed the vegetation on a two km square area in a single day (Volmer, 1976).
Motorcycle races have become increasingly popular as whole families are participating together, each with his or her own dirt bike. There are two types of races, the 'enduro' with a series of timed check points and the 'scramble', with the winner being the one who reaches the finish-line first as in the Barstow to Vegas and El Cajon (Table 1) motorcycle races (Luckenbach, 1975). Associated with both of these races are pit areas where racers and spectators park their vehicles, causing the greatest amount of disturbance in a small area. After several gatherings the pit area is usually bare of vegetation and the soil is greatly compacted. The degree of damage dependent upon the number of vehicles and extent of use (Davidson, 1974).

One of the largest scramble races was the Barstow to Las Vegas motorcycle race held annually in late November of eight years. A study of the vegetation after one of these races estimated that 140,000 creosote bushes, 64,000 burro bushes, and 15,000 Mojave yucca were damaged within the 100 mile race route (Luckenbach, 1974). This evidence prompted the BLM to ban the event after the 1974 race. Davidson (1974) suggests that, in addition to destroying plants, motorcycle racing results in a decrease in plant diversity in the area. The BLM (1975) showed that after a disturbance natural revegetation occurs slowly with annuals appearing first, followed by a gradual return of shrubs. Recovery of the climax community may take from one to ten years depending upon the environmental and disturbance variables. In cases of severe damage in very sensitive sites, it is of interest to deter-
Table 1. Summary data of selected physical and biotic characteristics of the Dec. 3, 1972 El Cajon Motorcycle race as compiled from the 1973-1975 Bureau of Land Management race course rehabilitation report.
<table>
<thead>
<tr>
<th>Item</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Location</td>
<td>--In the Yuha Desert in Western Imperial County, Calif., 5.5 miles to the east of Ocotillo, 25 miles north of Mexico. T 16,16⅓,17S R 10,11E SBB&amp;M.</td>
</tr>
<tr>
<td>B. Elevation:</td>
<td>--Range from 17 to 133 meters.</td>
</tr>
<tr>
<td>C. Geology:</td>
<td>--The Yuha Desert area contains hilly exposures of bedded fossiliferous sandstones, claystones, and shell reefs of the marine Imperial Formation overlain in some higher areas by Pliocene sandstones and clays, flanked by sandy alluvial slopes and surrounded by outwash plains and washes of western mountain areas.</td>
</tr>
<tr>
<td>D. Soils</td>
<td>--Associations:</td>
</tr>
<tr>
<td></td>
<td>-Rillito-Orita, Superstition-Acolita, Carrizo-Cajon = 72%.</td>
</tr>
<tr>
<td></td>
<td>-Rough Broken Land, Badlands = 28% -- exposed bedrock and concretions interspersed with small areas of shallow residual soil of coarse to fine sands.</td>
</tr>
</tbody>
</table>
--Surface Textures:
- Range from fine sandy loam on the terraces to coarse sand in the bottoms of washes.
- Most calcareous throughout and semi-hard lime concretions or layers throughout profile.

--After Race Effects:
- Fragile vesicular soil pavement was destroyed; depressed tracks may stay visible up to 30 years.
- Surface gravel and rock fragments depressed into soil or displaced to sides of the trails, tending to form rows between individual tracks.
- Results - Tracks leave discernible, often flour-like loose soil surface and provides for vulnerability to movement of fine soils by wind and water.

E. Vegetation:
--Three distinct communities of perennial plant species:
1. Dry sandy washes - Smoketree, Saltcedar, Desert Holly.
2. Gently sloping sandy alluvial fans and basins - as above plus,
3. Firmly pavemented terraces, most extensive—Creosote bush, Bursage, with occasional Ocotillo plants

F. Race:

--215 motorcycles all starting at once on extended line.
--4 laps at 20.7 miles/lap.
--Date run—December 3, 1972.
mine if recovery ever occurs.

What permanent damage is inflicted on the desert plant community by a large annual motorcycle event? To answer this question one must first document the immediate effects of the race. This might be accomplished by comparing aerial photographs of the site taken just before and after the race. A second stage of the analysis would determine if the primary damage was repaired in a reasonable time or if it persisted. This information could be obtained by comparing measurements of the plant communities on the race course several years after the event with identical measurements of a matching set of communities nearby which had not been disturbed.

This thesis reports the analysis of aerial photographs taken immediately before and after the Barstow to Las Vegas Race in 1974 and compares measurements of the plant communities on the race course with undisturbed communities four years after the event. Furthermore, this study documents the spectrum of disturbance discovered and reveals a relationship between intensity of use and plant response in terms of productivity, diversity and stability.

Location and Topography:

The race course (Fig. 1) between Las Vegas and Barstow was 152 miles long and the disturbed area has been estimated to be 5265 acres (BLM, 1974b). The elevation ranged from 930 feet at Soda Lake to 4800 feet at Clark Mt. The starting point was located 15 miles east of Barstow city limits and 10 miles from the outlying communities of Daggett and Yermo. The five study sites were all located on the first
Fig. 1. The Mojave Desert region of Southern California showing the start and finish (••••••), racepath (••••••), and site numbers (in parenthesis), of the 1974 Barstow to Vegas Motorcycle Race. Local highway numbers, towns, and state boundaries are indicated. Refer to Appendix B for site locations.
fourth of the course which lies on the north side of Interstate 15 (Table 2). The track crossed many sites with fragile surface features. These included extensive areas of desert pavement, flat playas of fine silt and clay, washes carved by torrents from flash floods, unconsolidated alluvial deposits eroded from the surrounding mountains (BLM, 1975). Creosote scrub, cheese bush, and alkali sink are the three predominant plant communities found in these geographic areas (Johnson et al., 1975).

Historical Background:

The November 26, 1974 Barstow to Vegas 'Hound and Hare' motorcycle race was the last of eight annual events. Over 3000 riders participated, divided into two heats of 1500 bikes each. The course had been changed somewhat from previous races (Luckenbach, 1975). The motorcycles started off abreast in a long line but the field gradually narrowed to a single track following the easiest route along roads and washes. Between 12,000 and 15,000 people were on hand including families, friends, pit crews, emergency crews, cleanup and organizers. During the three day event most of the spectators congregated in the pit areas where they unloaded the bikes from trailers and prepared them for the race. An impact report stated that 600 tons of dust was kicked up by the riders—ten times the amount produced by a heavy desert dust storm (Sheridan, 1979). Considerable harm was also done to plants, animals and fossils, all dependant on the condition of the soil (BLM, 1975). After the race was banned in 1974, it has been run illegally every year with approximately 500 participants. The exact
Table 2. Summary data from selected sites of the November, 1974 Barstow to Las Vegas Motorcycle Race as compiled from the 1974 and 1975 Bureau of Land Management impact and evaluation race reports. Percent increase in number of tracks and percent decrease in vegetation refer to tests run immediately before and after the race.
<table>
<thead>
<tr>
<th>ESP Site</th>
<th>Plant Association</th>
<th>Topography</th>
<th>Soil Association</th>
<th>% Increase</th>
<th>% Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Pit Area</td>
<td>Creosote scrub</td>
<td>Low sandy hill</td>
<td>Mojave-Adelanto</td>
<td>470*</td>
<td>15</td>
</tr>
<tr>
<td>2 Race Start</td>
<td>Creosote scrub</td>
<td>Bajada-gentle slope</td>
<td>Mojave-Adelanto</td>
<td>289</td>
<td>20</td>
</tr>
<tr>
<td>8 Race Course</td>
<td>Alkali Sink</td>
<td>Playa</td>
<td>Rosamond-Playa</td>
<td>72</td>
<td>27</td>
</tr>
<tr>
<td>11A Race Course</td>
<td>Creosote Scrub</td>
<td>Bajada-Steeper up slope</td>
<td>Anthony-Cajon- Arizo</td>
<td>41</td>
<td>20</td>
</tr>
<tr>
<td>13 Race Course</td>
<td>Cheesebush</td>
<td>Wash</td>
<td>Anthony-Cajon- Arizo</td>
<td>81</td>
<td>3</td>
</tr>
<tr>
<td>21 Race Course</td>
<td>Alkali sink-lake edge</td>
<td>Playa</td>
<td>Rosamond-Playa</td>
<td>106</td>
<td>3</td>
</tr>
<tr>
<td>26 Finish Area</td>
<td>Creosote scrub</td>
<td>Flats</td>
<td>Anthony-Cajon- Arizo</td>
<td>841</td>
<td>76</td>
</tr>
</tbody>
</table>

* corrected value
route of these illegal races has not been recorded but there is evidence that portions of the earlier race course were used. The research reported here evaluates the damage inflicted by the 1974 race but we can not rigorously exclude the possibility that some later damage occurred.
MATERIALS AND METHODS

The five sites chosen for evaluation in this study were selected to include a variety of desert plant communities and to represent the various degrees of disturbance. The study sites included the pit area at the beginning of the race course, the starting line and three plots on the first 40 miles of the course. At some of these locations the racers followed a narrow track while at others they were spread out over a wide expanse of the desert (see Fig. 1). The vegetation included creosote bush scrub, cheesebush scrub, and alkali sink communities growing on a variety of landforms, including sandy dunes, alluvial deposits and hardpan pavement. Only two of the study sites could be unambiguously identified in the aerial photographs taken immediately before and after the race.

Each of the five study sites was paired with a nearby, undisturbed 'control' site chosen to match the test site in terms of natural vegetation before disturbance, topographic setting and surface soil characteristics. Several of these 'control' sites could also be positively identified on the film strips. A transect was taken at each of the test and control sites.

The measurements and observations were focused on perennials. A study of annuals was included only in the test site which contained the pit area. The primary data consisted of measurements of plant density, ground cover and species composition for each transect.
Aerial Photographic Analysis:

Environmental changes have often been assessed from aerial photographs (Avery, 1977). Due to inadequate planning and insufficient documentation only two of the study sites could be identified in the aerial photographs borrowed from the BLM. These were taken on November 26, 1974 before the race and on December 5, 1974 after the race. Differences in the photographs due to variations in altitude during the photographic flights were corrected by measuring the actual ground distance between distinctive landmarks in the photographs and comparing those with the photographic measurements. These calibrations made it possible to measure the ground cover and total density of perennials from aerial photographs by using calibrated transparent plot overlay grids (Appendix C).

A large light box was built to illuminate the filmstrips evenly. Transparent grids were placed over randomly selected sample sites and the number of shrubs ($n$) in each plot ($k$) were counted through a stereo dissecting microscope. These values were used to calculate the total plant density by standard procedures (Brower and Zar, 1977). Density was expressed as no/plot or as the number of shrubs per 0.01 ha and 0.04 ha, depending on the calibration ratio of the filmstrips. As it was impossible to determine the species of individual plants from the photographs, perennial shrubs down to approximately a 4 inch crown diameter were counted without differentiation. The annuals were distinguishable and were eliminated from the calculations.
Cover was measured by use of a calibrated line transect divided into ten sections and superimposed onto a Rausch and Lomb Filar micrometer eyepiece attached to a standard stereo dissecting microscope. Two transect lines of 10 mm each were measured per film study plot with a moving needle calibrated in increments of 0.001. Any plant touching the transect line was measured across the crown. The sum of the vegetational distances was then divided by the length of the transect line (10,000 micrometers) and multiplied by 100 to yield the relative cover.

Ground Analysis:

Measurements of perennial plants on the five ground sites (see Fig. 1), which included two that were also analyzed in the aerial photographs, and the five control sites provided the data for calculations of total cover, density and relative cover (percentage composition). The most widely applicable technique for obtaining such quantitative information about the structure and composition of plant communities is the point-quarter plotless sampling method (Brower and Zar, 1977). In applying this method, a compass heading was randomly chosen from a point within a study site. A series of points were selected at random spacings along a 100 m line transect in the direction of the compass heading. At each point, four orthogonal quadrants were formed by placing a cross through the point on the transect with the arms oriented toward the four compass directions. The distance was measured from the center point to the nearest perennial regardless of age or size for a total of four plants (n) per
point \((k)\). Each plant's crown foliage coverage and species name was recorded. Assuming that, on the average, plants cover a circular ground area, the ground cover for each plant was calculated from its radius and the sum for each species in the transect was determined (Vasek et al., 1975a). Cover and density could then be calculated using standard formulas (Brower and Zar, 1977).

At the pit area and start of the race, sites 1 and 2 respectively, many of the tracks were sharply outlined by an enhanced growth of annuals. Since this was quite a spectacular example of the edge effect, in this instance annuals were counted for cover and composition by use of the point-frame method (Phillips, 1959). A large rectangular frame containing a block of twenty spikes was placed at random points along the transect line. The plants hit by the spikes were counted and species recorded. The edge effect seen in this area was thus tested by 1500 point samples at 75 randomly selected sites along 3 transect lines. One transect contained 10 tracks (sparse), and a second contained 38 tracks (dense), both through the race course. A third transect containing 45 tracks was run through the pit area.

The control sites were chosen to match the test areas. In situations where there was great disturbance in and around the test area, a more distant control site was selected to reduce the possibility that it also had been disturbed. In all cases the control site had the same topographic, physiognomic, and community association features as the test site.
Statistical Methods:

The criteria by which the effects of the motorcycle race were determined are productivity, species composition, diversity, and stability. Only productivity was measured in the aerial transects. These measurements reflect all the basic components of the vegetational biotic system. Productivity is assessed by density and cover which readily show the negative and positive response changes ($\Delta\%$).

Absolute density ($D$) is calculated according to the formula:

$$D = TD \times RD$$

Total density ($TD$) is the total number of individuals ($n$) of all species per unit area (no/ha). Relative density ($RD$) is the number of individuals of a species counted ($N_i$) divided by the total number of individuals of all species counted ($\sum N$). Coverage for a species ($C_i$), is the proportion of ground covered by the aerial parts of the plant, and is calculated by multiplying the sum of the foliage coverages ($a_i$) by the density and then dividing by the total number of species. Relative coverage for a species was obtained by dividing the cover of that species by the total coverage for all species ($\sum C$) as taken from Brower and Zar (1977).

Diversity of the perennial plants for disturbed and control transects was measured from richness ($R$), the number of species present, and from evenness ($V$), how equally the species were represented in the sample. Hurblert (1971) and Johnson et al. (1975) give this formula for the calculation:
\[ V = \frac{d-d_{\text{min}}}{d_{\text{max}}-d_{\text{min}}} \]

To obtain \( d \), the diversity index, the equation proposed by McIntosh (1967).

\[ d = \sqrt{\frac{S}{\sum_{i=1}^{S} N_i^2}} \]

where \( N \) is the total density or cover for individuals of all species present in the sample, \( N_i \) is the value for each species, and \( S \) is the number of species. Minimum diversity was calculated as:

\[ d_{\text{min}} = \frac{N}{n} (S-1) \]

where \( N \) is the total cover and \( n \) is the number of individuals. Maximum diversity was determined according to the relation:

\[ d_{\text{max}} = \sqrt{\frac{\left( \frac{\sum N_i^2}{S} \right)^2}{S}} \]

The formulations provide a means for comparing the complexity of the vegetation of the disturbed and control sites in terms of absolute numbers on a unit area basis.

Stability was evaluated by using the Community Quality Index (CQI) proposed by Vasek et al., (1975). It is based on the knowledge that most stable desert plant communities contain a high percentage of long-lived perennials (Johnson et al., 1975). Stability can thus be measured by the proportion of vegetation made up of long-lived perennials. The CQI includes an estimate of productivity (plant cover), and an estimate of relative community age (percent of ground covered by long-lived species). This is best shown by the formula:
In order to make the calculation the desert perennials must be assigned to four categories, long-lived perennials, short-lived pioneer shrubs, pioneer perennial herbs and other perennials. The long-lived perennials are larger and have lifespans that range from decades to centuries. Species of this type generally respond negatively to disturbance, whereas short-lived pioneer invaders often show a positive response to disturbance (Vasek et al., 1975).

In order to compare two communities, e.g. test and control, or to compare the condition of a single community at different times, Jaccard's coefficient was calculated. It is a quantitative measure of community similarity based upon percentage composition obtained from ground transect data:

$$ CC_j = \frac{C}{S_1 + S_2 - C} $$

where $S_1$ and $S_2$ = total cover in the two communities or dates being compared and $C$ = total cover common to both communities. The values of $CC_j$ range from 0, when coverage is very dissimilar, to 1.0, when cover measurements are equal in both communities (Brower and Zar, 1977 and Whitaker, 1975).

Percent change ($\Delta%$) values for estimates of productivity were obtained from the relation:

$$ (\text{control} - \text{test}) - \text{control} $$

and then given negative values for decreased vegetational growth and positive values for enhanced growth.
RESULTS

Table 3 and Fig. 2 compare ground measurements of percent cover in three tracked areas in and around the pit site (site 1). The pit area contained the most tracks (45), and the greatest soil compression depth (25 cm). The high proportion of plant cover in the tracks, approximately twice that found out of the tracks, indicates a positive response to disturbance. In the densely tracked area of the racepath the number of tracks was only slightly less (38), but the average depth of the tracks was only 5 cm. This showed a negative growth response with the 'out of tracks' cover approximately twice that of the 'in track' count. The sparsely tracked racepath transect had only 10 tracks with an average depth of 6 cm. The cover was about equal 'in' and 'out' of the track path. Table 4 shows that annuals comprise the only cover in the dense tracked pit area, growing mainly in the tracks. The perennials were completely destroyed by the heavy traffic in the pit, and were found on the racepath 'out of track' area only, as the riders tended to avoid the large shrubs and zigzaged around them.

Photo analysis of perennial vegetation on aerial photographs gives a comparison of density and percent cover before and after the race (Table 5, Figs. 3, 4, 5). In both sites 3 and 4, density was reduced by half after the race while the cover stayed about the same. The undulating paths of the motorcycles indicates that the racers skirted the larger perennials. Small plants were crushed or sheared
Table 3. Summary data of point frame samples (N=1500) of vegetation in sandy creosote bush scrub taken December 11, 12, 1977 at random sites (75) along transects (3) through the Barstow to Vegas Motorcycle Race of November 30, 1974. Transect sites through race path located at site 2, T. 11N, R. 4E, Sec. 10, and pit area at site 1, T 10N, R. 4E, Sec. 6, San Bernardino Base Line, San Bernardino County, California.
## Transect Data Summaries

<table>
<thead>
<tr>
<th></th>
<th>Pit Area</th>
<th>Racepath-Dense Tracks</th>
<th>Racepath-Sparse Tracks</th>
</tr>
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<tbody>
<tr>
<td>No. sites on transect line</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Average random distance between sites - m</td>
<td>3.2</td>
<td>4.6</td>
<td>43</td>
</tr>
<tr>
<td>No. sites with tracks</td>
<td>25</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>No. tracks at sites</td>
<td>45</td>
<td>38</td>
<td>10</td>
</tr>
<tr>
<td>Average width of tracks - cm</td>
<td>18.5</td>
<td>13.8</td>
<td>17.1</td>
</tr>
<tr>
<td>Average depth of tracks - cm</td>
<td>25</td>
<td>5</td>
<td>6</td>
</tr>
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</table>

### Cover %

<table>
<thead>
<tr>
<th></th>
<th>in tracks</th>
<th>out of tracks</th>
<th>in tracks</th>
<th>out of tracks</th>
<th>in tracks</th>
<th>out of tracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>320</td>
<td>180</td>
<td>192</td>
<td>308</td>
<td>61</td>
<td>439</td>
</tr>
<tr>
<td>Foliage</td>
<td>37.1</td>
<td>15</td>
<td>26.5</td>
<td>46.4</td>
<td>31.1</td>
<td>30.9</td>
</tr>
<tr>
<td>Sand</td>
<td>32.5</td>
<td>74.4</td>
<td>62.5</td>
<td>49</td>
<td>45.9</td>
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<tr>
<td>Litter</td>
<td>30.3</td>
<td>10.9</td>
<td>10.9</td>
<td>4.5</td>
<td>22.9</td>
<td>7.7</td>
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</table>
Fig. 2. Bar graph showing vegetation, litter, and bareground cover (%) in (●) and out (□) of tracks at the Barstow to Vegas Motorcycle Race of November 30, 1974 as taken from ground transects at sites 1 and 2.
Table 4. Relative cover (% composition) and total percent cover of perennial vegetation in race path located at T.11N, R.4E, Sec.10, pit area at T.10N, R.4E Sec.6, San Bernardino Base Line, San Bernardino County, California, of the November 30, 1974 Barstow to Vegas Motorcycle Race, as taken from ground transects.
Barstow to Vegas Motorcycle Race

<table>
<thead>
<tr>
<th>Species</th>
<th>Creosote bush scrub</th>
<th>Relative Cover</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Pit Area</td>
<td>Sites</td>
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<tr>
<td></td>
<td>In tracks</td>
<td>Racepath-dense Tracks</td>
</tr>
<tr>
<td></td>
<td>Out of tracks</td>
<td>In tracks</td>
</tr>
<tr>
<td>Annuals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bouteloua barbata</td>
<td>37.8</td>
<td>37</td>
</tr>
<tr>
<td>Pectis papposa</td>
<td>57.9</td>
<td>59.2</td>
</tr>
<tr>
<td>Aggregate</td>
<td>4.9</td>
<td>3.7</td>
</tr>
<tr>
<td>Perennials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambrosia dumosa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hilaria rigida</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larrea tridentata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cover %</td>
<td>37.1 15 26.5 46.4 31.1 30.9</td>
<td></td>
</tr>
</tbody>
</table>
Table 5. Photo analysis of perennial vegetation on aerial photographs of the November 30, 1974 Barstow to Vegas Motorcycle Race showing density (N, no/0.01 ha) and cover (%) of plots (K) before (Nov. 26, 1974) and after (Dec. 5, 1974) the race.
<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Date</th>
<th>K</th>
<th>N</th>
<th>Density</th>
<th>% Cover</th>
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</thead>
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<td>T 11N</td>
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<td>1581</td>
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<tr>
<td></td>
<td>R 4E</td>
<td></td>
<td>32</td>
<td>325</td>
<td></td>
<td>16.13</td>
</tr>
<tr>
<td></td>
<td>Sec. 10</td>
<td>Dec. 5, 1974</td>
<td>66</td>
<td>831</td>
<td>12.9</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>32</td>
<td>274</td>
<td></td>
<td>13.65</td>
</tr>
<tr>
<td>4</td>
<td>T 11N</td>
<td>Nov. 26, 1974</td>
<td>68</td>
<td>2015</td>
<td>29.46</td>
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<tr>
<td></td>
<td>R 4E</td>
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<td>19</td>
<td>207</td>
<td></td>
<td>17.98</td>
</tr>
<tr>
<td></td>
<td>Sec. 17</td>
<td>Dec. 5, 1974</td>
<td>66</td>
<td>934</td>
<td>14.15</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>24</td>
<td>203</td>
<td></td>
<td>17.44</td>
</tr>
</tbody>
</table>
Fig. 3. Bar graph showing mean density per 0.01/ha plot in two raceway sites of the Barstow to Vegas Motorcycle Race of November 1974 as determined from quadrat measurements \( K=354, n=6841 \) on 2\( \frac{1}{4} \)x2\( \frac{1}{4} \) inch aerial color photograph negatives taken before (Nov. 26, 1974) and after (Dec. 5, 1974) the race. (See Table 5).
Density/plot (.01 ha)

Site

Before

After

Before

After
Fig. 4. Bar graph showing mean density per 0.01 ha/plot in two raceway sites of the Barstow to Vegas Motorcycle Race of November 30, 1974 as determined from quadrat measurements on 2\(\frac{1}{4}\) x 2\(\frac{1}{4}\) inch aerial color photograph negatives taken before (Nov. 26, 1974) and after (Dec. 5, 1974) the race. Site 3, Dec. 5, includes *Hilaria rigida* where Fig. 4 does not. (See Table 5).
Fig. 5. Bar graph showing mean percent cover as determined from line transects (K=107, N=1009) of aerial photographs before (Nov. 26, 1974) and after (Dec. 5, 1974) the November 30, 1974 Barstow to Vegas Motorcycle Race. (See Table 5).
in two, making number identification difficult. On site 3 where the motorcycles were still spread out the cover was reduced slightly from 16.13% to 13.65%. The great reduction in density indicates that many small bushes were run over and destroyed.

Ground transects allowed measurements to be made more accurately, especially in the determination of diameters and density of perennials. Nevertheless, ground and aerial measurements showed similar trends. Ground measurements at site 4 (Table 6, Figs. 6,7) showed a decrease in density from 2688.16 no/ha to 1402.53 no/ha in the control and raceway plots, respectively. Cover decreased even more dramatically as the control had approximately three times the coverage area of the racetrack. At this site the motorcycles had converged to circle around one side of a hill, resulting in a concentrated swath of intense use. This site gave an excellent example of concentrated one event use. At site 5 a comparison of 443.49 m²/ha in the raceway with 1424.75 m²/ha in the control indicates a slightly greater change in cover than site 4.

Most of the long-lived plants observed at site 4 belong to species *Ambrosia dumosa* and *Larrea tridentata* and a large perennial bunch grass, *Hilaria ridgida* (Table 7). Percent composition of *Ambrosia* varies from 48 in the raceway to 18 in the control, 47 to 70 for *Larrea*, and 1 to 6 for *Hilaria*. The positive growing response of *Ambrosia* to disturbance is characteristic of species which repopulate by seed dispersion and find new niches in slightly disturbed areas. *Larrea*, which propagates vegetatively more than by seed, showed the
Table 6. Density and cover means for perennial vegetation ground measurements in racecourse and control of site 4, T 11N R 4E Sec 17 and site 5, T 12N R 5E Sec 28, San Bernardino County, California of the Nov. 26, 1974 Barstow to Vegas Motorcycle Race.
<table>
<thead>
<tr>
<th>Site</th>
<th>K</th>
<th>N</th>
<th>Density no/ha</th>
<th>Cover m²/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>4--Racecourse</td>
<td>32</td>
<td>128</td>
<td>1402.53</td>
<td>165.15</td>
</tr>
<tr>
<td>4--Control</td>
<td>32</td>
<td>128</td>
<td>2688.16</td>
<td>508.86</td>
</tr>
<tr>
<td>5--Racecourse</td>
<td>30</td>
<td>120</td>
<td>1779.35</td>
<td>443.49</td>
</tr>
<tr>
<td>5--Control</td>
<td>36</td>
<td>144</td>
<td>2427.19</td>
<td>1425.75</td>
</tr>
</tbody>
</table>
Fig. 6. Bar graph of cover m²/ha (□) and mean cover m²/individual (●) of perennial vegetation at two sites of the Barstow to Vegas Motorcycle Race of November 30, 1974. Transects taken January 22, 23, 1978 at T.11N R.4E Sec.17 and T.12N R.5E Sec.28, San Bernardino County, California for sites 4 and 5 respectively. (See Table 6).
Cover m²/ha

sites

race path

control

mean area/cover m²/individual
Fig. 7. Bar graph of density no/ha of perennial vegetation at two sites of the Barstow to Vegas Motorcycle Race of November 30, 1974. Transects taken January 22, 23, 1978 at T.11N R.4E Sec.17 and t.12N R.5E Sec.28, San Bernardino County, California, for sites 4 and 5 respectively. (See Table 6).
Table 7. Relative cover (% composition) and total percent cover of perennial vegetation at racecourse site 4 of the Barstow to Vegas Motorcycle Race of Nov. 30, 1974 as determined from ground measurements taken Jan. 22, 1978 at T.2N, R.5E, Sec.28, San Bernardino County, California.
<table>
<thead>
<tr>
<th>Species</th>
<th>Control</th>
<th>Raceway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambrosia dumosa</td>
<td>77</td>
<td>99</td>
</tr>
<tr>
<td>Atriplex polycarpa</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Coleogyne ramosissima</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ephedra nevadensis</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Hilaria rigida</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>Larrea tridentata</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td>Lycium cooperi</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Opuntia echinocarpa</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Total cover %: 5.09 (Control), 1.65 (Raceway)
typical negative response of most perennial species, a decrease of cover composition in the raceway from 70 to 47 percent. Slight changes in community composition is indicated by the presence of Coleogyne ramosissma and Lycium cooperi in the control but not in the raceway. Both of these species are intolerant to pressure on their niche. Due to increased competition with new species or to an impairment of soil conditions, these had not returned to the raceway in four years. Total percent cover at this site was 5.09 with 7 species in the control and only 1.65 with 5 species on the raceway. Ambrosia, Larrea, and Hilaria were common to both sites.

Table 8 describes the composition of site 5 in a similar manner. Considerable variation of species occurs between sites 4 and 5 which have only Ambrosia, Ephedra nevadensis, and Larrea in common. Such variations probably reflect differences in topography, slope, exposure, elevation and substrate (Vasek, 1975b). Hymenoclea salsola, a short-lived pioneer shrub, is the most abundant species at site 5. It occurs sporadically in the creosote bush scrub community, usually in washes or other naturally disturbed areas (Vasek, 1975b). In this case, Hymenoclea occurs as a major colonizer in a drastically disturbed area, and nearby control. Ambrosia, which was abundant at site 4, makes up only 9% of the composition. Apparently it was destroyed by the intense traffic on the narrow race path. This is reflected in the ratio of control to raceway percent total cover, 14.26 to 4.43. Cover, percent composition, and species richness at each site are unique and not comparable to the others in terms of use, topography,
Table 8. Relative cover (% composition) and total percent cover of perennial vegetation at racecourse site 5 of the Barstow to Vegas Motorcycle Race of Nov. 30, 1974 as determined from ground measurements taken Jan. 23, 1978 at T 11N, R 14E, Sec. 17, San Bernardino County, California.
<table>
<thead>
<tr>
<th>Species</th>
<th>N</th>
<th>Control</th>
<th>N</th>
<th>Raceway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambrosia dumosa</td>
<td>29</td>
<td>15</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Brickellia incana</td>
<td></td>
<td></td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Ephedra nevadensis</td>
<td>21</td>
<td>16</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Hymenoclea salsola</td>
<td>81</td>
<td>63</td>
<td>74</td>
<td>63</td>
</tr>
<tr>
<td>Larrea tridentata</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lepidium fremontii</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Lycium cooperi</td>
<td></td>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Petalonyx thurberi</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Stephanomeria pauciflora</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Total cover %: 14.26 . . . . 4.43 . .
and soils.

Tables 9 and 10 contain five summary statistical tests, the first two items referring to diversity. The diversity index is greatest in the control areas; the higher the index, the greater the variety of species. The racepath at site 5 is nearly three times as high as test site 4 revealing greater richness, or number of species, and cover. Site 5 had the greatest change in cover and also the greatest change in diversity index. Site 4 showed less change in cover and the moderate change in diversity index indicates a more well proportioned composition, in spite of the disturbance.

Evenness values range from 0 to 1; the higher the number, the more equal the number of individuals of each species are found at each site. The evenness value for site 5 was identical to the control even though the diversity index had changed. That would suggest that the number of species had been greatly reduced but the proportionality of the remaining species had not changed. Site 4 had a significant increase of evenness at the racepath as compared to the control. This is probably due to a decrease in species, while the number of individuals remained the same.

Stability is indicated by the Community Quality Index (CQI) and ranges in value from 0 to infinity. The higher the value, the more stable long-lived perennials inhabit the community and the fewer exotic plants or introduced new species there are. Both sites 4 and 5 showed a marked difference between the control and test sites. The control site values were about three times as large as the test sites.
Table 9. Summary table of diversity index (DI), evenness (V), community quality index (CQI) based on cover as taken from the tables and sites indicated of the Barstow to Vegas Motorcycle Race.
<table>
<thead>
<tr>
<th>Site</th>
<th>DI control/race</th>
<th>V control/race</th>
<th>CQI control/race</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 7 -- 4</td>
<td>1.398 .5455</td>
<td>.3735 .5761</td>
<td>5.09 1.65</td>
</tr>
<tr>
<td>Table 8 -- 5</td>
<td>4.730 1.540</td>
<td>.4995 .4683</td>
<td>8.31 2.42</td>
</tr>
</tbody>
</table>
Table 10. Summary table of coefficient of community similarity (CC_j), and percent change of vegetation based on cover for Tables 3, 6, 7, 8 and on density for Table 5 as taken from the sites indicated of the Barstow to Vegas Motorcycle Race.
<table>
<thead>
<tr>
<th>Site</th>
<th>CCj</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 3 -- 1</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>3</td>
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<td>1</td>
</tr>
<tr>
<td>Table 5 -- 3</td>
<td>.8463</td>
<td>47</td>
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<tr>
<td>4</td>
<td>.9700</td>
<td>55</td>
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<td>Table 6 -- 4</td>
<td>.3246</td>
<td>28</td>
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<td>5</td>
<td>.3111</td>
<td>51</td>
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<tr>
<td>Table 7 -- 4</td>
<td>.3242</td>
<td>68</td>
</tr>
<tr>
<td>Table 8 -- 5</td>
<td>.3107</td>
<td>69</td>
</tr>
</tbody>
</table>
The greatest difference is found at site 5 where the heavy use intensity of motorcycles cut down all but the largest of long-lived shrubs, opening spaces for lower succession species and new species not found in the control.

The Jaccard's coefficient of similarity ($CC_j$) was used to compare transect cover values. Generally, a similarity coefficient of 0.7 or higher is considered an indication of virtual identity. The Jaccard's coefficient for the transects in the six samples ranged from 0.3111 to 0.9700. Sites 3 and 4 (Table 5) showed maximum coefficients since the measurement of cover from the aerial photos did not change. After four years, a comparison between test site 4 and its control yields a $CC_j$ of 0.3246, and 0.3111 for site 5. Therefore, the control and test at each of these sites were very dissimilar.

Percent change ($\Delta\%$) reveals the productivity changes between test and control. Positive values indicate an enhanced growth with disturbance, and negative values a decreased growth due to disturbance. Sites 1, 3, 4, and 5 (Table 10) showed an overall negative response to the motorcycle racers passing through those areas. The values ranged from 28 to 69% decrease in growth. Only in site 2, where annuals were included in the calculation, was a positive response obtained in an area of heavy use. This was apparently due to the enhancement of the annuals growth by edge effect. Perennials in this area were not present in the tracks because of the heavy use by motorcycles. This statistic alone reveals the great difference between control and test sites due to the influence on the environment.
and individual plants.
Fig. 8. Track visibility enhanced by the presence of annual grass, measured here by the point frame method at site 1. January, 1978.

Fig. 9. Tracks hardened in desert pavement from race of November, 1974 at site 3. February, 1978.
Fig. 10. Pit area tracks at site 1 show results of edge effect on the deep numerous tracks. January, 1978.

Fig. 11. Study site 5 in cheesebush scrub, the original tracks crossed and enlarged in some parts by more recent use. January, 1978.
Fig. 12. Pit area showing extent of recreational vehicles brought to the site by friends and contestants. Large amounts of dust kicked up by these vehicles alone. November, 1974.

Fig. 13. Close up view of small section of the pit area during race with large amounts of dust settling across the valley. November, 1974.
Fig. 14. Congregation of spectators gather on either side of race-track as riders come in for the final stretch of the race. November, 1974.

Fig. 15. Close up view of check area along raceway where riders stop for gas and repairs from pit crew. November, 1974.
Fig. 16. Lone motorcycle making turn around checkpoint following previous riders, the dust marking his path. November, 1974.

Fig. 17. Three motorcycles kicking up dust as they try to follow washes or paths made by other riders ahead of them. November, 1974.
Fig. 18. Typical cross country racing, cyclists avoiding the large bushes which might cause a spill. November, 1974.

Fig. 19. Marking on roadside shows cyclist where to enter from paved road unto trail. Concentrated use of one pathway cut down widespread damage. November, 1974.
DISCUSSION

Whenever field measurements of plant response parameters are made years after a disturbance has occurred the results can be ambiguous or even contradictory. Site selection, seed availability, moisture factors, and the intensity of the disturbance can each contribute to the appearance of some responses but not to others. Furthermore, the direct effects of vehicles on vegetation includes not only crushing of the foliage but damage to the root systems of nearby plants, uprootings, loss of seed and changes in the soil characteristics (Wilshire et al., 1978). These affect plants which did not come in direct contact with the vehicle. Some combinations of factors may stimulate dispersal and propagation while others suppress it.

An example of a positive effect was seen at sites 1 and 2 (Table 4). The growth of *Bouteloua barbata* and *Pectis papposa* was greatly enhanced by a combination of conditions known as 'edge effect'. Deep motorcycle tracks serve as collection channels and storage troughs for water run-off from the surrounding desert surface. They are also efficient collecting basins for windblown seeds. The extra moisture provided in these tracks greatly influences the growth of *Bouteloua* and *Pectis* seeds and propaguls accumulated in the recesses of these tracks. The edge of the track provides shelter from the wind and from a portion of the day's sun, further reducing the water loss of evaporation from the soil and seedlings. The tracks clearly act as efficient 'water harvesting' systems (Johnson et al., 1975). Edge effects
should not, however, be isolated from the predominant plant response as evidence that disturbance is beneficial. It has been pointed out (BLM, 1975) that well used areas often display greater greenery, and some would argue that this disturbance has helped the desert to grow. Such growth, however, is composed strictly of transient annuals. It is usually accompanied by a reduction in stability of the community due to the destruction of long-lived perennials which do not often contribute to the popular spring wild flower displays. At sites 1 and 2 the CQI indicated that the plant communities at the control sites were much more stable than those on the racepath. Paradoxically, a site which supports an impressive display of annuals every season can be dead successionaly.

The pioneers of succession seem to be short-lived species that appear when some of the long-lived perennials are destroyed (Vasek, 1975b). An example of this is the large cover value held by *Hymenoclea salsola* at site 5. The equal cover representation of this species in both the racetrack and control is unexplainable. Some species can keep a strong hold in their habitat by adapting to the disturbance. At the site 4 raceway, *Larrea* shows its ability to form clonal rings as part of the reproductive cycle. According to Vasek (1975b),

The common pattern of growth involves the death of older branches as a consequence of drought, and their replacement by new branches that arise from the periphery of the old root crown. Accordingly, the center of a creosote bush dies and is replaced by new stems that eventually form new crowns peripheral to the original central crown. Over long periods of time with repeated cycles in which old stems die and new stems and new crowns are formed peripherally, the creosote bush growth pattern results in a ring of
satellite clumps around a circular to elliptic sterile center.

Destruction of creosote parts by motorcycles produces similar effects on a very small scale by enhancing vegetative propagation. The time required for formation of large creosote rings has been estimated in the range of 1500 to 3000 years, as deduced from current cm increment growth rates. If these time periods are correct, the fragility of the desert vegetation is sharply illuminated.

One of the goals of this work was to evaluate the severity of the damage inflicted on the desert vegetation during the Barstow to Las Vegas race by estimating the time required for a disturbed site to recover its original composition and ground cover. The results suggest that measurements must be made over a much longer time period before such determinations can be made with confidence. On the other hand, the data document the immediate extent of the destruction and show that it is not repaired in a few years.

Comparable results were obtained (Lathrop et al., 1978) in a study of a similar motorcycle race in El Cajon Valley (Table 1, Fig 20). Aerial photographs of sample plots taken in 1953 and 1972 were compared. Plant density had not changed (Table 11). A third set of photographs was taken of the same sites later in 1972, after a large motorcycle race had been run. Though the plant communities had been stable for nearly 20 years, the vegetational density on the race course was reduced to 1/3 of the control in one day. The severity of this reduction can be appreciated by realizing that natural climatic and ecological changes over the years had affected plant density insig-
Fig. 20. Outline map of the El Cajon Valley Motorcycle Racecourse (---) held December 3, 1972 in the Yuha Desert, Imperial County, California, showing study sites 1-4.
Table 11. Mean density, no./.04 ha plot (K), of perennial vegetation at the El Cajon Club racecourse site 1 (Fig. 20) as determined from aerial photographs taken before (April 18, 1953 and Nov. 26, 1972) and after (Dec. 12, 1972) the race.
<table>
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<th>Transects (K=90)</th>
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<td></td>
<td>4.97</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>414</td>
<td></td>
<td></td>
<td>4.60</td>
<td>4.78</td>
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</table>
nificantly compared to the one-day race. Though damage seems to be severe, recovery will be much more rapid if the area is not used again in the near future. The area could become denuded like the hills where motorcyclists ride every weekend causing heavy and repeated damage. According to the BLM Evaluation report (1975), impacts increase as the numbers of motorcycles increase, repeated use intensifies the damage, and repeated use lengthens the period of recovery.

Statistical treatment of the data reveals that there was a significant difference between the control and test transects in measurements of productivity as indicated by cover and density. In general, the impact of the Barstow to Las Vegas motorcycle race upon the California Desert plants and their habitats resulted in a negative response by the perennial plant population, the degree of response varying with conditions and use intensity. Positive responses were displayed only by annuals in severely disturbed areas due to edge effects in the tracks. On the average, after four years of recovery, the 1974 Barstow to Las Vegas race reduced plant cover by 34%. In addition, ground measurements of relative cover revealed differences in composition between control and test sites, indicating that motorcycle impacts also altered plant stability and diversity by changing the structure of the community.


APPENDIX A

Plant Specimen List

Plant Response Parameters

in the CDCA

Aizoaceae

Mollugo cerviana (L.) Ser.

Asteraceae

Acamptopappus sphaerocephalus (Harv. & Gray) Gray
Ambrosia dumosa (Gray) Payne
Baileya pauciradiata Harv. & Gray
Bebbia juncea (Benth) Greene
Brickellia incana Gray
Dyssodia cooperi Gray
Dyssodia therberi (Gray) Nels.
Encelia farinosa Gray ex Torr.
Encelia virginensis A. Nels.
Erigeron pumilus Nutt. ssp. concinnoides Crong.
Eriophyllum wallacei Gray
Gutierrezia microcephala (DC.) Gray
Geraea canescens T. & G.
Haplopappus acradenius (Greene) Blake
Haplopappus cooperi (Gray) Hall
Hymenoclea salsola T. & G.
Lepidospartum squamatum (Gray) Gray
Machaeranthera tortifolia (Gray) Crong. & Keck.
Palafoxia linearis (cav.) Lag
Pectis papposa Harv. & Gray ex Gray
Stephanomeria pauciflora (Torr.) Nutt

Agavaceae
Yucca shidigera Roege ex Ortigies
Tetradymia stemolepis Greene

Bignoniaceae
Chilopsis linearis (Cav.) Sweet Desert mallow

Boraginaceae
Coldenia palmeri Gray
Coldenia plicata (Torr.) Cov.

Brassicaceae
Lepldium fremontii Wats

Cactaceae
Echinocactus polycephalus Engelm & Bigel
Opuntia basilaris Engelm & Bigel
Opuntia echinocarpa Engelm & Bigel
Opuntia ramossima Engelm

Capparaceae
Cleomella obtusifolia Torr. & Frem
Isomeris arborea Nutt. var. arborea (Cleome isomeris Greene)
Chenopodiaceae

* Atriplex canescens* (Pursh) Nutt
* Atriplex humenelytra* (Torr.) Wats
* Atriplex plocarpa* (Torr.) Wats
* Ceratoides lanatum* (Pursh) T. Howell
* Grayi spinosa* (Hook) Mog.

Ephedraceae

* Ephedra nevadensis* Wats.

Euphorbiaceae

* Croton californicus* Muell-Arg

Fabaceae

* Acacia greggii* Gray
* Cassia armata* Wats.
* Cercidium floridum* (Benth) Wats. Benth
* Dalea californica* Wats.
* Dalea emoryi* Gray
* Prosopis glandulosa* Torr. var. *torreyana* (L. Benson) M.C. Jtn.

Lamiaceae

* Salvia columbariae* Benth.
* Salvia doriai* (Kell.) Abrams
* Salazaria mexicana* Torr.

Lennoaceae

* Pholisma arenarium* Nutt. ex Hook.

Loasaceae

* Petalonyx thurberi* G.
Malvaceae

Eremalche rotundifolia (Gray) Greene

Nyctaginaceae

Mirabilis froebelii (behr.) Greene

Papaveraceae

Argemone corymbosa Greene.

Plantaginaceae

Plantago aristata Michx.

Poaceae

Aristida fendleriana Steude
Bouteloua barbata Lag
Bouteloua eriopoda (Torr.) Torr.
Erioneuron pilosum (Buckl) Nash
Hilaria jamesii (Thurb.) Benth. ex Scribn.
Hilaria rigida (Thurb.) Benth. ex Scribn.
Muhlenbergia potteri Scribn.
Oryzopsis humenoides (R. & S.) Ricker
Tridens muticus (Torr.) Nash

Polygononaceae

Eriogonum fasciculatum Benth
Eriogonum heerimannii Dur. & Hilg.
Eriogonum inflatum Torr. & Frem.

Rosaceae

Coleogyne ramosissima Torr.
Fallugia paradaxa (D. Dom) Endl
Prunus fasciculata (Torr.) Gray
Solanaceae

*Datura meteloides* A. DC.

*Lycium cooperi* Gray

Zygophyllaceae

*Larrea tridentata* (sesse & Moc ex DC.) Cov.
APPENDIX B

Plaster City: El Cajon Motorcycle Race - Yuha Desert

A. Site 1 - T 15N, R 11E, Sec. 18 Imperial County, California
B. Site 2 - T 15S, R 10E, SW 1/4 Sec. 24
C. Site 3 - T 16S, R 11E, Sec. 15
D. Site 4 - T 15S, R 11E, Sec. 21

Barstow, California to Las Vegas, Nevada: Barstow to Vegas Race - Mojave Desert

A. Site 1 - T 10N, R 4E, Sec. 6 San Bernardino County, California
B. Site 2,3 - T 11N, R 4E, Sec. 10
C. Site 4 - T 11N, R 4E, Sec. 17
D. Site 5 - T 12N, R 5E, Sec. 28
APPENDIX C

Aerial Photograph Calibration Data
# Aerial Photograph Calibration Data

## AREA: Barstow to Vegas M. Race

Photo Date: 11/26/74  
Photo size: $2\frac{3}{4} \times 2\frac{3}{4}$"  
Photo Nos. 12/5/74  
#BLM ESP'1-26 4 rolls total  

## Ratio: 1:440.9

### Transparent Grid Measurements

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- 1.9 cm each side of sm. sqs.
- 2.95 cm wide

### On Ground Equivalent Measurements

- Area of sm. sqs. = 0.000019 ha
- 4.409 m ea. side of sm. sqs.
- AREA = 0.01 ha
- 13 m

- 1.05 m.
- 11.02 m
- 0.88 m
- 7.27 m

- 4.40 m
- 5.59 m
- 5.59 ha
**Aerial Photograph Calibration Data**

**Area:** Plaster City

**Photo Date:** 12-12-72
**Photo Size:** 9 x 9
**Photo Nos.:** 1000 BLM 04-06MC 1-47

**Scale:** 1:20,000

### Transparent Grid Measurements

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<td>4 5</td>
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- 10 cm each side of sm. sqs.
- 1.9 cm

### On Ground Equivalent Measurements

- Area of sm. sqs. = 0.04 ha
  - 20 m ea side of sm. sqs.
  - AREA = 22.42 ha
  - 380 m

- 24 cm
  - 2.5 cm

- 2 cm
  - 1.65 cm

- 1 cm
  - 1.27
  - AREA
  - 6.45 ha
  - 254 m

- 60 m
  - 200 m
  - 254 m

- 48 m
  - 500 m

- 40 m
  - 330 m
PLANT RESPONSE PARAMETERS - RV and ORV in CDCA, Ca.

Aerial Photograph Calibration Data

AREA: Plaster City

Photo Date: 4-18-53
Photo size: 1:20,000
Photo Nos. ABN-10M-137-139, 152, 153, ABN-11M-47, 48

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.10 cm each side of sm. aqs.

\[ \text{Area of sm} \text{ aqs.} = 0.04 \text{ ha} \]

20 m ea side of sm aqs.

\[ \text{AREA} = 22.42 \text{ ha} \]

On Ground Equivalent Measurements

\[ \text{Area of sm aqs.} = 0.04 \text{ ha} \]

20 m ea side of sm aqs.

\[ \text{AREA} = 22.42 \text{ ha} \]
**AREA:** Plaster City

**Photo Date:** 11-26-72  
**Photo size:**  
**Photo Nos.:** 5-159-160  6-130-134  7-119-122

**SCALE:** 1:20,000

### Transparent Grid Measurements

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</table>

- 10 cm each side of sm. sqs.
- 1.9 cm
- 2.95 cm

### On Ground Equivalent Measurements

- Area of sm. sqs. = 0.04 ha
- 20 m ea side of sm. sqs.
- AREA = 22.42 ha

- 380 m
- 590 m

- 48 m
- 500 m

- 40 m
- 330 m

- 200 m
- 254 m

- 60 m
- AREA = 6.45 ha
- 254 m