Invasion of Grassland by Baccharis pilularis DC.

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Highlight

A remeasurement of transects established in 1952 and a comparison of early vegetation maps with maps prepared in 1961 indicate that a brush species, Baccharis pilularis, has invaded grassland areas of the East Bay Regional Parks near Oakland, California. The common movement of the species has been as an advancing front on exposed soil occurring at baccharis-grassland boundaries. Experiments with controlled burning and with grazing animals show that baccharis seedlings and young plants are very susceptible to damage from these factors. These experiments support the hypothesis that baccharis has increased due to the reduction of wildfires and the elimination of grazing in the parks. There is need for management to preserve remaining grasslands in the park.

Baccharis pilularis DC., commonly called baccharis, coyote brush, or chaparral broom, is an erect shrub which attains an average height of six ft and is usually found in relatively pure stands (Fig. 1). Its leaves are spatulate, dentate along the upper margin, and evergreen. Baccharis is a member of the Compositae family and bears inconspicuous flowers during October and November. The species mainly occurs in the coastal region of California. It is especially abundant in the Bay Area where dense stands are common, such as those in the East Bay Regional Parks of Contra Costa and Alameda counties. Although no measurements have been made, many persons who are interested in the parks hold the opinion that baccharis is invading grasslands. The objectives of this study were to determine the extent of invasion since 1934 when the parks were established and to study the factors which result in the loss of grassland. The open grasslands are used frequently by recreationists, while the dense baccharis stands are not because of the difficulty in penetrating them and the frequent occurrence of poison oak (Rhus diversiloba T. & G.).

Four of the six parks in the Regional Park System which adjoin the east side of Oakland and Berkeley were included in the study. The climate is a cool Mediterranean type with frequent summer fogs. In nearby Berkeley, average January temperature is 48.3 F, average July temperature is 61.4 F, and average annual precipitation is 23.65 inches (U.S. Weather Bureau, 1956). The bulk of the rainfall occurs during the winter.

Elevations within the parks range from 300 to 1,900 ft, and the topography is characterized by steep slopes and narrow valleys with a northwest-southeast orientation. The soils have developed from sandstones and shales. The dominant soil series are heavy textured, as illustrated by their names—Los Osos Adobe Clay, Sobrante Stony Clay Loam, Botella Clay, and Alameda Clay. Landslides are common during periods of heavy rainfall. Both baccharis and grassland occur on the same soil types in the parks.

Prior to 1934, a major portion of what is now park land was grazed and occasionally burned. Since that year, grazing by domestic animals has been prohibited, except for a small area which was grazed until 1955. Fire protection has resulted in a steady decline of the acreage burned annually by wild fires (Clark, 1963).

Baccharis Invasion

Two methods were used to determine the extent of invasion. First, areas of baccharis on vegetational type maps drawn between 1927 and 1942 were compared with areas on the U.S.G.S. 7.5-minute topographic sheets made in 1961 from aerial photos and checked in the field as part of this study (Table 1). Over a period (21 to 36 years) since the original mapping, baccharis increased from approximately 7 to 22% of the land area in the park system. This amounts to an average increase of baccharis or decrease in grassland of 46 acres/year for the four parks combined. Two patterns of baccharis invasion were obvious. None of the existing areas in 1927 to 1942 had disappeared and most of them had increased in size. New stands were pres-
Table 1. Acreage of *Baccharis pilularis* DC. brushland in four of the East Bay Regional Parks.

<table>
<thead>
<tr>
<th>Park</th>
<th>Prior</th>
<th>1963</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tilden</td>
<td>130²</td>
<td>647</td>
<td>517</td>
</tr>
<tr>
<td>Round Top</td>
<td>19³</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Redwood</td>
<td>132⁴</td>
<td>480</td>
<td>348</td>
</tr>
<tr>
<td>Grass Valley</td>
<td>269</td>
<td>745</td>
<td>476</td>
</tr>
<tr>
<td>Total</td>
<td>550</td>
<td>1891</td>
<td>1341</td>
</tr>
</tbody>
</table>

²Prior to park establishment.
³Based on map prepared by Harris (1927).
⁴Based on map prepared by U.S. Forest Service (1942).
⁵Based on map prepared by Constance (1932).

ent in 1963 that were not on the earlier maps. A comparison of oblique aerial photographs of a portion of Tilden Park taken in 1935 and 1965 illustrates the increase in baccharis (Fig. 2).

Differences in maps are often due to the abilities and objectives of the mapper (Reid and Pickford, 1942). While errors no doubt exist in the acreages presented, a difference of more than 1,300 acres seems too great to be totally attributable to incorrect maps.

The second method was to remeasure 24 transects that were established across baccharis-grassland borders in 1952. On 22 of the transects where stakes could be found in 1965, the average expansion of baccharis into the grassland was 1.3 ft/year. Observations that baccharis is invading grassland in the East Bay Parks appear to be well founded.

A severe storm in October 1962 resulted in numerous landslides in the parks. These were characterized by bare soil, or at least scanty vegetation, during the ensuing winter and spring growing season. Baccharis seedlings in three plots, located at random on each of 31 landslides, were counted in March 1963 and again in April 1964. These plots were paired with others outside the landslides where the grass cover was undisturbed. Each plot was one m² in size. An average of 3.44 seedlings/plot were recorded on the slides and 0.02 seedlings/plot on undisturbed soil in 1964. Approximately half of those on the slides germinated in 1963 and half in 1964. Very few one year old plants were found in the grassland. Seed dispersal in baccharis begins in November and germination occurs during the winter and early spring. Landslides appear to present more favorable sites for germination and establishment during this period than the adjacent grasslands.

Existing dense stands of baccharis frequently have a sharp boundary with grassland. Between these two types exist a two to five-ft wide strip of bare soil where numerous baccharis seedlings commonly occur (Fig. 3).

The factors controlling these bare strips have not been determined. Similar zones of bare soil occur between chamise (*Adenostema fasciculatum*) brushlands and adjacent grassland. Landers (1962) related the occurrence of bare soil zones adjacent to chamise brushlands to the combined influence of shading, competition for water and nutrients, seed removal by herbivores, and the production of toxic materials by chamise. The increase of baccharis on the transects suggests a uniform addition of plants along the edges of baccharis stands. Both the transects and the plots indicate that invasion of baccharis into grassland occurs on mainly bare soil.

Grazing and Burning Influences

Local range managers and stockmen consider baccharis to be of low palatability to livestock. Little evidence can be found of browsing on mature shrubs. However, reduction of baccharis invasion into grassland by domestic livestock is suggested by the lack of seedlings in grazed areas and by fence-line boundaries between baccharis and grassland. To investigate possible grazing influences an enclosure study was undertaken. Three enclosures that excluded cattle, three that excluded cattle and rodents, and three unfenced plots were established near the boundary of one of the parks. Ten

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Fig. 2. Oblique aerial views of a portion of Tilden Park in 1985 (A) and 1965 (B). The forest is a planted eucalyptus grove. Areas outlined show that baccharis brushland has increased and grassland has decreased in the 30 years between the photos.
baccharis seedlings were planted on March 25, 1963 in each exclosure and in the unfenced grazed plots.

After 17 days, 10 seedlings had been eaten to ground level, 14 were partially eaten, and six showed trampling damage in the unfenced plots. None of the plants in the exclosures were eaten and all were vigorous. After 170 days, September 10, 1963, near the end of the dry season, all plants in the unfenced plots were dead. Five were alive in the cattle exclosures and 15 in the cattle-rodent exclosures. Mortality within the exclosures appeared to have resulted from the long summer dry period and extensive cracking of the clay soil as no evidence of grazing by rodents or other animals was found.

The combined effects of grazing and trampling by domestic animals probably is a factor in reducing the rate of baccharis spread. Animals may foster the spread by reducing the grass cover, but this appears to be over-shadowed by actual reduction of invasion by grazing on the baccharis itself. Elimination of domestic livestock from the parks is suggested as one of the factors which has permitted the gradual enlargement of the baccharis area within the parks.

Two approaches were used to determine the influence of burning on the spread of baccharis into grassland. In March, 1963, the aerial parts of 11 mature plants were burned. Another group of 11 plants were burned only at the base. These two treatments were chosen to simulate a crown fire in mature stands of baccharis where fuel on the ground is normally light and a fire in grassland where the ground fuels are heavy. Even though the degree of similarity between these heat treatments and the heat generated in wildfires is unknown, the results obtained were similar to those commonly observed. All the plants which had the aerial parts burned sprouted from the base within five weeks and eight of the 11 plants burned at the base were killed. Stems less than one inch in diameter were more susceptible to burning damage than larger plants. These data suggest that wildfires are effective in reducing the invasion of baccharis into grassland, and that fire is not so effective in eliminating mature brush stands. Therefore reduction of fires in the parks can be reasonably listed as a contributing factor to the spread of baccharis.

Discussion

The widespread observation that baccharis, a shrub, has invaded grasslands in the East Bay Regional Parks adjoining Berkeley and Oakland is substantiated on a basis of vegetational maps drawn in 1927 to 1942 and redrawn in 1963. Transects established in 1952 and remeasured in 1965 indicate an average annual expansion of baccharis of slightly more than a foot a year. Bare mineral soil along the edges of many baccharis stands and on landslides are favorable sites for establishment of new baccharis plants. Both observations and measurements indicate that elimination of domestic animals and reduction of wildfires have contributed to the increase in area of baccharis stands. This study shows that vegetation changes on areas that are used for recreational purposes, as it does under other types of use.

The value of grassland for recreational purposes in the parks is relatively greater than the dense stands of baccharis. The latter vegetation is unsuited for hiking, extended views, and horseback riding. However, the shrub stands have certain aesthetic and animal protection value.

The gradual reduction of the grasslands has been recognized by the administrators of the East Bay Regional Parks. In an effort to prevent invasion in Sunol Park, a newly acquired unit, limited grazing permits have been established. Further reduction of grasslands in the other parks in the Regional Park system should be given serious consideration in planning for future recreational services that the parks will provide.

LITERATURE CITED


U.S. Forest Service. 1942. Vegetation type map of East Bay Hills protection area. California Forest and Range Experiment Station.