Report No. 62
ISSN 0575—4968

PROCEEDINGS OF THE CHAPARRAL ECOSYSTEMS RESEARCH CONFERENCE

May 16-17, 1985
Santa Barbara, California

Sponsored by:

UNIVERSITY OF CALIFORNIA
WATER RESOURCES CENTER

UNIVERSITY OF CALIFORNIA
SANTA BARBARA

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

STATE OF CALIFORNIA
DEPARTMENT OF FORESTRY

U.S. FOREST SERVICE

Editor
Johannes J. DeVries
CALIFORNIA WATER RESOURCES CENTER
UNIVERSITY OF CALIFORNIA, DAVIS
June 1986

DEMOGRAPHIC STRUCTURE OF CHAPARRAL UNDER EXTENDED FIRE-FREE CONDITIONS

J. E. KEELEY
A. BROOKS
T. BIRD
S. CORY
H. PARKER
E. USINGER
Occidental College
Los Angeles, California

ABSTRACT

Old stands of chaparral vegetation are often described as "senescent" or "decadent." However, few such old stands have been studied in detail and much of the information on the fate of old chaparral is anecdotal. The demographic patterns and age structure of six stands of chaparral, ranging in age from 55 years to greater than 115 years, from southern California and the southern Sierra Nevada are examined. Important demographic differences exist between chaparral stands, dictated largely by species composition.

Shrub species capable of resprouting after fire are also able to rejuvenate their canopy from resprouts in the absence of fire. All resprouting species so far examined have an age structure indicating continuous recruitment of new stems from established root crowns. However, species differ in the rate of stem turnover.

Shrub species which seldom establish seedlings after fires, e.g., Quercus dumosa, Rhamnus crocea, Prunus illicifolia, do establish seedlings under the mature chaparral canopy. This is apparently restricted to more mesic older stands with a well-developed litter layer. On such sites the rate of successful recruitment into the population is variable with species.

Species which commonly establish seedlings after fire do not recruit seedlings in mature chaparral, regardless of the age of the stand. These include obligate seeding and resprouting species of Ceanothus and Arctostaphylos as well as Adenostoma fasciculatum.

INTRODUCTION

California chaparral is well known for its resilience to recurrent wildfires. Not only do the major shrub species regenerate their original cover from resprouts, but many species produce seeds which require the stimulus of fire to break dormancy. It would seem beyond question that recurrent wildfires have played a significant role in the evolution of chaparral taxa. Indeed, chaparral is often described as a fire-dependent vegetation.

Chaparral stands which remain unburned for more than 50 years are commonly described in the literature as being 'senescent' with little annual growth. While the concept of stand senescence has not been studied in detail, these generalizations have their origin in the observation of increasing levels of dead wood and early studies which showed markedly decreased levels of deer browse, defined as production below 1.5 m height (Biswell et al. 1952, Gibbens and Schultz 1963).

An important question about a fire-dependent vegetation is the extent of resilience to fire-free conditions. Some have suggested that in the absence of fire, chaparral would die out and be replaced by other vegetation. Although this question has not been studied extensively, studies of mixed chamise chaparral stands exceeding 90 years of age in both northern California (Hedrick 1951) and southern California (Keeley and Zedler 1978) found no evidence of imminent stand replacement.

STUDY SITE AND METHODS

Our study site was located in Silverado Canyon in the Santa Ana Mountains 30 km east of Santa Ana, California. It was a north facing slope at 950 m with an inclination of approximately 45 degrees. Unpublished fire records maintained for over 60 years by the U.S. Forest Service (Trabuco District, Cleveland National Forest) showed no recorded fires for this area.

The stand was sampled in the fall of 1983 by recording stem diameters at ground level for all woody stems in sixty-five 2x4 m plots laid out randomly across approximately half a hectare. Stems connected through a root crown or by underground rhizomes were considered part of a single individual. Seedlings were defined as plants which apparently had established in recent decades as suggested by small size, a taproot and no clear connection with an established root crown. Basal stem area was calculated from stem diameter by assuming the stems approximated a circle.

Sections of all stems on a number of individual shrubs for the dominant species were cut at ground level. These were returned to the lab, sanded, polished and the xylem rings were counted.

RESULTS AND DISCUSSION

Table 1 shows that this stand was dominated by Quercus dumosa (scrub oak). "Seedlings," defined as individuals established in recent decades, were most abundant for the dominant Q. dumosa and for Rhamnus crocea (redberry), a species not well represented in the mature population. In general, these are species which seldom establish seedlings after fire. Recruitment of new individuals into the community was not observed for Ceanothus crassifolius (hoaryleaf ceanothus), Adenostoma fasciculatum (chamise) or Arctostaphylos glandulosa (Eastwood manzanita).

The proportion of the population which was dead varied greatly amongst the species. Approximately a fifth of the scrub oak population was dead, although this represented only a fraction of the basal area. In ceanothus nearly two-thirds of the population was dead although many of these were the smaller plants, as the dead population represented only approximately half of the basal area.

Patterns of ring counts were quite different amongst the species studied. In ceanothus, due to rotting and splitting, only one of the five plants sampled gave a complete count of rings. This individual had 117 rings on the single stem. The other four plants had ring counts exceeding 100 on all stems. Since there is abundant evidence that ceanothus species lay down annual rings (Guntle 1974, Schlesinger and Gill 1978), we conclude that this stand of chaparral was 117 years old. Additionally, since this obligate seeding species establishes seedlings only after fire, and it does not initiate new basal sprouts in the absence of fire, we conclude that all stems were even-aged.

Evidence that xylem rings represent annual growth rings is largely lacking for the other species sampled from this stand. One piece of circumstantial evidence that annual rings are laid down by the other species is the following observation. The ceanothus stems showed a pattern in which the 1969 ring was exceptionally wide, suggesting very favorable growth conditions in that year. With an arbitrary ranking of 1.00 for that ring, the preceeding year's ring had a width of 0.60 and the 1970 ring width was 0.20. These widths probably reflect the precipitation patterns for those years; percentage of mean precipitation was 82 percent for 1968, 147 percent for 1969 and 59 percent for 1970 (for the nearest station, Santa Ana, based on the Climatological Summary published by the National Oceanic and Atmospheric Administration). This same pattern of relative ring widths for those years was observed in the ring patterns of all other species.

Table 1

Density and coverage of shrubs at Silverado chaparral stand

		Density (Plants/ha)	Density (Stems/ha)	Basal Area (m^2/ha)
Quercus dumosa	Alive	3420	7480	31.1
	Dead	700	1600	1.5
	Seedlings	1300	-	<.1
Ceanothus crassifolius	Alive	574	1130	5.7
	Dead	1110	1560	4.8
Heteromeles arbutifolia	Alive	1600	3300	3.3
	Dead	200	310	0.5
	Seedlings	50	-	<.1
Adenostoma fasciculatum	Alive	640	2460	2.0
	Dead	230	1070	1.7
Arctostaphylos glandulosa	Alive	570	1560	2.4
	Dead	120	680	0.8
Cercocarpus betuloides	Alive	230	2770	0.8
	Dead	0	410	0.1
Rhus ovata	Alive	310	720	0.8
	Dead	0	180	0.1
	Seedlings	50	-	<.1
Rhamnus crocea	Alive	40	270	0.1
	Dead	0	80	<.1
	Seedlings	920	-	<.1

One characteristic which held for all of the other shrub species was the observation that stems on a single plant were not even-aged. This is illustrated in Figure 1 for four of the species. All of the shrub species in this stand, other than ceanothus, are capable of resprouting after the tops are killed by fire. It appears from the patterns in Figure 1 that all of these species also are capable of continually producing new sprouts in the absence of fire. The single scrub oak individual shown in Figure 1 indicates that one of the stems was initiated immediately after the previous fire around 1866. Since that time new sprouts have successfully established approximately every 10 to 20 years.

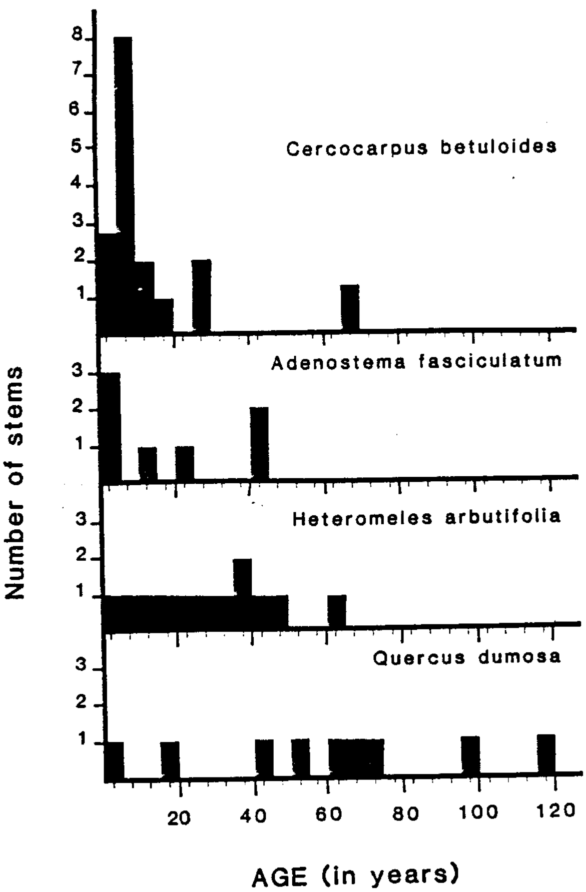

Figure 1

Distribution of ages, in five year age classes, for all stems on a single plant of scrub oak (Quercus dumosa), toyon (Heteromeles arbutifolia), chamise (Adenostoma fasciculatum) and mountain mahogany (Cercocarpus betuloides).

One major deviation from this pattern observed for the other scrub oaks sampled as well as the other sprouting species was the absence of stems which dated back to the previous fire. It appears that in general there is a significant amount of turnover of stems, and thus stems over 100 years were relatively rare.

One pattern which was quite consistent amongst the sprouting species was a very strong correlation between stem diameter and age as illustrated for scrub oak (Figure 2).

The regression line from these data (Figure 2) was used to construct the age distribution of stems recorded from the quadrat sampling. It is clear from Figure 3A that the vast majority of scrub oak stems are relatively recent sprouts. If one assumes a relatively constant rate of sprout production with age, it then appears that mortality is quite high during the first decade after production. It would appear that during the period between 40 to 70 years, either initiation of sprouts was greatly enhanced or mortality was much reduced over current patterns.

All of the scrub oak seedlings encountered in the quadrat sampling were collected and aged. The distribution of ages for this 'seedling' population are shown in Figure 3B. It is clear that while seedling establishment under the shrub canopy is common, it is doubtful whether many will be successfully recruited into the mature population. For example, the oldest seedling encountered was 33 years of age but was less than 1 meter in height, well below the mature shrub canopy of 2 to 3 m. This low level of recruitment, however, is probably sufficient for long term replacement since continuous sprout production by the shrubs would seem to ensure long term rejuvenation and stability.

CONCLUSIONS

Shrub species capable of resprouting after fire are also able to rejuvenate their canopy from sprouts in the absence of fire. All resprouting species so far examined have an age structure indicating continuous recruitment of new stems from established root crowns. Species, however, differ in the rate of stem turnover.

Shrub species which seldom establish seedlings after fires, e.g., scrub oak and redberry, establish seedlings under the mature chaparral canopy.

Species which commonly establish seedlings after fire do not recruit seedlings in mature chaparral. These include obligate seeding and resprouting species of ceanothus and manzanita as well as chamise.

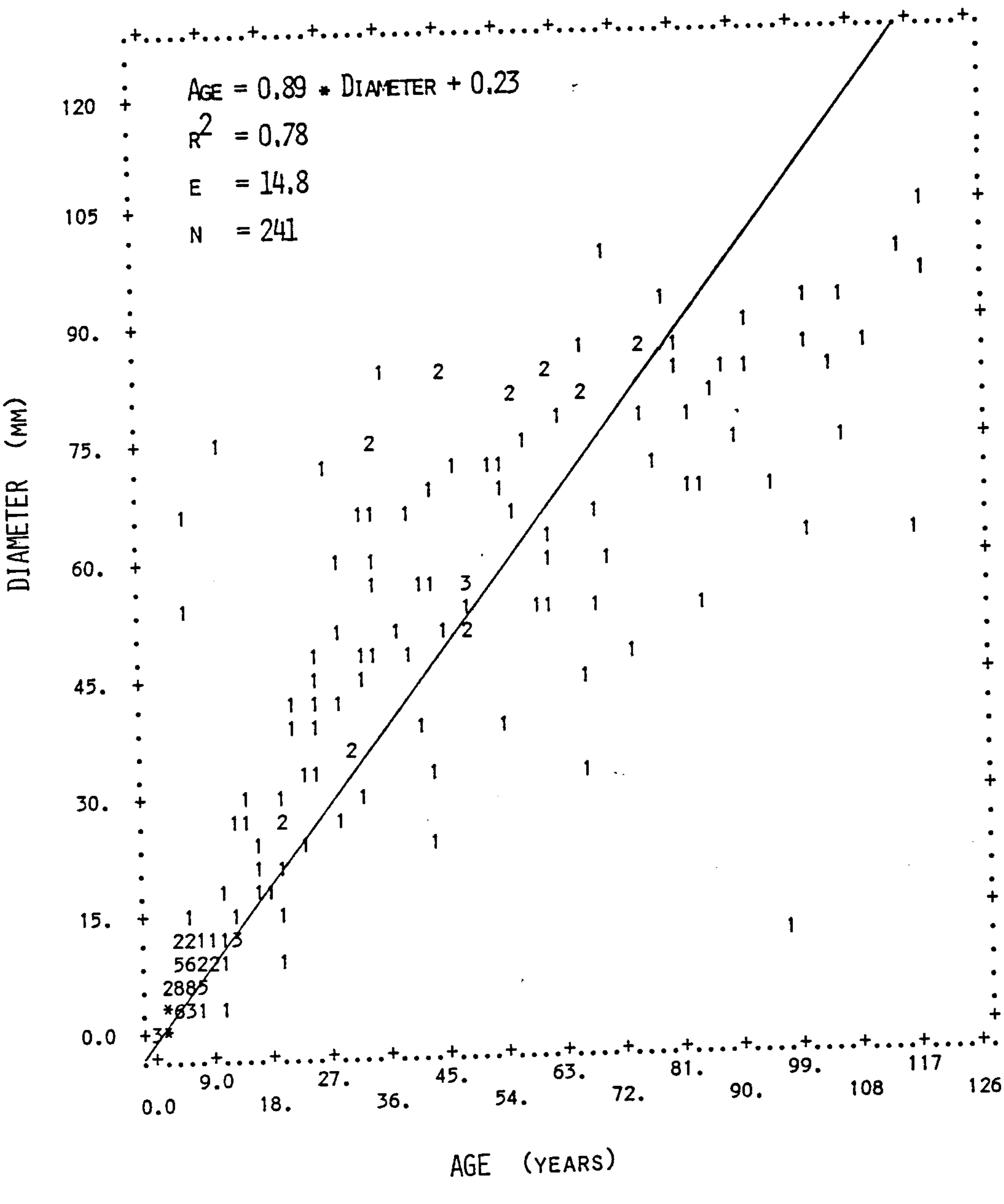

Figure 2

Correlation of diameter and age for all scrub oak stems sampled from mature shrubs (numbers indicate the number of individuals at a particular set of coordinates, * = > 9 individuals).

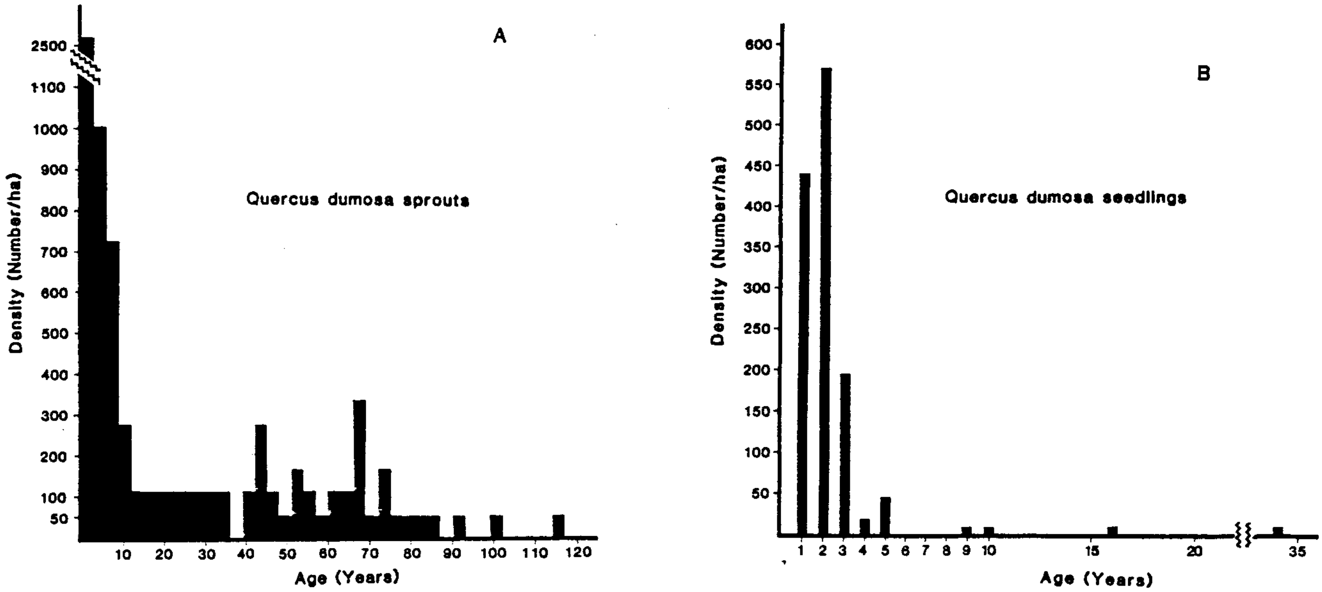

Figure 3

Age distribution of scrub oak stems on established shrubs (A) and for relatively recently established "seedlings."

REFERENCES

Biswell, H. H., R. D. Taber, W. W. Hedrick, and A. M. Schultz. 1952. "Management of Chamise Brushlands for Game in the North Coast Region of California." California Fish and Game 38: 453-484.

Gibben, R. P. and A. M. Schultz. 1963. "Brush Manipulation on a Deer Winter Range." California Fish and Game 49: 95-118.

Guntle, Gary Ray. 1974. "Correlation of Annual Growth in Ceanothus crassifolius Torr. and Arctostaphylos glauca Lindl. to Annual Precipitation in the San Gabriel Mountains." M.S. Thesis, Biological Sciences, California State Polytechnic University, Pomona.

Hedrick, D. W. 1951. "Studies on the Succession and Manipulation of Chamise Brushlands in California." Ph.D. Dissertation, Texas A & M College, College Station.

Keeley, J. E. and P. H. Zedler. 1978. "Reproduction of Chaparral Shrubs After Fire: A Comparison of Sprouting and Seeding Strategies." American Midland Naturalist 99: 142-161.

Schlesinger, W. H. and D. S. Gill. 1978. "Demographic Studies of the Chaparral Shrub, Ceanothus megacarpus, in the Santa Ynez Mountains, California." Ecology 59: 1256-1263.