Impacts of Postfire Grass Seeding on Vegetation Recovery in Southern California Chaparral

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Abstract

Postfire grass seeding as an attempt at erosion control on chaparral slopes has been a common practice for decades. Annual ryegrass (Lolium multiflorum) has been most frequently used. Critics point out that ryegrass can suppress native species and may reduce shrub seedling survival. In 1986, we began investigating the impacts of seeded ryegrass on chaparral regeneration. We gathered prefire vegetation data on sites scheduled to be burned in wildfire-intensity prescribed fires. After four prescribed fires and a wildfire, half of the vegetation plots at each site were seeded with annual ryegrass, and vegetation cover, composition, and shrub seedling density were measured each spring for 5 years. At only one site was average total herbaceous plant cover significantly greater on seeded plots than on unseeded plots. At all sites, average herbaceous plant cover other than ryegrass was less on seeded plots in at least one postfire year. Mean shrub seedling density was never significantly different between seeded and unseeded plots. After 5 years, surviving shrub seedling density appeared to be sufficient to replace plants killed by fire. Our results suggest that seeded ryegrass has a greater impact on the chaparral postfire herbaceous flora than on shrub seedling regeneration in southern California.

Introduction

Chaparral is the fire-prone, shrub-dominated vegetation type that cloaks steep hillsides in the hills and mountains adjacent to many southern California cities. At the end of a typical warm, dry summer, fuel moisture (plant water content) is very low and high-intensity fires may occur, killing all aboveground biomass (Keeley and Keeley 1988). A flush of annual and perennial herbaceous plants appears during the first spring growing season after a fire, along with shrub seedlings and resprouts from underground structures of some species (Horton and Kraebel 1955, Keeley and Keeley 1981). By about 4 years after a fire, shrubs again dominate burned areas (Hanes 1971, Keeley and Keeley 1988).

During the first winter after a chaparral fire, while slopes are still bare, rainstorms of even moderate intensity can mobilize destabilized hillslope surface material and cause major downstream debris flows and flooding (Wells 1987). To try to reduce this erosion and the threat posed to human structures and utilities, agencies such as the California Department of Forestry

and Fire Protection and the USDA Forest Service often seed burned chaparral hillslopes with annual grasses such as annual ryegrass (Lolium multiflorum Lam.; Hickman 1993), a native of Europe. Ryegrass has been chosen because it germinates quickly, produces an extensive fibrous root system, is inexpensive and readily available, and it can easily be applied from the air (Barro and Conard 1987). Critics of the practice point to studies showing that postfire grass seeding interferes with growth of the native postfire flora, particularly annuals with fire-stimulated germination, and seedlings of shrub species that are killed by fire (Gautier 1983, Keeler-Wolf 1995, Keeley and others 1981, Taskey and others 1989).

Previous studies often used a limited number of usually small plots located in areas burned by wildfire, where the prefire vegetation composition could not be known for certain. To address some of these limitations, in 1986 we began a long-term study of the effects of postfire grass seeding on vegetation development and erosion in southern California chaparral (Beyers and others 1998, Wohlgemuth and others, this volume). This paper summarizes the vegetation results of our study on the impacts of seeded ryegrass on chaparral regeneration after fire.

Methods

Study sites were established in areas of mature, mixed chaparral scheduled to be burned in wildfire-intensity prescribed fires. At each site, forty 2 m by 10 m vegetation plots were installed before the fire. Prefire vegetation measurements included density and cover of shrub species. After the fire on each site, fire severity was evaluated on each plot and only those plots where severity was moderate or high (table 1) were retained in the study. In the fall after each fire, half of all completely burned plots were seeded with annual ryegrass. Seed was applied by hand with rotary fertilizer spreaders at a target density of 430 seeds m^{-2} (approximately 9 kg ha^{-1} [8 lb. ac^{-1}], a common target rate for aerial seeding). Vegetation development on seeded and unseeded plots was measured each spring when herbaceous species were at peak biomass, for up to 5 years after fire. Cover of all species present was determined by eye after dividing each plot into five 2-m by 2-m subplots. Shrub seedlings were counted within five 1-m by 1-m subplots in each plot. The canopy volume of each sprouting shrub within each plot was estimated by measuring the shrub's height and two perpendicular canopy diameters. Differences between seeded and unseeded plots were analyzed using a two-sample randomization test (Manly 1991); each P-value was estimated from 1,000 randomizations, and only P-values less than 0.05 were considered significant.

Table 1. Characteristics of five chaparral study sites in coastal southern California.

	Bedford	Belmar1	Belmar2	Buckhorn	Vierra
Mountain range	Santa Ana	Santa Monica	Santa Monica	Santa Ynez	Santa Lucia
Elevation (m)	670	450	450	1035	425
Mean aspect	NE	S	SSE	SSW	S
Mean slope (°)[1]	36 ± 0.8	27 ± 0.9	27 ± 0.8	33 ± 0.7	28 ± 0.7
Prefire live shrub cover (pct)[1]	33 ± 1.7	45 ± 4.3	48 ± 2.7	28 ± 3.3	31 ± 1.1
Dominant prefire shrub species	Quercus berberidifolia Prunus ilicifolia Rhamnus ilicifolia Fraxinus dipetala	Ceanothus megacarpus Malosma laurina Cercocarpus betuloides Heteromeles arbutifolia	Ceanothus megacarpus Malosma laurina Cercocarpus betuloides Heteromeles arbutifolia	Ceanothus cuneatus Adenostoma fasciculatum Quercus berberidifolia Prunus ilicifolia	Adenostoma fasciculatum Ceanothus cuneatus Salvia mellifera Prunus ilicifolia
Burn month/year	July 1990	June 1988	Nov. 1993[2]	Mar. 1994	Nov. 1990
Fire severity[3]	High	Moderate	High	High	High/Mod.

[1] Slope and shrub cover values are means ± s.e.
[2]Burned in wildfire; other sites burned in prescribed fires.
[3]Moderate severity: leaf litter mostly consumed; soil charred to 1 cm depth; >25% unburned foliage remaining.
High severity: leaf litter completely consumed; soil charred to 2.5 cm depth; foliage completely consumed.

Results

Study sites were located in four coastal mountain ranges and burned in different years (table 1). One site (Belmar2) burned in a wildfire in November 1993; it was adjacent to a site burned 5 years earlier in a prescribed fire (Belmar1). The Buckhorn fire was conducted in March 1994, and seeding was not done until the following fall. Although vegetation sampling was conducted at Buckhorn in the spring of 1994, the spring of 1995 is considered the first growing season after fire for the purpose of comparing seeded to unseeded treatments on that site.

At the end of the first growing season after fire, total vegetation cover was not significantly different between seeded and unseeded plots at any site except Vierra (burned November 1990). At Vierra, vegetation cover was extremely low even on the ryegrass-seeded plots and consisted mostly of sprouting shrubs (fig. 1). At Belmar1 and Buckhorn, cover of herbaceous species other than ryegrass was significantly less on seeded plots during the first

year; there was no difference at the other sites. Ryegrass achieved its maximum absolute cover during the first growing season at Belmar1 and Buckhorn and declined thereafter.

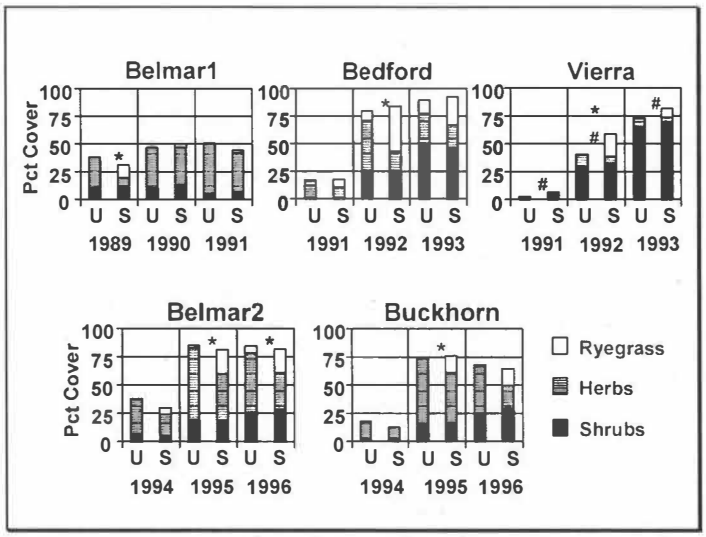

Figure 1. *Mean total vegetation cover at five chaparral study sites, measured in late spring during the first three growing seasons after fire and seeding. Bars are divided into relative amounts of shrub, herbaceous, and ryegrass cover (actual cover of individual species added to more than 100 percent in some years). Within each year,* ***U****=unseeded plots and* ***S****=seeded plots. #=mean total cover significantly different between seeded and unseeded plots at p<0.05. *=mean herbaceous cover other than ryegrass significantly different between seeded and unseeded plots at p<0.05.*

After the second and third postfire growing seasons, total vegetation cover again was significantly greater on seeded plots only at Vierra. Ryegrass cover was greatest during the second growing season after fire at Bedford, Vierra, and Belmar2. Cover of herbaceous species other than ryegrass was significantly less on seeded plots during the second growing season after fire on these sites as well (fig. 1). Ryegrass cover was low on all sites in the fourth and fifth year.

Sprouting shrub canopy volume and total shrub cover were not significantly different between seeded and unseeded plots at any site. At all sites except Bedford, species of Ceanothus were the most common chaparral shrubs regenerating from seed (the Bedford site produced few shrub seedlings of any kind). Ceanothus seedling densities in seeded and unseeded plots were not significantly different ($p>0.05$) at any site during the first three growing seasons after fire (table 2). At all sites, density of surviving Ceanothus seedlings after 3 to 5 years was greater than prefire shrub density.

Table 2. *Mean prefire density[1] of obligate-seeding Ceanothus species at four study sites, and mean postfire densities of seedlings of those species in seeded and unseeded plots.*

	Belmar1		Belmar2		Buckhorn		Vierra	
	Unseeded	Seeded	Unseeded	Seeded	Unseeded	Seeded	Unseeded	Seeded
Prefire # m^{-2}	0.3 ± 0.15	0.2 ± 0.09	0.4 ± 0.09	0.4 ± 0.10	0.3 ± 0.03	0.5 ± 0.08	0.4 ± 0.06	0.3 ± 0.05
Postfire # m^{-2}								
Year 1	4.6 ± 1.4	1.7 ± 1.0	9.4 ± 3.4	6.6 ± 3.2	6.9 ± 1.7	4.2 ± 1.3	5.4 ± 0.9	5.6 ± 1.0
Year 2	0.4 ± 0.2	0.2 ± 0.2	2.9 ± 0.9	2.3 ± 0.7	0.7 ± 0.3	0.4 ± 0.2	3.9 ± 0.7	3.4 ± 0.8
Year 3	0.4 ± 0.2	0.4 ± 0.2	2.2 ± 0.7	1.7 ± 1.7	0.6 ± 0.3	0.4 ± 0.2	2.0 ± 0.4	2.0 ± 0.4

[1] number m^{-2} ± s.e.

Discussion

Chaparral stands have a soil "seed bank" of shrub and herbaceous species, many of which are released from dormancy as a result of fire (Keeley 1991). Seedlings appear during the first spring after fire. Annual grasses are sown onto burn sites with the intention of increasing plant cover over what will be produced naturally.

Keeley and others (1981) observed a negative relationship between ryegrass cover and cover of native fire-annuals at several sites in San Diego County. Similar to other researchers (Gautier 1983, Taskey and others 1989), we found that annual ryegrass tended to replace, rather than add to, natural herbaceous plant cover on post-burn sites in southern California chaparral. At all sites, average herbaceous plant cover other than ryegrass was less on seeded than on unseeded plots in at least 1 postfire year. Herbaceous species richness was lower on seeded plots as well (Beyers and others 1994) . Only on the site with the least herbaceous vegetation cover, Vierra, did ryegrass seeded plots have significantly greater total plant cover. The slightly greater plant cover did not produce a significant decrease in winter erosion (Wohlgemuth and others, this volume).

Conard and others (1995) presented a conceptual model of postfire vegetation development in chaparral based on results from our first three study sites (Belmar1, Bedford, and Vierra). The model suggested that under environmental conditions favorable for plant growth, natural postfire plant regeneration should produce as much cover as sites augmented with seeded grass. Our results from two new sites (Belmar2, Buckhorn), where rainfall during the first few postfire winters was relatively high (Wohlgemuth and others in press), appear to support the model.

An obligate seeding Ceanothus species was an important component of the prefire vegetation at all sites except Bedford (table 1). Obligate seeders are killed by fire and must regenerate from seed. Unlike the herbaceous flora, Ceanothus seedling density was not negatively affected by ryegrass seeding. Average ryegrass cover during the first winter after fire, when shrub seedlings germinate and become established, did not exceed 20 percent on our study sites. Where greater winter rainfall results in higher grass cover during the first growing season

after fire, as in northern California, shrub seedlings may be suppressed by seeding (Schulz and others 1955). Shrub seedling density after 3 to 5 years on our sites appeared sufficient to replace plants killed by fire, though more seedling mortality may be expected in later years (Riggan and others 1988).

The long-term impact of the reduction in postfire native herbaceous plant cover on ryegrass-seeded sites is unknown. Keeley and others (1981) identified a group of annual plants ("pyrophyte endemics") that germinate and grow almost exclusively in the first growing season after a fire. Two of our study sites had enough ryegrass cover the first year to apparently cause a reduction in the abundance of native herbs (including pyrophyte endemics). These species may persist into the second year after fire, when ryegrass cover is usually greater. Reduction in growth of postfire specialists may reduce the seed bank available to germinate after the next fire. Resampling our seeded and unseeded plots after they burn again may help address this concern.

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