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A Postfire Seeding Experiment at the San Diego Wild Animal Park

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Abstract. Little is known about the impact of postfire grass seeding for erosion control on vegetation development in coastal sage scrub. After October 1993, when wildfire burned through undeveloped sage scrub at the San Diego Wild Animal Park (Escondido, California), we set up 16 test plots randomly divided among four seeding treatments: annual ryegrass, a native grass and forb mix, an exotic grass and forb mix, and control (unseeded). Sediment movement and vegetation development were monitored periodically from January through May 1994. In late spring we collected line-point vegetation data on each plot. Plant cover by late April averaged 88% to 94%, and seeded species comprised less than 5% of cover in all treatments. Natural regeneration was dominated by naturalized exotics such as *Hirschfeldia incana*, *Erodium* spp., and *Bromus madritensis*, along with native species such as *Mirabilis californica*, *Phacelia* spp, *Chaenactis* spp. and *Eucrypta chrysanthemifolia*. Cover of seeded species was so low that it probably had negligible impact on erosion or natural vegetation development.

Keywords: Annual ryegrass; coastal sage scrub; emergency revegetation; fire; soft chaparral; southern California.

Introduction

Coastal sage scrub is a fire-dominated, drought-deciduous, shrubby vegetation type in southern California that has largely disappeared due to development. Less than 20% of the original area once covered by coastal sage scrub probably remains (Westman 1981). Due in part to this habitat loss, several animal species associated with coastal sage scrub have been proposed for endangered species status; the California gnatcatcher, a small songbird, was listed in March, 1993 as threatened by the USDI Fish and Wildlife Service (United States Fish and Wildlife Service 1993; see also Atwood 1993).

On October 28, 1993, the Guejito fire burned approximately 325 ha (800 acres) of undeveloped coastal sage scrub habitat at the San Diego Wild Animal Park, San Diego County, California. Park officials feared that erosion of the land left bare by the fire would threaten Park structures and visitor safety. Most of the burned acreage was aerially seeded in November with annual ryegrass, *Lolium multiflorum*, in hopes of reducing erosion.

Ryegrass has been used for postfire seeding in southern California since the 1940's because it germinates quickly, produces an extensive root system, and is inexpensive and easy to apply (Department of Forester and Fire Warden 1985). However, the practice of seeding burned hillsides with annual ryegrass is controversial (Barro and Conard 1987). Studies on chaparral sites have found a negative relationship between ryegrass cover and native herbaceous cover (Keeley et al. 1981, Taskey et al. 1989, Beyers et al. 1994) and between ryegrass cover and shrub seedling survival (Schultz et al. 1955, Gautier 1983). There are no previous studies on the effects of ryegrass seeding on coastal sage scrub, which is sometimes called "soft" chaparral and shares many native species with "hard" chaparral. Concern about effects of postfire seeding on sage scrub regeneration prompted us to set up an experiment to assess the impacts of annual ryegrass and other available seed mixes on erosion and vegetation development.

Methods

In December 1993, on an unseeded portion of Park land, we set up 16 test plots divided equally among four seeding treatments: annual ryegrass (*Lolium multiflorum*), a "native" grass and forb mix (*Bromus carinatus*, *B. arizonicus*, *Hordeum californicum*, *Eschscholzia californica*, *Lupinus succulentus*; ratio 10:10:32:1:8 by weight), an "exotic" grass and forb mix

containing three non-native species (*Bromus hordaceous*, *Vulpia myuros* 'zorro', *Trifolium hirtum* 'hykon', *Eschscholzia californica*, *Lupinus succulentus*; ratio 20:12:30:1:8 by weight), and control (unseeded) (seed mixes were obtained from S & S Seeds, Carpenteria, California[1]). Each plot was approximately 15 m wide and extended from the base of the slope uphill to a natural slope break (40 - 150 m, depending on local topography). An erosion trap, consisting of a long plastic tray open on the uphill side, was installed near the bottom of each plot. Seeding treatments were randomly assigned to plots. Because of delay in acquiring some seed, seeding was not carried out until January 1994. Natural herb and shrub regeneration had begun by then, but little growth had occurred due to low rainfall. Hand-operated fertilizer spreaders were used to apply the seed at a target rate of 9 kg/ha (8 lb/ac), the rate typically used for aerial seeding. Application rate was checked by placing eight sticky papers within a plot (contact paper squares 529-cm² in size) and counting seeds after application (target rate 23 seeds/sticky paper).

Vegetation development was monitored monthly in marked 2-m by 10-m subplots. Line point transect samples, using the vegetation subplots as starting points, were taken on each plot during late April 1994. Two parallel lines, 25 m in length, were laid out; every 0.5 m along each line a pointer was dropped through the vegetation and the identity of each plant touched was recorded, for a total of 100 points per plot. Sediment accumulation was measured soon after seeding, checked monthly, and measured again in late April. In mid-May, we took three line-point transect samples within the area seeded aerially with annual ryegrass, on slopes with aspects similar to our study site, for comparison. We also noted animal use of the site at the times of our visits.

Results

We observed seedlings of grasses and forbs on the site as early as mid-November 1993. By April total plant cover was around 90 percent in all treatments. Revegetation was dominated by naturalized (non-native) species such as Mediterranean mustard (*Hirschfeldia incana*, also known as *Brassica geniculata*), filaree (*Erodium cicutarium*, *E. moschatum*), and red brome (*Bromus madritensis*) (Table 1). The mustard was particularly abundant, producing at least 60 percent aerial cover in all treatments. Resprouting wishbone bush (*Mirabilis californica*) was the most abundant native species, followed by several fire annuals (*Phacelia cicutaria*, *P. parryi*, *Eucrypta chrysanthemifolia*, *Chaenactis artemisiaefolia*, *C. glabriuscula*). Resprouting and seedling shrubs, such as laurel sumac (*Malosma laurina*), California sagebrush (*Artemisia californica*), California buckwheat (*Eriogonum fasciculatum*) and white sage (*Salvia apiana*), were present but contributed little cover by late April.

Seeded species produced less than 5 percent cover in all treatments (Table 1). This may have been partly due to the late seeding; however, ryegrass seeded in mid-November elsewhere at the park produced very little cover as well (Table 1, last column). There was considerable plot-to-plot variation in sediment accumulation before plant cover was established (data not

Table 1. Percentage cover[1] of selected native, naturalized (non-native), and seeded species on line point transects sampled in April 1994 at the San Diego Wild Animal Park study site.

Species	Treatment:	Percentage Cover									
		Control		Ryegrass		Native Mix		Exotic Mix		Aerial Ryegrass	
		$\bar{X}$	(S.D.)	$\bar{X}$	(S.D.)	$\bar{X}$	(S.D.)	$\bar{X}$	(S.D.)	$\bar{X}$	(S.D.)
Naturalized species											
Hirschfeldia incana		68.5	(12.8)	61.0	(19.1)	62.8	(2.8)	66.0	(11.5)	84.0	(8.7)
Bromus madritensis		10.0	(6.8)	28.5	(6.5)	5.0	(0)	17.5	(9.0)	13.3	(12.1)
Centaurea melitensis		10.5	(3.7)	7.8	(5.4)	12.5	(2.1)	15.5	(9.1)	20.3	(31.8)
Erodium spp.		27.2	(14.8)	29.0	(28.8)	34.0	(15.3)	25.5	(9.2)	13.0	(8.0)
Native species											
Mirabilis californica		13.8	(6.9)	15.2	(12.3)	12.2	(3.9)	10.3	(7.8)	13.3	(4.9)
Chaenactis spp.		7.5	(3.9)	3.6	(6.3)	7.0	(4.7)	8.3	(9.5)	7.4	(4.7)
Eucypta chrysanthemifolia		0.8	(1.5)	9.5	(19.0)	1.0	(2.0)	6.2	(11.8)	0	
Lotus strigosus		5.0	(8.7)	0.8	(1.5)	2.0	(2.1)	3.0	(4.1)	2.3	(4.0)
Phacelia cicutaria		6.0	(11.3)	9.8	(18.8)	8.0	(6.4)	15.3	(14.5)	0.1	(0.1)
Phacelia parryi		3.8	(4.7)	2.0	(3.3)	6.5	(5.3)	1.3	(1.8)	0.7	(0.5)
Seeded species (total)				4.8	(5.4)	2.1	(1.6)	2.6	(1.0)	1.4	(1.1)
Total Plant Cover		90.0	(2.2)	91.8	(3.0)	88.8	(4.2)	94.2	(3.0)	96.3	(2.1)

[1]Values for each treatment are the mean of four plots. Data in the last column were collected in May 1994 from three transects within the area seeded aerially with annual ryegrass in November 1993.

shown). After late February almost no sediment was found in the traps.

Incidental postfire observations of wildlife within the study area included San Diego horned lizard (*Phrynosoma coronatum blainvillei*), red-diamond rattlesnake (*Crotalus ruber ruber*), southern mule deer (*Odocoileus hemionus fuliginata*), red-shouldered hawk (*Buteo lineatus*), turkey vulture (*Cathartes aura*), Lawrence's goldfinch (*Carduelis lawrencei*), Lazuli bunting (*Passerina amoena*), western kingbird (*Tyrannus verticalis*), rufous-crowned sparrow (*Aimophila ruficeps*), and California gnatcatcher (*Polioptila californica californica*). A pair of California gnatcatchers nested on the site in a large *Phacelia cicutaria* plant, surrounded by mustard, and successfully fledged at least two young. Rodent and insect activity were noticeable throughout the study area.

Discussion

Cover of seeded species was so low, and total cover under all treatments so similar, that we doubt seeding could have had an impact on either vegetation development or erosion. Dry weather during the winter of 1993-94 undoubtedly contributed to both the poor showing by seeded species and to a lack of destructive erosion at the Wild Animal Park.. Several gentle rainfalls in November and December were followed by a month-long drought; mid-February and early March were also dry (San Diego Wild Animal Park records). Much of the aerially-seeded ryegrass may have germinated and then died; ryegrass is known to require adequate winter precipitation for successful establishment (Rice et al. 1965). The sporadic rain after our hand-seeding may have doomed the seed mixes to a similar fate. We might have seen different results had the winter included heavier or more evenly-spaced rains.

Fire intensity at the site was apparently moderate: herbaceous plants and small-branched shrubs such as California sagebrush and white sage burned to the ground, but fairly large branches of laurel sumac remained. Unlike chaparral, where herbaceous plants are common during the first few years after a fire and then exist for decades only as a seed bank, coastal sage scrub maintains a diverse herbaceous flora into maturity (Westman 1981). Abundant mustard and annual grass occurred on our study site during the previous growing season (personal observation, C. Sharp). Wild Animal Park staff had hoped that the fire and seeded ryegrass would reduce the amount of mustard and brome on Park property, alleviating the problems these species cause for Park animals (irritating seeds and stiff branches). However, sufficient seed of mustard and brome survived the fire and, unlike ryegrass, produced extensive cover despite the erratic winter rainfall. Prolific postfire growth of mustard and annual grasses has been documented in other coastal sage scrub studies (Keeley and Keeley 1984, O'Leary and Westman 1988). Mustard, in particular, may have helped control erosion on our site: species of *Brassica* (including *Hirschfeldia incana*) were used by Los Angeles County for postfire seeding until the 1940's (Department of Forester and Fire Warden 1985). Because plentiful seed of grasses and forbs is naturally available in coastal sage scrub for quick germination after a fire, postfire seeding is unlikely to be necessary for erosion control, except perhaps in cases of high fire severity where soil is charred to a considerable depth. More research is needed to determine the relationship between fire severity and coastal sage scrub seed banks.

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