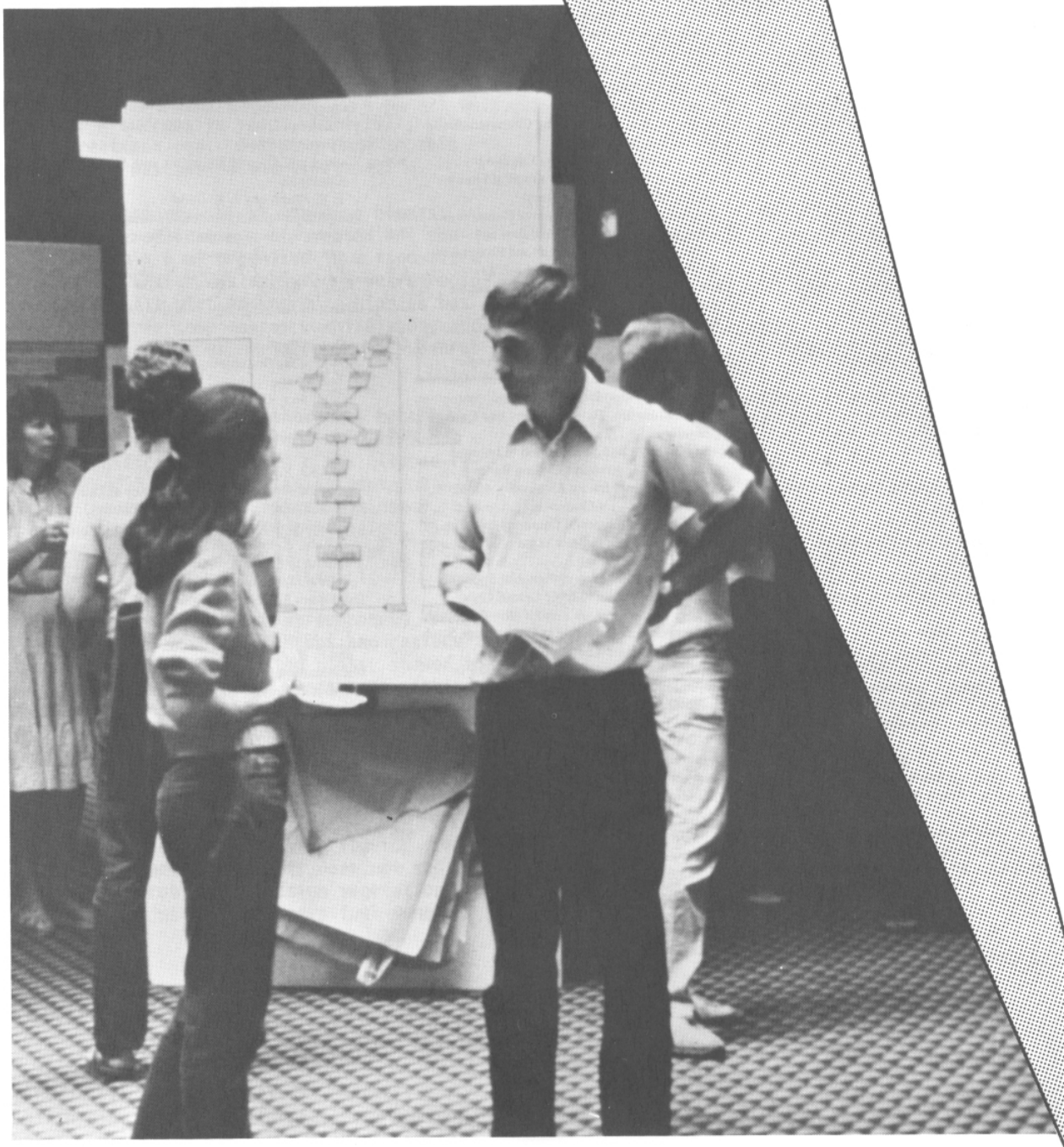
Poster Papers



Poster Papers

Biomass Response of Chamise (*Adenostoma fasciculatum* H & A) Chaparral to Clipping[1]

Theodore E. Adams, Jr., and Walter L. Graves[2]

Chamise is often the dominant species of California chaparral, and it crown sprouts vigorously after tops are removed by fire or other means. To determine the effect of top removal on chamise as a possible fuel management technique, two spring clipping treatments were applied to 3-year-old regrowth in a chamise stand recovering from wildfire in San Diego County. Clipping the 50-cm-high resprouts to a height of 30.5 cm for 4 successive years, 1974-1977, constituted treatment one. Clipping once to this height in 1974 was the second treatment.

Winter-season dry-weight standing biomass, including four replications of treated and control plots (3 m x 6 m) organized in a randomized complete block design, was measured 4 years beginning in 1975. All plot aboveground biomass was divided into three components: chamise above and below 30.5 cm, and other herbaceous and subshrub biomass.

The effect of clipping on chamise became apparent in 1977. Chamise biomass in 1977 and 1978 was significantly less in plots clipped repeatedly (Fig. 1). However, as an apparent result of the reduction of apical dominance, biomass of chamise below the clipping height was significantly greater (Fig. 2). Clipping once in 1974 had no lasting effect (Fig. 1, 3).

The herbaceous and subshrub component, which included grasses, forbs, subshrubs and residue from spring clipping in treated plots, showed no significant difference among treatments within years. By the end of the study in 1978, when this component was included with chamise, total biomass in plots clipped repeatedly was significantly less compared with unclipped plots (Fig. 3).

The results suggest annual spring top removal on 3-year-old chamise resprouts does not suppress growth of the shrub and companion vegetation sufficiently to justify this as a fuel management technique.

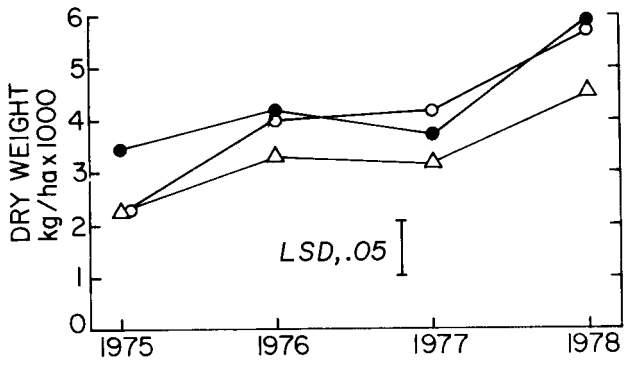


Figure 1--Chamise aboveground standing biomass in winter.

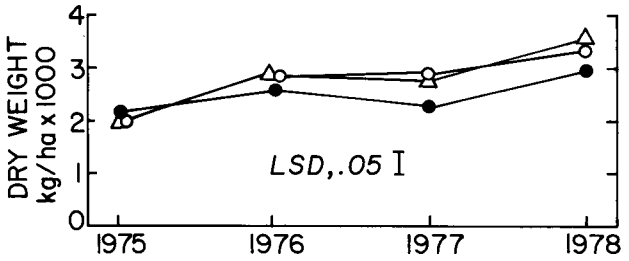


Figure 2--Chamise aboveground standing biomass in winter below 30.5 cm.

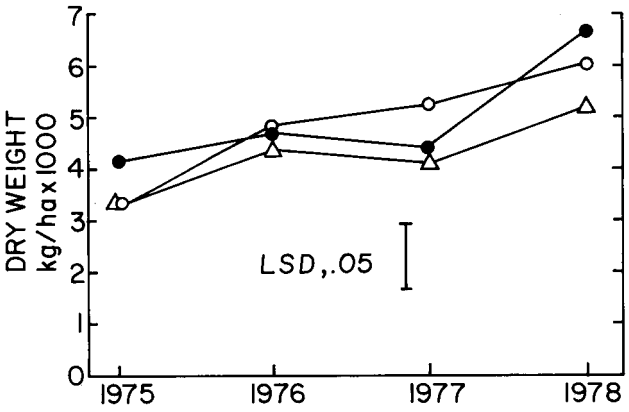


Figure 3--Total aboveground standing biomass in winter.

Control: ●

Clipped once: ○

Clipped repeatedly: Δ

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[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

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Postfire Recovery of Chamise Chaparral in Sequoia National Park, California[1]

Gail A. Baker, Philip W. Rundel, and David J. Parsons[2]

Chamise (Adenostoma fasciculatum) recovers after a fire by resprouting from root crowns and establishing seedlings. Growth in chamise is largely determined by the seasonal patterns of its physiological condition. Therefore the season of burning may affect root–crown survival and resprout growth rates. The following study examines the effects of a fall and spring burn on root–crown survival and seedling establishment.

Field studies were carried out in the foothills of Sequoia National Park (Tulare County, California) in old–growth chamise chaparral. Experimental manipulations consisted of paired burn and clip treatments during November 1979 and June 1980. An unmanipulated control stand was monitored throughout the study. Dimensional analysis techniques were used to estimate pre–and post–burn biomass of shrubs.

Our data suggest that spring treatments induce considerably higher levels of shrub mortality than do fall treatments (fig. 1). This differential pattern of survival is related to the annual cycle of growth reserves in chamise. At the end of the spring growing season, root reserves of carbohydrates are depleted and may not be sufficient to ensure resprouting. Fall treatments do not cause this type of mortality since carbohydrate translocation to the root crown over the summer months allows a recharge of stored reserves.

In addition to the seasonal difference of root–crown survival there is a significant difference in survivorship between spring burn and clip treatments that was not present in the fall. We

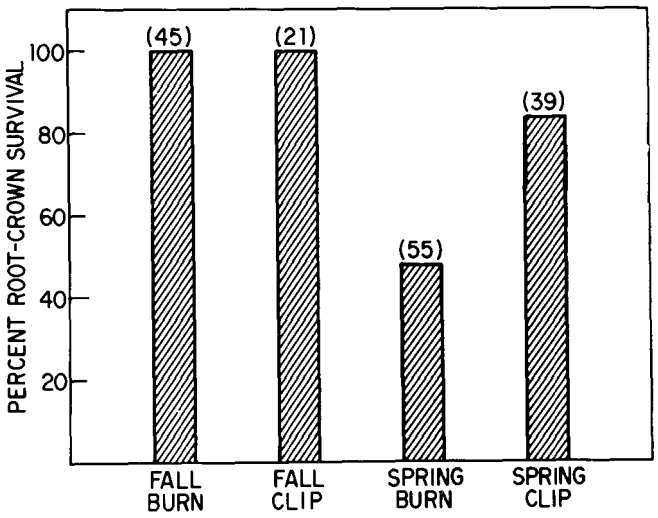

Figure 1--Percent of resprouting chamise root crowns following seasonal treatments. Numbers in parentheses indicate shrub sample size.

hypothesize that this differential pattern is related to the behavior of fire in the two seasons. Fall fires burn intensely and move quickly through the stand. Higher fuel moisture contents in spring mean that increased pre–heating times are necessary before combustion can take place. The slower speed of spring fires causes a greater depth of soil heating to occur and this appears to be the cause of the differential spring treatment mortality.

Pre–burn biomass of individual shrubs is a determinant of root–crown survival and post–burn growth rate. High mortality occurred in shrubs of the spring treatments whose pre–burn biomass was 1–5 kg. These smaller shrubs with hypothetically smaller carbohydrate reserves have a lower probability of surviving defoliation. Resprout biomass of surviving crowns at the end of the first season following fire is positively correlated with pre–burn biomass ($r = 0.60$, $y = 16.8(x) + 126.9$).

The lack of fire–induced mortality of our fall burn indicates that pre–burn shrub density is maintained, leaving little potential for seedling establishment. In the spring burn with less than 50 percent survival, establishment and successful growth of seedlings is of critical importance if succession is to restore prefire density.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean–type Ecosystems, June 22–26, 1981, San Diego, California.

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The Impact of Human Activities on the Vegetation of the Algarve[1]

Luís S. Barreto and Helena P. Dias[2]

The Algarve is a very well differentiated Province of Portugal. Its singularity comes from its geology, geomorphology and climate. In the Algarve, we find six ecological districts: 1) the Southern (Algarvian) Coast; 2) the Western (Atlantic) Coast; 3) the "Barrocal"; 4) the Algarvian Highlands ("Serra"); 5) Monchique Mountain; and 6) the Eastern Plateau.

The main vegetation units found in the Algarve are Pinewoods (*P. pinaster* and *P. pinea*); Acacia woodlands *(A. pycnantha*); Eucalyptus woodlands (*E. globulus*); cork oak woodlands (*Q. suber*) with strawberry trees (*Arbutus unedo*); cork oak woodlants with cistus (*C. landanifer*); strawberry tree woodlands; " Barrocal" (shrub layer formed by holm oak, *Q. rotundifolia,* or carob tree, *Ceratonia siliqua*; cistus formations; Calluna vulgaris and Erica australis formations; mountain rangelands (*Pteridium aquilinum* and *Festusca ampla*); vegetation of stabilized dunes (*Juniperus phoenica* and *Genista hirsuta);* vegetation of mobile dunes *(Polygonum maritimum, Malcomia littorea, Lotus creticus);* cliff vegetation; saltmarshes.

This vegetation has been influenced by several peoples that have colonized the Algarve. The introduction of new plants (the fig tree, presumed to have been introduced by the Phoenicians; the chestnut by the Romans C. 200 BC; the olive tree by the Visigoths; the carob tree, almond tree, lemon tree, orange tree, rice, cotton and *Triticum durum* by the Arabs), the intensification of cereal crops (Romans, Arabs, Portuguese); irrigation, grazing, afforestation, the rights given by the kings to the local peoples, and more recently the development of tourism have each had a certain impact upon the Algarve's vegetation.

Rare and endangered plants in the Algarve can be grouped as follows:

Very rare and endangered plants: *Asplenium petrarchae, Loeflingia tavaresiana, Mathiola parviflora, Tuberaria major, Erodium laciniatum, Astragalus sesameus, Pinguicula lusitanica, Orobanche trichocalyx, Senecio lopezii, Hyacinthoides vicentina, Bellevallia hackelii, Avena hackelli.*

Rare and endangered plants: *Quercus canariensis, Quercus x marianica, Quercus faginea, Silene rothmaleri, Iberis sampaiana, Ilex aquifolium, Rhododendron ponticum subsp. baeticum, Linaria algarviana, Linaria saturoides, Merendera filifolia, Narcissus willkommii, Narcissus gaditana, Biarum galiani.*

Plants which are rare but whose potential for extirpation is apparently low at present: *Aristolochia baetica, Biscutella vicentina, Diplotaxis vicentina, Ulex argenteus subsp. erinaceus, Astragalus massiliensis, Convolvulos siculus, Trisetaria dufourei.*

Plants of limited distribution or uncertain status: *Silene rothmaleri, Asteriscus maritimus, Scilla odorata, Hyacinthoides non-scripta, Stipa tenacissima.*

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Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

The Impact of Human Activities on the Fauna of the Algarve[1]

Luís S. Barreto and Lucio do Rosário[2]

By Mediterranean standards the Algarve is still very well preserved. In this region we can find 14 amphibians, 23 reptiles, 181 species of avian fauna and 13 mantras.

There are eight main wildlife habitats in the region: 1) *humid zones*: with 7 amphibians, 4 reptiles, 87 species of avian fauna and 4 mammals; 2) *cliff coast*: 23 species of avian fauna and 3 mammals; 3) *watersheds:* 6 amphibians, 3 reptiles, 27 avian species and 9 mammals; 4) *mountains*: 6 amphibians, 14 reptiles, 63 avian species and 11 mammals; 5) *eastern plateau*: 2 amphibians, 5 reptiles, 51 avian species and 6 mammals; 6) *western coast*: 9 amphibians, 8 reptiles, 64 avian species and 7 mammals; 7) *coastal plain*: 9 amphibians; 13 reptiles, 73 avian species and 7 mammals; 8) *beaches*: 13 avian species.

Man's impact on the fauna of the Algarve changes with the habitats. Among the most disruptive actions one can cite land development for dwellings and tourist resorts (especially near the coastline); destruction of vegetation in order to bring land under cultivation; afforestation with exotic trees and pines; degradation of cork oak woodlands; recreational camping (especially near the coastline); coincidence of the hunting season with the tourist season which leads to a very nigh concentration of hunters in the region; use of poisons and explosives in the streams; sand quarries; large dams.

The endangered species of the Algarve are: *Chameleon chamaleon, Porphyrio porphyrio, Fulica cristata, Padion haliaetus, Aquila heliaca (adalberti), Lynx pardina.*

The Algarve is also an important stopover along the routes of migratory species.

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[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

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Influence of Prescribed Burning on Small Mammals in Cuyamaca Rancho State Park, California[1]

Daniel J. Blankenship[2]

This study evaluated the responses of small mammal populations to disturbance or depletion of vegetation following prescription burns of April 24-30, 1978 and December 3 and 4, 1979. Results are based on 5430 trap nights.

The areas of study consisted of mixed conifer woodland with a chaparral understory in most places. The result of the fire was a reduction in shrubs (trees not affected) of 93 percent for the December 1979 burn and 91 percent for the April 1978 burn, based on evaluation 3 months and 1 year after the fire respectively.

The abundance of small mammals was reduced ($p < .02$) in the April 1978 burn as well as in the December 1979 burn when compared with controls (Table 1, Figure 1). The species composition did not differ significantly ($p > .05$) in the burned areas when compared with the controls (Table 2). The community did not show the regular pattern of postfire succession (brush species to grassland species) that is usually expected since the vegetation had not been completely altered by the light fire that is present under prescribed burning conditions. Consequently, very little damage results to the mammalian community structure when a carefully controlled fire is used. There was no significant difference ($p > .05$) in weight or sex ratios in the burn areas when compared with a control.

Table 1--Small mammal abundance for Control (C) and Experimental (E) study sites Al on East Mesa and B1-3 on Cuyamaca Peak Road.

Sample	Relative Abundance			
	Trapping Success		Total[1]	
	Ind./Trap Night (pct.)			
	C	E	C	E
Dec.'79 Al	3.33	0	3.33	0
Mar.'80 Al	1.05	1.58	1.05	2.64
May " B1,2	7.18	2.69	10.47	3.00
June " Al	2.77	1.04	5.03	1.38
July " B3	2.75	1.60	8.02	2.06
Sept." Al	1.40	1.14	4.59	2.93
Dec.'80 Al	2.97	1.48	8.62	3.27
X	3.00	1.30	5.87	2.18

"Total = Trapping Success and Recapture Success.

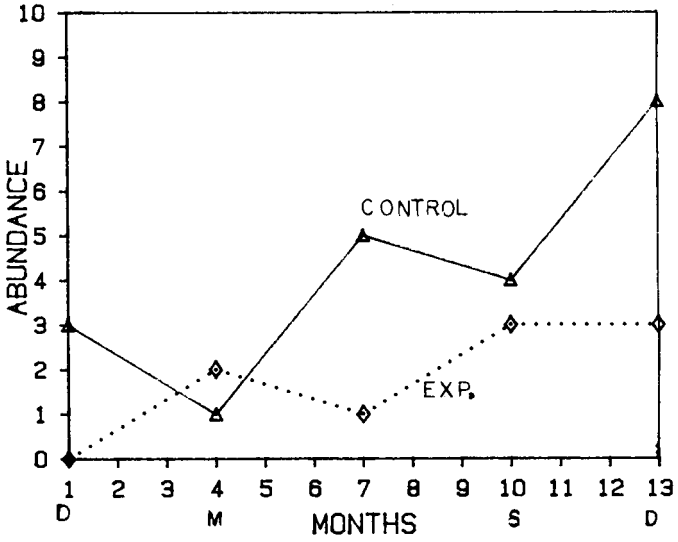

Figure 1--Graph showing relative abundance of animals for each month during the trapping period of December 1979-December 1980 on East Mesa study site.

Table 2--Percent composition based on total captures (N) of small mammals in study sites Al on East Mesa and B1-3 on Cuyamaca Peak Road. C=Control, E=Experimental.

Species	Composition	
	C (N=77)	E (N=37)
	pct.	
Al		
Peromyscus boylii	83.0	76.2
Perognathus calif.	9.7	4.8
Peromyscus calif.	2.4	-
Dipodomys agilis	4.9	14.3
Neotoma fuscipes	-	4.8
Spermophilus beecheyi	-	Incident
Eutamias merriami	-	Incident
B1-3		
Peromyscus boylii	94.4	100.0
Perognathus calif.	2.7	-
Neotoma fuscipes	2.7	-

The quantity of litter on the forest floor was found to be an important factor in maintaining maximum density in a population of mammals. In one study site (April 1978) where the density and composition of the vegetation did not differ from the control, there was still a reduction in the abundance of small mammals. This indicates that the reduction could possibly be attributed to the loss of litter and ground cover in the burn plots.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, California.

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Soil Resources and ORV Use Planning in Southern California National Forests[1]

Robert Blecker, James O'Hare, Tom Ryan, and Jeff Spector[2]

National Forests are mandated by law to develop land management plans according to specific rules and regulations (36 DFR Part 219, September 17, 1979). The regulations dictate that areas and trails will be classified according to whether or not off-road vehicle (ORV) use will be allowed. The four Southern California National Forests are in the planning process now.

The Forest Service must also respond to Executive Orders (E.O.) 11664, "Use of Off-Road Vehicles on the Public Lands" (2/8/72) and E.O. 11989, "Off-Road Vehicles on Public Lands" (5/24/77). These two E.O.'s require positive action on the part of the Forest Service in the management of ORV's on public lands.

The Los Padres National Forest (LPNF) has developed an ORV plan to meet the objectives of land management planning and Executive Orders. The Forest has signed and designated trails suitable for ORV use, closed and rehabilitated all hill-climbs and trails unsuitable for ORV use, and trained ORV enforcement officers to patrol and manage ORV use areas.

In the Ballinger Canyon area the LPNF has implemented a rehabilitation and monitoring program that will serve as a model for the remainder of the Forest's ORV use areas. Soil erosion is monitored using the California Division of Forestry's 3F erosion bridge method. Several monitoring methods are used to measure the impact ORV activity has on the land. The method used by the LPNF is the 3F method developed by the California Division of Forestry. Equipment consists of a level, two heavy steel stakes, and a length of welding rod. The level is modified so that it fits over the stakes, and ten holes equally spaced are drilled to fit the rod. The rod is inserted in each of the drilled holes. The distance from the top of the level to the end of the rod is measured. Changes in this measurement with time determine the erosion rate. The 3F method is used to measure the natural erosion rate on the badlands in Ballinger Canyon.

LPNF has modified the 3F method by using a 2x4 board to measure erosion impact on wide trails. Where deep channels or gullies are found, the sage tape technique is used. A measuring tape is placed across the study area, and the distance from the tape to the soil surface is measured. The heavy rope is used as a safety line on hill climbs with slopes greater than 60 percent. The Soil Conservation Service has a guide for rating soils for ORV activity. The LPNF has amended and expanded these guides to fit local conditions. The Speedy moisture meter is used to measure soil moisture conditions that could change as a result of ORV activity. A core sampler is used to measure changes in soil compaction. In heavy soils, compaction has been found to a depth of 0.4 foot. This compaction could result in increased runoff from the site and cause an impact to onsite and offsite resource values.

Soil piping is a characteristic of some of the heavier textured soils. The soil is high in exchangeable sodium (Na) and shrink/swell clays. Surface cracking as a result of the high clay content facilitates the channeling of water within the subsoil. This, in combination with the dispersion action of sodium, causes piping.

When the heavy soils are compacted, runoff increases, which aggravates the piping problem. For the past two years hill climbing has been reduced extensively by the LPNF management policy. Hill climbing activity has had an impact on the area immediately adjacent to the Ballinger Campground. The soils on many of the hill climbs near Ballinger Campground have a heavy texture and an annual plant community. These two factors lend the area to short recovery period (1-2 years) once the ORV activity is removed. The harsh site conditions of steep slopes and shallow sandy soils at many other Southern California ORV use areas may increase the recovery time for hill climbs and trails to five or even ten years. The trails also exhibit this ability to recover, given some rehabilitation. Rehabilitation structures such as waterbars play an important part in ORV trail management. Waterbars need constant maintenance to withstand the impact from trail bike use.

Where trails are narrow or have been washed out, watershed improvement structures are used to maintain the trail and make it safe for use. Dead native plant material is placed and compacted within the rills to control erosion on the steeper trails. Twenty to thirty percent material tends to wash out if not properly anchored. Since bikes will not run in rills, the trails may widen over time if they are not maintained.

The issue of the use of public lands for ORV activities is national in scope. While this is a single focus issue, there are two very important components--social and environmental--which must be considered. The Forest Service will continue to implement policies as directed by our ORV planning and management effort. We will continue to seek the balance needed for both the social and environmental needs that man has for himself and for his environment.

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[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

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Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Vegetation Change on Santa Cruz Island, California: The Effect of Feral Animals[1]

Robert W. Brumbaugh and Norman J. Leishman[2]

Coastal sage scrub and chaparral communities on Santa Cruz Island, California, have been substantially modified by feral sheep grazing within the last 130 years. The sheep population rapidly increased after a probable introduction in the early 1850's as part of a large-scale sheep ranching program. By 1870, at least 45,000 sheep were on the island (U.S. Census of Agriculture 1870). Other estimates of sheep population on the 61,000-acre island during the late 19th century range between 45,000 and 100,000 (Brumbaugh 1980). Today feral sheep are confined to the more rugged, less accessible northwest and northeast mountains and marine terraces. Fewer and fluctuating numbers of sheep remain on the hilly southern portion while sheep are excluded from the central valleys.

A sizeable reduction of brush cover on south-facing slopes north of the Central Valley is evident in the comparison of photographs taken of the Central Valley in 1869. An extensive chaparral cover with patches of coastal sage scrub is shown in the 1869 photographs. The coastal sage scrub (e.g., Artemisia californica) has been especially affected by feral sheep grazing. Comparison of photographs taken in 1869 with recent photographs show complete destruction of coastal sage on the heavily grazed south-facing slopes along the Central Valley. Only 6 percent of Santa Cruz Island is presently covered by coastal sage scrub (Minnich 1980). Regeneration of coastal sage is occurring on some portions of the island in response to sheep removal from selected areas within the last 25 years.

A more extensive chaparral cover existed in 1869 than exists today on the slopes immediately north of the Central Valley. Changes are species selective. Adenostoma fasciculatum has been especially susceptible to feral sheep impacts, while Quercus dumosa and Heteromeles arbutifolia have suffered less attrition. In addition, the 1869 photographs show that chaparral plants lacked the arborescence characteristic of much of the woodlands today. Brumbaugh (1980) and Minnich (1980) have suggested a role of fire on the island, prior to the advent of sheep grazing, as a reason for this lack of arborescence. There is abundant charcoal in late Holocene sediments and on many almost barren ridgetops. It is also possible that late 19th century management practices included controlled burning in order to provide more sheep pasturage. The woodland slopes shown in the historic photographs have not been burned during the last half century.

Stature of Quercus dumosa and Adenostema fasciculatum, two abundant species in the chaparral woodland, increases with grazing intensity as does the chaparral community as a whole. Their stature was examined in contrasting regimes (heavily, moderately, and lightly grazed) across a large north-south belt in the middle of the island. Trunk diameter, number of trunks per shrub, and canopy areas of the two species were recorded in 4-meter-wide belt transects. Only populations on north-facing slopes were sampled in order to help reduce variation caused by unmeasured environmental factors. The two species have responded similarly to grazing pressure with respect to magnitude of stature variation within the 3 grazing regimes. However Adenostoma fasciculatum is more susceptible to eradication as indicated by a paucity of basal sprouts in heavily grazed areas. In the heavily grazed areas shrubs tend to have a noticeable browse line and a definite trend toward increased trunk diameter, canopy area, and height. A younger aced population has become established in areas where sheep have been reduced in number over the past 25 years.

There is a rapid response in areas completely removed from feral sheep use. Three exclosures in heavily grazed shrub-savanna communities were sampled over a two-year period after construction (Brumbaugh 1980 and Leishman 1981). Vegetation changes included an increase in herbaceous cover within the exclosure. In addition, Quercus dumosa and Heteromeles arbutifolia immediately sprouted at their bases and within 3 years the pruned appearance was greatly diminished.

LITERATURE CITED

Brumbaugh, Robert W. Recent geomorphic and vegetal dynamics on Santa Cruz Island, California. In Power, Dennis, ed. A multidisciplinary symposium on the California Islands. Santa Barbara, Calif.: Santa Barbara Museum of Natural History; 1980: 139-158.

Leishman, Norman J. Effects of feral animals on woody vegetation, Santa Cruz Island. California. M.A. Thesis (unpublished); Univ. of California, Los Angeles; 1981. 71 p.

Minnich, Richard A. Vegetation of Santa Cruz and Santa Catalina Islands. In Power, Dennis, ed. A multidisciplinary symposium on the California Islands. Santa Barbara, Calif.: Santa Barbara Museum of Natural History; 1980: 123-137.

U.S. Census of Agriculture. Ninth census of the United States. Sacramento, Calif.: Calif. State Library: 1870; schedule of agric. recapitulation, Santa Barbara County (microfilm); vol. 2.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, California.

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Life History and Seed Dispersal of *Dendromecon rigida*[1]

Stephen H. Bullock[2]

Longevity, fecundity and reproduction were studied in bush poppies (Dendromecon rigida Benth.) focusing on a site burned in 1970 in the Santa Monica Mountains (densities up to 38 plants per m^2, fig. 1); 15 other populations were examined from San Diego to Shasta counties.

Germination is normally restricted to the first winter after a fire. Seedling growth rates are high, total dry weight averaging 8.5 g at age 1 yr (Otay Mtn, 1980; compared to 1.45 g for Ceanothus and 0.12 g for Cupressus forbesii). However, adults are usually less than 2m height.

Reproduction can begin in the second spring. The plants are self-compatible and the flowers are unspecialized. Seed set averaged 7.6 per fruit at age 3 yr and 6.3 at 8yr; no geographic trends appeared but means ranged from 2.9 to 10.7. Mean weight of the oil-rich seeds ranged from 10.1 to 15.8 mg. The number of fruits per plant was small, barren plants being common (46 percent at 3yr, 39 percent at 10yr). However, a sparse population on San Jacinto Mtn had many plants with >100 fruits.

Survivorship was 95 percent at age 3yr, 21 percent at 7yr, and 5 percent at 10yr. The causes of adult mortality in undisturbed stands are obscure. Fire kills all except seeds; various herbivores and seed predators are known.

The seeds are dispersed by explosive fruits and by gravity, and are also collected by ants, principally carpenters (Camponotus spp) and harvesters (Pogonomyrmex subnitidus). Ants consume a caruncular appendage in their nests and discard the intact seed, Camponotus in subterranean middens and Pogonomyrmex on surface middens. Camponotus provides burial and predator avoidance, but Pogonomyrmex moves longer distances, often uphill to ridge-top nests. Birds and rodents are predators of the seeds. Experiments showed that ants were more ubiquitous foragers than vertebrates: Visitation to baited stations was 67 and 30 percent respectively. Ants were also more thorough than vertebrates: Removal of bait seeds was 55 and 18 percent respectively. Birds may focus their foraging on aggregations of seeds discarded by Pogonomyrmex.

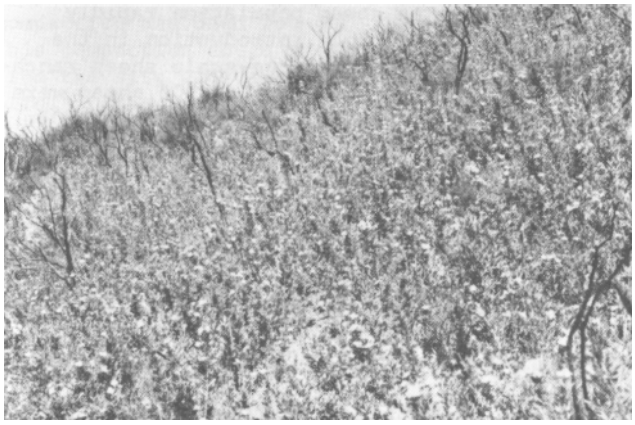

Figure 1--This stand extended over several km^2 at varying densities, including perhaps 5 million Dendromecon.

Figure 2--Pogonomyrmex loses a negligible percent of the seeds during transport.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems

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Seasonal Progressions in the Water Relations of Deciduous and Evergreen Perennials in the Northern California Chaparral[1]

Howard W. Calkin and Robert W. Pearcy[2]

Perennial plants native to Mediterranean climates should exhibit behavioral adaptations allowing survival during drought periods. Buffering of cell volume and turgor is thought to be important for maintenance of metabolism (Zimmermann 1978). Stomatal reactivity and osmotic adjustment interact with environment to buffer cell volume and turgor.

In this study, a pressure bomb (Tyree and others, 1973) and null balance diffusion porometer were used to follow the seasonal progression of osmotic adjustment and stomatal reactivity. Toyon (Heteromeles arbutifolia M. Roem) is an evergreen sclerophyll shrub. Redbud (Cercis occidentalis Torr. ex Gray) is a winter-deciduous shrub and buckeye (Aesculus californica (Spach) Nutt.) is a drought-deciduous small tree. These plants exhibiting different adaptive syndromes were growing together in the G.L. Stebbins Cold Canyon Reserve in the Vaca hills of northern California.

Figure 1 shows diurnal courses of water potential and leaf conductance for two days. This 6-week span illustrates the trends seen throughout the rest of the season (Table 1). In general, as the season progressed, stomatal opening became more restricted to morning hours, and the magnitudes of the morning peak and mid-day plateau decreased. Leaf water potentials became more negative and for Heteromeles and Cercis reached values near their turgor loss point. Aesculus leaves maintained turgor pressures of at least .5 MPa (72.5 psi) all season.

The seasonal drop in osmotic potentials (ΨTLP) and plant water potentials was greatest in Heteromeles, intermediate in Cercis and least in Aesculus. During the next winter and spring, the water potential of Heteromeles recovered, but the osmotic potential of the leaves from the previous spring remained low (data not shown). Daily water loss was similar for Cercis and Heteromeles, decreasing after May. In April, Aesculus had a total transpiration much higher than the other species; but already in May, water use had decreased by 60 percent and was much lower than in the other species.

In Heteromeles and Cercis both stomatal and osmotic adjustments contribute to the buffering of cell volume and turgor. Osmotic adjustment played little role in Aesculus.

Table 1--Seasonal changes in osmotic potential (ΨTLP), leaf conductance and daily transpiration during 1979

Date	Aesculus			Cercis			Heteromeles		
	ΨTLP[1]	g[2]	Ts[3]	ΨTLP	g	Ts	ΨTLP	g	Ts
Apr 25	-1.3	11	4.3	-1.3	7.2	2.7	-1.6	4.2	1.9
May 20	-1.4	10	2.1	-1.6	7.0	4.3	-1.9	6.9	3.4
Jul 5	-1.6	4	2.8	-2.3	6.0	3.7	-3.1	3.7	3.1
Aug 8	-1.7			-2.6	5.3	2.5	-3.4	3.0	3.0
Oct 17	-2.5				4.2	1.1	-3.9	3.0	1.8

[1]Water potential at turgor loss point MPa.

[2]Leaf surface conductance to water vapor mm/sec (averaged over mid-day hours).

[3]Total daily transpiration Kg/m^2 leaf surface.

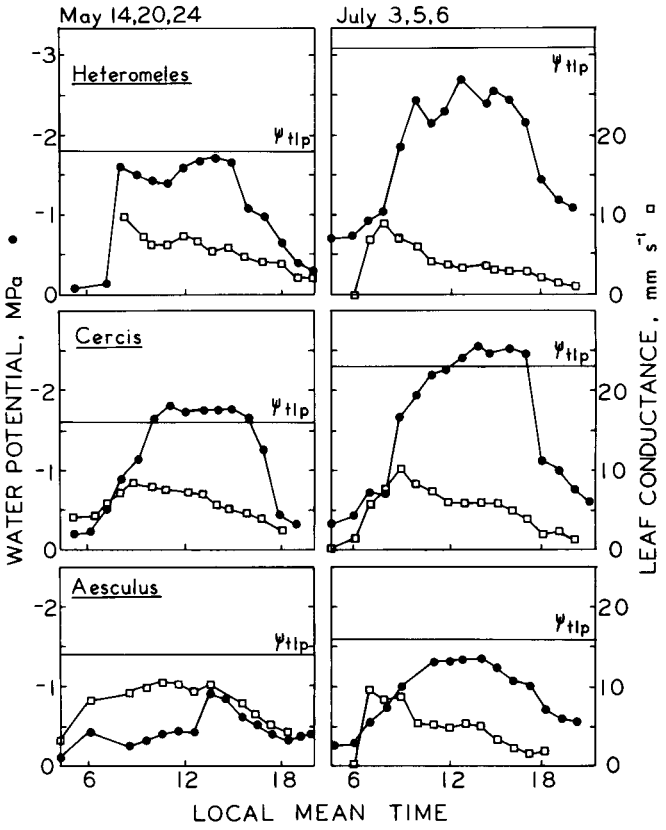

Figure 1--Daily courses of water potential and leaf conductance illustrating the seasonal changes.

LITERATURE CITED

Tyree, M.T.; Dainty, J.; Benis, M. The water relations of hemlock (Tsuga canadensis). I. Some equilibrium water relations as measured by the pressure bomb technique. Can. J. Hot. 51:1471-1480; 1973.

Zimmermann, U. Physics of turgor- and osmo-regulation. Ann. Rev. Plant Physiol. 29:121-148; 1978.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2]Regents Fellow in Plant Physiology and Associate Professor of Botany, respectively, University of California, Davis, California.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Distribution of Grasshoppers (Orthoptera: Acrididae) Along Environmental Gradients in a Mediterranean-Type Ecosystem[1]

Susan L. Coon[2]

In the past, most studies of faunal distributions along environmental gradients have analyzed large, taxonomically diverse groups of animals, such as birds and insects. This study analyzes the distribution of the family Acrididae (grasshoppers), a large group of species with relatively similar behavior and food preferences.

The vegetation and soil characteristics of nine field sites on the east (rain shadow) slope of the San Jacinto Mountains, California, ranging in elevation from 65 meters below sea level to 1920 meters above sea level, were earlier studied by R. B. Hanawalt and R. H. Whittaker. Grasshopper species were sampled by "sweeping" the vegetation along a randomly chosen transect and by searching for specimens for a specific timed interval at each site. Collected specimens were preserved for identification and analysis. Environmental variables including temperature, precipitation, relative humidity, and percent soil moisture were also recorded.

Grasshopper species tended to be more widely distributed along the elevational gradient than plant species, with some grasshopper species found at as many as six elevations, but no plant species found at more than three elevations.

Species richness, the number of species present at a site, was very low at the lowest elevations, increased to a maximum at mid-elevations, and decreased again at the highest elevations. A regression line (r = 0.30) showed a general trend for the number of species to increase as elevation increased (fig. 1). There was a positive correlation between the number of grasshopper species present at a site and the percent of ground covered by herbs (r = 0.52) and semi-shrubs (r = 0.46), the most important food sources for grasshoppers.

Acridid abundance, the total number of grasshoppers of all species present at a site, tended to decrease with increasing elevation (r = -0.42), (fig. 2). This may be explained by the fact that along the elevational gradient, total percent vegetation cover, especially percent cover by trees, increased with elevation. The increase in total vegetation cover was correlated with a decrease in herb cover and semi-shrub cover, the food sources of the grasshoppers.

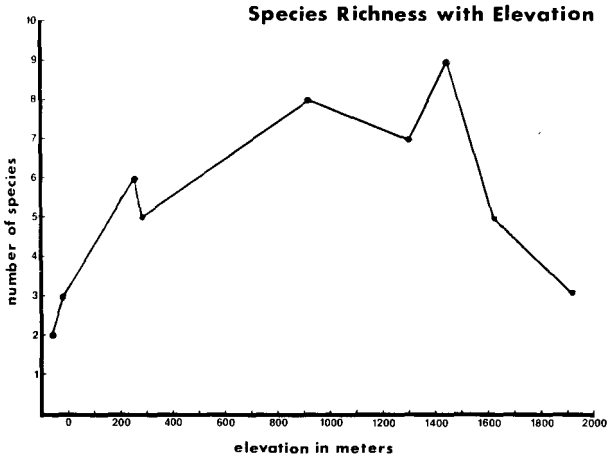

Figure 1--Species richness with elevation.

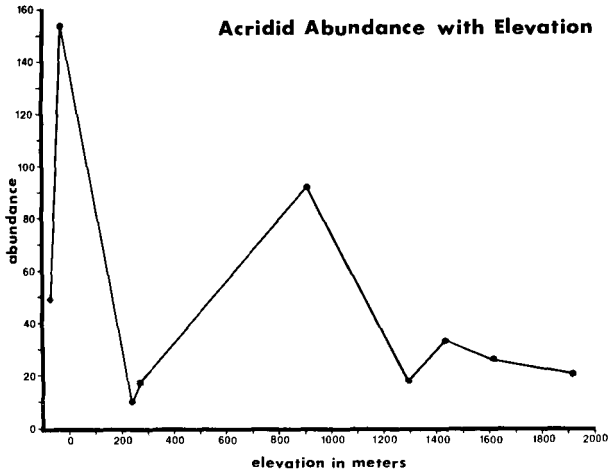

Figure 2--Acridid abundance with elevation.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, California.

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A LANDSAT Approach to Mapping Vegetative Fuel Type and Density Classes[1]

Michael J. Cosentino[2]

Maps that accurately describe the physical characteristics of the vegetative cover within the Mediterranean-type ecosystem of Southern California are needed to drive computer simulation models of wildland fires. Remotely sensed data can provide spatial maps of vegetative characteristics. These vegetative characteristics contain valuable information concerning factors which influence fire behavior. Landsat data, including a synthesized standard deviation "texture" channel, was used to produce a physiognomic classification of vegetative fuel types and densities (relative crown closure) for a 7.5-minute quadrangle area in the Angeles National Forest in Southern California.

Digital Landsat data was precisely registered to terrain data derived from orthophotoquads. The Landsat data was resampled to 50 meter cells such that each cell represented approximately .27 hectares (.6 acres) on the ground. A fuel-type classification scheme was devised based upon the discrimination capabilities of the Landsat sensor by first identifying 129 unique spectral "types" inherent in the data, and then labeling each type according to actual ground conditions as interpreted on 1:24000 color infrared air photos. Similar type-labels were grouped into 12 distinct fuel type and relative density classes.

The accuracy of the classification was determined by selecting over 500 random points and comparing the mapped fuels information with actual ground conditions. The overall accuracy of almost 90 percent was the result of several factors: 1) individual fuel type and density classes which contained spectral variation due to illumination and reflection geometry, were expressed as a large number of classes with low variance rather than a small number of classes with high variance, thus reducing the impact of differential illumination due to topography and sun angle; 2) spectral classes derived from the Landsat classification were described in terms of actual ground conditions and then aggregated into fuel classes rather than forcing the spectral classes into pre-determined fuel type systems or models; and 3) highly accurate registration of the Landsat data to the orthophotoquad allowed for precise location of the spectral classes on the ground, which greatly facilitated the labeling process.

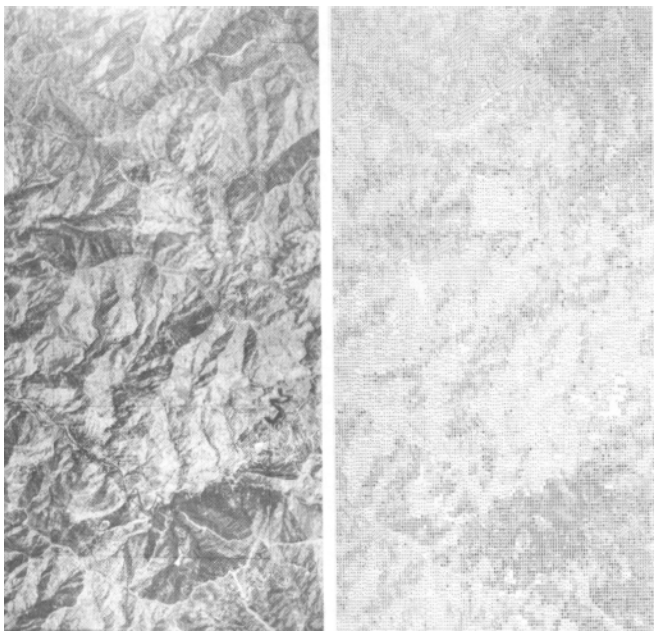
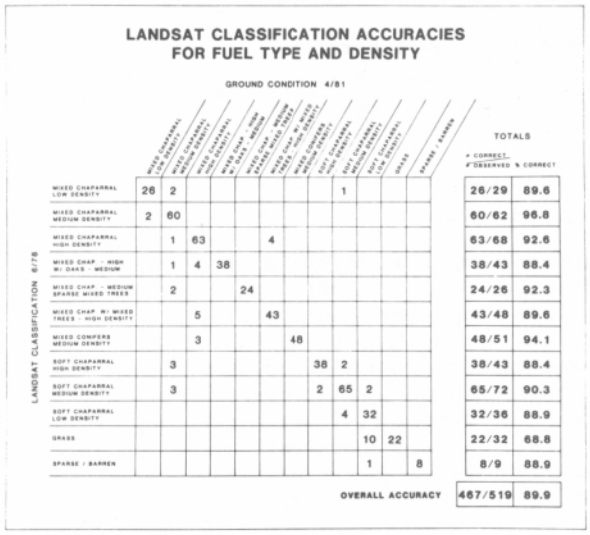


Figure 1--Portions of a standard USGS orthophotoquad and a precisely registered Landsat fuels classification. Fuels data can be reproduced on transparencies for overlay with the map and used in pre-attack planning, or input as digital data to computerized fire simulation models.

Table 1--Landsat-based Fuel Type/Density Classes

Mixed Chaparral / Low (density)
Mixed Chaparral / Medium
Mixed Chaparral / High
Mixed Chaparral / High - w/ Oaks / Medium
Mixed Chaparral / Medium - w/ Mixed Trees / Low
Mixed Chaparral / High - w/ Mixed Trees / High
Mixed Conifers / Medium
Soft Chaparral / High
Soft Chaparral / Medium
Soft Chaparral / Low
Grass
Sparse-barren

Table 2--Fuels Map versus Field Observations



[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, California.

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Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Effects of Fire on Certain Physical Properties of Selected Chaparral Soils[1]

Dan M. Duriscoe, Wade G. Wells II[2]

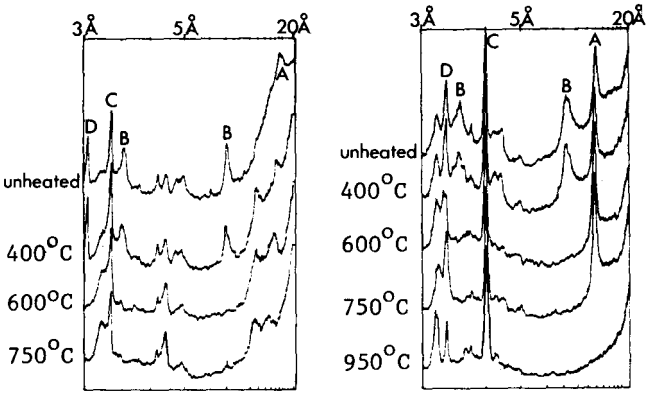
The effects of heating to wildfire temperatures on the particle size distribution and mineralogy of soils were investigated in the laboratory. Samples from the San Dimas Experimental Forest and the Pine Canyon study area of the Los Padres National Forest were subjected to temperatures of from 400° to 800° C. Particle size analysis was performed on heated and unheated control samples, with results summarized in table 1.

Table 1--Percent by weight of sand, silt, and clay in chaparral soils heated for 10 min.

Temperature	Pine Canyon soil			San Dimas soil		
	Sand	Silt	Clay	Sand	Silt	Clay
Unheated	61.4	26.6	12.0	38.8	43.4	18.6
400° C	68.4	30.3	1.3	43.7	51.0	5.3
600° C	72.7	26.8	0.5	40.7	51.6	7.7
800° C	77.0	23.0	0.0	44.5	50.8	4.7

Soils from both areas display a shift in particle size distribution when heated. Most notable is the reduction in the amount of clay present before and after heating. The effect is most dramatic in the Pine Canyon soil, which contains 12 percent clay: after heating to 800° C, no measurable clay could be detected. The percentage of sand-size particles increases proportionately with the decrease in clays, while the silts remain essentially unaffected. Lumping or fusion of clay particles upon heating as a possible cause of this phenomenon has been reported by other researchers (Sertsu and Sanchez 1978), but the mechanism by which it occurs is not clear.

Changes in clay mineralogy were identified using x-ray diffraction analysis. Heating the Pine Canyon soil to 600° C resulted in the decomposition of calcite, dehydration and collapse of kaolinite, and partial decomposition of smectite. Higher temperatures led to further collapse of the smectite structure in a stepwise fashion (fig. IA). Clays from the San Dimas soil were found to contain mica as well as kaolinite. Heating again resulted in the dehydration of kaolinite at 600° C, while collapse of the mica structure occurred between 800° and 950° C (fig. 1B).



1A. Pine Canyon Soil
A smectite
B kaolinite
C quartz
D calcite

1B. San Dimas Soil
A mica
B kaolinite
C cristobalite
D quartz

Figure 1--X-ray diffractograms of the clay fraction of the soils investigated.

These results suggest that soils on steep slopes may become less stable after fire because the cohesive influence of the clays is diminished. Particle size shifts have not been detected in field samples, but there is reason to believe that they occur. Dunn and DeBano (1977) report temperatures of 800° C at the surface and 350° C at 2 cm depths during prescribed burns. Increases in both dry ravel and rill formation on freshly burned slopes have been reported, and both can be initiated by failures at depths of 2 cm or less (Wells 1981). Both of these erosion processes may be caused or enhanced by this shift in particle size distribution.

LITERATURE CITED

Dunn, P. H.; DeBano, L. F. Fire's effect on biological and chemical properties of chaparral soils. In Mooney, H. A.; Conrad, C. E., eds. Proceedings of the symposium on the environmental consequences of fire and fuel management in Mediterranean ecosystems, 1-5 August 1977, Palo Alto, California. Washington, D.C.: Forest Serv., U.S. Dep. Agric. Gen. Tech. Rep. W0-3; 1977; 75-84.

Sertsu, S. M.; Sanchez, P. A. Effects of heating on some changes in soil properties in relation to an Ethiopian land management practice. Soil Sci. Soc. Am. J. 42:940-944; 1978.

Wells, W. G. II. Some effects of brushfires on erosion processes in coastal southern California. In: Erosion and sediment transport in Pacific Rim steeplands. Christchurch, New Zealand: IAHS Publ. 132; 1981; 305-342.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2]Resources Management Technician, Sequoia-Kings Canyon National Park, National Park Service, U.S. Department of Interior, Three Rivers, Calif.; and Hydrologist, Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Glendora, Calif.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Asymbiotic N_2 Fixation and Nitrogen Content of Bulk Precipitation in Southern California Chaparral[1]

Barbara A. Ellis[2]

The nitrogen (N) budget for southern California chaparral remains uncalculated. Particularly evident is the lack of understanding concerning the importance of asymbiotic N_2 fixation, which has not been evaluated in southern California to date. Similarly, few measurements of N input by atmospheric deposition exist for inland chaparral sites.

Limiting factors of asymbiotic N_2 fixation seem to be energy (carbon) and soil moisture (fig. 1). Assays with unamended soil cores did not always indicate N_2 fixation. However, rates of N_2 fixation in unamended soils when measurable, indicated that N_2 fixation may fluctuate year to year. Experiments under a range of controlled environmental conditions should clear this uncertainty.

Deposition of N from bulk precipitation (dry fallout + rainfall) is not correlated with rainfall intensity in this study due to inadequate frequency of sampling (fig. 2). Values from May 25, 1978 through Nov. 2, 1978 reflect N concentration primarily in dry fallout. The extent to which the NO_3 ion in bulk precipitation may originate from local sources of dust, though thought to be minimal, should be considered in an interpretation of the results.

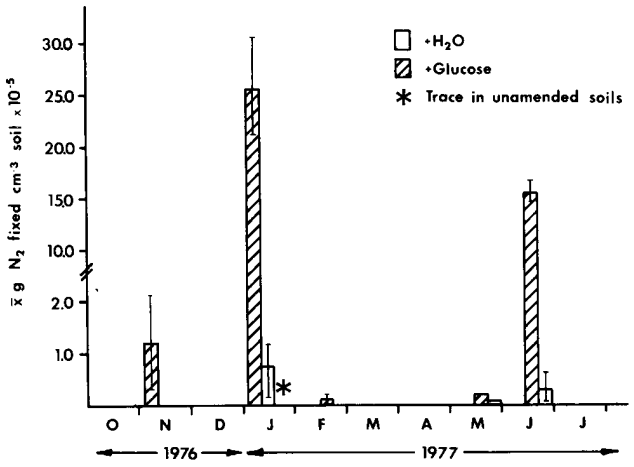


Figure 1--Comparison of N_2-fixing activity (C_2H_2-C_2H_4) in glucose and water amended soil cores. (C_2H_2 concentration 0.1 atm.; ambient $p0_2$ incubation conditions; assay duration ca. 65 h)

Estimated annual deposition of total N by bulk precipitation is ca. 3.6 kg N/ha/yr, far in excess of contributions from symbiotic N_2 fixation by Ceanothus greggii (0.1 kg N/ha/yr) and from asymbiotic N_2 fixation (0.5 kg N/ha/yr, unamended soil cores). The importance of symbiotic N_2 fixation by angiosperms, especially legumes, in early post-burn stands has yet to be thoroughly investigated. Since carbon seems an important limiting factor for asymbiotic N_2 fixation (fig. 1), the role that these microorganisms may play in replenishing N losses in carbon-enriched early post-burn soils poses an intriguing question.

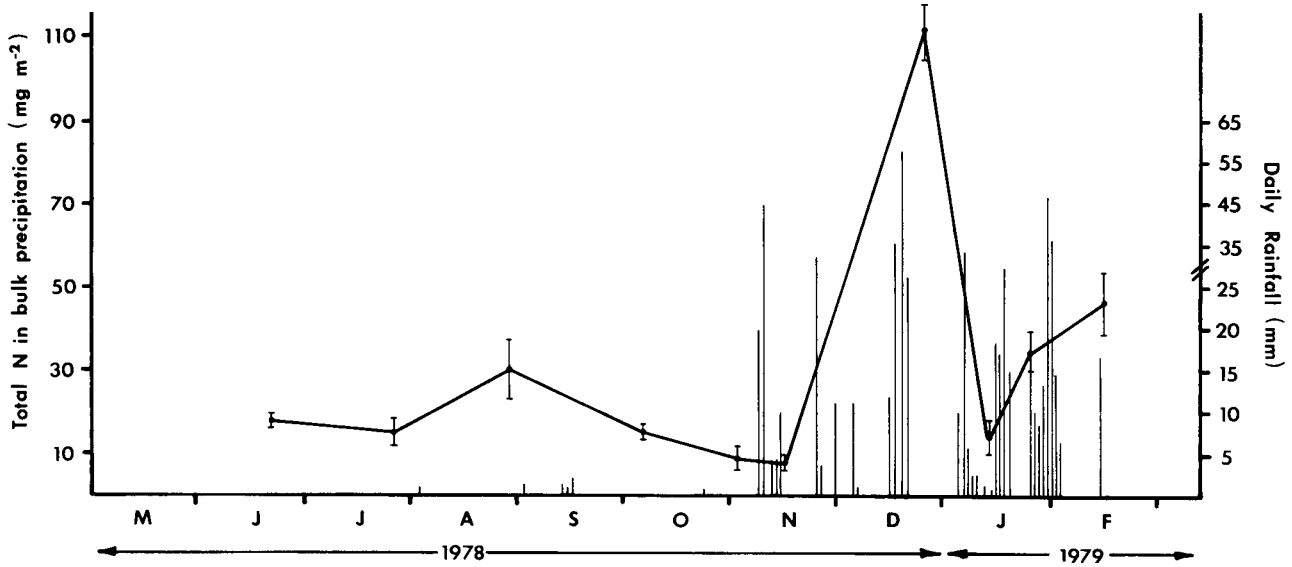


Figure 2--Total N (TKN and NO_2^- + NO_3^-) in bulk precipitation. First five data points represent ionic concentration of total N in dry fallout only (Vertical bars = Standard Error).

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[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California

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Nutrient Cycling in Montane Evergreen-Oak Forest at La Castanya (Montseny, Catalunya, NE Spain)[1]

L. Ferrés, F. Rodá, C. Verdú, and J. Terradas[2]

We are studying the circulation of N,P,K,Ca,Mg, and Na in an evergreen-oak (Quercus ilex L.) forest in the montane stage of the Montseny mountains. All sampling is made in a 0.23 ha experimental plot (41° 46' N, 2° 24' E) at 660 m a.s.l. near the bottom of a 30°, W-facing slope. Slope within the plot is gentler (7-20°). The soil is a brunisol on schist bedrock. Annual rainfall is c. 900 mm. Mean annual temperature is c. 9°C. Summer drought is present. The sea is at 27 km. The site now experiences acid rain (mean volume-weighted pH is 4.7). The Barcelona conurbation is at 25-50 km. Q. ilex is the only tree species in the plot.

Canopy is closed, dense (2010 boles dbh>5 an/ha), and 9-13 m high. Dominant trees have 17-27 cm dbh. Basal area is 26.6 m^2/ha. Undergrowth is very sparse. Litter (11 t/ha) accumulates on the forest floor. Part of the plot was under cultivation in the past, but it was abandoned probably >100 years ago. The stand was later coppiced. Present age of the trees is unknown, but they are probably <60 years old.

Results are shown in figure 1. Biomass and mineralomass refer to trees of dbh >5 cm. All fluxes are averages of 2 years of study (June 1978-May 1980). Compared with the lowland, limestone-underlain, older Q. ilex forest at Le Bouquet, France (Lossaint and Rapp 1971), our stand is much lower in biomass; mineralomasses of the 6 elements; whole-tree concentrations of P, Ca, and Na; Ca litterfall flux; Na precipitation flux; and K, Ca, and Na throughfall fluxes. Whole-tree concentrations of N, K, and Mg are within 20% of those at Le Bouquet. All Mg fluxes are very similar at both stations. Litterfall and K flux in litterfall are higher at La Castanya.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2]The first three authors are teaching assistants of Ecology; last author is Associate Professor of Ecology, all of them at the Universitat Autonoma de Barcelona, Bellaterra, Barcelona, Spain.

LITERATURE CITED

Lossaint, P.; Rapp, M. Répartition de la matière organique, productivité et cycles des éléments minéraux dans des écosystèmes de climat méditerranéen. In: Duvigneaud, P., ed. Productivity of forest ecosystems. Paris: Unesco; 1971; 597-617.

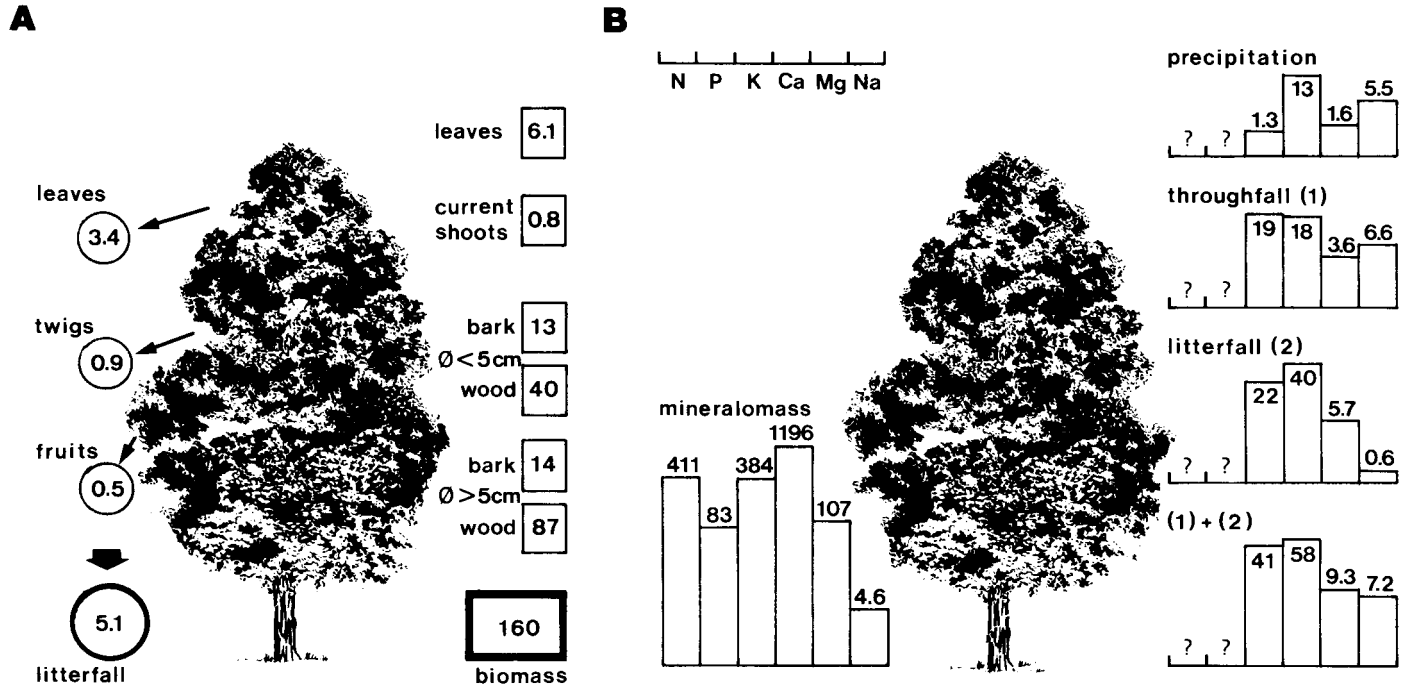

Figure 1--(A) above-ground tree biomass (t/ha) and litterfall (t/ha/yr). (B) mineralomasses (kg/ha) and mineral fluxes (kg/ha/yr) in the montane evergreen-oak forest at La Castanya (Montseny, Catalunya).

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Ecosystems Management, Renewable Resources, and Urban Habitats[1]

Larry Fishbain[2]

Historically technology has been developed with a short-sighted disregard for its effects on natural systems. These systems provide the raw materials which make modern urban society possible, and any damage done to them limits the potential of future human development. Impending shortages of food, energy, and mineral resources; pollution; and the increase in environmentally aggravated diseases are just the most visible signs of these self-imposed limits.

The use of technology to manage renewable resources will require a new framework for evaluating its costs and benefits, one which considers long-range implications as well as immediate monetary costs, one that takes into account such social costs as the effects on human health and personal satisfaction.

The following are a few guidelines for technological development that meets the needs of a healthy human and natural environment. Some relate specifically to the Mediterranean-type ecosystem and urban problems of the San Diego/Tijuana Region. This is certainly not the only model for development, nor is the model complete. We hope this work will stimulate thinking in this area.

Air

We all breathe the same air. Because elements of the ecosystem are interactive, air pollution soon becomes water and soil pollution. Air pollution reduces the useable solar flux, thereby robbing us of needed energy potential. Air pollution must be stopped at the source, yet pollution abatement practices which merely turn air pollution into a solid waste disposal problem are not solutions.

Water

Water resource management in the San Diego/Tijuana Region is almost nonexistent. Urban areas here are 90 pct. dependent upon imported water supplies, yet experience damaging flooding with every substantial rainfall. Urbanization has contributed to increased runoff and a reduction in groundwater storage potential. Water storage is inadequate for any long-term disruption in imported supplies. Present plans call for the construction of expensive facilities to increase water imports from areas where local demand is also increasing, and supplies are not assured. There is legitimate concern that these facilities will cause serious environmental damage at the source of supply.

The use of local water supplies will require a comprehensive program including improvements in air quality; control of substances in common use that might pollute runoff; management of floodplains to control and store runoff, and prevent damage to buildings, roads, and aquifers, while preserving estuary and other wildlife habitats.

An integral part of water management must be a program of water reclamation. San Diego's present sewage system is operating over capacity while 99.9 pct. of sewage volume is just water. Recognizing this as a source problem can relieve pressures on sewage capacity, and the majority of water can be recycled more easily.

Present sewage treatment facilities produce methane gas, only a small part of which is utilized. Dilution of nutrients by excess Water reduces the amount available for gas production, and necessitates the disposal of the excess water. If the plumbing system handled only toilet wastes, present methane digester capacity could fully utilize available nutrients. By excluding toxic materials from the waste stream digester residue containing valuable soil nutrients can be used in agriculture.

Grey water from sinks and baths, and storm runoff could then be treated separately in oxidation ponds. Aquatic biomass from these ponds can be used to increase methane production, and

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June 22-26, 1981, San Diego, California

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treated water is suitable for irrigation.

Industry which produces toxic wastes must reclaim and reuse its own water.

Food

A healthy agricultural system is a healthy ecosystem. There is a diversity of plant and animal life adapted to the conditions of soil, water, and climate. The soil is kept fertile by the recycling of basic nutrients, and pests are kept under control by natural enemies.

Modern agricultural practices are unhealthy monocultures, supported by a constant supply of biocides and force feeding of fertilizers and water. These practices are energy intensive, increasingly expensive, destructive to the ecosystems they supplant, and surrounding ecosystems as well.

Integrating agriculture with other urban activities can help solve many urban problems. Using reclaimed nutrients and water from sewage for soil fertility and irrigation reduces water pollution and imported water demand. Recycling of organic wastes into compost also helps save valuable canyons from becoming landfills. Employment opportunities are created near population centers, food requires less transportation, processing, storage, etc., all of which saves energy and reduces costs,

Energy

Sunlight is the energy that sustains all ecosystems. Properly developed it can drive the machinery of urban industrial society, replace fossil fuels and nuclear power, and improve the quality of life. Developed improperly it can be as destructive to ecosystems as strip mining. Large energy "plantations" of windmills, biomass farms, or solar collectors have the same limitations as monoculture agriculture. Sited far from population centers they lose efficiency and require new transmission facilities.

A decentralized, diversified solar energy program including liquid, gaseous and solid fuels from biomass, wind and the direct use of the sun can be located near urban areas to provide safe, clean, dependable energy, jobs, and a healthier environment.

Industry

Industrial production should be geared to the use of local materials, energy, and labor. Product utility, longevity, and recyclability, and the health effects on workers and users must be given high priority. Any toxic by-products of manufacture must be kept within the production facility for reclamation and reuse. The true social and environmental costs of production must be borne by the industry and not externalized as waste, pollution, and disease.

Summary and Conclusion

A healthy ecosystem provides the guidelines for its own management, and the keys to improving the conditions of human life as well. The need for a healthy "environment" and the need of the World's people for adequate food, shelter, health care, and personal fulfillment are not exclusive needs, but are one in the same.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

The Effects of Ryegrass on Erosion and Natural Vegetation Recovery After Fire[1]

Clayton R. Gautier[2]

Excessive transport of sediments from recently burned chaparral watersheds during intense winter storms has long been a serious problem in southern California. As part of a state-wide program, the California Department of Forestry and other government agencies have been seeding burned watersheds with fast-growing annual plants since 1956 to reduce sediment yields during floods. The assumption behind the "emergency revegetation" program has been that increasing plant cover in the first few years after fire reduces hillslope erosion rates and, hence, the quantity of material available for sediment discharge. Few quantitative data exist, however, to support this assumption and there is doubt that seeding is effective enough to justify its cost. Moreover, there is concern that seeding burns may increase hillslope erosion later in the fire cycle by retarding the recovery of the native shrub vegetation. The purpose of this study was to determine whether seeding annual ryegrass (Lolium multiflorum), the most commonly used species, a) reduces erosion rates in the first year after fire, and b) interferes with the post-burn recovery of the native vegetation sufficiently to retard reestablishment of native plant cover.

The study was performed in southwestern San Diego County within a recent (1979) burn. Measurements of rainfall, erosion and the vegetation were taken throughout the 1979-1980 growing season in 4 large experimental plots (half seeded with ryegrass at the standard 8 lb/acre rate and half left unseeded) located within the burn.

Because of above-average rainfall and generally cool climatic conditions at the study site, ryegrass establishment was excellent. End of season cover in the seeded treatments of the 4 experimental plots (comprised almost completely of ryegrass) ranged from 39 to 86 percent. In controls, end of season cover was substantially less, ranging from 20 to 35 percent. High cover values in seeded treatments (both early and late in the season) apparently reduced hillslope erosion. Mean soil surface displacement (measured with an erosion bridge) was consistently lower in seeded treatments than in controls once ryegrass plants grew to a sufficient size (late February) to intercept rainfall (Figure 1). Seeding, however, also substantially increased shrub seedling mortality (from 59 percent in controls to 91 percent in seeded treatments) and apparently reduced end-of-season cover of resprouting shrubs in north facing plots (Table 1).

Table 1. Shrub resprout cover. Asterisks indicate statistically significant differences (P<.01) from control values.

Aspect	Plot	Cover (percent)	
		Seeded	Control
North	1	6*	20
	2	9*	31
South	1	4	8
	2	10	7

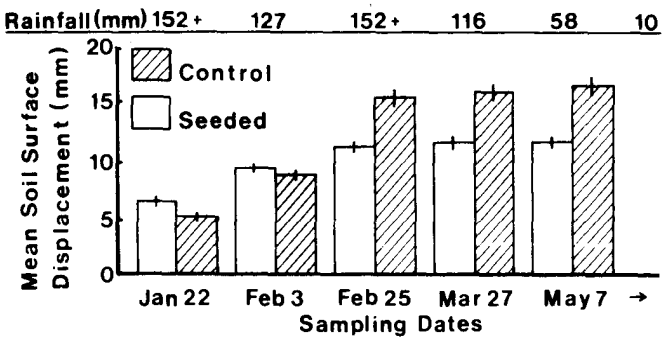

Figure 1. Soil surface displacement averaged (without considering sign) over all plots. Vertical bars approximate 2 standard errors. Rainfall occurring during each interval is shown above.

Although ryegrass seeding seems to be able to reduce hillslope erosion in the first year after fire if climate conditions are conducive to ryegrass establishment and growth, this early post-burn erosion control may be obtained only by sacrificing control of future longterm hillslope erosion. Reducing shrub seedling density and slowing the recovery of resprouting shrubs will retard the reestablishment of native plant cover after fire. Loss of shrub seedlings may be especially important since they contribute greatly towards rapid recovery of the shrub canopy even though many may be eliminated from the stand through thinning. Because there is a reciprocal relationship between cover and erosion rates (documented in this study and elsewhere), slowing the recovery of shrub cover will almost certainly result in increased erosion rates once ryegrass disappears from the vegetation (2--3 years). Increasing erosion rates during the interval beginning a few years after fire and ending with canopy closure (or another fire) would be counterproductive from an erosion management point of view since all hillslope erosion occurring throughout the fire cycle contributes to the size of sediment loads discharged during floods.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, California.

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Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Insect Herbivory and Polyphenols in Three Mediterranean-Type Ecosystems[1]

J. P. Glyphis and G. M. Puttick[2]

Some recent tropical ecological studies have suggested that forest vegetation growing on low-nutrient substrates contains high levels of digestibility-reducing "defensive" compounds. Theoretically, a plant drawing nitrogen from a very low-level nutrient pool should conserve this nitrogen in some way. This could be achieved, for example, by lowering the dietary quality for primary consumers. Mediterranean-type ecosystems with their characteristic low soil nutrient status are interesting from this point of view. We therefore examined a range of plants in three mediterranean-type shrublands for total poly-phenols and insect herbivory.

Our data show a clear relationship between soil nitrogen and plant polyphenol levels in South Africa, France and California (Table 1). Insect herbivory correlates significantly with plant polyphenol levels in South Africa ($r = -0.64$, $p < 0.01$, $n = 20$) but not in France ($r = -0.37$, $p > 0.1$, $n = 16$). The relationship between insect herbivory and plant "quality" is certainly also dependent on other factors such as leaf nitrogen and phosphorus, fibre and moisture content. We are currently testing these for their possible effects on herbivory.

Table 1. Soil nitrogen(%), soil C:N ratios, and total polyphenols(mg/g fresh weight Tannic acid equivalents) in plant species collected at the end of the growing season in South Africa, France and California.

	Plant Polyphenols			Soil Nitrogen	Soil C:N
	Mean	S.D.	n		
Strandveld (South Africa)	117.9	76.1	13	0.013	21.1
Maquis (France)	56.9	21.6	12	0.330	18.0
Garrigue (France)	54.8	15.0	25	0.320	14.7
Chaparral (California)	52.2	19.0	17	0.300	1.9

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22 - 26, 1981, San Diego, California.

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Landscape Analysis and Ecosystems Management at Portola Valley Ranch[1]

Nancy M. Hardesty[2]

Portola Valley Ranch is a 450-acre planned unit development of 200 homes designed around a magnificent hilly oak woodland site with spectacular views of San Francisco Bay and coastal mountains. Because many nearby towns have undermined their oak woodland heritage with insensitive development, the Town of Portola Valley enforces stringent environmental standards to protect its natural wealth. Portola Valley Ranch exceeds town standards in preservation of native vegetation and strict use of native plants for landscaping.

Landscape analysis and design criteria for the project involve 1) preservation and perpetuation of existing oak woodland, 2) preservation and perpetuation of existing watersheds and natural drainage patterns, 3) open space analysis for grassland and native oak maintenance and fire management, and 4) visual resource inventory.

Site vegetation consists of a 250-acre ridge of dense oak-madrone woodland, permanently dedicated to open space, and 200 acres of "monarch oaks" and rolling grassy hills with fingers of oak woodland. Six types of California native oaks exist on the site: Quercus agrifolia, Q. chrysolepis, Q. wislizenii, Q. kelloggii, Q. douglasii and Q. lobata. An oak chart developed to study these oaks summarizes habit, habitat, character, ecological niche, landscape use and fire tolerance.

Oak management guidelines outline procedures for 1) field assessment of individual oaks, 2) construction and landscape planting near existing oaks, 3) watering of existing oaks, 4) planting of new oaks, and 5) contract growing of plant materials. Oak analysis, management and design guidelines have been adapted into "Nature Notes" for distribution to project homeowners on such subjects as acorn planting and plant communities.

Watershed and watercourse preservation and management are equally as significant as oak woodland preservation in this drought vulnerable location. An early project design and engineering team decided against storm sewers which would carry runoff away from native oaks and down into the San Francisco Bay. Later, watershed management guidelines were compiled to achieve these goals: 1) maintenance of natural watercourses, 1) storage of water in ponds, ditches, creeks, 2)design of subdivision drainage systems to direct water into existing drainage channels.

Design guidelines for watercourse preservation suggest 1) curbless roads, minimal non-absorptive pavement and minimal compaction to help recharge ground water, 2) tree preservation, erosion control seeding, native plant landscaping and mulching to help stabilize slopes for water and soil retention, 3) on-site drainage swales controlled with storm water dispersers, mini-dams and wattling. Wattling bundles of live, native riparian twigs are buried in trenches in project drainage swales, creeks and ponds; installation in December takes full advantage of California winter rains for optimal soil moisture and rooting conditions. Wattling field days, under the supervision of the landscape architect, have involved both project staff and homeowners.

Landscape analysis and ecosystems management at Portola Valley Ranch have enabled builder, homeowners and townspeople to develop, use and appreciate this unique site. Equally important, guidelines, concepts and techniques developed for the project are now part of town policy and homeowner land management programs,

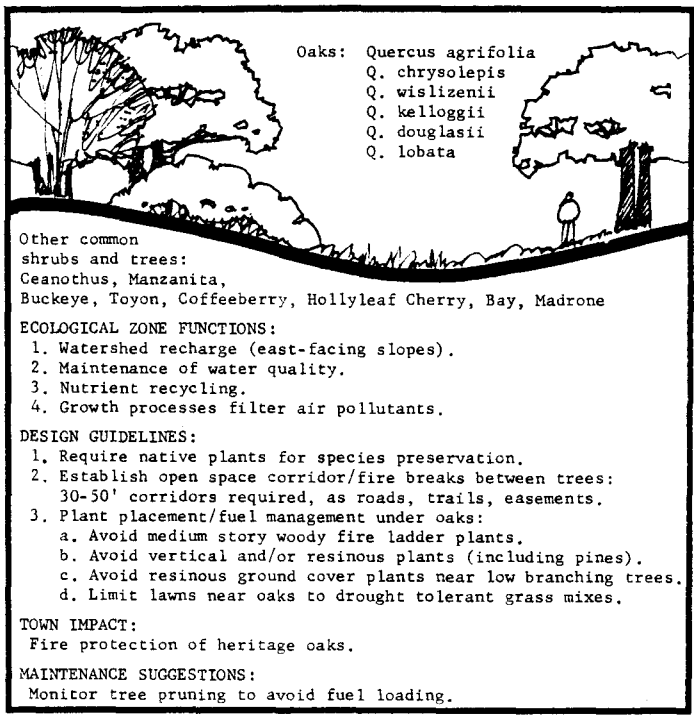

Figure 1--Foothill Oak Woodland Fire Management Design Criteria

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2]Owner, Toyon Landscape Architecture and Ecosystems Management, Palo Alto, California.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Photosynthesis and Water Relations of Mature and Resprout Chaparral Vegetation[1]

Steven J. Hastings and Walter C. Oechel[2]

Photosynthesis leaf conductance, and water potential were measured in the field over time, on mature (ca 34 years) aid resprouts of Arctostaphylos glandulosa Eastw Quercus dumosa Nutt.. and Adenostoma fasciculatum H. & A . The experimental site is within the U.S. Forest Service's Laguna-Morena Demonstration area of the Cleveland National Forest in southern California U.S.A.. 78 kilometers east of the coast of San Diego. Calif. It is characterized as a mixed chaparral community located on an east-facing slope at ca. 1400-meter elevation. Plots of the mature vegetation were marked off (250 meters wide, 675 meters long) and the aboveground biomass removed by either handclearing or controlled burning Measurements were typically made from sunrise to sunset. A null balance porometer, Sholander pressure bomb, and carbon-14 dioxide were utilized to measure leaf conductance, water potential, and carbon dioxide uptake, respectively.

Water potentials in mature vegetation exhibited a similar seasonal pattern among species, decreasing from a maximum value during May-June to minimum values during October-November. However, water potentials in the resprouts (due to fire and handclearing) were significantly higher than in the mature vegetation throughout the duration of the seasonal drought typical of chaparral-type ecosystems. It was concluded that a reduction in the aboveground biomass due to top removal decreased the transpiration surfaces of the resprouts, thereby decreasing water loss and increasing water potentials.

In June. maximum photosynthetic rates by resprouts due to fire were 5, 2.5 and 3 times greater than mature species of A. fasciculatum, Q. dumosa, and A. glandulosa, respectively. These differences diminished with time until burn resprouts and mature rates were equal in August and September for A. fasciculatum and A. glandulosa. However, in November their rates had increased until burn resprouts of A. fasciculatum were 3 times greater than the mature, while in A. glandulosa they were 5 times greater. The photosynthetic rates of the mature plants either decreased or remained constant throughout the duration of the drought. As mentioned earlier, water stress was not a factor for the resprouts and does not explain the observed depression in photosynthetic rates during the drought period. Photosynthetic rates of Q. dumosa post-fire resprouts were less than the mature vegetation for most of the drought. This is attributed to an infestation of powdery mildew (Sphaerotheca lanestris) which resulted in dieback of many of the shoots of the post fire resprouts.

Leaf conductance values were low and relatively constant in mature A. fasciculatum and A. glandulosa during the drought, while in mature Q. dumosa aid all species of resprouts studied, leaf conductance values were higher and more variable. It appears that at higher water potentials, additional factors interact with a plant's tissue water status in controlling stomatal behavior.

Lower water stress alone cannot explain the higher rates of photosynthesis in burn resprouts of A. fasciculatum and A. glandulosa versus mature plants. If this was the case, one would have predicted similar photosynthetic rates in the two field manipulations. The resprouts due to hand clearing generally exhibited rates similar to the mature vegetation, while the post fire resprouts showed higher rates of photosynthesis. It is hypothesized that the higher rates are due to nutrient enhancement, primarily as nitrogen in the ash resulting from the burning of the aboveground biomass. Measurements of soil nutrients before and after the controlled burn revealed a 10-fold increase in soil ammonia-nitrogen. Table 1 presents data collected in June and October for the various treatments aid species.

Table l-Photosynthesis (Ps, $mgCO_2 \cdot g$ dry $wt.^{-1} \bullet h^{-1}$). conductance ($cm\ s^{-1}$) and water potential Ψ, bars) in A. fasciculatum (A.f.). A. glandulosa (A.g.) and Q. dumosa (Q.d.) in mature (1) and resprouts after fire (2) and hand-clearing (3).

Species & Treatment		Ps June	Ps Oct.	Cond. June	Cond. Oct.	Ψ June	Ψ Oct.
A.f.	1	6.0	3 .5	0.178	0.120	-12.1	-57.0
	2	33.0	11.5	0.461	0.357	- 5.2	-24.3
	3	6.3	2.4	0.361	0.258	- 9.2	-29.3
A.g.	1	4.4	1.3	0.207	0.219	-16.0	-56.3
	2	12.1	3.9	0.114	0.685	-13.8	-18.2
	3	10.5	1.6	0.101	0.376	-16.3	-19.7
Q.d.	1	4.3	2.8	0.093	0.512	-12.8	-34.7
	2	10.3	2.3	0.283	0.500	- 5.5	-12.3
	3	6.6	6.5	0.309	1.372	- 4.1	-12.2

ACKNOWLEDGEMENTS

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[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California

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Vegetation Dynamics of a California Island[1]

Elizabeth Hobbs[2]

Vegetation change between 1929 and 1970, in terms of increase or decrease in foliar cover of woody vegetation, was mapped from air photos for a portion of Santa Cruz Island, California (fig. 1).[3] The vegetation of this area includes forests of Bishop pine (Pinus muricata) as well as chaparral and groves of ironwood (Lyonothamnus floribundus).

Cattle, horses, sheep and pigs were brought to the island in 1853. Since that time, the sheep and pigs have become feral. Their effects are clearly seen on the landscape. Dead logs, branches, and snags provide evidence of the former vegetation. Exposed roots of trees and shrubs suggest significant loss of top-soil. For this portion of the island there is no record of forest or brush fires having occurred within historic time. Vegetation loss has apparently been caused exclusively by grazing, trampling, and undermining of roots by erosion.

Fences were erected in the late 1950's. Sheep removal from the fenced areas had variable success. Vegetation recovery in areas where sheep removal was successful resulted in striking contrasts between vegetation at fence lines. Since the effective removal of sheep from Christy Canyon, the Bishop pine forest has increased in cover, largely due to better seedling survival. Based on size and age data collected in 1977-78, it is estimated that most of the trees in this forest are less than thirty years old (Hobbs 1978). In contrast, the pine population on Sierra Blanca and Ragged Mountain is in serious decline, and the slopes of these mountains are almost completely bare.

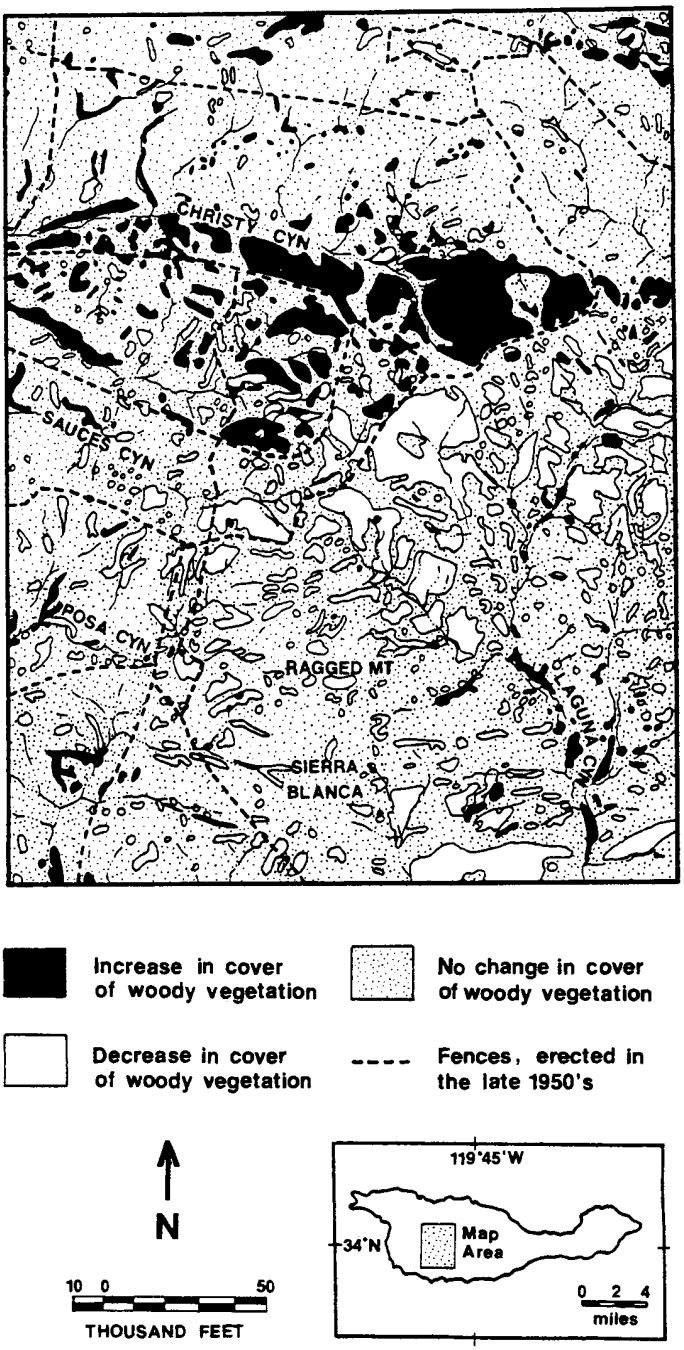

Figure 1--Vegetation Change: 1929 to 1970, portion of Santa Cruz Island, California.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2]Graduate Student, Department of Geography, University of California, Los Angeles, Calif.

[3]Black and white air photos, Fairchild Collection, Whittier College, 1929, 1:20,000 and color infrared air photos, Geography Department, UCLA, 1970, 1:20,000.

LITERATURE CITED

Hobbs, Elizabeth R. The effects of feral sheep grazing on Bishop pine (Pinus muricata) forests, Santa Cruz Island, California. Los Angeles, Calif.: University of California, M.A. Thesis; 1978. 61 p.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

The Effect of Fuel Management on Nutrients in a Chaparral Ecosystem[1]

David Y. Hollinger[2]

The effects of 3 fuel management techniques on the nitrogen, phosphorus, potassium and magnesium pools of a chaparral ecosystem were studied. The study site was located at an elevation of 480 m in Foothills Park in the Santa Cruz mountains, approximately 42 km SE of San Francisco. Annual precipitation at the site averages somewhat more than 500 mm. Stand age was 42 years.

Treatments were carried out on plots varying in size between 50 and 200 square meters in December of 1979 and January of 1980. These consisted of prescribed burning, mechanical chopping (vegetation chopped to pieces less than 15 cm and left in place) and hand clearing (vegetation removed). Adjacent plots were left as controls. Plots were sampled in 6 to 10 locations per plot just before and after treatments and again at the end of the rainy season. Total nitrogen was determined by the micro-Kjeldahl method, and total phosphorus by the molybdate method. Potassium and magnesium were determined by atomic absorption spectrophotometry of perchloric acid digests.

Harvest measurements of a 100 square meter plot indicated a total standing biomass of approximately 41,000 kg /ha. Pretreatment litter mass was comparable at about 40,000 kg /ha. Pretreatment pool sizes of the various nutrients are shown in table 1.

Table 1--Pretreatment nutrient pool sizes

Compartment	Total N	Total P	Total K	Total Mg
	Kilograms/hectare			
Vegetation	237	34	155	57
Litter	554	68	397	383
Soil				
0-5 cm	1102	291	4680	4720
5-10 cm.	811	362	5060	5870
10-15 cm.	776	344	5200	5570

The prescribed burning led to a reduction in biomass of approximately 35 percent and a reduction in litter mass by about 15 percent. Approximately 270 kg./ha N moved out of the vegetation and litter pools; of this perhaps 50 kg /ha moved to the deeper soil layers while the remainder (about 6.3 percent of total N in vegetation, litter and soil to 15 cm) was lost. About 48 percent of the P in the vegetation (16 kg /ha) moved to the litter and deeper soil layers. This is only about 1.5 percent of the system total P, although it may represent a much greater proportion of the exchangeable P in the system. Values for K and Mg were 69 kg/ha and 32 kg/ha respectively. Mechanical chopping led to an initial doubling of litter biomass. N, P, K and Mg were conserved with little loss from the system by the end of the season. At that time approximately 25 percent of the chopped biomass had decomposed, releasing between 40 and 60 percent of the various nutrients. Hand clearing led to a loss of all of the standing biomass. Nutrients lost included approximately 6.8 percent of the total system N, 3.1 percent total system P, and 1 percent or less total system K and Mg.

Fuel managers should be aware that hand clearing leads to the loss of system nutrients and can result in decreased site fertility. Burning can result in overall system nitrogen loss but initially releases N and other minerals, temporarily increasing site fertility. N fixers such as Lotus spp. tend to restore system N. Site fertility and productivity could conceivably be controlled by selectively encouraging or eliminating these species. Mechanical chopping appears to maintain site fertility but may result in an increase in importance of species adapted to the slower nutrient mineralization rates.

Acknowledgments: I wish to thank the Rangers of Foothills Park and other employees of Palo Alto, Ca. for their assistance in this project. Funding was provided by the city of Palo Alto.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, California.

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The Effects of Photosynthesis and Water Relations on Plant Distribution[1]

James L. J. Houpis[2]

The adaptive responses of photosynthesis to the environment can be translated into increasing carbon assimilation. This increases energy and carbon, and thus increases competitive ability and vegetation cover. However, the effects of carbon gain are moderated by controls of water loss. Thus, seasonal photosynthetic rates in conjunction with a water use efficiency ratio should be correlated with species distribution. This study was to investigate this premise in relation to the present distribution of four chaparral species. The four species studied and their associated percentage of cover (at the elevation of 800 to 1000 min San Diego County) are Adenostoma fasciculatum (66 percent), Arctostaphylos glauca (12.7 percent), Ceanothus greggii (15.8 percent), and Rhus ovata (5.6 percent).

To determine the thermal and light dependence of photosynthesis and water use, in situ, gas exchange analysis in conjunction with Vaisala Humidity Sensors was used. Sampling was conducted during four measurement periods (fall, winter, spring, and summer) using six replicates of each species. It should be noted that the species were measured sequentially rather than concurrently.

Since it was impossible to constantly measure photosynthetic rates for all four species throughout the year, two indirect methods were developed to characterize seasonal photosynthetic traits that can be correlated to plant distribution. The first was the thermal acclimation potential ratio, henceforth referred to as TAPR. This indirect index of acclimation is used because the acclimation of photosynthesis among the four species is not directly comparable due to different sampling periods for different species. The index is the ratio of the change in the photosynthetic thermal optimum between two contrasting measurement periods, to the change in mean daily temperature (corresponding to the months in which the photosynthetic data was collected). The resulting TAPR are A. fasciculatum with 43.2 percent, C. greggii with 34.8 percent, A. glauca with 29 percent, and R. ovata with 22.4 percent.

The second method involved an empirical model in which yearly photosynthetic rates were estimated. The model estimated yearly photosynthetic rates for A. fasciculatum with 72.3 g CO dm^{-2} yr^{-1}, C. greggii with 40.6 g CO_2 dm^{-2} yr^{-1}, A. glauca with 29.2 g CO dm^{-2} yr^{-1}, and R. ovata with 28.3 g CO_2 dm^{-2} yr^{-1}. Although the orders of both TAPR and yearly photosynthesis are indicative of cover, the magnitudes of rates are not on the same order as the percentage of cover would indicate.

Water use efficiency was calculated to further understand the percent distribution (in this case water use efficiency is the ratio of transfer resistance of water to that of carbon). It was shown that throughout the year A. glauca had a higher WUE than any other species. This most likely would account for the fact that the percentage of cover of A. glauca is closer to that of C. greggii (and higher than R. ovata) than the photosynthetic rates alone would indicate. A. fasciculatum had a lower WUE in the winter than the other three species, but a higher WUE in the sunnier than two of the species. This strategy effectively eliminates these species from the more xeric habitats that are associated with a higher percentage of cover of A. fasciculatum.

If photosynthesis and WUE traits play an important role in determining plant distribution, one would expect A. fasciculatum to occur in the more xeric habitats. There are two main reasons for this. First, A. fasciculatum has a substantially higher photosynthetic rate than the other species, but lower above-ground tissue. Thus, it can be assumed that a greater percentage of A. fasciculatum's photosynthate, as compared to the other species, is being allocated to the roots. Secondly, with A. fasciculatum's low WUE in the winter months, it is effectively lowering soil moisture and the water table, thus making water increasingly unavailable to competitors of A. fasciculatum. A. fasciculatum adapts to this situation by increasing its WUE in the summer. These factors make A. fasciculatum a superior competitor in the xeric habitats. However, because of its short stature, it is a poor competitor in the mesic, more closed canopy habitats, due to light limitations. In the mesic habitats, neither A. glauca nor C. greggii should be favored in percent cover because neither predominates over the other in both photosynthesis and WUE. R. ovata has a low WUE and photosynthetic rates, and would be unable to avoid drought to any great extent through root development or physiological responses to water stress. Therefore, one would expect R. ovata to occupy areas where moisture tends to collect (e.g. rock crevices, slope bottoms).

This scenario is what is observed in the field. Thus, from this preliminary study, it can be concluded that both photosynthetic rates and water use efficiency are playing an interactive role in determining the present distribution of these chaparral species.

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[1] Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California

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Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Variation in Acorn and Seedling Characteristics of Two California Oaks[1]

Serena C. Hunter and Robert Van Doren[2]

Variation within and among plant species is caused by the genetic makeup of the plants and by their environment. Patterns of variation may be indicative of evolutionary trends and can guide man in his use of the species. Two studies were initiated in 1980 to get some idea about the amount and distribution of natural variation within two oak species, Quercus kelloggii and Quercus agrifolia, in southern California. The findings of these pilot studies will help to direct the design, emphasis, and scope of future investigations.

PROCEDURE

Acorns were collected around the first of October from 11 Q. kelloggii mother trees distributed among 3 stands on the San Bernardino National Forest. The stands were at elevations ranging from 4500 to 6300 ft. Measurements were taken on 10 acorns from each mother tree to determine acorn shape, size, dry weight, and moisture content. Thirty acorns from each tree were stratified for 70 days at 35° F and then germinated in separate 3-by-3-by-14-inch pots in a greenhouse. Top emergence rates and height growth were monitored for 5 months. A similar procedure was followed with acorns from eight mother trees distributed between two Q. agrifolia stands at elevations of 3200 and 3400 ft. Their acorns were collected during the last 10 days of October and stratified for 45 days.

RESULTS

Q. kelloggii

Results for the Q. kelloggii samples indicated significant differences in acorn lengths and in acorn dry weights among mother trees. However, acorns from the same tree appeared to be very similar in size, shape, and weight. Percent emergence and time to emergence varied within and among stands. Five months after planting, emergence of acorns from the 11 mother trees ranged from 20 to 93 percent. In general, emergence was poorer for acorns with higher moisture contents. Average acorn moisture content for the 11 mother trees ranged from 37 to 66 percent. In spite of a later collection date, acorns from the high elevation stand showed the highest moisture contents, and slowest germination rates, and produced the fewest seedlings.

Seedling height at 5 months also varied by mother tree. For progeny from the 11 mother trees, average height ranged from 4.7 cm to 7.9 cm. Height growth of the seedlings was positively correlated (R = 0.63) with acorn dry weight.

Q. agrifolia

Analyses of variance for the Q. agrifolia samples indicated within-stand differences in acorn length, time to emergence and percent emergence, and total height at 5 months. Between-stand variation was small in comparison with tree-to-tree differences within stands. Percent emergence of acorns from the various Q. agrifolia mother trees ranged from 3 to 93 percent. The average height of seedlings among mother trees also ranged substantially--from 4.5 cm to 9.9 cm at 5 months after planting. The average moisture content of the acorns from the eight mother trees ranged from 45 to 65 percent. Acorns with lower moisture contents were more likely to germinate and to produce taller seedlings.

For both the Q. kelloggii and Q. agrifolia seedlings, most or all of the height growth was accomplished within a few weeks after top emergence. Therefore, height measurements taken at 5 months were, in many cases, the same as measurements taken at 2 months. Whether taller seedlings will lose their height advantage during future growth flushes is yet to be seen.

Results of this small study suggest that substantial variation can exist within stands of both Q. kelloggii and Q. agrifolia for the variables measured. Variation among progeny from the same tree appeared to be much less. Collection and germination of acorns from these same mother trees will be repeated in future years to test for year-to-year environmental differences.

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[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

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Pasture Improvement and Prevention of Fires in Maquis: A Corsican Case Study[1]

Richard Joffre and Jean-Baptiste Casanova[2]

The maquis (shrubby evergreen vegetation type) is the result of progressive evolution of the vegetation since cultivation was abandoned as well as regressive evolution under the effect of fire. Indeed, during the last century, the agro-pastoral system where cereal cropping and livestock production were closely associated has been replaced by a more and more extensive use of land where only livestock production survives.

The low animal pressure and the free grazing system do not permit the control of the encroachment and provoke a decrease of the amount of pasture available. In order to regenerate the range and make it accessible to the herds, the shepherds use fire in an uncontrolled manner which gravely disrupts the ecosystem: erosion, development of pyrophytic brushes.

EXPERIMENTAL DESIGN

Following research described in Long and others (1978), an experiment is being carried out since 1978 near Corte (Corsica). The object is to evaluate the possibility of creating pasture without tillage (frequent high slopes) nor fire, from maquis of low pastoral value. These pastures are located in such a way that they also serve as fuelbreaks.

In the experimental zone (7 ha), the initial vegetation was low maquis (1.5-2 m) made up of Cistus monspeliensis L. and Erica arborea L. under a sparse cover of Quercus suber L. Shrubs made up 30 to 100 percent of the cover depending of vegetation type. The vegetation was mulched in April 1978, fertilized (100 kg ha^{-1} $year^{-1}$ of N and P_2O_5), fenced off and rotationally grazed by 50 dairy ewes and 200 dairy goats. A second mulching was done in the summer of 1979.

PHYTODYNAMICS

The more interesting points are

– The very rapid domination of herbaceous over shrubs. The evolution of floristic list in different sites depends on the initial amount of shrub cover and original floristic diversity.

– The qualitative improvement of the grazing value (ranging from 0 to 100) is due to the development of palatable species such as Dactylis glomerata L. and Trifolium subterraneum L.

– The edible herbaceous phytomass increased from 0.3 tons of dry matter ha^{-1} in 1978 to 5.5 tons in 1980.The stocking rate, expressed in Corsican sheep unit ha^{-1} $year^{-1}$ goes from 0,2 in 1978 to 4.2 in 1980.

Table 1-- Trends of cover and grazing value (from Claudin and Casanova, 1980, Joffre and Casanova, 1981)

	1977	1978	1979	1980
cover of herbaceous (pct.)	14	80	95	100
cover of shrubs (pct.)	81	17	7	1
grazing value	2	11	29	32

GRAZING MANAGEMENT

In the conditions of Corsican breeding system it seems necessary to render the improved zones complementary to areas of maquis, as much for sociological as for technical reasons. But, in any case it is important to avoid waste and range degradation, to have a high stocking rate and a rotational grazing. Only an integrated land management will lead to a significant reduction of pastoral fires in Corsica.

LITERATURE CITED

Claudin, J; Casanova, J-B. Améliorations pastorales dans le Venacais-Cortenais (1978, 1979). 1980; DGRST-PNRC, Ajaccio, 211 D.

Joffre, R; Casanova, J-B. Creation de paturages améliorés à partir d'une cistaie sous chêne-liège 1981; DGRST-PNRC, Ajaccio, 29 p.

Long, G.A; Etienne, M; Poissonet, P.S; Thiault, M.M Inventory and evaluation of range resources in maquis and garrigues.1978;Proc.of 1st Intern. Rangeland Congress. Denver, Co. p. 505-509.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

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Response of *Adenostoma fasciculatum* and *Ceanothus greggii* to Nitrogen and Phosphorus[1]

W. M. Jow, G. S. McMaster, and J. Kummerow[2]

The importance of nutrient availability in altering carbon allocation and growth of mediterranean scrub species has frequently been stressed but rarely tested. Nitrogen (80 kg/ha) and phosphorus (40 kg/ha) were applied in the early spring of 1978 to a 23-year-old stand dominated by Adenostoma fasciculatum and Ceanothus greggii var. perplexans to examine the effects of N and P additions on biomass production and carbon allocation of the two dominant species.

In the first year a combination of N+P resulted in the greatest increase in total new shoot biomass for both species, although in the second year this treatment produced shoots whose biomass were below the level of the unfertilized control plots (Fig. 1). The effects of N and P fertilization varied not only among the species but between years. Nitrogen significantly increased shoot biomass for both species in the first year but only in A. fasciculatum were significantly larger new shoots observed in 1979. Phosphorus has a relatively greater effect on C. greggii in the first year, producing a significantly greater shoot biomass, but no increased shoot biomass was found for either species in 1979. This difference in absolute biomass production between 1978 and 1979 cannot be explained by differences in precipitation, which was abundant in both the winters 1978 and 1979.

Phosphorus fertilization resulted in increased leaf and stem growth in C. greggii while the reproductive biomass (flower buds or seeds) was not significantly altered by N or P. The low response of C. greggii to nitrogen fertilizer may reflect the well-documented nitrogen-fixing capacity of symbiotic Actinomycetes in the roots of many Ceanothus species.

On the other hand, nitrogen increased both leaf and stem production in 1978 A. fasciculatum shoots while a decrease in inflorescence production occurred in this treatment. Conversely, phosphorus stimulated the formation of reproductive biomass.

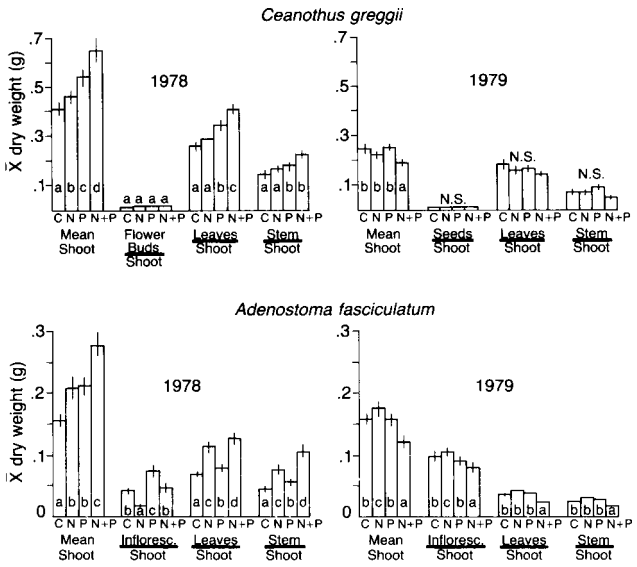

Figure 1. Individual new shoot biomass of C. greggii and A. fasciculatum produced in 1978 and 1979. Biomass values are expressed as mean grams per individual new shoot (± 1 SE). Statistical groupings within a shoot fraction are designated by lowercase letters according to a non-parametric equivalent to the Newman-Keuls multiple comparison test. Identical letters indicate statistically similar means (a = .05). N.S. denotes no statistical difference according to a Kruskal-Wallis test.

New shoot biomass of A. fasciculatum and C. greggii was significantly increased by the application of N and P. Estimates of the stand's response to N and P were made based upon the number of new shoots. Results show that N and P additions alter the number of new shoots, but the number is inversely related to new shoot biomass. The overall effect is that yearly production per m^2 canopy area of A. fasciculatum is increased by nitrogen and C. greggii by phosphorus. Current management options for the chaparral include the possibility of biomass harvesting for energy use. Based upon our results harvest would be increased by the addition of modest amounts of fertilizer, although the cost effectiveness of such fertilizer application is questionable. The long-term effects of fertilization on population patterns are unknown.

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Silvicultural Biomass Plantation: A Renewable Fuel Source[1]

Michael L. Kirkley, Norman H. Pillsbury, and Walter R. Mark[2]

Wood has long been recognized as a major source of energy around the world. It traditionally has been the most important source of energy in the early development of most countries, and in many countries it still comprises a major source of fuel for some uses. Today in the United States fossil fuels have all but replaced wood as a major fuel source. However, with increases in demand, along with the uncertainty of imported energy supplies and prices, investigation into environmentally acceptable, domestically produced, renewable energy sources is needed. The establishment and operation of energy plantations offer a reliable source of energy from woody biomass.

THE ENERGY PLANTATION CONCEPT

Tree species selected for biomass production must be resistant to insect and disease, demonstrate rapid growth and have high energy yield during short rotations, and respond to intensive cultural treatments. Hardwood species are thought to have the greatest potential for energy farming. They have the added advantages of not competing with timber and product uses of commercial conifer species and they can be coppiced. Sane of the hardwoods being examined in trial plantings in the United States include *Alnus, Eucalyptus, Platanus,* and *Populus.* A number of *Eucalyptus* species appear most promising in California. Of the 700 plus species in the genus, perhaps 20 or 30 could be used in the various climate regimes of California (Pillsbury 1980). Tree spacing in the plantation may range from 400 to 11,000 or more trees per acre. The energy plantation must be of sufficient size to guarantee a reliable long-term supply of fuel, on scheduled demand, to the power plant. Additional support acreage for storage, road network, and facilities ranges from 10 to 40 percent over the planted area.

Energy yield from plantations is a subject of much debate. Values used for California range from 5 to 13 dry tons/ac/yr depending upon species selected, spacing, cultural treatments, fertilization, irrigation, soil and site quality, weed control, and rotation age at harvest. Under ideal conditions, some say it may be possible to produce up to 22 dry tons/ac/yr (Fege 1979). The cost of producing energy feedstocks is equally debatable. Regional differences are created by land lease, interest and taxes, transportation costs and distances, the cost of investment, land steepness, and water availability. Although no reliable estimates are available for marginal lands in California, cost per million BTUs is $1.20 to $2.50 based on 17 million BTUs per dry ton, while 1985 costs for coal are projected at $1.50 per million BTUs.

CAL POLY ENERGY PLANTATION

In 1979 a 20-acre biomass energy plantation was established at California Polytechnic State University, San Luis Obispo. The objective of the study is to evaluate the growth response of eleven species of *Eucalyptus* at eight different spacings, utilizing pre- and post-emergent herbicides and mechanical means of weed control. The results will provide information on optimum spacing, cultural treatment, and fertilization to maximize biomass energy production on rotations ranging from 4 to 7 years.

The plantation is non-irrigated and is located on marginal land previously used for livestock production. The predominate soil type is a Los Osos variant clay-loam with slopes ranging from 5 to 22%, with a predominately south-facing aspect. Extensive site preparation was undertaken prior to planting with up- and downslope and cross-slope ripping of the site to an approximate depth of 2.5 feet (0.76 m). Round-up, a non-selective post-emergent herbicide, was applied to eliminate existing grass and broadleaf growth (Mark *et al* unpublished).

A Nelder circular plot design was developed to provide eight planting densities ranging from 400 to 11,000 trees per acre. Each plot is 0.23 ac (0.09 ha) in size and contains 240 trees. The species planted included *Eucalyptus camaldulensis* (Dehnh.), *E. cinerea* (F. Muell. ex Benth), *E. citriodora* (Hook.), *E. globulus* var. '*compacta*' (Labill.), *E. polyanthemos* (Schau.), *E. pulverulenta* (Sims), *E. stellulata* (Sieb. ex DC.), *E. viminalis* (Labill.). One of these species was randomly selected and planted in each plot. A total of 25 plots were planted allowing replication of species and cultural treatments. Plots were given split fertilizer treatments, one half receiving 10-gram tablets and the other receiving 21-gram slow release fertilizer tablets, both with a 20/15/5 (N/P/K) formulation.

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Tree planting was completed in the winter of 1980. Both pre-emergent herbicides and mechanical means were used to control competing grasses and forbs. Twelve additional plots were planted in the spring of 1981. The species planted included *Eucalyptus globulus, E. melliodora* (A. Cunn. ex Schau.), *E. paniculata* (Sm.), and *E. sideroxylon* (A. Cunn. ex Woolls). *A* pre-emergent herbicide was used to control competing vegetation.

PRODUCTIVITY EVALUATION

Measurements of productivity were limited to height and diameter for the first year. Selective cutting for correlation between height, diameter, weight, and energy yield will be made the second year. Similar data will be collected in the subsequent years. The cutting will allow study of the coppicing characteristics of the species being tested. Cuts will be made at various times of the year to determine the best timing to obtain maximum sprout numbers and vigor. The effects of species, spacing, planting dates, fertilizer treatments, and weed control on growth and yield will be analyzed.

An economic evaluation of the project will be conducted. Basic input cost groups such as labor, capital and materials expenditures, maintenance, operation, and harvest expenses will be recorded. The cost data and yield data will be used to determine production costs per million BTU's for various species, spacing, and cultural combinations.

LITERATURE CITED

Fege, A.S., *et al.* 1979. Energy Farms for the Future. J. of Forestry (June, 1979).

Mark, W.R., Pillsbury, N.H. and M. Kirkley. unpublished. Silvicultural energy plantation establishment Cal Poly, San Luis Obispo Progress Report. Wood Energy Program, California Department of Forestry, Sacramento, Ca, 36 p.

Pillsbury, N.H. 1980. *A* Summary of the potential and Problems of Silvicultural Energy Plantations in California. Presented at the July, 1980 CEC Biomass/Synfuels Workshop, Sacramento, CA.

The Mediterranean Ecosystem and the People: Resource Management in Santa Monica Mountains Natural Resource Area, California[1]

Kheryn Klubnikin, David Ochsner, and Robert Chandler[2]

The boundary of Santa Monica Mountains National Recreation Area, administered by the National Park Service, U. S. Department of the Interior, encompasses a Mediterranean-type ecosystem with significant scenic, recreational, educational, scientific, natural, archeological, and public health values. In the Establishment Act, Public Law 95-625 (16 USC 460kk), the United States Congress recognized that there is a national interest in protecting and preserving these benefits for the residents of and visitors to the area. This legislation mandated that the recreation area will be managed in a manner which will preserve and enhance its scenic, natural, and historical setting and its public health value as an airshed for the Southern California metropolitan area while providing for the recreational and educational needs of the public.

The Santa Monica Mountains form a complex geological unit. The evolution of the mountains is marked by repeated episodes of deposition of marine sediments, uplifting, regression of the sea, erosion, and the transgression of the sea to deposit new sediments. These episodes were interspersed with periods of faulting and folding of sedimentary beds due to the movement of the Pacific Plate and the North American Plate along the San Andreas Fault, and the intrusion of magma into the sedimentary beds. The Santa Monica Mountains are one of the ranges in California in an east-west alignment.

The mountains are a diverse botanical island that is representative of the California Floristic Province. Vegetative communities include chaparral, coastal sage, oak woodland, oak grassland-savannah, riparian woodland, beach and dune, southern coastal salt marsh, freshwater marsh, grassland and rocky intertidal. Five of these communities are considered critical in California for preservation.

Much of southern California's native wildlife still survives in the mountains. A small population of mountain lions remains as do extensive populations of birds of prey. The Santa Monica Mountains are significant in the Pacific Flyway as resting and feeding areas for migratory birds, as is Mugu Lagoon at the western end of the Range.

A broad spectrum of human uses is represented in the Santa Monica Mountains. In pre-European times the mountains and the sea sustained the Chumash and Gabrielino native American coastal cultures. The Hispanic occupation brought about a drastic change in the cultural history of the mountains with the virtually complete subjugation of native Americans. Current land uses include a broad range of urban development, rural homes, high density recreation, and the preservation of open space and natural and cultural features. The present jurisdictional arrangements are very complex.

Within this context, the National Park Service encourages new and innovative concepts of ecosystem maintenance through cooperative planning. These concepts are intended to encourage private and governmental entities to design actions that perpetuate the integrity of the inherent resources. Resource management projects include monitoring surface water quality, delineation of wildlife corridors, determination of research needs, monitoring air quality, the role of fire in the mountains (including prescribed fire), preservation of the cultural continuum, and assessment of the environmental impacts of human uses in the mountains.

Educational programs are vital to the success of the Santa Monica Mountains National Recreation Area for resource-based recreation activities and for conservation of Mediterranean-type ecosystems. Over 70 colleges and universities and approximately 10 museums and research facilities are within easy reach of the area. Through present educational programs school children and other visitors are given experiential understanding of the natural world and the human cultures that occupied the mountains and coast. These programs include traditional nature walks, seminars featuring scientists, coastal walks, musical interpretations and a recreation transit program that brings inner city residents into the Santa Monica Mountains.

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Species Diversity and Stratification to Improve Grazing in Mediterranean Chilean Range[1]

Sergio Lailhacar, Héctor Manterola, Alfredo Olivares, and David Contreras[2]

An important area of the mediterranean Chilean range, approximately 4 million ha, mainly in the arid zone, is being affected by a strong process of desertification. The zone affected extends between parallels 32° and 36° S.

Climatic conditions are typical of a mediterranean-type zone, with rainfall between June and September, at an average of 200-250 mm. Twenty-seven percent of the total rain occurs in fall, 53 percent in winter, and 17 percent in spring. Normally every year has about 7 months of drought, and the incidence of drought years is very high. These climatic conditions have induced the development of a typical matorral-type vegetation, characterized by a herbaceous stratum, actually very low in annual biomass production, and a woody one, with a wide variety of species.

The herbaceous stratum has been severely affected by overgrazing, and some species have disappeared or are rarely found. Dominant genera actually present are Erodium, Vulpia, and Oxalis. Less common, but still present are Tricetobromus, Bromus, Lolium, Koeleria, and Avena. Almost extinguished are Medicago, Trifolium, Trigonela, Hosakia, and Adesmia.

The woody stratum has been affected by wood cutting, either for firewood or to clean the fields for further cultivation. Also, animals such as goats have produced a negative effect on the matorral. The dominant genera are Bahia, Baccharis, Puya, Adesmia, Muehlenbeckia, Heliotropium, Trichocereus, and Haplopappus. In some areas that were under cultivation, some toxic species such as Cestrum palgui appear.

Less degraded matorrals can be found toward the south where Acacia caren steppe starts. The vegetation has not been so degraded and some microphanerophytes such as Azara celastrina, Maytenus boaria, and Lytrea caustica are found.

Under these conditions, the ecosystem has changed its morphology and composition, and productivity, expressed as stocking rate capacity, or edible dry matter production, has significantly decreased. Continuous human pressure on the ecosystem, either through wood harvesting, overgrazing, or cultivation, has produced an accelerated erosion process that in many situations cannot be easily stopped or reversed.

EDIBLE BIOMASS PRODUCTION

Most of the areas considered in this study are low in biomass production, which is also very dependent upon amount and distribution of rainfall. Average forage production is about 0.7 to 1.2 ton/ha/yr, but it has been seen that under experimental conditions (modifying the rainfall system and management), production can be increased to 3 to 4 ton/ha/yr. The main herbage genera that actually produce this biomass are Erodium, Vulpia, and Bromus. Most of the palatable genera are on a low stand or have disappeared (Medicago, Trifolium, Tricetobromus) and genera such as Raphanus, Lamarkia, Capsell, and Amsimckia have invaded the land.

The nutritive value of the available forage has wide variation through the year, related to the vegetative cycle. Energy is always the most limiting factor for animals, and fluctuates between 1.2 and 2.5 kcal/gr organic dry matter. The crude protein content is also a limiting factor, especially during the dry season. When pasture is the preblooming state, the protein content is about 10 to 14 percent, and decreases to 3 to 4 percent after pasture gets dry. Crude fiber goes from 10 percent to 30 percent for the same periods.

ANIMAL PRODUCTIVITY

Current ecological conditions only allow the development of extensive animal production systems, based either on goats or sheep, depending upon rangeland conditions. In the area where the degradation is higher, farmers raise goats, producing cheese or selling the kids. Small flocks of sheep are present in some better areas. As the pasture conditions improve, sheep replace goats because they bring a higher price for meat.

The average stocking rate for the worst condition varies from 0.1 to 0.3 sheep/ha, and for better conditions, from 0.5 to 1.5 sheep/ha. Goats can make use of shrubs, so are not so much affected as sheep during critical periods, but both goats and sheep have very low yields because of chronic under nutrition, reproductive performance, and sanitary problems.

There are some periods during the year when animals cannot meet their nutritional requirements, especially during the last third of the gestation period and during lactation, producing high lamb or kid mortality. Adults also die when starvation continues too long.

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Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

RESEARCH STRATEGIES TO DEAL WITH THE PROBLEM

The first strategy studied was based on the introduction of foreign forage genera, such as Phalaris, Trifolium, Lolium, and Sorghum in order to replace the natural pasture. It did not work because those genera did not become adapted to the climatic conditions, mainly to the low rainfall level. After that, a new strategy was started, based on the transformation and modification of the ecosystem but trying to produce the least alteration in its structure. The idea was to produce a diversification of species and stratification of them in order to optimize the use of solar energy, water, and soil minerals. This procedure, together with an improvement in rangeland management and water collection systems, is the basic action needed to partially solve the problem.

In order to replace some of the inedible brush with others more valuable, a worldwide collection of native and foreign shrubs was tested. After an evaluation process, it was concluded that Atriplex repanda, followed in rank by Atriplex numularia and Atriplex semibaccata, fitted very well in the conditions where they were needed.

Atriplex repanda is a native species from the north of Chile (400 km from Santiago). It is a saltbush with very high palatability for sheep and goats; this has almost produced its extinction. This saltbush grows all year, but the growth rate is significantly higher during the summer. In late fall and winter, its growth is minimal. The nutritive value is very high, with a protein content of 18 to 21 percent in the leaves, 11 to 12 percent in the stems, and 8 to 9 percent in the seeds. The crude fiber of the edible portion is about 23.6 percent.

The most relevant characteristics of this species are

- -its high resistance to dry conditions
- -its ability to make available green forage and protein, during the most critical period in the pasture
- -its high palatability
- -its habits of growth, that provide protection against weather

Taking into account these advantages, the government, through its Forestry Agency, has developed special legislation in order to encourage the settlement of this plant in the arid and semiarid zone of Chile. At the present time, more than 15 million ha have been planted.

RESEARCH RELATED TO ATRIPLEX REPANDA

One of the problems that scientists have found in Atriplex is the very low seed germination rate, no higher than 5 percent. Studies have been made to detect the presence of inhibitors or some special dormancy mechanism. It has been shown that age of seed plays an important role in germination of Atriplex, 3-year-old seed having a higher germination percentage compared with 1- or 2-year-old seed.

Another interesting problem studied was the density of plants. It was observed that in a high density stand, there is marked competition between plants, which reflects on their growth and persistence through the years. Studies have shown that an adequate density can fluctuate between 700 and 1200 plants per hectare. This will produce a yield of 1.0 to 1.5 tons dry matter per hectare. Rainfall and soil conditions are the main factors affecting density.

In relation to the use of Atriplex by animals, two studies have been done up to date. One is on grazing intensity, and the other on the response of animals to Atriplex feeding during the period of highest nutritional requirement. The first was related to when and how many times should Atriplex be used to get the best response in terms of plant longevity. Studies indicated that these shrubs could be grazed any time of the year, but once in a year, for maximum productivity and longevity. Used twice a year, Atriplex produces more edible material, but plants are significantly affected. The second problem of utilization was how to integrate this supplementary saltbush to the annual cycle of the animal, especially during the critical periods. It has been seen that pregnant ewes perform better when they have access to Atriplex during the last third of the gestation period. Lambs are born with higher weight and growth is faster, indicating an effect on lactation.

Also, in other phases of the animal productive cycle, Atriplex has shown a significant effect on animal performance.

CONCLUSION

After 20 years of study, it can be concluded that it is possible to replace some of the ecosystem components with others of greater suitability, without any significant alteration of its morphology and functioning. It produces an improvement of the natural pasture, provides another ecological niche, and animals perform better.

REFERENCES

Gasto, C. J.; Silva, G. M.; Cariedes, E. Santiago, Chile: Facultad de Agronomía, Univ. Chile: 1968; Boletín Téchnico 28. 19 p.

Gasto, C. J.; Contreras, T.D. Santiago, Chile: Facultad de Agronomía, Univ. Chile: 1972; Boletín Téchnico 35. 61 p.

Gasto, C. J.; Contreras, T. D. Santiago, Chile: Facultad de Agronomía, Univ. Chile: 1979; Boletín Téchnico 42. 99 p.

Olivares, E. A.; Gasto, C. J. Santiago, Chile: Facultad de Agronomía, Univ. Chile: 1977; Boletín Téchnico 34. 00 p.

Coastal Sage Environmental Conservation—The Navy's Experience at Point Loma[1]

Ronald La Rosa[2]

San Diego's Point Loma, a relatively undeveloped three-mile peninsula, has been a military reservation since 1852. Through the Naval Ocean Systems Center (NOSC), the Navy and Point Loma have been linked through research and development. NOSC has recognized its responsibility to preserve, protect and improve the 507 acres that are entrusted to them. In recent years, their commitment to this responsibility has been a planned and executed program to assure that the natural state of the land is protected.

The Navy's four-year program has resulted in the installation of hundreds of native trees and shrubs, most of them rare and endangered species, to enhance the environment and increase biological productivity. Steps have been taken to correct erosion problems through revegetating disturbed soil, restoring natural contours, and improving drainage patterns to check run-off and soil loss.

ENVIRONMENTAL PLANNING

The NOSC Environmental Resources Conservation Program was implemented through a multidisciplinary team approach consisting of engineers, planners, and an environmental specialist augmented by a soil scientist, architect and contracts administration staff. Master planning provided the framework for the division of conservation activities into annual phases: Phase I involved an initial study of resources and environmental needs assessment; Phase II concentrated on installation of plant material; Phase III activities were a culmination of the previous phases as well as the beginnings of three experimental projects; and Phase IV focused on erosion control and runoff management. After a phase-end evaluation, the Master Plan was revised accordingly. The program's underlying philosophy was one of minimizing research costs and maximizing on-the-ground conservation efforts.

COASTAL SAGE CONSERVATION

Enhancement of NOSC lands went beyond simple "beautification". Components of wildlife management, engineering geology and landscape architecture were combined to provide an action-oriented, ecological approach to land use planning and environmental protection. Nearly 2,000 plant species including Torrey pine (Pinus torreyanna) shown in Figure 1, California sycamore (Platanus racemosa), Wild cherry (Prunus illicifolia), Coast white lilac (Ceanothus verrucosus) and Encilia (Encilia californica) were planted on wildlands and disturbed sites. In wildland sites, irrigation consisted of drip-type systems; landscaped areas were watered by impact-type heads. In addition, a repository for rare and endangered flora displaced by development in the region was created.

Project Results

The environmental enhancement of disturbed areas through the installation of forbs, shrubs, and trees resulted in the dramatic increase of wildlife species benefiting from successive vegetation. Shrubs and trees planted as seedlings, one-and five-gallon as well as twenty-four-inch containers, have had to date a success factor of 90 percent. (Losses were due to burrowing animals and pockets of clayey soils underlying loamy areas.) Landscape, revegetation and wildlife plantings have, over the years, become established to provide food plots, wildlife shelter, aesthetic screens and stabilization of soil.

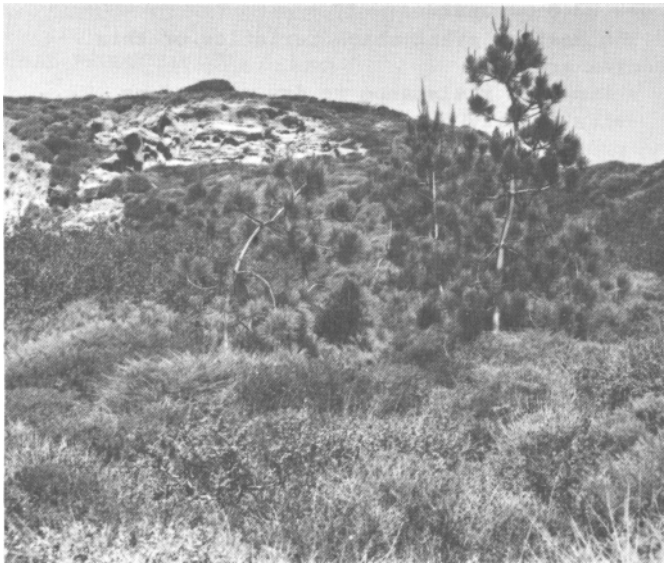

Figure 1--Torrey pines, installed by hand to protect existing shrubs, create aesthetic wildlife habitat in the low-profile coastal sage of Point Loma, San Diego.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-Type Ecosystems, June 22--26, 1981, San Diego, California.

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Photosynthetic Production of Perennial Species in the Mediterranean Zone of Central Chile[1]

William T. Lawrence, Jr., and Walter C. Oechel[2]

The carbon balance of a plant is a key parameter, integrating the biotic and abiotic interactions of the individual with its intrinsic physiological rates of photosynthesis and respiration. In the field, carbon balance cannot be directly measured, but it is calculated by summing the carbon gained or lost by all plant tissues under the given set of environmental conditions. In Chile we have begun such a carbon balance study by gathering a season of basic data on the CO2 exchange of above-ground parts of some of the dominant shrub species.

Both leaves and several size classes of stems were measured in situ with an infrared gas analysis system to determine their CO_2 exchange under a range of light and temperatures. The stems are an often overlooked, but nonetheless important component of the plant carbon balance as they respire, losing carbon, and in some cases may photosynthesize.

A wide range of life forms were examined, including Satureja gilliesii, a drought-deciduous subshrub; Trevoa trinervis, a drought-deciduous, green-stemmed shrub; Colliguaya odorifera and Litraea caustica, both evergreen shrubs; and Mutisia linearifolia, a composite vine.

As would be expected, the species fall out over a range of leaf photosynthetic rates, but more interestingly, every one of the shrubs shows a net gain of carbon by stems at least one temperature. Both Lithraea and Colliguaya have the lowest stem photosynthesis rates, but when positive, they are 9 and 5% respectively of the leaf rate. Satureja also has a low rate, but maintains the positive 3-5% level all across the temperature range. Trevoa's current-year stem rate is 30-38% of that of the ephemeral leaves, and a rate for older stems is fully 10% of the leaves, so even when the leaves are shed at the onset of drought, a strongly photosynthesizing surface remains.

The stem photosynthesis of the shrubs varies strongly with light intensity. Both the light response and the stem gas exchange diminish rapidly with stem age, probably due to decreased conductance of CO_2 by the thickened bark.

Stem photosynthesis would naturally be of less importance in older stems as they are increasingly shaded by canopy development. Once a stem no longer provides carbon through photosynthesis, it can then only be mechanical support, and it becomes a carbon sink. A large bulk of respiring stems can be costly, but some of our data indicates a reduction in respiration on an area basis as stems age, thus effectively reducing some carbon loss associated with non-green support stems.

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[1]Presented at the Symposium on Dynamics and Managment of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

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Table 1. CO_2 exchange for leaves and current and last year's stem age class for the fie Chilean species. Both dark respiration (Rd) and full-sun gas exchange (Ps) are tabled in mg $CO_2 \cdot dm^{-2} \cdot h^{-1}$ ± one standard error. Photosynthesis is represented by a positive CO_2 flux. Measurements were made at 5, 15, and 25°C air temperatures in a thermoelectrically cooled cuvette system near Santiago, Chile.

Species	Tissue	Rd	Ps	Rd	Ps	Rd	Ps
		5°		15°		25°	
Trevoa	leaves	-0.34±0.02	14.53±1.31	-0.30	18.45±1.28	-0.88±0.53	18.03±1.84
	current	-0.20±0.10	4.36±1.11	-1.97±0.22	7.07±0.49	-4.44±0.74	5.76±1.64
	last	-2.08±0.28	1.52±0.08	-4.43±0.43	2.48±0.29	-11.26±1.12	-1.77±0.36
Satureja	leaves	-0.60±0.02	6.11±0.41	-1.80±0.10	10.97±0.37	-4.28±0.19	17.37±0.17
	current	-0.75±0.13	0.25±0.05	-1.43±0.11	0.34±0.11	-2.53±0.13	0.87±0.09
	last	-0.17±0.03	-0.22±0.04	-0.76±0.06	-0.31±0.05	-1.98±0.10	-0.37±0.11
Collig.	leaves	-0.71±0.01	14.72±2.69	-1.77±0.12	14.76±1.69	-5.50±0.40	23.75±2.50
	current	-0.43±0.16	0.18±0.11	-1.40±0.24	-0.59±0.09	-4.35±0.22	-2.62±0.39
	last	-0.52±0.15	-0.51±0.35	-1.81±0.16	-0.82±0.53	-3.79±0.18	-1.91±0.39
Lithraea	leaves		3.32±0.48	-0.29±0.06	11.99±1.38	-1.17±0.08	13.74±1.18
	current	-1.74±0.22	-1.17±0.46	-1.48±0.32	-0.35±0.35	-2.36±0.41	1.17±0.08
	last	-0.86±0.09	-0.51±0.05	-1.22±0.11	-1.20±0.32	-2.90±0.39	-2.42±0.96
Mutisia	leaves	-0.05±0.03	5.88±0.26	-0.30±0.01	9.45±0.54	-0.75±0.32	9.79±0.74

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Modeling Postfire Succession in Coastal Sage Scrub[1]

George P. Malanson[2]

Coastal sage scrub in the Santa Monica Mountains regenerates following fire primarily through resprouting from root crowns. Dominant shrubs are variable in post-fire resprout and seedling regeneration and also in continual seedling establishment. Such differential reproductive success in both the immediate post-fire environment and in the succeeding years should result in a changing relative abundance of species. Thus fire interval should be an important factor in determining the relative abundance. A constant fire interval should result in a dynamic equilibrium species composition, but might exclude some species if the interval is very long or short; a variable fire interval should create a shifting abundance that may allow the coexistence of a greater number of species.

The model being constructed is based on the regenerative success of the species, in the first post-fire years and through time. Fire intensity will be considered in setting the initial post-fire densities of resprouts and seedlings. These densities will then be iterated at 5-year intervals using a Leslie matrix of fecundity and survivorship (fig. 1).

$$\begin{bmatrix} f_0 & f_1 & \cdots & f_n \\ p_0 & 0 & \cdots & 0 \\ & p_1 & & \\ & \ddots & & \\ 0 & & p_{n-1} & 0 \end{bmatrix} \begin{bmatrix} n_{0,t} \\ \\ \\ n_{n,t} \end{bmatrix} = \begin{bmatrix} n_{0,t+1} \\ \\ \\ n_{0,t+1} \end{bmatrix}$$

f - probable fertility function
p - probable survival function

Figure 1--Leslie matrix of age-dependent fecundity and survivorship with age class population vectors.

The entries in the Leslie matrix will be based on postulated graphs of age-dependent natality and mortality (cf. fig. 2) which in turn will be based on known age structures for species populations. A small number of age structures are being sampled by counting the xylem rings of the largest basal branch of all the individuals of a given species dominant on a 25x25 m site. The entries will be computed as logistic functions of extant shrub cover; total shrub cover will limit the reproduction of all species. For this purpose a relationship between density and cover on different age sites is being established through size distributions for intercepted plants as the longest chord perpendicular to a line transect. For the most important shrubs (Artemisia californica Less., Encelia californica Nutt., Eriogonum cinereum Benth., Salvia leucophylla Greene, and S. mellifera Greene) at least 3 different age 25x25 m sites on which a species is dominant or co-dominant are being sampled along 4 randomly located transects.

With each iteration the densities and foliar cover of the species will be incremented, the relationship depending on the age of the stand. In this form the Leslie matrix embodies the assumptions that competition for space through regenerative strategy is the primary process controlling species relative abundance. Through time relative abundance will shift toward the optimal combination of fecundity and survivorship, and this prefire relative abundance will affect the new initial post-fire densities. The model will predict foliar cover of species given various hypothetical or observed fire history scenarios. The predictions will be tested against actual abundances on sites of known fire history in the Santa Monica Mountains. The form and direction of variation in abundance will be of equal interest to ecologists and land managers.

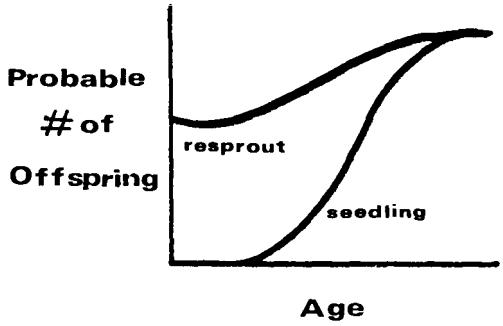

Figure 2--An example of a postulated natality graph.

Acknowledgements: Support for this study is from NSF grant 76-81712 to W.E. Westman.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, Calif.

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Vegetation Responses to Prescribed Burning in Cuyamaca Rancho State Park, California[1]

Bradford D. Martin[2]

This study reports the results of light-intensity prescribed burning on the vegetation of 3 jeffrey pine-black oak woodland sites in Cuyamaca Rancho State Park, California. The 1.2 ha Oakzanita burn, 85 ha Granite Springs burn, and 6 ha Paso Picacho burn were measured for tree and shrub density and basal area in June, 1980, 6 months, 1½ years, and 2 years following burning for the 3 sites respectively (fig. 1). Each burn site measured was compared against equivalent unburned control plots to help assess the effects of the burning. Density of saplings, seedlings, and herbaceous vegetation was also determined for the woodland understories. Dominance and relative dominance of herbaceous foliar cover in meadow areas were obtained to determine the recovery of the perennial bunch grasses.

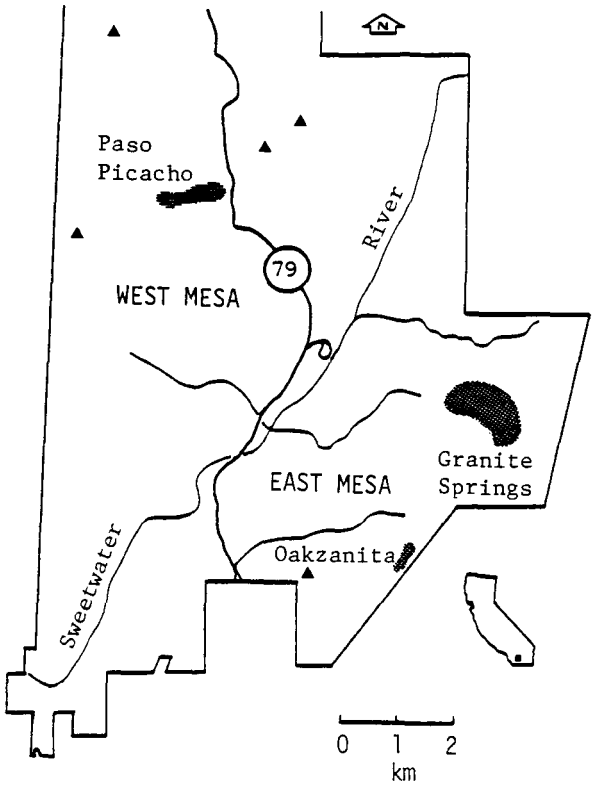

Figure 1--Locations of the Paso Picacho burn, Granite Springs burn, and Oakzanita burn in Cuyamaca Rancho State Park, California.

The greatest change which took place as a result of the burning was a significant reduction ($P<.05$) in density and basal area of shrubs in the understory (table 1). The dominant shrub, Arctostaphylos pungens (non-sprouting), averaged a 93 percent density reduction in the burn sites compared to the control sites. Other shrubs such as Arctostaphylos glandulosa, Ceanothus leucodermis, Ceanothus palmeri, Cercocarpus betuloides, and Rhamnus californica were also reduced to a lesser extent. Except for a slight reduction in the number of trees with very small trunk diameters at breast height (2-8cm), tree density and basal area were not affected by the burning (table 1).

Table 1--Mean density and dominance (based on basal area) of shrubs and trees in $100m^2$ control and burn quadrats at all 3 burn areas.

Area	Density		Dominance	
	control	burn	control	burn
	no/ha		Mean pct.	
Paso Picacho				
Shrubs	480	43	0.12	0.02
Trees	1039	1165	0.59	0.62
Granite Springs				
Shrubs	31	3	0.005	0.001
Trees	369	345	0.36	0.45
Oakzanita				
Shrubs	3529	240	0.25	0.03
Trees	374	407	0.22	0.21
TOTAL				
Shrubs	4040	286	0.38	0.05
Trees	1782	1917	1.17	1.28

Shrub and tree sapling density was significantly reduced ($P<.05$) in burn sites when compared to control sites. Mean density of tree seedlings was also generally decreased in burn sites except for Quercus agrifolia, Quercus chrysolepis, and Quercus kelloggii, which increased in some study sites in the most recent burn. Shrub seedlings (Arctostaphylos pungens and Ceanothus palmeri) were very infrequent in all control and burn areas. Density and diversity of herbaceous vegetation were generally increased as a result of the burning. Bunch grasses in meadow areas recovered quickly from the removal of dead grass in bunches by the fire. Muhlenbergia rigens (a bunch grass) recovered 143 percent of the live foliar cover 3 months following one burn.

The results of this study indicate that prescribed burning done in woodlands can eliminate shrubs in the understory without affecting trees.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, California.

[2]Graduate Student in Biology, Loma Linda University, Loma Linda, California 92354.

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Fire in the Ecology and Management of Torrey Pine (*Pinus torreyana*) Populations[1]

Gregory S. McMaster[2]

Fire has been an important historical and biological factor in southern California for many centuries, but the frequency and intensity of fires remains uncertain. The role of fire must be incorporated into any management consideration, particularly for areas such as the Torrey Pines State Reserve in San Diego, Calif., which is charged with maintaining the naturally rare Pinus torreyana in its native habitat.

This summary will present three lines of evidence to support the hypothesis that crown fires have had a strong selective role on recruitment in Torrey pine stands and the implications for management alternatives in the Reserve: 1) significant recruitment in an area of a crown fire, 2) limited seedling establishment between fires, and 3) the delayed seed dispersal traits of the cones.

In 1972 4.8 ha were burned with complete mortality of the 93 adult Torrey pines in the area. Sampling in 1981 revealed that the burned stand has apparently replaced itself (Table 1), particularly since no mortality has been observed from 1979 to 1981, mean seedling height has increased from 1.54 m in 1979 to 2.40 m in 1981 and some establishment is still occurring (two 1981 seedlings were found).

Table 1. Seedling establishment following a 1972 crown fire with complete adult mortality. The burned area was first sampled in May 1979 and then resampled in May 1981. Seedling estimates for the area immediately adjacent to the burned area includes all individuals 20 years and less.

	Burned	Unburned
Live seedlings/ha	66	0.8
Adults/ha	20.8 (dead)	29.5

Sampling in other unburned stands recorded relatively few seedlings (Table 2). Establishment in 1978 was exceptionally above normal (28/ha) and correlates well with the near record rainfall and large seed crop for that year. However, less than 25% of the total seedlings established in 1978 (including those outside of the stands studied) were still alive by June, 1981. Seedling establishment declined drastically to less than 1/ha in 1979 and 1981. The reduced establishment noted in 1979 and 1981 appears to be more typical and is supported by the sapling densities which represents establishment for the last approximately 15 years. A mean establishment rate of .6 seedlings/ha/yr is yielded if a constant rate of establishment is assumed. The majority of seedlings and saplings discovered in the Reserve (about 93%) are found in microsites with no shrubs or dense herbaceous cover and the survival rate of seedlings in open areas is greater than those with dense vegetation nearby. Further, seedling density is correlated with the amount of open ground within a stand. These data show that establishment is much higher in burned than unburned areas. This holds for both total number of seedlings established and the proportion of live seedlings to adults which is 3.17 for the 1972 burned area and 0.17 for the unburned areas when combining 1978-81 data.

Table 2. Seedling establishment between fires. Sapling data were recorded in 1978 and are those individuals older than one year that have not reached reproductive age, approximately 15 years. Adult densities vary over time as the size of the sample areas was increased. Estimates of live seedlings are through May 27, 1981.

	Year of Establishment			
	1978	1979	1981	Saplings
Total seedlings/ha	28	0.3	0.5	9
Live seedlings in 1981/ha	10	0.0	0.0	9
Adults/ha	58	58	61	58

Torrey pine cones can be retained on the tree for as long as 15 years after pollination, and cone opening is only about 75% complete 2 years following seed maturity. About 77% of the total seed crop in 1978 was contained in cones one year or more past maturity. Serotinous or closed-cones are considered to be an adaptation to crown fires in areas with little establishment between fires. The retained seed is available for the period immediately following a fire when the probability of successful establishment is greatest. The existence of delayed seed dispersal in Torrey pine is consistent with the hypothesis of sporadic crown fires.

The probable historical importance of crown fires to Torrey pine presents a dilemma to the Reserve management since intense conflagrations are rarely acceptable, particularly in an area with an urban interface. The only alternative that can be foreseen is to attempt experimental controlled burns of lesser intensity in order to see if this will be acceptable in place of crown fires.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California

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Growth and Maintenance Costs of Chaparral Leaves[1]

Jose Merino[2]

Deciduous and evergreen species coexist in mediterranean-type ecosystems. Their leaves differ considerably in a number of central properties. In order to assess the benefit one leaf type has over another in a given habitat, the costs of producing and maintaining the leaf must also be taken into account. Here I compare the costs of building and maintaining leaves of drought deciduous (Lepechinia calycina and Diplacus aurantiacus) and evergreen (Heteromeles arbutifolia) mediterranean-climate plants.

For calculating the respiration components, I adopt the model

$$SRR = Rg\ SGR + Rm$$

where Rg and Rm are the coefficients of growth and maintenance respiration, SRR is the specific respiration rate and SGR the specific growth rate of the leaf.

RESULTS AND DISCUSSION

There were no significant differences among the Rg values of the three species on a weight basis (table 1). The average total cost per gram of leaf tissue for all the species is 1.76 g of glucose (0.52 from respiration and 1.237 from molecular skeletons) (table 2).

Table 2--Total growth cost

	g gluc/g dw	g glue/m^2
March		
L. calycina	1.72	91.58
D. aurantiacus	1.82	118.26
May		
L. calycina	1.72	128.14
D. aurantiacus	1.82	209.85
H. arbutifolia	1.71	146.89

The results indicate that the hypothesis that evergreen leaves are more expensive to construct than deciduous ones may not be generally true. This may be due to the high concentrations of resins or terpens in the deciduous species which were studied. Those components are presumably involved in such functions as drought resistance, herbivore protection and, perhaps, flammability.

The maintenance cost values found in this study are significantly higher than those calculated by others for different chaparral species (table 3).

The lower maintenance cost of the evergreen species may be important in the plant's long term success, because many evergreen leaves endure extended periods in which photosynthetic CO_2 gain is very low.

Table 3--Maintenance cost

	g gluc/g dw/day	g gluc/m^2/day
March		
L. calycina	0.0339	1.8204
D. aurantiacus	0.0199	1.3015
May		
L. calycina	0.0227	1.6911
D. aurantiacus	0.0190	2.1907
H. arbutifolia	0.0174	1.4907

Table 1--Respiration coefficients expressed on a weight and area basis

	Rg	Rm	Rg	Rm
	g CO_2/g dw	μgCO_2/g dw/s	g CO_2/m^2	μg CO_2/m^2/s
March				
L. calycina	1.071	0.5750	57.51	30.88
D. aurantiacus	0.620	0.3378	40.54	22.08
May				
L. calycina	0.740	0.3851	55.13	28.77
D. aurantiacus	0.855	0.3232	98.58	37.27
H. arbutifolia	0.646	0.2958	55.49	25.41

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26,1981, San Diego, California.

[2]Assistant Professor of Ecology, University of Seville, Faculty of Biology, Seville, Spain

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

New Approaches to Harvesting Chaparral for Energy[1]

J. A. Miles and G. E. Millen

Harvesting chaparral for fuel requires meeting constraints which will require new machines and systems. In addition to being economically feasible, the systems must keep the fuel as clean as possible because even a very small amount of soil or rock will make the biomass unacceptable for combustion or gasification. Any rock may also be very detrimental to intermediate processing equipment. The system must also be able to harvest chaparral on a variety of terrain types without major changes in road systems. Finally, in sane areas, minimum impact systems which do little soil disturbance and leave root systems intact are essential to protect soil and water quality.

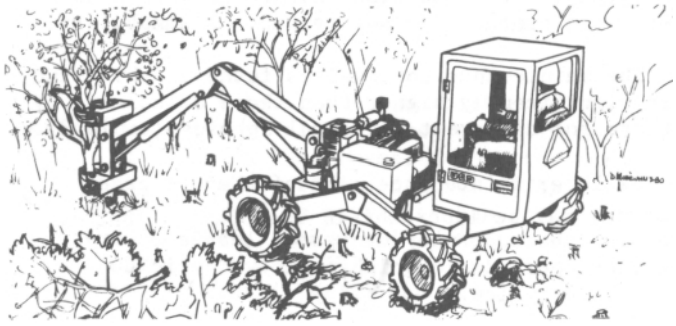

Figure 1--A very light weight vehicle is used to cut and windrow chaparral.

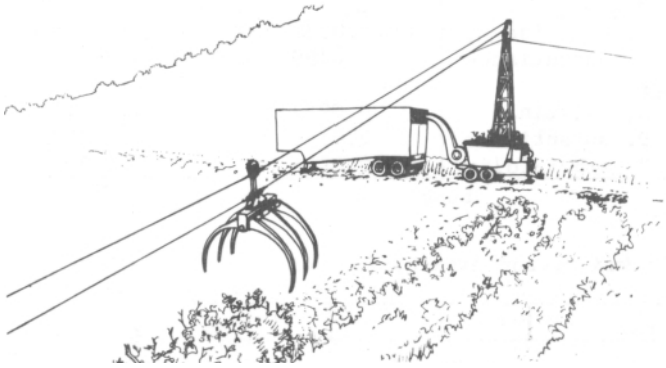

Figure 2--The biomass is moved to a landing site using a cable system which can move over the area with reasonable speed and very little impact.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26,1981, San Diego, California.

[2]Assistant Professor of Forest Engineering and Extension Specialist in Agricultural Engineering, respectively, University of California, Davis.

Figure 3--The biomass is placed into a module builder, adapted from the cotton industry, distributed and compressed into a unit 7½ feet wide, 30 feet long and 8 feet high.

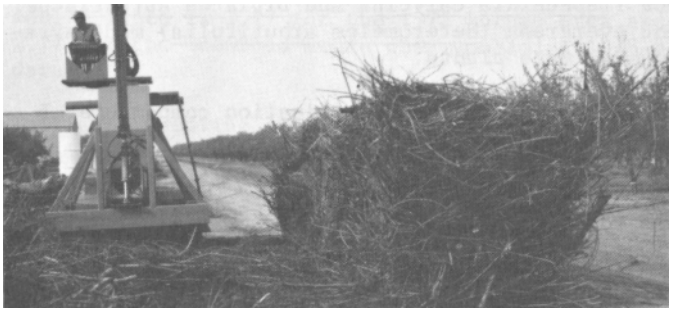

Figure 4--A free standing module, having a density of 8 to 10 lb /ft^3, ready to be picked up by a transport vehicle.

Figure 5--To increase biomass density, the material may first pass through a tub grinder, then into the module builder.

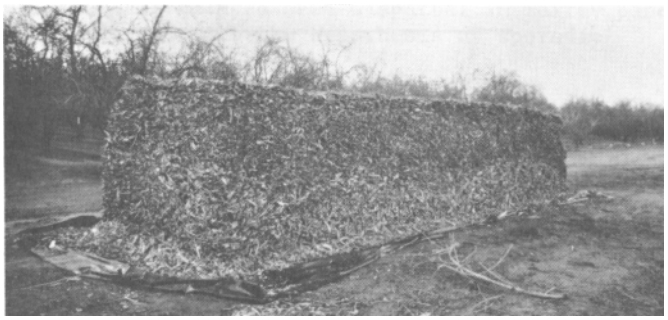

Figure 6--The resultant free-standing module has a density of 25 to 30 lb /ft^3.

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Ponderosa and Jeffrey Pine Foliage Retention Indicates Ozone Dose Response[1]

Paul R. Miller and Robert E. Van Doren[2]

Ozone is the component of photochemical air pollution responsible for damage to tree species comprising the mixed conifer and pine types of southern Sierra Nevada and southern California mountains. In these forests ponderosa pine (Pinus ponderosa (Laws.) and Jeffrey pine (P. Jeffreyi Grev. and Balf.) are the most sensitive to ozone. The purpose of this study was to examine needle injury symptom development leading to premature senescence and abscission as a function of ozone dose and intraspecific variation of ozone sensitivity.

Thirteen ponderosa or Jeffrey pine saplings or small pole-sized trees were selected at each of 5 plots located in the San Bernardino National Forest along a gradient of decreasing ozone dose. The experimental plot locations and respective mean seasonal ozone doses (parts per million-hours) for 1976, 1977, and 1978 were: Dogwood (DWA), 244.3; Tunnel 2 Ridge (T-2), 222.8; Camp Angeles (CA), 208.0; Deer Lick (DL), 191_.8; and Camp Osceola (CAO), 166.4. The individual ozone sensitivity of trees at each plot was recognized by segregating them into categories defined by the average number of annual needle whorls retained in the lower crown at the outset of the three-year observation period. Incremental increases of the percent of the total needle length with chlorotic mottle (ozone) symptoms were measured for each needle age at biweekly intervals from mid-June to early September. Incremental values were summed to obtain the seasonal increase. Counts of needles of different ages remaining in their respective whorls were made at the beginning and end of each summer season to provide information on abscission rates.

Results show that: 1) needle injury symptom development of the trees was significantly different among four chronic injury categories resulting from exposure to the range of ozone doses experienced at the five plots; and 2) the abscission rates with all chronic injury categories combined have a positive correlation with the gradient of increasing seasonal doses represented by the five plots.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-25, 1981, San Diego, California.

[2]Research Plant Pathologist and Physical Science Technician, respectively, Chaparral R and D Program, Pacific Southwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Riverside, California.

The example of needle injury symptom development for 1977 in Table 1 illustrates the important effect of inherent tree sensitivity to ozone as represented by the average number of annual needle whorls retained. Significant injury to current year needles was experienced only by trees of the most sensitive category. The rate of injury increase is most rapid for one-year-old needles in all chronic sensitivity categories.

Table 1--Mean percentage of the total needle length with ozone injury symptoms for the current and

Number of Annual Needle Whorls Retained	Needle age	
	One-year-old	Current Year
	Percentage of total length injured	
	1	
1	91.4A	33.2 A
2	53.7 B	5.2 B
3	25.6 C	0.8 B
4	23.7 C	0.1 B

[1]Means with same letter are not significantly different.

Needle fall (abscission) was most dramatic after two seasons of exposure when visible needle injury had reached 80-90 percent. Most abscission occurred over the winter. In Figure 1 the relation of increasing needle loss to increasing ozone dose is evident with the exception that CA with a slightly lower dose than T-2 had a greater loss of needles. This result cannot be explained by any single variable, however the influence of winter conditions on abscission is the least defined variable and requires further investigation.

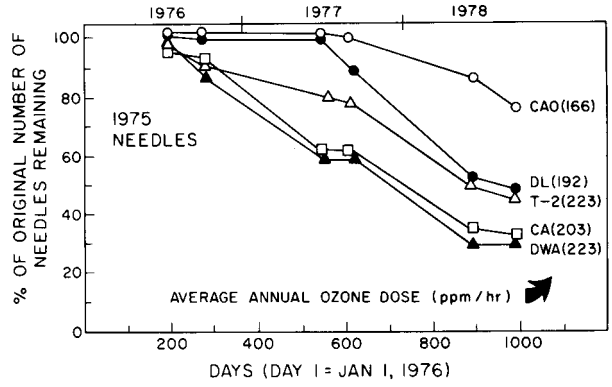

Figure 1--Needle abscission rates for a population of ponderosa and Jeffrey pines including all ozone sensitivity categories in relation to the ozone doses experienced at 5 plots.

These results provide better quantification of the population response of these pines to chronic ozone doses under field conditions, and suggest that silvicultural prescriptions should identify and conserve ozone tolerant individuals.

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Consumption, Digestion, and Utilization by Yearling Goats of Oak (*Quercus coccifera*) Foliage at Three Phenological Stages[1]

Anastasios S. Nastis and Leonicas G. Liacos[2]

Kermes oak (Quercus coccifera L.), a small tree occurring, in general, in shrub form, is a dominant species of brushlands which occupy several million hectares of land in the Mediterranean area. This plant gives a relatively good browse production and is consumed in varying quantities by domestic and wild animals (Liacos and Moulopoulos 1967, Nastis 1981). However, its nutritional value has not been fully assessed.

Oak browse harvested at three discrete phenological stages was offered fresh to yearling goats. Feed intake and excretions were measured during 10-day digestion trials. Nitrogen content was determined for feed, feces, and urine. Feed and fecal samples were analyzed for gross energy content (A.O.A.C. 1960) and urinary energy was calculated according to Street et al. (1964).

Results

Voluntary intake by goats was found to be significantly (P 0.05) higher when animals were consuming the spring diet (74 g/$BW^{.75}$) as compared to the summer diet (55 g/$BW^{.75}$), while fall diet (59 g/$BW^{.75}$) was not significantly different from either of them. This variation in intake might be attributed to the differences of the rate and extent of feed digestion (digestion coefficient 69, 51 and 52 respectively). Digestion was closely related to crude protein content (7.9, 6.4 and 7.1 percent respectively), and to soluble carbohydrates but inversely related to structural carbohydrates and lignin.

Intake rates of kermes oak browse collected in spring and fall were higher from that of an alfalfa diet (Nastis 1977) while intake of kermes oak collected during summer was not different. Probably, intake rates were higher because browse was fed in its natural green form.

Nitrogen intake was significantly higher for spring than for summer and fall diets. In a similar way nitrogen digested (73.9 percent) and retained (51.9 percent) for spring diet were significantly higher than for summer (43.9 and 15.1 percent) and fall (42.0 and 0.0 percent) diets. This indicates that net nitrogen retention was influenced by browse quality, which undoubtedly varied indifferent phenological stages.

Energy balance for browse collected in spring has shown that digested (75 percent) and metabolized energy (49 percent) were significantly higher (P, 0.05) than for simmer (51 and 20 percent) and fall (50 and 5 percent)diets.

Animal weight gain had a similar trend to feed, nitrogen and energy intake and their digestibility. Although nitrogen consumption per kg of body weight is higher for the browse collected in spring and fall in comparison to an alfalfa diet (Nastis 1977), weight gain was always lower and even a loss was observed for the summer and fall diets. This was attributed to the high proportion of nitrogen lost as metabolical fecal component and the limited metabolized energy of kermes oak browse.

LITERATURE CITED

A.O.A.C. 1960. Official methods of analysis (9th ed.). Association of Official Agricultural Chemists. Washington, D.C. 832 p.

Liacos, L.G. and Ch. Meulopoulos 1967. Contribution to the Identification of some range types of Quercus coccifera L. Thessaloniki.

Nastis, A.S. 1977. Consumption, Digestion and Utilization by Goats of the Dry Matter and Nitrogen in Diets Containing Oak (Quercus Gambelii) Foliage and Estimation of in Vivo Digestibility of Oak-Containing Diets by Micro-Digestion Techniques. MS Thesis. Utah State Univ.

Nastis, A.S. 1981. Mediterranean shrublands. Presented at the FAO-Cooperative network on pastures and forage production, Sub-network on mediterranean pastures. Thessaloniki.

Street, J.C., J.E. Bucher and L.E. Harris. 1964. Estimating urine energy from urine nitrogen. J. Anim. Sci. 23: 1039-1041.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean type Ecosystems.

[2]Senior Lecturer and Professor of Range Management, University of Thessaloniki, Greece.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Postburn Vegetation Along Environmental Gradients in a Southern California Shrubland[1]

John F. O'Leary[2]

Ten thousand hectares of chaparral and coastal sage scrub in the central Santa Monica Mountains burned in fall, 1978. Following an exceptionally wet winter, the post-burn landscape was covered by a heavy flush of herbaceous vegetation. High geologic and topographic diversity in this area prompted several questions regarding this herbland phase. Does composition of post-burn vegetation vary along an elevational gradient, aspect and substrate held constant? Does composition vary between sites due to substrate differences, aspect and elevation controlled? Can changes in floristic similarity be attributed to aspect if substrate and elevation don't vary?

Twenty-two sample sites were stratified by two substrate-types, andesite and sandstone, two aspects, NNE. and SSW.; and elevation at 150 meter intervals between 95 and 875 meters. Floristic resemblance between sites was computed by using a percentage-similarity index. Progressive comparison of sites encountered along the elevational gradient to the lowest site of a particular substrate and aspect yielded mixed results (Figure 1). As expected, floristic resemblance decreased as elevation increased with south-aspect andesite and north-aspect sandstone sites. Sites along the south-aspect sandstone gradient fluctuated while those along the north-aspect andesite gradient increased, probably due to the elevational range sampled being less than the mean amplitude of the dominant species.

Floristic resemblance of sites located on differing substrates having identical aspects and elevations produced different results (Figure 2). On southerly aspects, dissimilarities between such sites were initially high, but decreased regularly with elevational increase. Greater rainfall and cooler temperatures associated with elevational gain may provide additional soil moisture which could compensate for the more xeric nature of sandstone-derived soils and the substantial differences in each substrate-type's nutrient status.

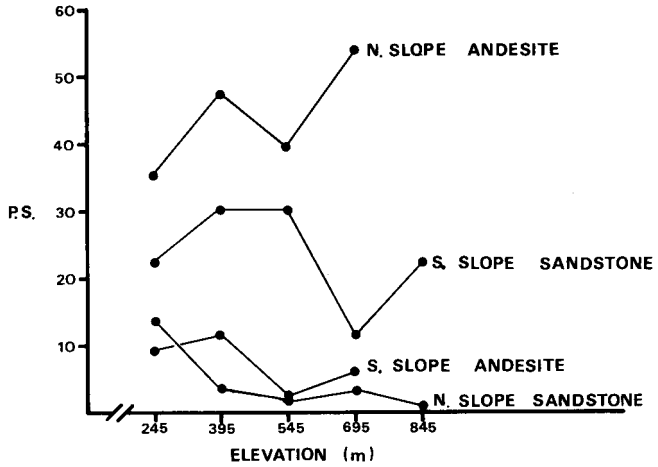

Figure 1--Percentage similarity of sample sites encountered along elevational gradient compared to lowest sites (95 meters).

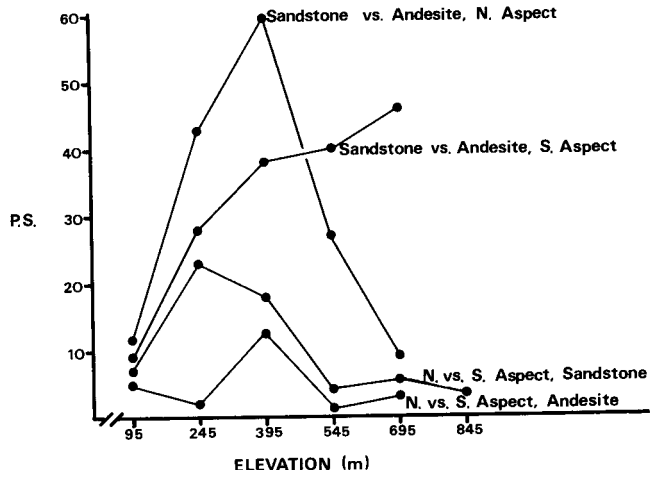

Figure 2--Floristic similarities of sites having different substrates, aspect and elevation being identical, and of sites having opposing aspects, substrate and elevation being identical.

The greatest dissimilarities were found on opposing aspects when elevation and substrate were similar. Dominant post-burn herbs appear to possess narrow soil-moisture and micro-climatic tolerances, and most exhibited distinct aspect preferences (e.g. Chaenactis artemisiaefolia and Phacelia parryi). Some preferred a specific substrate-type in addition to a particular aspect (e.g. Eucrypta chrysanthemifolia and Calystegia macrostegia).

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[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, Calif.

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Reseeding of Burned Mediterranean Brushlands in Greece[1]

Vasilios P. Papanastasis and Anthony C. Pittas[2]

There are two major types of mediterranean brushlands in Greece, phrygana and the evergreen sclerophyllous brushlands. Phrygana are open-scrub communities and occupy the driest part of the precipitation gradient. Evergreen brushlands are dense communities and occupy the wettest part of the precipitation gradient. They include maquis and the kermes oak (Quercus coccifera L.) brushlands.

Large areas are burned by wildfires in both these types every year. Existing management policy anticipates reforestation of the burned areas either by artificial or mainly by natural means (through regeneration of the native vegetation) and allows no grazing by the domestic animals. This policy, however, does not protect the burned areas since natural revegetation takes a relatively long time, when the potential for soil erosion is very high.

Over the last few years experiments were made in several burned brush sites around the country in order to investigate the possibilities of securing a temporary vegetative cover by seeding right after the fire improved annual or perennial grasses and legumes. This cover will not only protect the soil from erosion but it will also provide abundant and nutritious forage to the domestic and wild animals.

This paper summarizes the up-to-now results of the reseeding experiments over both the phrygana and the evergreen brushlands.

[1]Presented at the Symposium on Dynamics and Mamanagement of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

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PHRYGANA

Seedings were done at three different sites dominated by the dwarf shrub Sarcopoterium spinosum (L.) Spach. and at one site dominated by the half-shrub Phlomis fruticosa L. All sites were burned by wildfires in the summertime and they were planted during the early fall months.

The species used were a mixture of the annual grasses Blando brome (Bromus mollis L.), California bromegrass (Bromus carinatus Hook.), Italian ryegrass (Lolium multiflorum Lam.), and Wimmera ryegrass (Lolium rizidum Gaud.). The seeds were broadcasted at a rate of 20 Kg/ha.

It was found that all species germinated and established quite well but only in places where white ash was deposited following the wildfire. On the contrary, in places where black ash was formed, indicating an incomplete burn, either the species did not germinate or they germinated but the seedlings died soon due to the heavy competition by the native vegetation.

It is concluded that reseeding should be restricted to only those sites where the burning is complete and a layer of white ash is deposited on the ground after the wildfire.

EVERGREEN BRUSHLANDS

They were seeded on two sites burned by wildfires, one in a typical maquis and the other in an open kermes oak brushland; also, a third site in a dense kermes oak brushland burned by a controlled fire. The species planted were the annual grasses Italian and Wimmera ryegrasses and Blando brome and the perennial ones orchardgrass (Dactylis glomerata L.), Hardinggrass (Phalaris tuberosa L.), and smooth brome (Bromus inermis Leyss.). In addition the legumes rose clover (Trifolium hirtum All.) and birdsfoot trefoil (Lotus corniculatus L.) were used.

It was found that most of these species secured a good vegetative cover and an increased herbage yield in the burned study sites. Perennials got established and performed better in places with deep soil and less than 25 per cent slope. (Papanastasis 1978, Liacos et al. 1980).

LITERATURE CITED

Liacos, L.; Papanastasis, V.; Tsiouvaras, C. Contribution to the conversion of kermes oak brushlands to grasslands. For. Res. 1(2); 1980. (In Greek).

Papanastasis, V. Potential of certain range species for improvement of burned brushlands in Greece. Proc. 1st Int. Rangeland Congress;1978 :715-717.

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Factors Affecting Germination of Southern California Oaks[1]

Timothy R. Plumb[2]

Successful propagation of California oaks (Quercus spp.) requires that factors controlling germination be identified. To accomplish this, several laboratory and greenhouse studies were run to determine (1) how close to acorn maturity (here considered to be the time of acorn drop) viable acorns can be harvested, (2) the effect of cold treatment (stratification) and removing the acorn shell (pericarp) on viability, and (3) the effect of moisture content on long-term acorn storage.

DATE OF COLLECTION AND ACORN TREATMENT

The acorns of southern California oaks, depending on species, ripen between September and November. Ripening time varies from year to year depending on growing conditions and elevation. Early trials indicated germination is hastened by removing the tip of the acorn pericarp. A later test using Quercus dumosa Nutt. acorns showed that (1) viable acorns could be picked at least 1½ to 2 months before normal drop, (2) the tip of the pericarp needed to be removed from immature acorns to obtain satisfactory germination, and (3) when the acorns were mature, pericarp removal was unnecessary (table 1).

Between July 14 and October 19, 1978, I ran another collection test using Q. kelloggii Newb., Q. chrysolepis Liebm., and Q. wislizenii A. DC. acorns. Acorn moisture content (fresh weight basis) declined from a July 14 high of 70 to 80 percent, to 40 percent on the last collection date of each species. At planting, detipped acorns were placed in moist vermiculite in plastic bags at a temperature of about 24° C. When stratified, viable acorns could be picked as early as July 27 for Q. kelloggii and August 10 for Q. chrysolepis and Q. wislizenii; unstratified acorns did not germinate unless collected 2 to 4 weeks later.

ACORN STORAGE

Early picked Q. dumosa acorns were stored in plastic bags at 4° C for 6 to 12 months with limited success. Most of the acorns germinated within 1 to 2 months but produced an unacceptable mass of twisted, moldy roots, shoots, and acorns.

I ran tests to determine the effect of air drying on the viability of immediately planted and stored acorns. In one test, acorns harvested in early September were dried to different percentages of their initial fresh weight (IFW) ranging from no drying (100 percent) down to 40 percent of IFW in 10 percent increments. Acorns from each moisture class were sown immediately or placed in cold storage and removed at 2-month intervals for sowing. No acorns dried to 40 percent IFW germinated, but those dried to 50 percent IFW germinated when sown immediately (acorns in this moisture class were not stored). No acorns dried to 60 percent IFW germinated during storage and 90 percent germination was obtained after 8 months of storage. Most acorns dried to 80 percent had germinated in cold storage within 6 months, while 84 percent of the undried acorns had germinated within 2 months.

Table 1--Germination of intact and partially shelled acorns harvested at different dates

Acorn treatment	Germination, by harvest date				
	8/17	8/31	19/14	9/28	10/12
	Percent				
Intact acorns	15	4	0	20	90
Tips removed	50	89	86	100	95

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2]Plant Physiologist, Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Riverside, Calif.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Control of California Scrub Oak with Soil-Applied Chemicals[1]

T. R. Plumb and J. R. Goodin[2]

In two tests, pelleted, soil-applied herbicides were used to prevent sprouting of California scrub oak (Quercus dumosa Nutt.).[3] A trial broadcast application of 12 lb active ingredient (a.i.) of picloram (4-amino-3,5,6-trichloropicolinic acid) pellets per acre prevented sprouting of scrub oak stumps. Further tests were designed to confirm these results and to determine minimum effective rates of picloram and other pelleted herbicides such as fenuron (1,1-dimethyl-3-phenylurea) and karbutilate [tert-butylcarbamic acid ester with 3-(m-hydroxyphenyl)-1,1-dimethylurea].

In the first test, three rates of fenuron, picloram, and karbutilate (high and low rates are listed in table 1) were broadcast applied in December 1968 to a total of twenty-seven 40- by 40-ft plots. Herbicide effect was monitored on 20 oak plants in each plot. The area had been burned in a wildfire in 1967. At the time of treatment, oak regrowth was 1 to 3 ft tall and occasional grass and other herbaceous plants were present.

Results 3 years after treatment (table 1) show that an average plant kill of 70 percent or greater was obtained with per acre rates of fenuron at 30 lb (a.i.), picloram at 8 and 12 lb, and karbutilate at 8, 16, and 24 lb. Oak response to picloram was considerably more rapid than it was to fenuron and karbutilate, and 25 to 50 percent of the plants were dead within 8 months of treatment, compared to only 0 to 2 percent kill for the other herbicides. Rate of plant kill was also directly related to the amount of herbicide applied, with most kill occurring within 24 months at the high rates. At the low rates, more than 50 percent of the kill occurred between 24 and 36 months.

There were obvious differences among herbicide effects on herbaceous vegetation 1 year after treatment. A dense stand of grass had been established on the picloram plots, while the karbutilate plots were bare. Fenuron did not noticeably affect grass establishment at the low rate but inhibited it at the higher rates. A dense grass cover was present on all plots within three growing seasons, with the exception of those that received the high rate of karbutilate; those were still bare. After 5½ years, there was a dense cover of grass on all plots; after 7 years, there was a stable grass cover with no invasion of woody plants where initial shrub control had been obtained.

The complete soil sterilization resulting from broadcast application of karbutilate was undesirable. A second test was run on an adjacent site in April 1969 to determine the amount of oak control obtained with karbutilate applied at 8 and 16 lb a.i. per acre in a 2½- and 5-ft grid pattern. Good oak control was obtained with both rates in the 2½-ft pattern and with 16 lb at 5 ft. Karbutilate did not prevent grass establishment throughout the major portion of the plots. However, the treated spots themselves were still bare 7 years later with a few grass plants beginning to invade the "8-pound" spots.

Table 1--Response of sprouting scrub oak trees to soil-applied herbicides and subsequent grass production

Herbicide	a.i.[1] per acre	Dead plants		Grass weight at 30 months
		24 months	36 months	
	Lb/acre	Percent		Lb/acre
Fenuron	10	9	22	350
	30	57	82	800
Picloram	4	18	44	1090
	12	73	78	740
Karbutilate	8	35	71	1060
	24	98	100	0

[1]a.i. = active ingredient.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2]Plant Physiologist, Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Riverside, Calif.; and Associate Professor of Biology, Texas Tech University, Lubbock, Tex.

[3]This summary reports on herbicide research; it does not recommend their use or imply that these uses are registered.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Range Experimental Dynamics, Management and Hydrology in "Garrigue" of *Quercus coccifera* L. (S.-France)[1]

P. Poissonet, J. Poissonet, M. Thiault, and S. Rambal[2]

The "garrigue" of Quercus coccifera is a dense shrubby evergreen vegetation; under humid and subhumid mediterranean climate, generally situated on limestone areas. It is used for extensive pasture (about half a sheep per ha) or abandoned, 97 % of the total aerial weight is composed of shrubs and the rest (3 %) of herbaceous vegetation. From time to time, it is burnt, but, consequently, little by little, this practice diminishes the fertility.

OUR RESEARCHES

Their aims are to open the vegetation, to favour herbaceous species and to increase the number of sheep per ha. So, two experimental phases have been taking place from 1969 till now.

First experimental phase

The hypotheses are the following: first, to break up aerial vegetation allows us to open the shrubland, and then fertilization and cutting allow us to keep the vegetation open, to decrease the percentage of shrubs, and thus to increase that of the herbaceous species. So, the aerial material was broken up in 1969. The area was divided in 63 plots (10 x 5 m each). Two factors were tested at three levels:3 dates of successive cuttings and 3 levels of fertilization (0, 100 and 200 kg of N, P,05 and K20 per ha, per year), according to a factorial design, from 1,69 till 1976.

The main results are:

. Breaking up and cuttings allow to open vegetation
. From 1970 till 1976, the not-fertilized plots give 500 kg DM per ha per year, on an average, the moderately fertilized ones 2,400 kg, the highly fertilized ones 3,000 kg.
. At the end of the experiment, the ratio $\frac{\text{herbaceous dry weight}}{\text{total dry weight}}$ reaches 50 % in the not-fertilized plots, 90 % in the moderately fertilized ones and 95 % in the highly fertilized ones.
. The maximum number of sheep (from calculations) is 2 per ha in the not-fertilized plots and 3,5 in the fertilized ones.
. In all cases, the quality and quantity of vegetation are better for sheep than the ones after burning.
. The leguminosae are never numerous.

In conclusion, breaking up, cuttings and fertilizations are interesting processes to open the "garrigue" and to increase the livestock, but it is necessary to try these processes with flock on large plots, replacing cutting by grazing.

Second experimental phase

The hypotheses concern the second part of the above conclusions plus differences about the hydrological system between the natural garrigue and the experimental garrigue.

In 1974, after breaking up aerial material, 12 hectares were subdivided in 4 plots for rotating a flock - 3 sheep/ha-, with the moderate level of fertilizing. Moreover, twelve access tubes for neutron moisture gauge were set up, with a self-propelled wagon drill, beyond the root range (five meters for the deep-rooted evergreen species like kermes scrub-oak):4 access tubes in the natural garrigue and 8 in the experimental garrigue.

In 1976, another similar experiment began, with 5 sheep/ha.

The results are:

. It is necessary to break up aerial shrubs every three years if there are 3 sheep/ha, every four years if there are 5 sheep/ha.
. The increase of the pastoral value is slower but lasts longer with sheep than with cuttings. It reaches 7 sheep per ha, after five years of experiment.
. The quantity of bare ground is decreasing and the one of herbaceous species is highly increasing, specially Arrhenatherum elatius (L.) Mert. et K., but almost no leguminosae.
. During the vegetative period, the total actual evapotranspiration is 10 % higher in the natural garrigue than in the experimental one. So, the increase of hydrogeological resources (i. e. deep percolation beyond the root zone) is not negligible in the experimental garrigue: from 6.1×10^3 m^3/Km^2 to 113.5×10^3 m^3/Km^2 during the experiment years.

In conclusion, the experimental garrigue feeds 5/sheep/ha against half a sheep/ha in the natural garrigue and the water balance is comparatively excedentary. However, 5 sheep/ha are not able to perfectly control the shrubs, and the leguminosae are not numerous.

GENERAL DISCUSSIONS

. Is the excedentary water balance to be employed to produce more herbaceous food? If the answer is positive, how is it possible?
. How to perfectly control shrubs by means of animals ? To increase the instantaneous livestock by an obligatory shrub-browsing after grass-browsing, by trampling and by litter? To use another type of animals or several ones (goats, cows, horses)?
. Are the leguminosae going on increasing, little by little? What is the manner to favour their increase: seeds, oligo-elements or general increase of fertility ?

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[1]-Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California

[2]-Researchers, Centre d'Etude Phytosociologiques et Ecologiques Louis Emberger, B.P. 5051 34033 - Montpellier - Cedex - FRANCE

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Effects of Sulfur Dioxide Pollution on California Coastal Sage Scrub[1]

Kris P. Preston[2]

The effects of sulfur dioxide emissions (up to 0.13ppm for 25 yr) from an oil refinery were studied near Santa Maria, on the rural central coast of California. Injury to individual shrubs of Salvia mellifera and changes in community structure and foliar composition were measured at varying distances downwind from the refinery. A Gaussian plume rise model and soil pH indicated that maximum $S0_2$ ground level concentrations (GLCs) occurred between 1300 and 1600 meters downwind of the refinery stacks.

Polynomial regressions were used to plot changes in community and damage parameters with increasing distance from the pollution source. Figure 1A illustrates the changes in species diversity along the $S0_2$ gradient. The curve for species richness (R^2=.80, P <.001) peaks where maximum $S0_2$ GLCs occur. In contrast, the curve for Simpson's index (R^2=.77, P< .001) reaches its lowest value in this area. Polynomial curves for percent perennial cover (R^2=.82, P< .001), percent annual cover (R^2=.83, P < .001), and percent cover of exotic species (R^2=.86, P <.001) are given in figure 1C. Perennial species, for the most part, showed a decline in percent foliar cover in the area where maximum $S0_2$ GLCs occurred. However, annual and exotic species cover peaked in this part of the gradient. Three types of response curves were discerned for the 21 most abundant species (figure 1B). Tolerant species (curve A) reached their maximum foliar cover where $S0_2$ GLCs were highest. These included Chorizanthe california (R^2=.64, P < .0l) and Bromus rubens (R^2=.78, P <.001). Species whose foliar cover values were maximum at further distances from the pollution source were classified as sensitive (curve C). Among these were Haplopapus ericoides (R^2=.73, P <.001), Artemisia californica $4R^2$=.76, P < .001), and Salvia mellifera (R^2 =.76, P <-001). Intermediately tolerant species, such as Lotus scoparius (R^2=.37, P <.05) and Horkelia cuneata (R^2=.80, P 4.001) were most highly correlated with curve B.

Damage resulting from chronic $S0_2$ stress to Salvia mellifera, a coastal sage dominant, was also extensively studied. Stomatal resistance was found to be significantly lower on the polluted sites with a concomitant 35 percent increase in the mean transpiration rates of Salvia compared to the pollution-free control sites. Plant height, internodal length, leaf size and frequency, and reproductive capacity as measured by the number of flower whorls per flower spike, were also found to be significantly reduced on the polluted sites when compared to the control sites (P=.01). Reductions in photosynthetically active tissue, reproductive capacity, and increases in transpiration rates accounted for 68 percent of the variation in the foliar cover of Salvia along the $S0_2$ gradient. The evidence indicates that these factors decreased the shrubs' ability to compete with the more r-selected annuals. As such, the annuals gained a competitive advantage over perennials and greatly increased their relative abundance in the most polluted sites. The SO_2-stressed coastal sage community consequently retrogressed to where it floristically and structurally resembled an early post-fire seral stage.

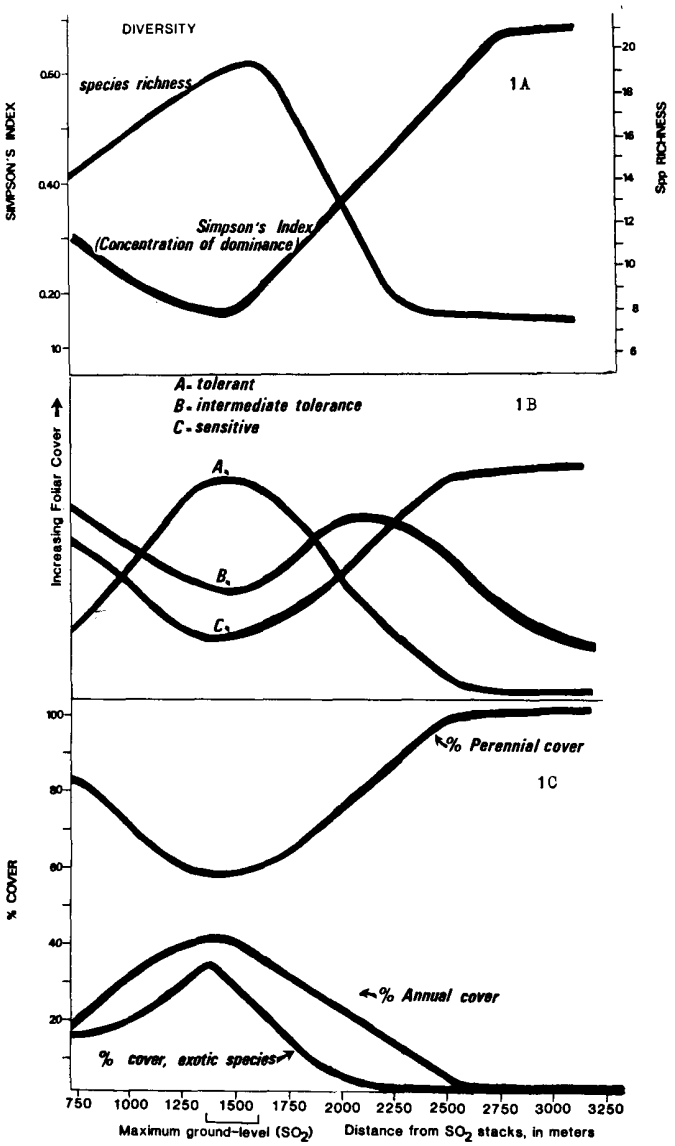

Figure 1A,B,C. Polynomial curves fit by the least squares method.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

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A Method for Determining When to Implement a Technology[1]

Carol Rice, Gary Elsner, Ed Thor, and Carl Wilson[2]

This paper presents a procedure that can be used by fire managers to help decide whether to implement new fire-fighting technologies. A two-step method is used. The first step identifies whether the agencies in an area consider the system useful and desirable in terms of fulfilling their needs. The second step identifies the benefits and implementation costs, thus providing an economic basis for the decision whether to adopt the technologies. The procedure uses local conditions (local costs fuels, weather and resource values) whenever possible. The benefits and costs are determined by a change in resource values due to implementation, a change in costs, and other "spin-off" effects.

In the past, fire management decisions could be made primarily on a biological basis. However, new fire suppression policies mandating cost effectiveness makes economic evaluation essential. The two models presented outline a procedure by which this evaluation can be made.

The two models presented support a new USDA Forest Service project, FIRETIP (Firefighting Technologies Implementation Project). The project's objectives are to provide information about modern firefighting technologies; to assist other federal agencies and states in analyzing costs and benefits of implementation; developing work plans for implementation; and developing proficiency in the technologies.

The six technologies to be transferred in the FIRETIP project are products of FIRESCOPE (Firefighting Resources of Southern California Organized for Potential Emergencies). The specific technologies are

(1) A Decision-Making Process that provides a vehicle for many agencies to implement the technologies in a practical manner. The Decision-Making Process furnishes a structure and method for agencies to cooperate to an extent never before realized and still maintain complete autonomy and identity.
(2) A Multi-Agency Coordinating System, (MACS), by which collective regional decisions on emergency priorities and firefighting resource allocations are made. It is a central point for collecting, screening, and processing essential data, coordinating public information and training programs. The system also provides pre-planning assistance.
(3) and (4) A Situation Status Summary Reporting System (SITSTAT) and a Resource Status Reporting System (RESTIT) that summarize "what's happening" in the region for allocating firefighting resources. SITSTAT deals with the numbers and types of emergencies; RESTAT indicates where equipment and personnel might be obtained to handle those emergencies.
(5) A Fire Modeling System (FIREMOD), that provides accurate fire behavior predictions. The program supplies an initial assessment of fire potential. In addition, FIREMOD can act as a second opinion to supplement judgment and observation.
(6) An Ortho Photomapping System, that provides a standardized set of maps and orthophotos tailor-made to meet emergency response needs.

DESCRIPTION OF MODELS

The feasibility model aids the user in determining which fire-prone areas are likely to want to use these new technologies. First, the fire damage potential of the area is assessed. There fire damage potential is high, the benefits accrued from applying a new technology may also be great.

The technology transfer specialist then made contact, introduces the technology, and if there is interest, obtains pertinent background information on the physical area and agencies involved. This step is needed so that applications of the technologies can be designed to meet real needs and abilities to change.

Next, the specialist will visit the area to conduct a feasibility analysis, assuring all the appropriate personnel from agencies to be involved are included. Key individuals are polled to determine their feelings about the applicability of the technologies. Descrip-

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[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, California.

[2]Proprietor, Wildland Resource Mgt., Walnut Creek, Calif.; President and Chairman, Resource Perspectives Inc., Lafayette, Calif.; Forest Fire Consultant, Berkeley, Calif.

tions of the technologies are included in the guide. Topics to discuss are offered that could bring out opinions as to the system's applicability. Finally, guides are given for interpreting expected responses.

At this point the technology transfer specialist makes a feasibility recommendation. The recommendation will be based on whether the local needs are filled by the technologies and whether any obstacles to implementation exist. The recommentation will be presented to each of the agencies, where feedback is incorporated into the final decision.

If local adoption of a technology is judged feasible, the second step of the procedure, a benefit/cost analysis, is conducted. A guidebook provides complete step-by-step instructions and worksheets for completing the analysis. Designed for completion by a non-economist, this step does require some knowledge of resource values and firefighting costs in the area.

Resource categories are delineated in the area. Categories might be "brush and scattered residential", or "timber along primary corridors". The participants then develop data on total number of fires per year by size for each resource category.

Future trends are then developed from the historical data and knowledge of local trends. For example, more fires of each size category may be expected in "brush and scattered residential" because acres and risk in that resource category will have increased.

The participants are asked to combine the documented benefits of the new technologies (decreased response times, more appropriate equipment available, etc.) with their knowledge of their own area to determine average effects on fire size. Differences in fuel types, access, weather, and other local conditions are the criteria for this adjustment.

The reduction in burned area is then multiplied by a net resource value change per acre and also used to determine a change in total suppression costs.

Costs and organizational cost savings of the implementation of the new technologies are then estimated. Costs of implementation in the area of original development are provided, and participants are then asked to consider local conditions (salary levels, existing equipment, etc.) to calculate local implementation costs for each technology. All the various changes in costs and benefits are then combined to determine whether adoption of the technology would be justified economically.

This two-step process assures that technologies considered for an area are needed, feasible, and cost effective. It avoids conducting detailed analyses in those situations where the technology is not appropriate, and yet provides the economic information needed prior to deciding to adopt a new technology.

Nitrogen Relations in *a Quercus dumosa* Chaparral Community[1]

Philip J. Riggan and Ernest Lopez[2]

The balance and availability of nitrogen in a chaparral community may be strongly affected by management practices. Accelerated nitrogen loss or reduced nitrogen fixation could lead to long-term degradation of the chaparral and its watershed values. Yet little is known about the rate of primary production or nitrogen cycling properties of several important chaparral communities. To provide such quantitative data, we have estimated the rates of biomass accumulation, nitrogen uptake, and fire-associated nitrogen loss in well-stocked stands of Quercus dumosa.

SITE AND METHODS

The research site is located at an elevation of 1340 to 1580 m on an east-facing hill slope at Kitchen Creek in the Cleveland National Forest. The site is dominated by mixed chaparral with a large proportion of Quercus dumosa. It last burned in 1944. Three vertical strips on the hill slope were burned by prescription November 13-14, 1979. Maximum recorded fire temperatures at the litter surface averaged 720° C. Estimates of pre- and postfire biomass in aboveground vegetation were made by evaluating regressions of biomass as a function of shrub basal area with the basal area distributions from each of five 64 m^2 plots. First-year resprout growth was estimated as a function of prefire shrub basal area. Litter mass estimates were made from 26 quadrats of 0.25 m^2 each. Nitrogen determinations were made on modified Kjeldahl digests with a Technicon Auto-analyzer II.

RESULTS

Quercus dumosa stands at this site accumulated biomass at an average annual rate of 0.53 MT ha^{-1} over 35 years. The first-year biomass accumulation rate was 5.3 times greater than this long-term average. Aboveground biomass at this site was moderate; 14 percent of the biomass was accounted for by foliage. Nitrogen accumulated in aboveground vegetation and litter at an average annual rate of 13.4 kg ha^{-1}. The biomass and nitrogen content of the litter were high, respectively 20 and 12 times that found in live foliage.

With the foliage of mature plants retained less than 1½ years, and nitrogen concentrations of 1.15 and 0.6 percent in dormant-season and senescing foliage, the annual nitrogen supply to new foliage from internal redistribution was calculated to be 14.7 kg ha^{-1} and that from uptake and other storage sources was estimated to be 16.0 kg ha^{-1}. Net uptake to foliage the first year after fire is approximately the same (table 1). Mature and resprouting burls lost 23 percent (6.7 kg N ha^{-1}) of their nitrogen content during the growing season from June through October; this may have been an important source of nitrogen for growing tissue.

Prescribed fires at this site produced moderately high soil surface temperatures, yet burning conditions were just severe enough to carry fire in the stand. Fire consumed 60 percent of the aboveground vegetation biomass and 75 percent of the forest floor mass. Fire-associated volatilization losses accounted for 25 percent of the nitrogen in the aboveground vegetation, litter, and upper 10 cm of the soil.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2]Soil Scientist and Ecologist, respectively, Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Glendora, Calif.

Table 1--Nitrogen and biomass distributions in pre- and postfire Quercus dumosa

	Prefire		Postfire		Fire loss		Resprout growth	
	Biomass MT ha^{-1}	Nitrogen kg ha^{-1}	Biomass MT ha^{-1}	Nitrogen kg ha^{-1}	Biomass MT ha^{-1}	Nitrogen kg ha^{-1}	Biomass MT ha^{-1}	Nitrogen kg ha^{-1}
Aboveground	18.5 ± 1.3	87.6 ± 6.0	7.4 ± 6.0	26.8 ± 2.0	11.1 ± 0.8	60.9 ± 4.5	2.8 ± 0.2	27.3 ± 2.3
Foliage	2.7 ± 0.2	30.7 ± 2.6	0	0	2.7 ± 0.2	30.7 ± 2.6	1.1 ± 0.1	15.4 ± 1.4
Burl	13.3 ± 0.9	28 ± 1.8						
Litter	53 ± 7	382 ± 68	14 ± 1.4	65 ± 7	39	317		
Soil (0-10 cm)		1586		1448		138		
Total (less burl)		2056		1540		516		27

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

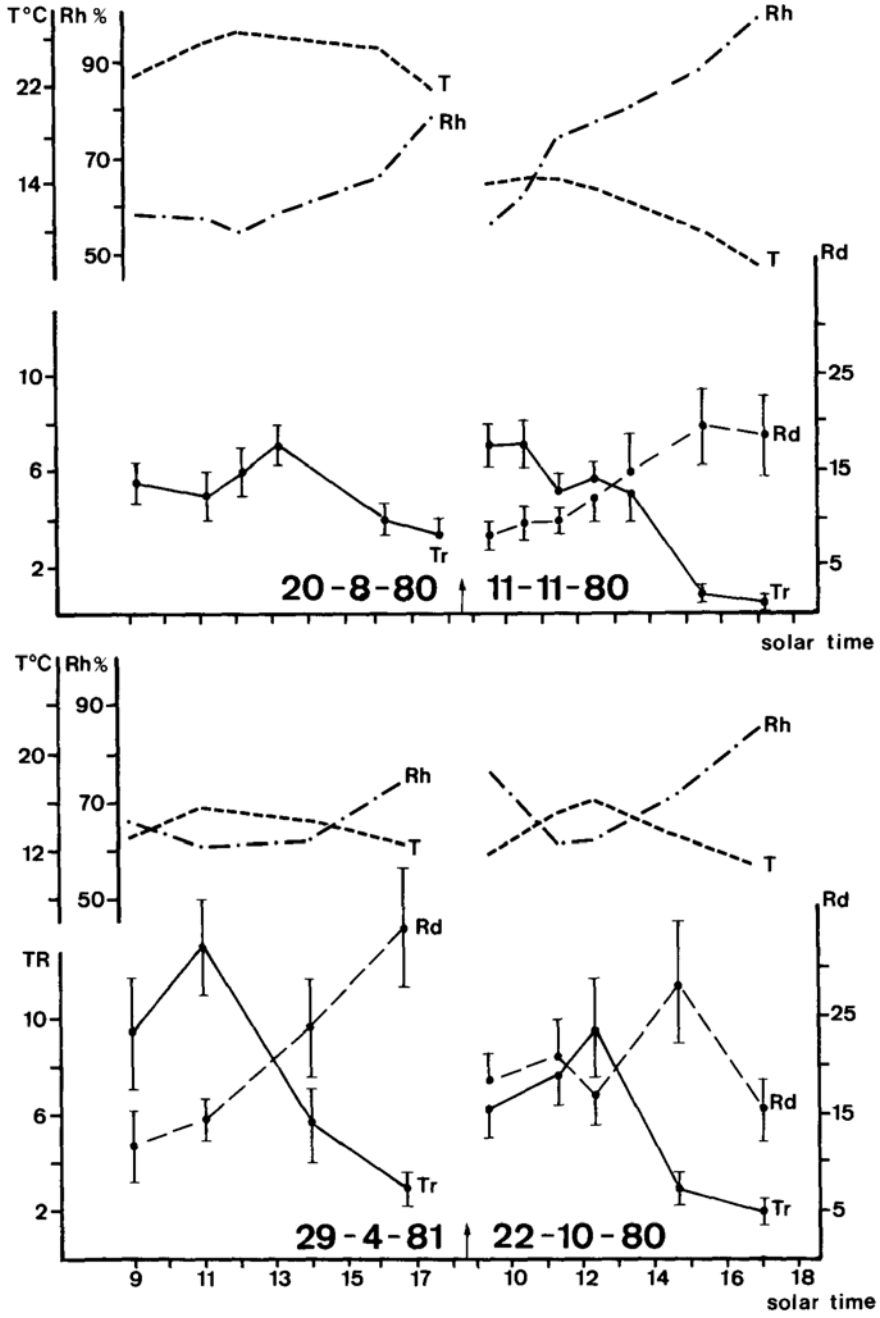
Transpiration and Diffusion Resistance of Leaves of *Quercus ilex* L. at La Castanya (Montseny, Catalunya, NE Spain)[1]

R. Save, R. Rabella, E. Gascon, and J. Terradas[2]

We have followed the transpiratory behaviour of the evergreen-oak Q. ilex one day each week from february 1980 to april 1981 in an experimental plot at Montseny (41°46'N, 2°24'E; altitude, 660m; exposition, W). We measured transpiration (TR) by quick weighing method (Huber, 1927; Stocker, 1956) and diffusion resistance (Rd) with Lambda L1-56 autoporometer.

The 1980 TR values (in g H_2O g dry weight^{-1} min^{-1}) satisfied a linear trivalent correlation with temperature and relative, humidity (Rh) according to TR = 0052 - 0,023 Rh + 0,42 T, with r = 0,976. The T observed values are comprised between 7 and 30°C and the Rh values between 45 and 100%.

TR and Rd show similar highly correlated behaviour with a TR midday reduction and Rd similar increment, as a result of stomatal closure. At high canopy levels, average daily TR is a little smaller than at lower levels, but confidence intervals overlap. We can explain this by xerophytic regulation and reduced cuticular transpiration in accordance also with Berger (1977) results. Stomata are closed in average behind a 16.5% water saturation deficit and cuticular TR is nearly 7% of total TR by an atmospheric evaporation of 1.1 mm/h.



Daily evolution of TR, Rd, T and Rh for some typical days at La Castanya. See text for symbols.

LITERATURE CITED

Berger, A. Régime hydrique. In: Moyse, A. Les processus de la production végétale primaire. Paris: Bordas 1977.

Larcher, W. Transpiration and photosynthesis of detached leaves and shoots of Quercus pubescens and Quercus ilex during desiccation under standard conditions. Bull. Res. Counc. of Israel 8D, 1960.

Larcher, W. Ecofisiología vegetal. Barcelona: Omega 1977.

Slavík, B. Water Exchange between Plant Roots and Soil. In Methods of Studying Plant Water Relations 253-257p. Berlin: Springer Verlag 1974.

[1] Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2] The first three authors are collaborators; last author is Associate Professor of Ecology at the Universitat Autonoma de Barcelona, Bellaterra, Spain.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Approach to Public Involvement for Greenbelts[1]

Jean M. Schwabe[2]

The Challenge

Throughout the United States, development is spreading into the wildland areas. Often the only remaining lands are the steep hillsides adjacent to metropolitan areas. In chaparral ecosystems, this creates an extreme fire hazard for human lives, property, and natural resources.

Many development features, such as landscaping, access, building materials, and greenbelts[3], can be used to provide more fire-safe communities while permitting growth in the foothills.

The Angeles is surrounded by the Los Angeles metropolitan area. Population growth puts pressure on local government to allow development on the chaparral-covered hillsides. It is unrealistic in our area to expect growth to stop. Communities can plan for safer hillside areas by incorporating greenbelts, and other fire-resistant development features, into General Plans and zoning ordinances.

Public Involvement

It is important to inform and involve the public and local governments about fire hazards and greenbelt zoning. We have developed several visual displays on greenbelt planning which can be effective with citizens and professionals.

We first wrote an informational brochure about greenbelts and developed a slide tape. A contractor mapped a twenty-mile strip of the Tujunga Ranger District to show land suitable for a greenbelt zone.

A two-mile section of this greenbelt zone was developed into a three-dimensional scale model. The model shows the interface area of a portion of the San Gabriels and portrays many uses of a greenbelt, including parks, cemeteries, nurseries, appropriately designed subdivisions, equestrian trails and orchards (fig. 1).

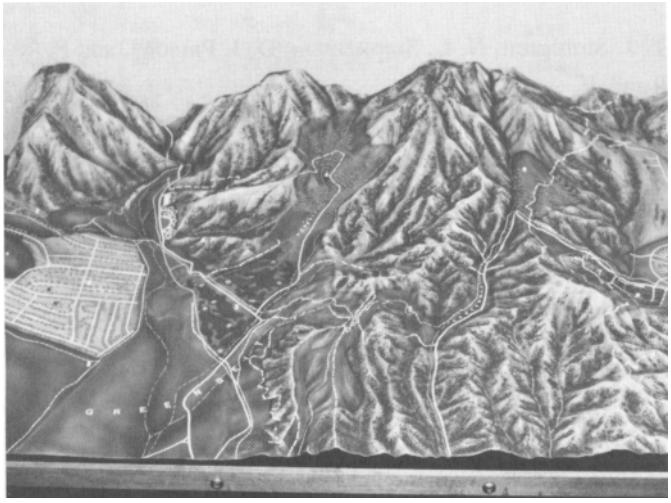


Figure 1--Greenbelt Model

Then, our landscape architecture department designed a display of a fire-safe Conceptual Subdivision. The board is approximately 3 feet by 4 feet, done in pastels on a photographic print. It can be used with planning departments and the public. Greenbelts buffer the periphery of the subdivision, making the homes more fire safe. A variety of uses is shown on the greenbelt. It is unlikely that a subdivision would have so many amenities, but we wanted to show the many options available to homeowners and builders. Gardens, softball fields, orchards, equestrian facilities, maintained open space and tennis and pool facilities are shown. We designed the subdivision to have more density than the zoning originally specified, because of the fire-safe design of the homes, landscaping, and surrounding greenbelts. Municipalities can award more density to developers if fire-safe features are proposed, much like density bonus incentives are given to developers for low income housing.

Focus of Public Involvement Activities

In working with local government, we emphasize the flexibility of greenbelt planning. Planning commissions are encouraged to develop fire-safe greenbelt areas which meet the community's need -- be it for recreation, housing or agriculture. Communities are encouraged to be flexible in developing zoning and economic incentives for greenbelt areas.

It is difficult to implement greenbelt zoning when development pressures and land values are extremely high. Communities now beginning to experience growth in the chaparral covered foothills need to plan for interface areas soon, or the opportunity will be lost. Coordinated planning by agencies and local government, with effective public information programs, needs to be emphasized

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[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22--26, 1981, San Diego, Calif.

[2]Community Planner, Angeles National Forest, Forest Service, U. S. Department of Agriculture, Pasadena, Calif.

[3]Bands of land on private or public property, at least 300 feet wide, which serve as a fire-resistant buffer zone between the wildlands and adjacent urban development.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Using Stem Basal Area to Determine Biomass and Stand Structure in Chamise Chaparra[1]

T. J. Stohlgren, N. L. Stephenson, D. J. Parsons, and P. W. Rundel[2]

Assessment of structural characteristics of chaparral is important in predicting fire effects and planning prescribed burns. Chamise (Adenostoma fasciculatum), the most common constituent of California chaparral, has been analyzed for twig and branch size class distribution, fuel loading and density, and chemical composition (Countryman and Philpot 1970). In San Diego County, Wakimoto (1978) used volume measurements to estimate shrub biomass. However, when we applied this method to chamise in the southern Sierra Nevada, we found the correlation to be inadequate due to assymetrical shrub growth forms. We then investigated a simple non-destructive technique of using basal stem diameters and basal stem area to predict above-ground shrub biomass (Brown 1976).

We randomly selected a 64m^2 plot of mature chamise (over 60 years old with 110 percent ground cover) in the foothills of Sequoia National Park. The diameter of all basal stems at 30 cm above ground was measured for each shrub and converted to total stem basal area. Percent dead was estimated to the nearest five percent and each shrub was then cut above the burl and weighed to the nearest 0.1 kg. Basal stem diameters and wet weights of 11 additional randomly selected mature chamise shrubs found in other areas of the Park were also measured to increase our sample size. Subsamples of live and dead material were oven dried to constant weight to derive correction factors for converting wet to dry weights. A standard linear regression was used to correlate stem basal area, stem diameter, and shrub volume with biomass on a dry weight basis.

For the 39 shrubs sampled in our study plot a correlation of $r^2 = 0.93$ was found between stem basal area and dry weight (fig. 1). The correlation between stem diameter and dry weight was weaker ($r^2 = 0.82$). The 11 additional shrubs used to increase the sample size improved the stem basal correlation ($r^2 = 0.94$). This improved the regression equation from y = 0.18x + 0.11 (fig. 1) to y = 0.18x + 0.06 to adequately predict shrub biomass (y, in kg) from stem basal area (x, in cm^2).

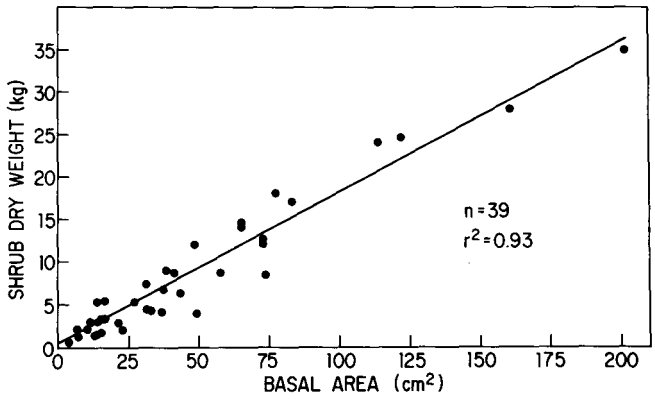

Figure 1--Relationship between basal area and shrub dry weight.

Chamise stand characteristics that can be estimated using our stem basal area method include densities, biomass per ha, and a stand structure profile of the number of individuals by dry weight class. For example, from our original study plot we estimate 6,100 shrubs per ha and 52,000 kg/ha dry weight biomass. We found an inverse-J shaped distribution of shrubs by size class with a few dominant shrubs and larger numbers of smaller shrubs, similar to the findings of Schlesinger and Gill (1978) for Ceanothus megacarpus.

While the validity of our correlation for chamise shrubs in other areas, as well as for other shrub species, has yet to be tested, the method has the potential to be a valuable tool for chaparral fire research and management. We intend to pursue this approach in additional studies of stand structure as a function of environmental variables, including past fire frequency.

LITERATURE CITED

Brown, J. K. Estimating shrub biomass from stem basal diameters. Can. J. For. Res. 1976; 6(2):153-158.

Countryman, C. M.; Philpot C. W. Physical characteristics of chamise as a wildland fuel. USDA Forest Service Res. Paper PSW-66; 1970. 16 p.

Schlesinger, W. H.; Gill, D. S. Demographic studies of the chaparral shrub, Ceanothus megacarpus in the Santa Ynez mountains, California. Ecology; 1978. 59(6):1256-1263.

Wakimoto, R. H. Responses of southern California brushland vegetation to fuel manipulation. Ph.D dissertation, Univ. of Calif. Berkeley, Ca.; 1978. 238 p.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

[2]Research Technicians and Research Scientist, respectively, National Park Service, U.S. Department of Interior, Three Rivers, Calif.; Professor of Ecology, University of California, Irvine, Calif.

Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Microcommunity Patterns in Coastal Sage Scrub[1]

Arnold R. Troeger[2]

Microcommunity pattern refers to the arrangement of coassociated species in the landscape at scales ranging from a fraction of a meter to several meters. This poster presents the results of a study on the microcommunity patterns of California coastal sage. The microcommunity pattern study is one aspect of a larger study to assess the diversity and pattern relationships of coastal sage and to compare these results to similar communities elsewhere in the world.

The microcommunity pattern index (Table 1) measures the intermingling of species groups through space and was measured as follows: First, species groups were identified by classifying the individual 1 X 1 quadrats in a 20 meter long belt transect into 8 groups using Twinspan (a polythetic divisive classification program). Next, the floristic class to which each quadrat belonged was mapped along the belt transect. Thirdly, the number of times adjacent quadrats along the transect belonged to different floristic groups was divided by the maximum possible number of changes (19)(Westman 1975).

Micrommunity pattern was determined on 7 0.1 ha sites of coastal sage scrub of three ages (3, 7, 23-4 y). The microcommunity pattern index did not change significantly with age. There was a significant correlation between age and changes in floristic cover across the site, as measured by the first axis of the Decorana ordination (r=.55, P=.11). This indicates that despite significant changes in floristic composition with age, the scale of microcommunity patterning is not changing.

The "ecological distance" between floristic groups can be measured as the distance between midpoints of occurrence of the groups along an ordination axis. These ecological distances, relativized by ordination axis length, remain constant with age. This indicates that spacing of the floristic groups along the first major ordination axis remains relatively even, despite changes in the beta diversity. The standard deviation in mean ecological distance (s.d.) between floristic groups in site 5 is lower than for other sites, implying a regularity in floristic change among groups on this site. The factor most likely to be operating at this scale is competition. Site 5 is located on a northeast facing slope where environmental conditions are most mesic. Because site 5 had the highest species richness (31 spp./.l ha vs. X=12.3 spp/.l ha for the other 2 mature sites), interspecific competition may be higher, causing a more even spacing of floristic groups along the ordination axis.

Table 1--Summary of the microcommunity pattern statistics.

sites	length of ord. axis	mean distance between row s		mean dist. ord. axis	microcommunity index
		x	s.d.		
3 yrs old					
1	285	40.71	27.41		.526
2	209	22.46	20.56		.842
mean	247	31.58	24.22	.128	.684
7 yrs old					
3	362	46.19	33.85		.526
4	429	51.29	29.14		.737
mean	395	48.74	31.58	.123	.631
> 20 yrs					
5	210	28.35	17.00		.684
6	206	29.43	23.64		.737
7	216	21.00	23.47		.474
mean	210	26.26	21.59	.125	.632

The average alpha diversity at 1 m^2 (Figure 1) decreases with age. At 3 yrs. individual plants tend to be small and post-fire species tend to be abundant, allowing for a high number of species at the 1 m^2 scale. A few long-lived post-fire species are still present at 7 yrs. but most of the annuals have been eliminated, contributing to a decrease in alpha diversity.

Beta diversity measures the species turnover along an environmental gradient and is usually expressed as half changes (B.C.) in species composition. Beta diversity reaches a peak at around 7 yrs., strongly suggesting a higher floristic heterogeneity between patches at the 1 m^2 scale at this age. One explanation for this may be the spatial segregation of post-fire followers from mature phase dominants at this time.

LITERATURE CITED

Westman, W. E.; Pattern and diversity in swamp and dune vegetation, North Stradbroke Island. Aust. J. Bot. 23:339-345; 1975

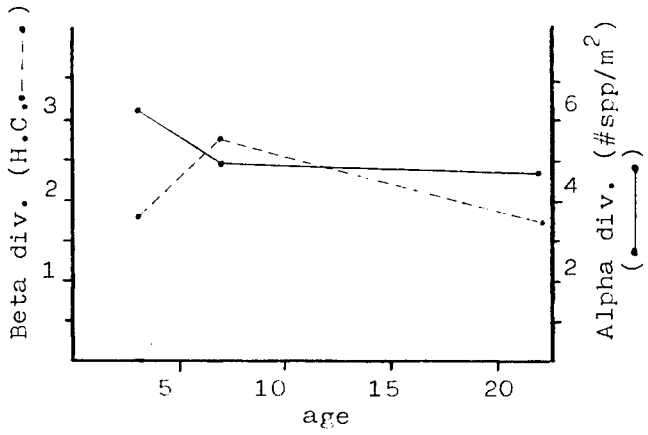

Figure 1--Alpha and Beta diversity vs. age.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

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Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Restoring and Managing Indigenous Plant Communities at Malibu Creek State Park[1]

Wayne Tyson and George Rackelmann[2]

The California Department of Parks and Recreation is exploring new ways to meet the two major, but conflicting goals of the state park system (landscape preservation and recreation) at the lowest possible cost. Indigenous vegetation may have significant economic advantages as well as potential carrying capacities as high or higher than alternatives in some situations. Practical methods are needed to restore, modify and manage indigenous plant communities for an increasing number of applications.

The traditional approach to preserving the natural landscape has been to limit access. Recreation demands access, and the demand has been increasing faster than the supply of park land. When the recreation load exceeds the capacity of the natural landscape to repair itself, the result is increased cost and degradation or loss of the landscape resource.

The usual approach to meeting excessive recreational demand loads has been to replace inigenous plant communities with exotic landscaping, though recent practice has included individual "native" species. This is an expensive procedure to construct and maintain, and it often does little to improve carrying capacity. The perpetual maintenance required intentionally limits species diversity by eliminating all species not on the landscape plan. Significant quantities of water and other resources are required, and the natural landscape resource is destroyed.

At Malibu Creek, the alternative of restoring, modifying (for increased carrying capacity) and managing indigenous plant communities is being explored. The part of the site selected for development of picnic and camping areas has been disturbed for most of this century by grading, plowing, cattle grazing and movie-making (site is a former major studio "movie ranch"). Vegetation in these areas is mostly alien grasses and forbs. Areas which are relatively undisturbed will be preserved for appropriately lower levels of use.

The objective of this project is to (1) increase indigenous plant associations in disturbed areas; (2) lower the cost of development, management and maintenance; (3) accommodate recreation needs within the carrying capacity (increased by modification where necessary) of the restored indigenous plant community. As much as possible, the general goal is to restore the site to as near those which existed prior to disturbance as possible, including reduction of alien species populations.

The restoration of self-sufficient plant communities requires consideration of existing environmental conditions and the development of techniques appropriate to them to be successful. Ordinary gardening and landscaping methods are fundamentally inappropriate. The mere introduction of indigenous seeds or plants will not necessarily produce a viable, self-regenerative plant community--or even a successful stand of the species "selected." The planting program must be carefully timed and designed for a high level of survival. Species composition and density should be carefully determined as to habitat, its changing nature and carrying capacity in terms of soil moisture potential. It may not be advisable to plant all species at one time. Timing and conditions required by the species concerned, rather than administrative convenience, should determine the program, but enough latitude often exists to satisfy practical scheduling concerns. Adjustments are often necessary, but absolute precision isn't necessary. Fairly good mimicry of some of the rather sloppy natural processes involved may be the most we can do. Beyond that, that which is out of our control is in control.

Some field trials were initiated in February of 1981. Plant communities include valley grassland/valley oak savanna, southern oak woodland, coastal sage scrub and chaparral. The main species/associations are Stipa pulchra, Quercus lobata, Elymus triticoides, Quercus agrifolia, Rhamnus californica, Artemisia californica and Heteromeles arbutifolia.

Initial emphasis has been placed upon Stipa pulchra, since this grass produces a large and reliable seed crop and is suitable for the largest part of the project. Field plots have been established to evaluate the cost-effectiveness of several methods, including seeding by broadcast and drilling on cleared, uncleared and mulched sites as well as the planting of seedlings grown in two different soils and container types on cleared and uncleared sites at various densities. A 300' x 100' plot was planted with seedlings at 1/100 square feet. Trial plantings of other species were made on a smaller scale. The project will be expanded in the fall of 1981 when soil moisture and other conditions are at optimum.

We have gratefully drawn upon the work of many researchers, including W. James Barry, Harold F. Heady, V. L. Holland and R. H. Robinson. Much more such work is needed.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems: An International Symposium, June 22-26, 1981, San Diego, California, U.S.A.

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Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Integration of Chaparral Vegetation Data Into Land and Fire Management Decisionmaking[1]

Thomas C. White[2]

A management compartment examination procedure is being applied in the field on the Laguna-Morena Demonstration Area (L-MDA). L-MDA is a cooperative interagency program designed to demonstrate both new and existing techniques of chaparral management. Approximately 130,000 acres of land are included in the L-MDA representing many ownerships and management responsibilities.

It is the purpose of this poster to demonstrate how chaparral vegetation and other resource information collected in a compartment inventory can be effectively integrated into land and fire management decision making.

A CONCEPTUAL MODEL OF COMMON VEGETATION ASSOCIATIONS

A classification system was developed by the Pacific Southwest Forest and Range Experiment Station to standardize terminology used to describe chaparral and related vegetation types (Southern California Vegetation Classification System-SCVCS). This common language facilitates technology transfer both within and between agencies. The classification system is hierarchical so that each level of description can be generalized to the next higher level. The four levels defined in order of increasing specificity are formation, series, association and phase. Figure one is a model describing chaparral plant communities in L-MDA at the formation series and association level. This is a conceptual model. The species distributions shown are not rigorously defined.

The model shown in Figure one was successfully used to reclassify the vegetation mapping units of the 1969 Soil-Vegetation Survey into the Southern California Vegetation Classification System.

INTEGRATION OF THE VEGETATION MAPPING SYSTEM INTO THE PLANNING PROCESS

The vegetation mapping system is integrated into the planning process by means of a Resource Capability Unit (RCU). An RCU is a mapping unit describing a relatively homogenous unit of land designed to give land managers easy access to a wide range of site specific data. This information is stored on a computer to allow easy manip-

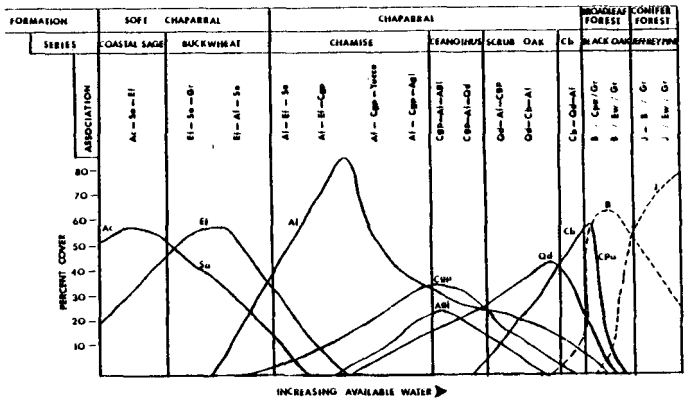

Figure 1--Conceptual Model of Vegetation Associations in Chaparral of Related Formations Laguna-Morena Demonstration Area.

ulation of the data. The RCU also serves as a device to give planners and managers a rapid "feel" for the land by providing a framework for integrating previous field experiences with resource data. Compartment examinations are the preliminary phase of project planning. Existing information is assembled and organized in the compartment exam. Resource Capability Units are delineated and management goals and objectives are identified. (The final output of a compartment exam from management perspective is a package of project proposals). Project proposals are then selected for formal decision making on a priority basis, as determined by the overall program level strategic plan for formal decision making which includes detailed alternative formulation, environmental effect assessment and alternative selection.

CONCLUSIONS

One of the important lessons drawn from experience in L-MDA planning is that lack of resource data is not necessarily the limiting factor for high quality chaparral management. The real limiting factor is ability to integrate existing data into a meaningful information system which is intimately linked to management decisions. The process described above is an example of how integration can be accomplished through comprehensive interdisciplinary examination of existing resource information and management goals.

References

Forest Service, USDA, Cleveland National Forest Managing Chaparral: Management Plan and Environmental Analysis--Laguna-Morena Demonstration Area, San Diego, Calif.; 1979

Forest Service, USDA, Cleveland National Forest. Soil Vegetation Survey Cleveland National Forest, San Diego, Calif.; 1969

Paysen, Timothy E., et. al. A Vegetation Classification System for Southern California. Berkley, Calif., Pacific Southwest Forest and Range Exp. Stn., Forest Service, USDA: draft document 1979.

[1]Presented at the Symposium on Dynamics and Management of Mediterranean-Type Ecosystems, June 22-26, 1981, San Diego, California.

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Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982.

Conrad, C. Eugene; Oechel, Walter C., technical coordinators.

Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems, June 22-26, San Diego, California. Gen. Tech. Rep. PSW-58. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982. 637 p.

The symposium, held at San Diego State University, provided information about the Mediterranean-type ecosystems found throughout the world. In the papers, and in brief summaries of poster displays, both researchers and managers addressed concerns relating to vegetation, fauna, soils, hydrology, fire, and planning. A Review and Follow-up section presents general comments of selected participants.

Retrieval Terms: Mediterranean climate, chaparral, plant succession, wildlife, soils, hydrology, fire management, biomass