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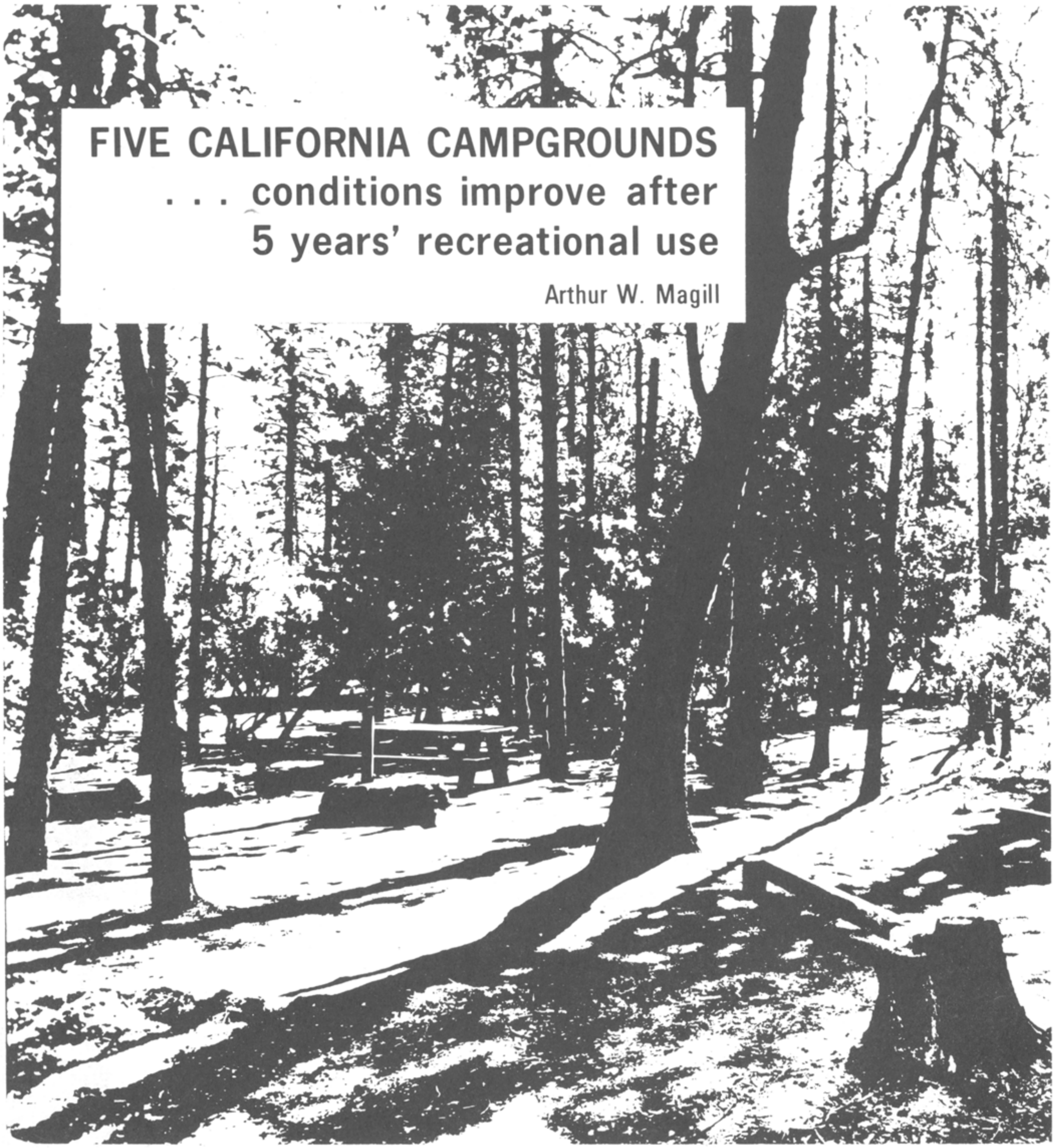
FIVE CALIFORNIA CAMPGROUNDS
. . . conditions improve after 5 years' recreational use

Arthur W. Magill



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Changes in condition that may have been caused by recreational use, from 1961 to 1966, at five campgrounds in three widely separated locations in California were studied by measuring four variables: vegetation, plant litter, interunit screening, and overstory cover. The increase in vegetation after 5 years was attributed to barriers placed in campgrounds and to greater precipitation. The over-all improvement in campground conditions is interpreted as an "adjustment" to recreational use.

OXFORD: 907.2.
RETRIEVAL TERMS: campgrounds; recreation use; deterioration.

CONTENTS

The Author

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I am indebted to Eamor C. Nord, range ecologist, Pacific Southwest Forest and Range Experiment Station, for providing me with invaluable guidance during preparation of the study plan and for sharing the responsibility of collecting the first year's data. I also thank Robert E. Jones, formerly with the Station, who assisted with the 1966 field work.

Over a long period of time, the habitat of heavily used campgrounds appears to deteriorate. But how serious is this decline? Recent studies conclude that vegetation and soils of public campgrounds may be more resistant to visitor use than visual observations have suggested. In California, Hartesveldt (1963) found that trampling, root cutting for roads, and root covering by roads have not seriously impeded the growth of giant sequoia *(Sequoia gigantea).* In another California study, Magill and Twiss (1965) reported that heavily used campgrounds showed little changes in vegetation and soil surface over a 10-year period. In southeastern Michigan, Wagar (1964) determined that vegetation survival dropped as simulated recreational use increased, but deterioration did not accelerate. And in northwestern Pennsylvania, LaPage (1967) found that herbaceous ground cover was heavily depleted in the first year of use at a new campground located on a typical old field. Later, more resistant plants replaced those susceptible to trampling, but did not provide a ground cover equivalent to that existing before the site was used.

In 1961, the Pacific Southwest Forest and Range Experiment Station began a long-term study of changes in campground habitat. Part of the study included a comparison of plant growth on five campgrounds and at three sites not subject to recreational use. The study was not expected to explain all habitat changes. The relationship of changes on unused sites to those on campgrounds could only suggest whether recreational use might be responsible. And, information on climatic trends and administrative actions could suggest other reasons for habitat changes.

This paper reports the changes in habitat from 1961 to 1966 on the five campgrounds and on the neighboring sites not used for recreation. It evaluates the relative impact of factors responsible for the changes, interprets what these changes mean in terms of campground conditions, and suggests an approach for future research.

METHODS

The campgrounds and unused sites studied are on three widely separated National Forests in California *(fig. 1; table 1).* The campgrounds have been used for 16 to 30 years, with one exception. Barrier systems to control vehicular traffic were installed in 1960 and 1961. Recreational use at the five campgrounds rose steadily during the 5-year period.

Nested plots were either established along transect lines or uniformly distributed through the sites in a manner that would sample any obvious soil or vegetation differences *(fig. 2).* Plots were not extended into areas disturbed by roads, paths, parking spurs, power lines, pipe lines, or other recreation facilities.

Plots were measured in summer of 1961 and remeasured in 1966. The used and unused sites were compared, but because their soils and vegetation could not be shown to be related, true “controls” were not established. And because the major study areas were widely separated–Lake Almanor is 580 miles north of the Laguna Recreation Area–the differences in soils, vegetation, and climate prohibited any direct comparisons between campgrounds.

Horse Heaven, being a group campground, had to be sampled in a different way. A 150-foot radius semicircular area was subdivided into quarters to sample trees, and 15 nested plots were established *(fig. 3).* The five nested plots nearest the center had some overlap, but this proved of little significance

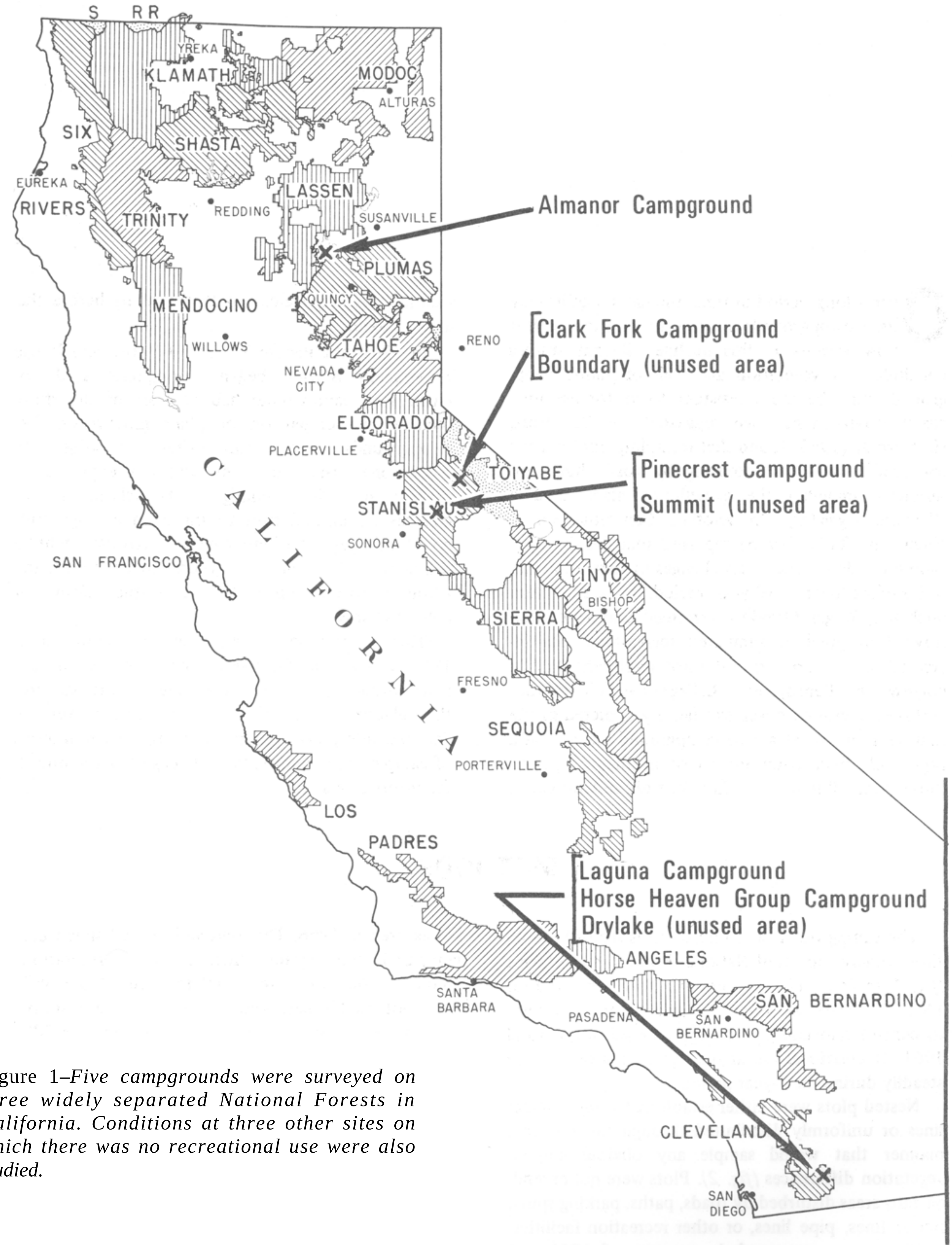

Figure 1–*Five campgrounds were surveyed on three widely separated National Forests in California. Conditions at three other sites on which there was no recreational use were also studied.*

Table 1—*Campgrounds and unused sited on National Forests in California studied for changes in habitat 1961-1966*

Study sites	Family units	Elevation	Temperature (1961-1965) max. & min.	Precipitation (1961-1965) avg. annual	Soils depth	Texture	Parent material	Forest types
	No.	*Feet*	*°F.*	*Inches*	*Inches*			
Almanor Campground	98	4,500	100 -11	32.1	+60	0-30 inches clay loam to sandy loam. Below 30 inches gravelly clay to sandy loam	Basaltic	Ponderosa pine-sugar pine-fir (S.A.F. Type 243)1 White fir predominates Jeffrey pine (S.A.F. Type 247) found in pockets
Clark Fork Campground	34	6,200	(2)	(3)	+48	Sandy loam to loamy sand	Granitic alluvium	White fir (S.A.F. Type 211)
Boundary	0	6,200	(2)	(3)	+48	Sandy loam to loamy sand	Granitic alluvium	White fir (S.A.F. Type 211)
Pinecrest Campground	221	5,600	90 0	35.6	+52	Fine gravelly sand except loamy sand below 14 inches on moist sites	Granitic (terminal moraine)	Ponderosa pine – sugar pine – fir (S.A.F. Type 243)
Summit	0	5,600	90 0	35.6	+52	Fine gravelly sand	Granitic (terminal moraine)	White fir (S.A.F. Type 211)
Laguna	118	5,600	95 0	36.8	+60	Crouch sandy loam and Cuyamca fine sandy loam	Brown de-Composed granitic rock	Jeffrey pine (S.A.F. Type 247) with 1/3 of stand being California black oak
Horse Heaven Group Campground	(4)	5,600	95 0	36.8	+60	Crouch sandy loam and Cuyamca fine sandy loam	Brown de-Composed granitic rock	Jeffrey pine (S.A.F. Type 247) with 1/3 of stand being California black oak
Drylake (unused site)	0	5,600	95 0	36.8	+60	Crouch sandy loam and Cuyamca fine sandy loam	Brown de-composed granitic rock	Jeffrey pine (S.A.F. Type 247) with 1/3 of stand being California black oak

[1]Society of American Foresters 1954.

[2]Slightly lower than temperatures at Pinecrest.

[3]Slightly higher than average at Pinecrest.

[4]50 to 100 people capacity.

because neither shrubs nor tree and shrub seedlings were found within 50 feet of the center during either sample period.

Ground Cover

The vegetative cover was determined, by species, on 1- by 20-foot belt transects. The basal area of perennial grass species was measured at one-half inch above the soil surface. Frequency and distribution of annual and sod-type grasses were determined within 80 6-inch square quadrats in each transect. The belt transects were also used to measure foliar coverage by shrubs and forbs, area covered by litter and dead wood, and area covered by tree overstory. Overstory coverage consisted of tree foliage more than 5 feet above the sample area. Litter depth was measured at five equally spaced points beginning 15 feet from the camp stove or transect origins. Established shrubs (those more than 6 inches tall and 5 years old) were recorded, by species, on 20-foot square plots.

Seedling Establishment

Seedling establishment for both shrub and tree species was determined within the same plots. In a preliminary study in California, Magill and Nord (1963) found that a critical stage exists between the establishment of new seedlings and their development into saplings. Consequently, I set up two classes of seedlings: (a) Class I seedlings included tree and shrub seedlings that were 5 years old and 6 inches tall or less; (b) Class II seedlings included only tree seedlings that were more than 5 years old and 6 inches tall but less than 1 inch in diameter at 4.5 feet above the ground.

Tree Occurrence and Growth

Tree size-class and species composition were recorded from 20- by 50-foot plots and converted to a per acre basis exclusive of acres in roads, spurs, and other facilities. The size classes used were:

	Diameter breast height *(inches)*
Size classes:	
Saplings	- 1.0 - 4.9
Poles	- 5.0 - 10.9
Small timber	-11.0 - 20.9
Large timber	over 20.9

Growth information was obtained from five dominant or codominant trees nearest to the plot center or stove but within a 50-foot radius. Trees were identified with numbered 1-inch-square aluminum tags placed 6-feet or more above the ground and facing away from the camp stove. Information collected for each tree included species, diameter at 4.5 feet, basal area, height, age, and growth rate (radical increment for 5-year intervals over the past 30 years).

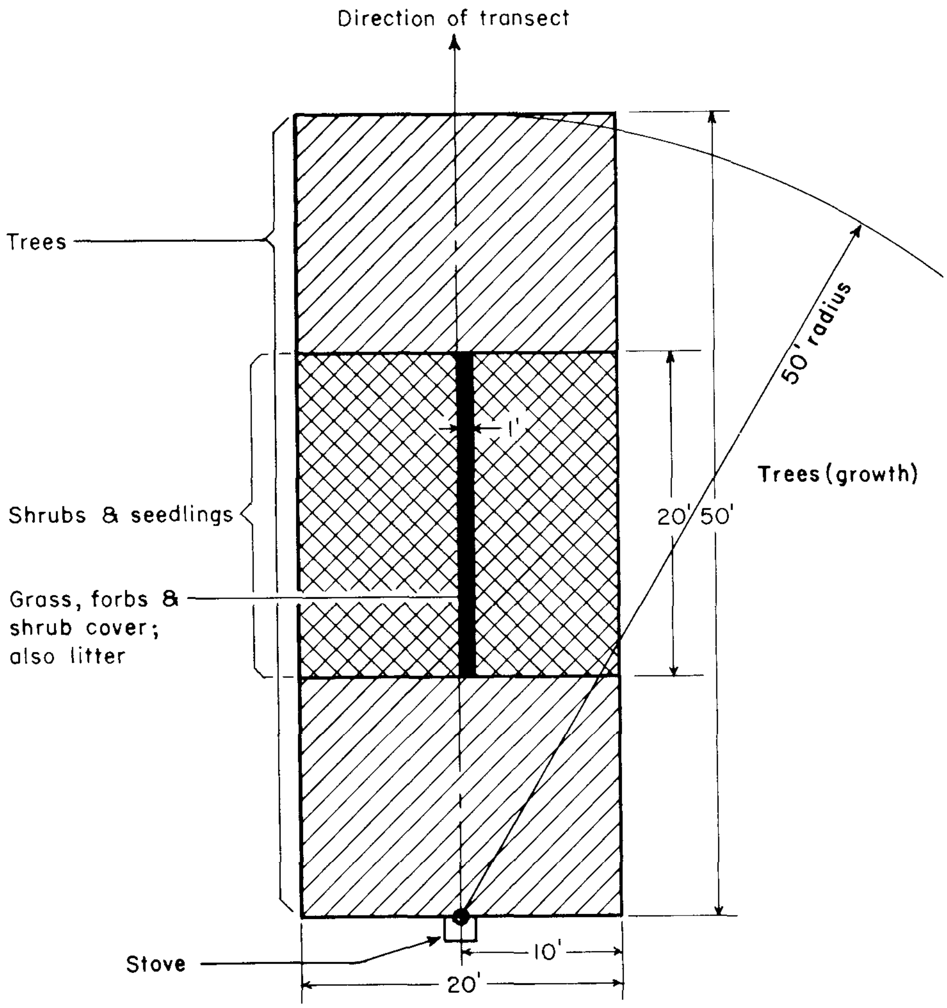

Figure 2–*Study plots were established along transect lines or distributed uniformly through the sites.*

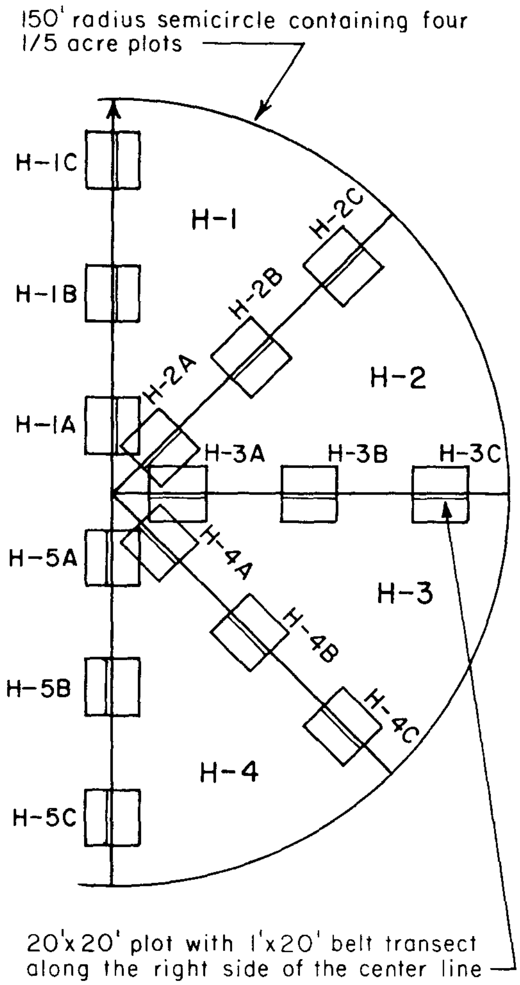

Figure 3—*Plot layout for Horse Heaven. This site could not be sampled in the same way as the others because it is a group campground.*

Screening

Screening is the percentage of the surrounding landscape which is completely masked by vegetation, land forms, or facilities when viewed parallel to the prevailing ground surface. It was measured with a pantallometer or screenometer developed by Nord and Magill (1963). Screening coverage was recorded as the percent of total screening at any given sampling point according to the following types of obstruction categories: tree boles for pole size and larger trees, foliage and twigs of trees and shrubs, and miscellaneous items, such as structures, large boulders, and down timber.

Soils Classification

Standard soil survey procedures were used to determine the soil series. In addition, the soil penetrometer was tried out in the 1966 survey to evaluate soil compaction on the campgrounds. Although the soil penetrometer appeared promising for assessing soil compaction according to an earlier study,[1] results from the present study showed this was not the case except at Pinecrest, where the initial work had been performed. Why the penetrometer test was unsuccessful could only be attributed to variability among soils, soil moisture, and possibly other site factors.

Photography

Permanent photo points were established on each plot to provide a photographic record of any changes in site conditions. The points were identified either by stakes or fixed objects and referenced by permanent objects, such as rocks or trees.

RESULTS AND DISCUSSIONS

Tree Occurrence

Some fluctuations in the numbers of plants ought to be expected as trees grow from one size class to another or are destroyed by insects, diseases, drought, and competition for space, light, and nutrients. Except for epidemic conditions, the resultant changes should be small.

At all campgrounds, the total number of saplings declined *(table 2).* This decrease might have been predicted after a pilot study in 1961 which found that saplings had been cut for various uses (Magill and Nord 1963). The greatest losses were at Clark Fork Campground (24 percent) and the adjacent unused Boundary site (32 percent). At Clark Fork, the barrier system is made of medium size rocks and logs which the campers have moved, thus allowing them to drive from the roads and parking spurs into the camping area. This ineffective system may account for some of the sapling and seedling mortality. But the losses at both sites suggest that other environmenttal factors may also be responsible. The only increases

[1]Magill, Arthur W. *Soil compaction in relation to forest recreation.* 1963. (Unpublished M.S. thesis on file at the Univ. Calif., Berkeley.)

Table 2–*Number of trees per acre, by species and size classes, at campgrounds and adjacent unused sites, California 1961, 1966*

Sites[1]	Seedlings I[2]		Seedlings II[3]		Saplings		Poles		Small timber[4]		Large timbers[5]	
	1961	1966	1961	1966	1961	1966	1961	1966	1961	1966	1961	1966
					INCENSE-CEDAR							
Almanor	–	–	–	–	3	3	5	5	–	–	–	–
Clark Fork	54	82	11	22	–	–	–	–	–	–	–	–
Pinecrest	11,053	536	7	33	36	25	22	33	11	11	15	15
Boundary	–	–	11	11	11	11	–	–	–	–	–	–
Summit	272	681	446	359	174	185	0	11	–	–	–	–
					WHITE FIR							
Almanor	136	912	207	280	133	125	33	41	27	16	5	11
Clark Fork	1,307	518	316	555	174	152	76	87	0	11	11	11
Pinecrest	336	154	11	25	163	134	91	105	22	25	11	11
Boundary	1,035	1,252	1,176	1,252	762	566	98	142	0	11	–	–
Summit	109	1,906	152	229	142	131	109	65	22	65	–	–
					PONDEROSA PINE							
Almanor	–	–	24	27	92	82	19	16	8	8	3	3
Pinecrest	–	–	–	–	7	4	25	18	33	33	11	11
Summit	–	–	0	11	22	22	11	11	–	–	–	–
					JEFFREY PINE							
Clark Fork	–	–	0	11	65	54	11	22	–	–	–	–
Laguna	0	27	5	0	38	27	49	49	–	–	–	–
Horse Heaven	0	65	41	21	36	24	20	18	45	48	4	4
Boundary	0	82	98	87	54	33	0	11	–	–	–	–
Drylake	55	245	54	44	44	33	44	44	–	–	–	–
					BLACK OAK							
Pinecrest	0	9	–	–	–	–	–	–	–	–	–	–
Laguna	0	41	49	38	0	5	–	–	–	–	5	5
Horse Heaven	15	123	42	30	–	–	–	–	1	1	11	11
Drylake	1,007	1,090	44	207	–	–	–	–	11	11	–	–

[1]Campgrounds Almanor, Clark Fork, Pinecrest, Laguna, Horse Heaven. Unused sites: Boundary, Summit, Drylake.

[2]Trees and shrubs 5 years old and 6 inches tall or less.

[3]Trees more than 5 years old and 6 inches tall, but less than 1 inch in diameter and 4.5 feet above ground.

[4]11 to 20.9 inches diameter breast height (d. b. h.).

[5]Over 20.9 inches d. b. h.

in the number of saplings were ascribed to black oak at Laguna Campground and incense-cedar at Summit (unused).

Pinecrest Campground was the only study site where Class I seedlings (less than 6 inches tall and 5 years old) suffered losses. At all the remaining sites, Class I seedlings increased. The change at Pinecrest was not representative because it could be attributed to a single plot at which a clump of trees protected large quantities of incense-cedar, white fir, and lodgepole pine seedlings that had germinated on a small moist area. But, after 5 years, the seedlings had suffered a fourteenfold decrease, possibly as a result of summer drought, disease, and some trampling.

Seedlings not only germinated and survived 5 years on most sites, but apparently advanced into the Class II stage with few exceptions *(table 2).* Incense-cedar at Summit and Jeffrey pine at Boundary suffered losses, but since they are not recreation sites, the losses may be attributed to other environmental influences. Furthermore, recreational use may not be the cause of Jeffrey pine losses at Laguna and Horse Heaven since similar losses occurred at Drylake, an unused site. On the other hand, Class II black oak seedlings decreased at Laguna by about 22 percent and at Horse Heaven by 29 percent. During the same period the number of plants increased nearly five times at Drylake, and Class I seedlings were increasing at all three sites. This growth suggests that black oak can successfully germinate in the campgrounds, but may not be able to withstand trampling or other elements of the campground habitat.

Trees in the pole class remained stable or grew more numerous–white fir increased by 16 percent at the three northern campgrounds *(table 2).* Some minor losses at Almanor, Pinecrest, and Horse Heaven may be attributed to growth into the small timber class or removal after insect infestations. The most notable drop in number of poles occurred at Summit (unused site), but it was countered by an equal increase in the small timber class. The number of trees over 11 inches in diameter remained nearly stable at all sites and for all species. The small changes that did occur were probably not related to recreational use.

Ponderosa pine appears to be susceptible to damage from recreational impact. Class I seedlings were not observed during either sample period at any of the campgrounds. Even though Class II seedlings increased slightly at Almanor between 1961 and 1966 and appeared for the first time at Summit in 1966, they were not found either year at Pinecrest. Furthermore, ponderosa pine poles and saplings growing at Almanor and Pinecrest had decreased by 1966.

Previous work has shown that poor seedling germination and survival may be expected with ponderosa pine (Curtis and Lynch 1965). Evidence from this study does not point to recreational use as a reason for lack of seedlings. However, losses of saplings and poles in the campgrounds may be related to recreational use since the number of trees in both classes remained unchanged at the Summit unused site.

Red fir, scrub oak, willow, and bittercherry were minor stand components on the study sites. Red fir showed slight promise as a durable species. Large red fir at Clark Fork and Class II scrub oak and willow were found at Pinecrest, red fir at Boundary, and bittercherry at Summit.

Two additional observations concern seedlings and saplings. The unused sites (Boundary, Summit, and Drylake) are not true controls. Nevertheless, the gross difference between seedling and sapling counts from the campgrounds and unused sites was so great as to make comparison inevitable. A greater abundance of plants was evident on the unused sites–clearly suggesting that trees below the pole stage found the campground habitat inhospitable.

Usually seedlings grew where protection from vehicular and foot traffic was provided by large rocks, groups of trees, constructed barriers, and clumps of shrubs. Thorny mountain whitethorn often proved to be an effective barrier by fending off visitors.

Tree Growth

The growth rates of trees on the eight study sites did not reveal any changes over a 30-year period that could be directly related to recreational use. Some small changes were noted, but appeared to follow normal growth patterns. For example, growth rates of trees in the younger more open stand at the Summit site were more rapid than that at Pinecrest campground, where the trees are older and more closely spaced. On the other hand, trees at Clark Fork Campground grew faster than those at Boundary. Again, reduced competition for space, this time in the campground, may be responsible for the differences. Similarly, some campground trees with accelerated growth rates were found during a pilot study on the Sequoia National Forest, and the greater spacing between campground plants was believed to be responsible (Magill and Nord 1963). Site development may account for some increased growth, but these studies have not shown recreational use to influence growth rates.

Undergrowth

The combined coverage of forbs and shrubs increased at all sites by 1966. Both groups of plants were detected on the Clark Fork plots for the first time *(fig. 4).* However, shrubs and forbs covered less than 25 percent of each study site. The coverage increases ranged from 18 percent at Almanor to over 1,000 percent at Laguna. A similar range of increases were recorded for the unused sites. The greatest increases were at the two campgrounds and one unused site in southern California.

Considered separately, shrub coverage at Summit decreased by nearly 11 percent. This may be attributed to competition from trees resulting from an increase in the number of poles and small timber and a 20 percent increase in overstory cover.

Shrub coverage was stable at Clark Fork, Boundary, Laguna, and Drylake, but forb coverage increased on all sites and did so substantially on the three sites in the Laguna recreation area. Shrubs comprised nearly all of the surface area coverage at the northern and central sites, but forbs were of equal or greater importance in southern California. The hot, dry summer climate associated with all of the study areas does not support abundant herbaceous vegetation, but does favor development of extensive brushland or an intermingling of shrubs with widely spaced trees.

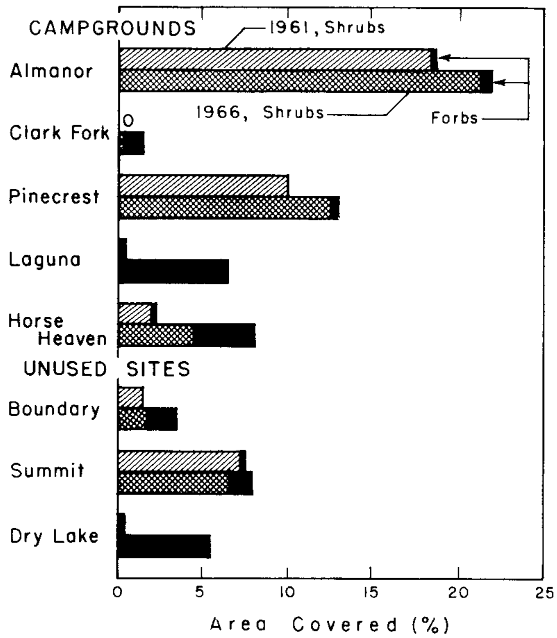

Figure 4–*Percent of area covered by forbs and shrubs on five campgrounds and three unused sites in California in 1961 and 1966.*

Between 1961 and 1966, the number of shrubs per acre decreased 38 percent at Laguna campground and 60 percent at Horse Heaven campground. Yet, shrubs also decreased 86 percent at Drylake (unused), which suggests losses on the campgrounds were not related to recreation use *(fig. 5)*. However, during 1961 and 1966, the total number of shrubs per acre was greater at the southern California campgrounds than at the unused site. Thus, the campground environment may have been more hospitable for shrubs than the unused site.

In northern California, shrubs increased 77 percent at Almanor and 145 percent at Clark Fork, but at Pinecrest there were practically no changes between 1961 and 1966. At Boundary, shrubs increased 38 percent; at Summit they decreased nearly 84 percent. Again this difference suggests that shrubs grow better on campgrounds–possibly because of less competetion from tree seedlings, saplings, and poles.

Shrubs Suggested for Study

Some shrubs may merit further study to determine their potential for absorbing the shock of recreational impact. They include mountain whitethorn, sharpleaf snowberry, wood rose, and Sierra chinkapin. In the Western United States where summers are hot and dry, I believe emphasis should be on woody shrubs because they may be able to withstand heavy recreational use and severe climate better than herbaceous plants. Continued study should be directed toward identifying understory species useful for revegetating worn sites or establishing plants on barren recreation sites.

Mountain whitethorn is considered the most promising shrub because it is widely distributed, has a good appearance, has thorns to fend off campers, and may serve as nurse plant for tree seedlings. Results from this study *(tables 3,4)* and observations elsewhere indicate that whitethorn may have potential for withstanding recreational use. Losses of whitethorn at Summit and Boundary (unused areas) suggest that the species may not be tolerant of severe tree competition, and may grow well if it is planted in campgrounds where there is less tree cover.

Growth of snowberry was favorable at three sites. Most of the plants tallied were relatively small, vine-like, without thorns, and growing in well protectted locations. Consequently, snowberry should be carefully screened to determine if it can withstand greater exposure to trampling.

Wood rose is armed with fine thorns that may contribute to its usefulness as a visitor control plant. But research is necessary to determine if it resists visitor impact. Future studies should determine if the

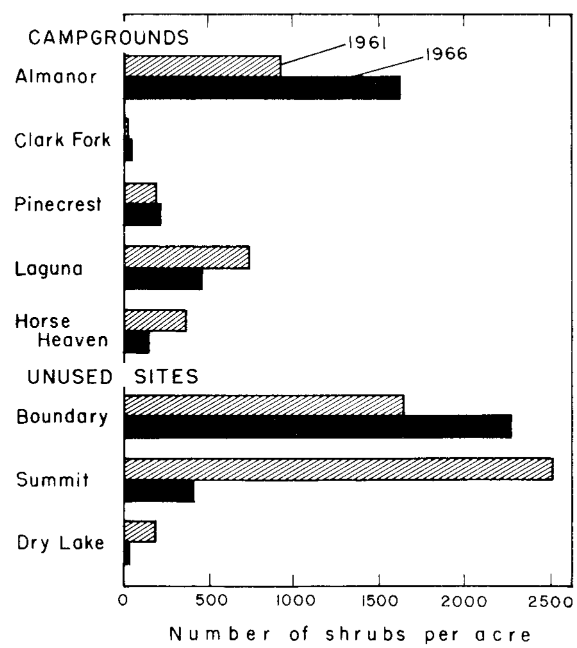

Figure 5–*Number of shrubs per acre on five campgrounds and three unused sites, 1961 and 1966.*

Table 3—*Composition and density of shrubs on campgrounds and unused sites, 1961, 1966*

Species	Almanor		Clark Fork		Pinecrest		Laguna		Horse Heaven		Boundary		Summit		Drylake	
	1961	1966	1961	1966	1961	1966	1961	1966	1961	1966	1961	1966	1961	1966	1961	1966
	Number of plants per acre															
Mountain whitethorn	191	232	27	27	27	91	–	–	–	–	27	0	191	136	–	–
Sharpleaf snowberry	252	463	0	27	–	–	–	–	–	–	1,633	2,232	–	–	–	–
Wood rose	48	211	–	–	18	54	–	–	–	–	–	–	82	191	–	–
Wright Eriogonum	–	–	–	–	–	–	259	231	0	123	–	–	–	–	0	27
Palmer ceanothus	–	–	–	–	–	–	14	14	29	29	–	–	–	–	–	–
Squawcarpet ceanothus	136	177	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sierra chinquapin	225	429	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 4—*Percent of shrub crown area for all plots*

Species	Almanor		Clark Fork		Pinecrest		Laguna		Horse Heaven		Boundary		Summit	
	1961	1966	1961	1966	1961	1966	1961	1966	1961	1966	1961	1966	1961	1966
Mountain whitethorn	9.5	15.1	–	–	10.0	12.1	–	–	–	–	–	–	1.7	0.7
Sharpleaf snowberry	.4	1.0	0	0.1	0	.1	–	–	–	–	1.6	1.9	–	–
Wood rose	1.1	.6	–	–	0	[1]0	–	–	–	–	–	–	–	–
Palmer ceanothus	–	–	–	–	–	–	[1]0	0	2.0	4.4	–	–	–	–
Squawcarpet ceanothus	5.5	2.0	–	–	–	–	–	–	–	–	–	–	–	–
Sierra chinquapin	1.3	2.6	–	–	–	–	–	–	–	–	–	–	–	–

[1]Indicates values above zero but less than 0.05.

Figure 6–*Squawcarpet ceanothus* (right foreground) *and mountain whitethorn at Almanor Campground in 1961. Squawcarpet was gone by 1966 , apparently removed by campers clearing tent spaces.*

plant's scraggly appearance is typical or only the result of severe shading.

Sierra chinkapin is a handsome shrub that doubled its areal coverage at Almanor between 1961 and 1966 *(table 4).* It was not found on the other study areas, but should grow at Clark Fork and Pinecrest. Further investigation is necessary to determine its potential for use on recreation areas.

Three other shrubs may deserve some attention. Squawcarpet ceanothus looked like an excellent ground cover plant, but while the number of plants per acre increased, the area covered decreased more than 60 percent. Squawcarpet forms a surface mat beneficial for soil stabilization, but its vulnerability to trampling should be studied *(fig. 6).* Wright eriogonum showed some ability to withstand human impact on the southern California sites. This low growing shrub appeared for the first time at Horse Heaven and Drylake, but decreased in numbers at Laguna. The population of Palmer ceanothus was stable during the study period, but the species' crown area increased by nearly 120 percent. However, the increase could be expected because it is naturally a large spreading shrub and is growing on the perimeter of the camps where visitor influence is probably minimal. Although not an attractive plant, Palmer ceanothus may prove valuable as a screen if new plants can be established and their appearance improved by pruning.

Forbs

During 1966, notable increases in forb occurrence were recorded in all study areas. And 19 species were recorded in the campgrounds for the first time. The increase in herbaceous plants may be related to more favorable weather conditions, the installation of a vehicle barrier system during 1960 and 1961, or both. Undoubtedly, many of the delicate, low-growing forbs would have been crushed and destroyed without the protection offered by the barriers.

In northern California, a few unidentified forbs made the greatest increase in frequency of occurrence. The plants were usually very small and did not have enough parts remaining to allow identification. Though no particular species could be singled out as excelling in frequency or growth, 12 species appeared for the first time in the campgrounds. Of the 12, only iris had previously been recorded on the unused sites, which also supported four new species not found in the campgrounds. In 1966, a phacelia was the only identified plant not found at Almanor and Pinecrest after being recorded during the 1961 sampling.

In southern California, five forbs appeared to be potentially resistant to recreational use on the basis of their vegetative spread and frequency of occurrence. Foliar coverage by western yarrow, aster, deervetch, and California goldenrod either increased between 7 to 14 times or had invaded the plots on the three study sites by 1966. Deervetch had the largest gain of any species in 1966 *(table 5).* In 1966, western yarrow and phlox occurred on 60 percent or more of the plots at Laguna, Horse Heaven, and Drylake. Also, deervetch and aster occurred on over 50 percent of the plots at Laguna as did goldenrod and deervetch at Horse Heaven. The same three species had only a 25 percent occurrence at Drylake. During 1966, nine species invaded the campgrounds but mint and clover, which were very sparse on the campgrounds in 1961, were absent in 1966.

Despite their small size, sometimes delicate structure, and frequently sparse distribution, forbs may help stabilize campground soils and add a pleasing touch to the esthetic value of recreation sites. But their tolerance to the impact of recreational use has yet to be determined.

Grasses

Grasses were a minor component of the undergrowth. Their basal area accounted for less than 2 percent of the sample area at all study sites. Apparently not deterred by trampling, sedge increased

Table 5—*Percent of plots stocked by forbs, by campground or site, 1961 and 1966*

Species	1961	1966
ALMANOR CAMPGROUND		
Low Dogbane	6	25
Pacific Monardella	0	12
California Strawberry	6	12
Bigflower Gunsmoke	0	6
Bull Thistle	0	6
Kelloggia	0	6
Whitevein Pyrola	0	6
Unknown spp.	12	6
Phacilia	6	0
CLARK FORK CAMPGROUND		
Unknown spp.	0	75
Bigflower Gunsmoke	0	50
Bluestem Eriogonum	0	25
Clover	0	25

Table 5—*Percent of plots stocked by forbs, by campground or site, 1961 and 1966,* continued

Species	1961	1966
BOUNDARY UNUSED AREA		
Unknown spp.	0	50
Kelloggia	0	25
Pioneer Rockcress	0	25
Western Pipsissewa	0	25
Western Yarrow	25	25
PINECREST CAMPGROUND		
Unknown spp.	0	25
American Adenocaulon	0	17
California Strawberry	0	17
Bigflower Gunsmoke	0	8
Iris	0	8
Minerslettuce	0	8
Sweetroot	0	8
Phacelia	8	0
SUMMIT UNUSED AREA		
Kelloggia	0	50
Iris	50	50
Unknown spp.	0	25
Western Houndstongue	0	25
Barestem Eriogonum	0	25
Braken	0	25
Bigflower Gunsmoke	50	0
LAGUNA CAMPGROUND		
Western Yarrow	62	100
Deervetch	0	80
Phlox	25	62
Aster	25	62
Unknown spp.	12	50
California Goldenrod	0	38
Bigflower Gunsmoke	0	12
Dwarf Ragweed	0	12
Milkvetch	0	12
Paintedcup	0	12
Wyethia	0	12
Mint	12	0
HORSE HEAVEN CAMPGROUND		
Phlox	33	60
California Goldenrod	40	60
Western Yarrow	53	60
Deervetch	0	53
Fleabane	0	33
Bigflower Gunsmoke	0	13
Aster	0	7
Penstemon	0	7
Clover	7	0
DRY LAKE UNUSED AREA		
Phlox	25	100
Western Yarrow	25	75
Unknown	0	50
Deervetch	0	25
California Goldenrod	0	25
Aster	25	25
Gilia	25	0

threefold at Clark Fork and twofold at Boundary. Bluegrass invaded Pinecrest campground, but its basal area contributed only one-tenth of 1 percent. Otherwise, grasses and grasslike plants were stable or decreased at the Sierra sites. Grasses appear to be an important component of the undergrowth at the Laguna recreation area. Sixteen species were found on the three southern California sites, and each species was represented on one or the other campground. However, only four species invaded the campground; six species dissappeared by 1966. Cheatgrass, an abundant annual during the first sampling, decreased in 1966. The basal area of smooth brome increased tenfold at Laguna, thirteenfold at Drylake, and fourfold at Horse Heaven. Needlegrass basal area was stable at Laguna, but increased twenty-eightfold at the Horse Heaven plots and sixfold at Drylake. Smoothbrome, needle grass, and possibly koeleria merit further study to determine trampling resistance.

Soil Surface Coverage

Exposed and often dusty soil surfaces are common for a distance of possibly 10 to 15 feet surrounding family units at many National Forest campgrounds in California. Areas where people concentrate, such as restrooms, water faucets, trails, or campfire circles, are also essentially free of soil cover.

The percent of soil surface covered by plant litter increased between 18 and 32 percent at all campgrounds but Almanor where it increased only 8 percent *(fig. 7).* Litter coverage at Boundary increased modestly, but at Summit and Drylake it suffered 8 and 2 percent losses. The increase in the area covered by plant litter on the campgrounds is not easy to explain. Raking and trampling spread existing litter over a wider area. In addition, annual litter-fall may have assumed new distribution patterns that were not disturbed by visitor use. Increased precipitation during the 5-year study period, may have stimulated vegetative production and subsequent litter-fall. Considering the upward trends in recreation visits, it is doubtful that litter coverage can increase to the levels that probably existed before site development.

In contrast to areal coverage, changes in litter depth, between 1961 and 1966, showed decreases of 25 percent at Almanor and 29 percent at Pinecrest, and no change at Clark Fork. And at Boundary and Summit the decreases were even greater: 37 and 47 percent, respectively. Similar trends existed in southern California, but the changes were not as great. This suggests that the decrease in litter depth during the study period was not the result of recreational use.

If changes in time are ignored, a comparison of litter coverage and depth on campgrounds and unused sites suggests that camping reduced both *(figs. 7,8).* The percent of area covered by plant litter was actually greater on the unused sites at each sampling date than on the campgrounds. Furthermore, litter depth was greater at the unused sites on both sampling dates, and it was two to four times greater in 1966 *(fig. 7).* It may be that recreational impact exerted an influence over a period longer than the 5 years of this study, or during a short period after a campground was opened.

Accumulations of deadwood are another source of soil surface cover. The percent coverage at Pinecrest, Laguna, and Horse Heaven campgrounds was very small and stable. In 1961, deadwood was not found on the Clark Fork plots, but by 1966 it accounted for about 8 percent of the soil cover. Almanor was the only campground which had less deadwood in 1966; the decrease amounted to 50 percent. Increases in deadwood were recorded at the three unused sites: at Drylake by 75 percent; at Summit by 62 percent; and at Boundary by over 4,000 percent. But, at each location the actual area covered by deadwood was very small.

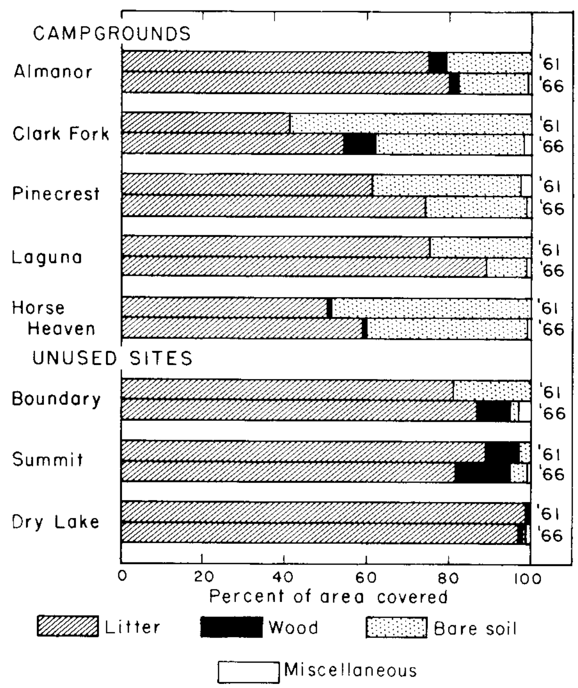

Figure 7–*Percent of soil surface covered by vegetative litter varied widely among the campgrounds and unused sites that were studied.*

The low percentages of deadwood at Pinecrest, Laguna, and Horse Heaven reflect the normal paucity of wood at heavily used campgrounds. As every campground manager knows, piles of wood left in campgrounds are usually gathered and burned by the campers. Naturally, some small pieces remain, and they likely account for the very small area values recorded. At Almanor, slightly higher values for 1961 may reflect the influence of several new units not scavenged, but by 1966, all sites were in use, and wood coverage had been reduced. Natural mortality of pole size and larger trees and some cutting for a new road outside of the campground may account for the increase of deadwood at Clark Fork and Boundary. At Clark Fork, fallen trees that contributed deadwood were recorded only in plot photography, since they were growing adjacent to our plots rather than on them *(fig. 9).*

What causes the losses of tree seedlings, shrubs, grasses, forbs, and litter on campgrounds? Trampling often is given as the major cause. Another activity that is just as obvious but much less often suggested is tent site clearing. The group camp layout of Horse Heaven illustrated the disturbance wrought by tent site clearings most vividly. Clearings totaled 3,110 sq. ft. of bare soil surface in 1961. Horse Heaven has a 10 to 15 percent slope. Consequently, many of the tent clearings were bordered by small cuts and fills that

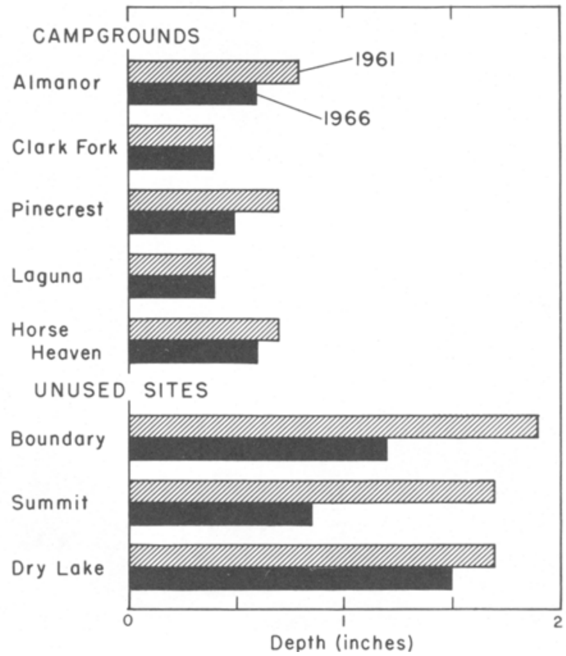

Figure 8–*The unused sites had more litter than any of the campgrounds.*

Figure 9–*Removal of dead or dying trees adds to the deadwood accumulations at campgrounds. Near the woman is the stump of a tree that was felled across the study area.*

Figure 10–*Bare areas occur where campers have prepared tent foundations. Sharp cuts and fills slough away as the site is used.*

tend to slough away under traffic *(fig. 10)*. By 1966, the tent clearings had decreased to 2,356 sq. ft. The original platforms were still present, but tent clearings supporting a sparse cover of new plants and litter were considered stabilized and subtracted from the 1961 area. The campground was opened in 1960 and probably underwent the major clearing during the first or second season. Naturally, tent sites are necessary, but it may be desirable for administrators to build them to minimize vegetation and soil damage.

Soil Compaction

The attempt to establish soil compaction trends, using soil penetrometer and supporting soil moisture information, was generally unsuccessful, as previously mentioned. Yet, a few high penetration resistance values[2] were clearly associated with old roads, trails, or parking areas, and low readings were consistently found beneath clumps of shrubs. Concentrations of vehicles and people obviously compact the soils. However, several studies have shown that soil compaction may not always pose serious problems, and compaction may prove beneficial by effecting greater root firmness and increasing growth rates by providing a greater supply of soil moisture and nutrients and reducing microflora competition for nitrogen (Hartesveldt 1963; Lull 1959; Magill and Nord 1963).

Screening and Overstory Cover

Interunit screening increases ranged between 13 and 37 percent at all but two sites between 1961 and

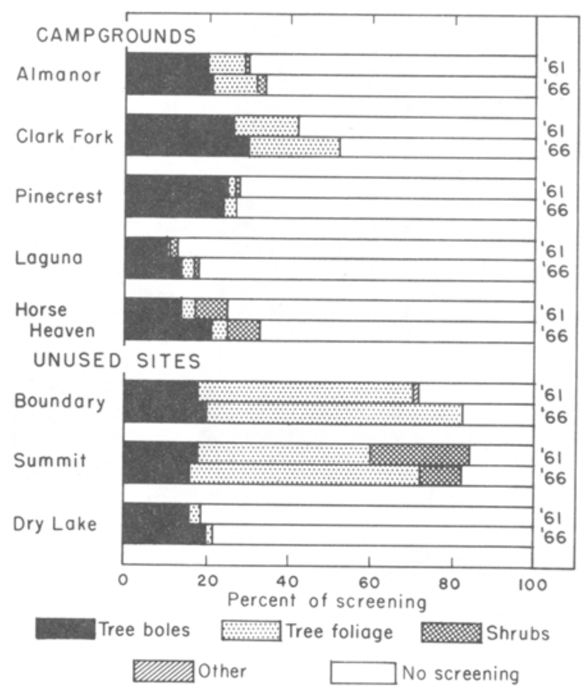

Figure 11–*Percent of campground screening varied at each unit.*

[2]Penetration resistance is defined as the resistance of the soil to the penetration of a steel rod with a known cross-sectional area. The values are computed from the pounds of force required to push the needle into the soil to a given depth. They are recorded in pounds per square inch.

1966. Screening remained generally unchanged at Pinecrest and Summit since losses were less than the 5 percent error inherent in the sampling method *(fig. 11)*. If periodic changes are disregarded, screening was less on the campgrounds than on the unused sites except at Horse Heaven. A comparison between campgrounds and the associated unused sites in 1966, showed that screening was less by 37 percent at Clark Fork, 67 percent at Pinecrest, and 18 percent at Laguna. However at Horse Heaven, it was 54 percent greater than at Drylake. The results suggest that recreational use adversely influenced campground screening, but periodic increases suggest that conditions may be improving.

Tree bole and foliar screening increased between 1961 and 1966, except at Pinecrest campground. Tree boles accounted for over 50 percent of the total screening on campgrounds during both sample years.

Tree foliage provided 50 to 75 percent of the screening on the unused areas except at Drylake. The 76 percent overstory closure of the mixed oak-pine forest at Drylake may have restricted the amount of foliar screening and accounted for the 92 percent screening by tree boles in 1966. Shrub screening was notable only at Horse Heaven and Summit. At Horse Heaven, shrubs provided 8 percent of all screening during both years, while at Summit they had decreased 58 percent by 1966.

SUMMARY AND CONCLUSIONS

The first of the study's objectives–to record changes in campground habitat–was accomplished. The second objective–to identify the factors responsible for change–was achieved but only to a limited degree. Our efforts might have been more successful had they been confined to one or possibly two campgrounds. Then the variables could have been examined in greater detail and sampling period scheduled annually.

The study provided a basis for evaluating the effectiveness of barrier systems, for suggesting more intensive studies of plant species potentially tolerant of human impact, and for developing the hypothesis that recreation sites may adjust to or even partially recuperate from heavy recreational use–especially with the occurrence of wet years, some protection, and remedial site treatment.

The potential influence of the barrier systems, installed before 1961, was suggested by the germination and growth of various species of tree seedlings, the increase of forbs and grasses and the invasion of previously unrecorded species on some sites. Apparently, establishment and survival are best where young plants are protected from mechanical injury. But the above-average rainfall in northern California and increasing rainfall in southern California, where precipitation had been below average until 1965, may have contributed to vegetative improvement. Quite likely, the combination of increased available moisture and protection offered by barriers afforded the plants an opportunity to survive human impact.

The study suggests that the "wornout" appearance of campground habitats may only be superficial. True, the greater total amount of tree seedlings and saplings, shrubs, screening, and litter associated with unused sites indicates some environmental decline on campgrounds. But photographic records of the plots show a characteristic sameness between 1961 and 1966 on all sites. Some new plant growth is evident, but losses of litter, soil, and plants are not readily detectable. Photographs show that a few trees have been cut, but factors other than recreational use may be responsible for their forced removal. Tree growth patterns did not show any trends indicating adverse influences from use. These findings agree with Hartesveldt's (1963). However, data from this study do not agree with those of LePage (1962), who reported that in the New Hampshire State Parks, diameter growth responded unfavorably to increasing recreational use and favorably to reductions in use. The improving distribution and cover of undergrowth and the invasion of new species on some sites do correspond with the findings by LaPage (1967) in Pennsylvania. But unlike that study, forbs were a more important component than grasses on the California sites.

The results of this and other studies (Hartesveldt 1963; LaPage 1967) suggest that campground ecosystems may be capable of "adjusting" to human impact. Evidence indicates some actual improvement rather than continued deterioration. Soils tend to be compacted where traffic is concentrated, but this compaction may be beneficial to plant growth.

Barrier systems and an information program asking public forebearance from wood gathering and plant removal or tree scarring are essential for site protecttion. Accelerated programs for identifying and growing durable plants as well as establishing effective cultural treatments should prove effective for stabilizing and improving campground habitats.

Investigations of human impact on the soils and vegetation of intensively used recreation sites probably do little more than document the obvious. We had hypothesized that trend studies might be useful in determining campground-carrying capacities. But the variety of environmental conditions associated with outdoor recreation areas, diversity of uses, and varying intensities of impact require that such capacities be determined on a site-by-site basis after intensive study.

A more fruitful approach might be to develop effective means for recreation site management. To develop this means, researchers should stress studies that show managers (a) how to select trees and shrubs that can withstand recreation impact; (b) how to develop effective, practical methods of irrigating, seeding, planting, fertilizing, mulching, and cultivating recreation sites; and (c) how to improve site designs, facilities, and traffic patterns so as to protect sites. At the Pacific Southwest Forest and Range Experiment Station, we plan to close out trend studies and to continue and expand use of this other approach in future recreation research.

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APPENDIX

SPECIES AND WHERE THEY WERE FOUND ON CAMPGROUNDS

Scientific name	Common name	Almanor	Clark Fork/ Pinecrest	Laguna/ Horse Heaven
ANNUAL GRASSES				
Avena barbata	Slender oat	–	–	X
Avena fatua	Wild oat	X	–	–
Bromus mollis	Soft brome	–	–	X
Bromus rigidus	Ripgut brome	–	–	X
Bromus tectorum	Cheatgrass brome	–	–	X
PERENNIAL GRASSES				
Agropyron spp.	Wheatgrass	–	–	X
Agrostis spp.	Bentgrass	–	–	X
Bromus carinatus	Mountain brome	–	–	X
Bromus spp.	Brome	X	–	X
Carex spp.	Sedge	X	X	X
Danthonia spp.	Danthonia	–	–	X
Elymus spp.	Wildrye	–	–	X
Koeleria spp.	Koeleria	–	–	X
Muhlenbergia spp.	Muhly	–	–	X
Poa spp.	Bluegrass	–	X	X
Sitanion hystrix	Bottlebrush squirreltail	X	–	–
Stipa lettermanii	Letterman needlegrass	X	–	–
Stipia spp.	Needlegrass	–	X	X
FORBS				
Achillea lanulosa	Western yarrow	–	X	X
Adenocaulon bicolor	American adenocaulon	–	X	–
Ambrosia pumila	Dwarf ragweed	–	–	X
Apocynum pumilum	Low dogbane	X	–	–
Arabis platysperma	Pioneer rockcress	–	X	–
Astragalus *douglasii*	Milkvetch	–	–	X
Aster spp.	Aster	–	–	X
Castilleja martinii	Paintedcup	–	–	X
Chimaphilia umbellate var. *occidentalis*	Western pipsissewa	X	–	–
Cirsium vulgare	Bull thistle	X	X	–
Claytonia perfoliata	Minerslettuce	–	X	–
Cynoglossum occidentale	Western houndstongue	–	X	–
Eriogonum latifolium ssp. *nudum*	Barestem eriogonum	–	–	–
E. wrightii ssp. *membranaceum*	Wright eriogonum	–	–	X
Erigeron spp.	Fleabane	–		X
Fragaria californica	California strawberry	X	X	–
Gayophytum diffusum	Bigflower groundsmoke	X	X	X
Gilia spp.	Gilia	–		X
Iris spp.	Iris	–	X	–
Kelloggia galioides	Kelloggia	X	X	–
Lotus nevadensis	Deervetch	–	–	X
Lupinus spp.	Lupine	–	–	X
Mentha spp.	Mint	–	–	X

SPECIES AND WHERE THEY WERE FOUND ON CAMPGROUNDS, continued

Scientific name	Common name	Almanor	Clark Fork/ Pinecrest	Laguna/ Horse Heaven
	FORBS, continued			
Monardella odoratissima ssp. *pallida*	Pacific monardella	X	–	–
Osmorhiza chilensis	Sweetroot	–	X	–
Penstemon spp.	Penstemon	–	–	X
Phacelia spp.	Phacelia	X	X	–
Phlox spp.	Phlox	–	–	X
Potentilla spp.	Cinquefoil	X	–	–
Pteridium aquilinum	Braken	–	X	–
Pyrola picta	Whitevein pyrola	X	–	–
Solidago californica	California goldenrod	–	–	X
Spraguea umbellata	Umbellate pussypaws	–	X	–
Thermopsis macrophylla var. *semota*	Bigleaf thermopsis	–	–	X
Trifolium spp.	Clover	–	X	X
Wyethia ovata	Wyethia	–	–	X
	SHRUBS			
Amelanchier pallida	Saskatoon serviceberry	X	X	–
Arctostaphylos patula	Greenleaf manzanita	X	X	–
Artemisia ludoviciana	Louisiana sagebrush	–	–	X
Castanopsis sempervirens	Sierra chinquapin	X	–	-
Ceanothus cordulatus	Mountain whitethorn	X	X	X
Ceanothus palmeri	Palmer ceanothus	–	–	X
Ceanothus prostratus	Squawcarpet ceanothus	X	–	–
Chamaebatia foliolosa	Mtn. misery or Bearmat	–	X	–
Chrysothamnus viscidiflorus ssp. *pumilus*	Low Douglas rabbitbrush	–	–	X
Lonicera conjugialis	Purpleflower honeysuckle	–	X	–
Ribes spp.	Gooseberry	–	X	–
Rosa gymnocarpa	Wood rose	X	X	–
Spiraea densiflora	Mountain spiraea	–	X	–
Symphoricarpos acutus	Sharpleaf snowberry	X	X	–
	TREES			
Abies concolor	White fir	X	X	–
Abies magnifica	Red Fir	–	X	–
Libocedrus decurrens	Incense-cedar	X	X	–
Pinus contorta	Lodgepole pine	–	X	–
Pinus jeffreyi	Jeffrey pine	–	X	X
Pinus lambertiana	Sugar pine	X	X	–
Pinus ponderosa	Ponderosa pine	X	X	–
Prunus emarginata	Bittercherry	–	X	–
Quercus dumosa	Scrub oak	–	X	–
Quercus kelloggii	California black oak	–	X	X

GPO 980-069

Magill, Arthur W.

1970. **Five California campgrounds . . . conditions improve after 5 years' recreational use.** Berkeley, Calif., Pacific SW. Forest & Range Exp. Sta. 18 p., illus. (U S D A Forest Serv. Res. Pap. PSW-62)

Changes in condition that may have been caused by recreational use, from 1961 to 1966, at five campgrounds in three widely separated locations in California were studied by measuring four variables: vegetation, plant litter, interunit screening, and overstory cover. The increase in vegetation after 5 years was attributed to barriers placed in campgrounds and to greater precipitation. The over-all improvement in campground conditions is interpreted as an "adjustment" to recreational use.

OXFORD: 907.2.
RETRIEVAL TERMS: campgrounds; recreation use; deterioration.

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