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U.S.DEPARTMENT OF AGRICULTURE
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# PACIFIC SOUTHWEST Forest and Range Experiment Station

# Herbs and Brush on California Red Fir Regeneration Sites: a species and frequency sampling



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*Research Note PSW-329*
1978

Gordon, Donald T., and Eugene E. Bowen.
1978. **Herbs and brush on California red fir regeneration sites: a species and frequency sampling.** Res. Note PSW-329, 10 p., Pacific Southwest Forest and Range Exp. Stn., Forest Serv., U.S. Dep. Agric., Berkeley, Calif.

In a sampling of 32 logged areas in red fir forests of northern California, 58 plant species were found. Species corresponded with less than one-fifth of the 93 species reported in an earlier study of the virgin forest. Sampling of uncut areas adjacent to cuttings does not seem useful for predicting the earlier successional vegetation that will appear when the areas are logged.

*Oxford:* 174.7 *Abies magnifica:* 231.3:182.46/.48
*Retrieval Terms:* red fir; *Abies magnifica;* cutover forests; regeneration; ground cover; competition; plant succession; vegetation sampling.

The forest manager's role in regeneration is to ensure proper conditions under which young trees may be established naturally or artificially, and quickly enough so that their survival and growth are not impeded by other plants. The often slow processes of normal plant succession are thereby circumvented. At present, low plants which might affect tree regeneration are generally removed more or less indiscriminately. Our knowledge is still too rudimentary to allow accurately selective control of undesirable low species. Sound biological methods for dealing with such plants are much needed, but for this we must have knowledge of the typical plant species associated with the various timber types.

Various kinds of plant lists for California's commercial timber types are available, but autecological and synecological studies applicable to the geographical area occupied by those types are scarce. Almost every square mile of that area, including the parks, has been disturbed by man to some degree in the last 125 years.

In the regeneration of California red fir (*Abies magnifica* A. Murr.), the flora which develops after cutting and site preparation is in marked contrast to that of the virgin forest. Plants on the cutover areas belong, of course, to earlier successional stages, and are well adapted to the site. In their relative abundance, and in their aggressiveness in occupying disturbed areas, both the species and the individual plants vary widely.

The study reported here is a limited sampling of plant species and frequency of occurrence on red fir regeneration sites, with a lighter sampling of selected adjacent uncut areas. The primary aims of the study were to determine

1. The number of plant species identifiable by a simple sampling technique.
2. Similarities or differences in plant associations among cutting units.
3. Relation of plant associations recorded to those listed by other investigators[1] on red fir forests.
4. Usefulness of species in uncut areas as indicators of species that would be more abundant on adjacent cutting areas.

In addition, we hoped to find general information of several other kinds:

- Indications of possible effects of such factors as time, site treatment for conifer regeneration, elevation, aspect, and slope.
- Indications of possible effects of any plants on establishment of fir seedlings.
- A data base for developing more refined studies of plant communities.

The conditions of the study did not permit observation of a number of other influences on regeneration, such as site quality, soil types, or animal browsing. Neither were detailed data sought on soil types, or the relation of microsites, seed characteristics and other factors to the occurrence of plant species in particular places at particular times. The information contained in this note may be useful, however, in the planning of more definitive studies.

## METHODS

During late August 1972, 32 cutting units were sampled, as well as 9 uncut areas adjacent to cuttings. Personnel on the Stanislaus, Eldorado, Tahoe, and Klamath National Forests suggested appropriate sampling areas, and we also chose areas on Swain Mountain Experimental Forest, which lies within Lassen National Forest.

Because the field survey had to be completed by one man in 3 weeks, we selected the loop method, which samples a ¾-inch circular plot, over the method using a square-foot quadrat. Preliminary field evaluation showed that the loop was quicker, because a "hit" requires only a rapid categorical decision rather than the series of measurements or counts needed with the quadrat frame. We followed the general U.S. Forest Service[2] sampling scheme for the loop; this method is based on an earlier work by Parker.[3] The field report form we designed allowed for a uniform description of each cutting unit and for specific notation of the loop hits—for example, plant, bare soil, litter, stump, or rock.

One specimen of each plant species hit was collected for identification, and a second specimen was pressed. Herbs and brush were identified initially according to Munz and Keck[4]; tree names follow Little.[5] Identifications were checked later by Dr. Kingsley R. Stern, Professor of Botany at California State University, Chico, California. Species vouchers are filed at Redding, California, in the herbarium of the Pacific Southwest Forest and Range Experiment Station.

All repeated hits for any species or other category were recorded. Hits on the ground beneath shrubs or small tree crowns were recorded for the tree or shrub, on the assumption that roots dominate soil areas equal to those subtended by crowns. In sampling of uncut areas, where there were large firs, only the low vegetation beneath them was recorded.

Preliminary testing indicated that about 100 sample points at each cutting unit would be adequate. Spacing between sample points was based on an estimate of the total length of two compass line transects across the opening. Transect locations were chosen by ocular estimate of "average" conditions at the site.

Uncut areas were sampled using only 50 sample points in each area, distributed fairly evenly on transect lines that were parallel to two sides of the adjoining cut unit. Transect locations were determined subjectively because logging had affected vegetation and soil surface near the clearcut openings. Low vegetation was generally sparse.

Data from field sheets were punched on cards for automatic data processing. Several tables then were prepared to allow appraisals of different combinations of data, and results were compared with plant lists from the other studies available.

## RESULTS AND DISCUSSION

The state of plant development in late August was found to be less than ideal for our purposes. Late July or early August probably would have been better for collecting flower specimens, if areas could be visited only once. A few small herbs had already died at the time of survey. They were tallied as species, if identifiable, otherwise as litter.

In some places, phacelia, lupine, willow herb, currant, and fir seedlings were grazed heavily by deer or cattle. A few grasses and sedges had been too closely grazed to be readily identified. These "grass-likes" were placed in the "unidentified" category, along with a few other plants. Two different plants could be identified only as being in the Composite family.

Less than 4 percent of the plants observed were not identified, at least as far as genus.

Within the 32 cutting areas sampled, 58 different plant species were found (*table 1*). A few additional species are probably included in the plants which could be classified only as to genus. The number of different species sampled on individual cutting areas ranged from 5 to 18, with the mean at 9.8. Because we found that an average of nearly five species per area that could be readily noted on the cuttings did not fall within the sample, we concluded that our sample size per cutting unit was too small to describe the number of prominent plant species present.

### Species Diversity

The results shown in the table suggest that diversity of plants is a dominant feature of disturbed openings, although one or a few species may dominate individual areas. (Within a suitable environment in the geographic range of any species, past history and pure chance determine the occurrence of a particular species at a specific point.) This diversity of plant associations is illustrated by comparison with the gross results of two other studies.

Considerable difference exists between the 58 species of *table 1* and the plant list of 93 herbs, shrubs, and trees presented by Oosting and Billings[1] for their virgin red fir forest plots. Only 11 of the plant species we found—less than one-fifth—were listed there.

In Kings Canyon National Park, Kilgore[6] found, during 3 years of observations, two shrubs, seven grasses, and approximately forty species of forbs on twelve 100- by 100-foot plots installed in red fir. Some of the plots had been burned recently. Several shrubs not found on his plots were identified in an adjacent heavily burned montane chaparral area.

Although not listed for our sample, *Quercus vaccinifolia* is a dominant shrub at some places in the red fir type. Because it is characteristic of infertile soils, its absence from our list probably reflects foresters' reluctance to attempt fir regeneration under known adverse soil conditions.

### Relative Abundance of Species

The five species which were hit most (out of about 100 possible) on any single cutting area were *Arctostaphylos nevadensis,* 45; *Lupinus* sp., 43; *Phacelia mutabilis,* 40; *Stipa* sp., 39; and *Gayophytum nuttallii*, 30.

Another indication of relative abundance of species among sampled cuttings is the distribution among 32 cuttings of species with five or more sample hits per cutting:

| Species: | *Number of cutting areas* |
|---|---|
| *Gayophytum nuttallii* | 23 |
| *Phacelia mutabilis* | 17 |
| *Ribes roezlii* | 12 |
| *Abies* sp. | 8 |
| *Carex* sp. | 8 |
| *Ribes sanguineum* | 8 |

The absence from this group of *Ceanothus cordulatus* seems unusual, because we had the impression that this plant was prominent. Its relative scarcity may be an accident of sampling, or our impression may have been mistaken. *C. cordulatus* is found (with other shrubs, of course) on some old burns which have not yet become regenerated naturally by firs.

Twenty-four species were sampled at only one cutting area each (*table 2*). Most were observed infrequently, but a few were locally important. Half (29) of the 58 species listed in *table 1* were found only in two widely separated counties—Siskiyou and Sierra (*table 2*).

### Cuttings vs. Uncut Areas

The limitations of our comparison of vegetation on cuttings and uncut areas (*table 3*) became apparent in the field. Uncut areas close to the regeneration areas had been affected by logging. Soil surface was visibly disturbed, and in some skid trails small trees had apparently been wiped out, changing the amount of light that reached the soil. Some typically open-grown plants had become established on the disturbed soil within uncut areas. For proper comparison, we should have sampled the uncut areas before the adjacent areas were logged, but this was not feasible.

To compare the incidence of low vegetation species in nine paired cut and uncut areas, we first adjusted the data for sample size. The result indicates (a) that total vegetation hits on uncut areas were 82 percent of those on cuttings, and (b) that in seven of the nine pairs there was more vegetation on cuttings than on uncut areas. These results seem to reflect the effects on uncut areas of the disturbances noted above, and the additional fact that uncut areas sampled often did not bear dense stands composed only of old trees; such stands have scarcely any vegetation beneath them.

Table 1 *Frequency of loop sampling hits on plants at each location*[1]

| Plant | Location | Frequency |
|---|---|---|
| * ABIES SP. | ELD09N15E12 | 6 |
| ABIES SP. | ELD09N15E12 | 1 |
| ABIES SP. | ELD09N16E06 | 2 |
| ABIES SP. | ELD11N16E27 | 5 |
| ABIES SP. | ELD11N16E27 | 4 |
| ABIES SP. | SIS47N09W30 | 1 |
| ABIES SP. | SIS47N10W15 | 3 |
| ABIES SP. | SIS39N09W21 | 5 |
| ABIES SP. | SIS39N09W17 | 1 |
| ABIES SP. | PLU30N08E21 | 6 |
| ABIES SP. | CAL07N17E19 | 8 |
| ABIES SP. | CAL07N17E18 | 5 |
| ABIES SP. | CAL06N17E29 | 2 |
| ABIES SP. | SIE21N12E14 | 1 |
| ABIES SP. | SIE21N12E13 | 2 |
| ABIES SP. | SIE21N12E22 | 3 |
| ABIES SP. | SIE20N12E13 | 4 |
| ABIES SP. | SIE20N13E14 | 6 |
| ABIES SP. | SIE20N13E14 | 4 |
| ABIES SP. | SIE20N13E14 | 10 |
| ABIES SP. | SIE20N13E14 | 3 |
| ACHILLEA LANULOSA | SIS47N10W13 | 4 |
| ACHILLEA LANULOSA | SIS45N11W17 | 3 |
| ACHILLEA LANULOSA | SIS45N12W24 | 2 |
| AGASTACHE URTICIFOLIA | SIS45N11W17 | 5 |
| AGROPYRON SP. | SIS45N11W17 | 16 |
| * APOCYNUM PUMILUM | SIE21N12E22 | 10 |
| * ARABIS PLATYSPERMA | SIE20N13E14 | 1 |
| * ARCTOSTAPHYLOS NEVADENSIS | SIS47N10W15 | 17 |
| ARCTOSTAPHYLOS NEVADENSIS | SIS47N10W13 | 45 |
| ARCTOSTAPHYLOS NEVADENSIS | SIS45N12W24 | 1 |
| ARCTOSTAPHYLOS NEVADENSIS | SIS45N12W24 | 12 |
| ARCTOSTAPHYLOS NEVADENSIS | SIS39N09W17 | 2 |
| ARCTOSTAPHYLOS NEVADENSIS | CAL07N17E19 | 2 |
| ARENARIA MACROPHYLLA | SIS39N09W21 | 1 |
| * CALYPTRIDIUM UMBELLATUM | ELD09N15E12 | 1 |
| CALYPTRIDIUM UMBELLATUM | ELD11N16E27 | 1 |
| CALYPTRIDIUM UMBELLATUM | ELD11N16E27 | 1 |
| CALYPTRIDIUM UMBELLATUM | SIS47N10W15 | 4 |
| CALYPTRIDIUM UMBELLATUM | SIS47N10W13 | 2 |
| CALYPTRIDIUM UMBELLATUM | SIE21N12E13 | 6 |
| CALYPTRIDIUM UMBELLATUM | SIE20N13E14 | 7 |
| CALYPTRIDIUM UMBELLATUM | SIE20N13E14 | 5 |
| CALYPTRIDIUM UMBELLATUM | SIE20N13E14 | 4 |
| * CAREX SP. | ELD09N16E06 | 1 |
| CAREX SP. | SIS39N09W21 | 8 |
| CAREX SP. | SIS39N09W17 | 5 |
| CAREX SP. | PLU30N08E21 | 11 |
| CAREX SP. | LAS30N08E21 | 7 |
| CAREX SP. | CAL06N17E29 | 1 |
| CAREX SP. | CAL06N17E29 | 3 |
| CAREX SP. | SIE21N12E34 | 3 |
| CAREX SP. | SIE21N12E13 | 5 |
| CAREX SP. | SIE20N12E13 | 1 |
| CAREX SP. | SIE20N13E14 | 14 |
| CAREX SP. | SIE20N13E14 | 5 |
| CAREX SP. | SIE20N13E14 | 1 |
| CAREX SP. | SIE20N13E14 | 7 |
| CEANOTHUS CORDULATUS | ELD09N16E06 | 3 |
| CEANOTHUS CORDULATUS | ELD11N16E27 | 1 |
| CEANOTHUS CORDULATUS | PLU30N08E21 | 16 |
| CEANOTHUS CORDULATUS | LAS30N08E21 | 4 |
| CEANOTHUS CORDULATUS | CAL07N17E19 | 4 |
| CEANOTHUS CORDULATUS | CAL07N17E18 | 1 |
| CEANOTHUS CORDULATUS | CAL06N17E29 | 2 |
| CEANOTHUS CORDULATUS | CAL06N17E29 | 2 |
| CEANOTHUS CORDULATUS | CAL06N17E29 | 1 |
| CEANOTHUS CORDULATUS | SIE21N12E34 | 4 |
| CEANOTHUS CORDULATUS | SIE21N12E14 | 4 |
| CEANOTHUS CORDULATUS | SIE21N12E22 | 1 |
| CEANOTHUS CORDULATUS | SIE20N12E13 | 2 |
| CEANOTHUS CORDULATUS | SIE20N13E14 | 1 |
| CEANOTHUS CORDULATUS | SIE20N13E14 | 7 |
| CEANOTHUS VELUTINUS | SIS47N10W15 | 1 |
| CEANOTHUS VELUTINUS | SIS47N10W13 | 1 |
| CEANOTHUS VELUTINUS | SIS45N12W24 | 21 |
| CEANOTHUS VELUTINUS | SIS39N09W21 | 1 |
| CEANOTHUS VELUTINUS | SIS39N09W17 | 4 |
| CHAMAESARACHA NANA | PLU30N08E21 | 15 |
| CHAMAESARACHA NANA | LAS30N08E21 | 12 |
| CHAMAESARACHA NANA | SIE20N13E14 | 2 |
| CHAMAESARACHA NANA | SIE20N13E14 | 2 |
| CHAMAESARACHA NANA | SIE20N13E14 | 5 |
| CHRYSOTHAMNUS VISCIDIFLORUS | SIS47N10W13 | 4 |
| CIRSIUM SP. | SIS47N09W30 | 1 |
| CIRSIUM SP. | SIS46N05E35 | 2 |
| CIRSIUM SP. | CAL07N17E19 | 2 |
| CIRSIUM SP. | CAL06N17E29 | 12 |
| CIRSIUM SP. | CAL06N17E29 | 9 |
| CIRSIUM SP. | CAL06N17E29 | 5 |
| COMPOSITE a | SIE21N12E34 | 1 |
| COMPOSITE a | SIE21N12E14 | 6 |
| COMPOSITE a | SIE20N13E14 | 2 |
| COMPOSITE a | SIE20N13E14 | 3 |
| COMPOSITE a | SIE20N13E14 | 2 |
| COMPOSITE a | SIE20N13E14 | 4 |
| COMPOSITE b | ELD09N15E12 | 3 |
| COMPOSITE b | SIE21N12E13 | 3 |
| COMPOSITE b | SIE21N12E22 | 1 |
| ELYMUS SP. | SIS47N10W13 | 7 |
| ELYMUS SP. | SIS45N11W17 | 5 |
| ELYMUS SP. | SIS39N09W21 | 2 |
| ELYMUS SP. | SIS39N09W17 | 3 |
| ELYMUS SP. | PLU30N08E21 | 8 |
| ELYMUS SP. | LAS30N08E21 | 3 |
| ELYMUS SP. | SIE21N12E13 | 1 |
| ELYMUS SP. | SIE20N13E14 | 2 |
| ELYMUS SP. | SIE20N13E14 | 4 |
| EPILOBIUM SP. | SIE20N13E14 | 2 |
| * ERIOPHYLLUM LANATUM | SIS45N12W24 | 5 |
| ERIOPHYLLUM LANATUM | SIS45N12W24 | 6 |
| GAYOPHYTUM NUTTALLII | ELD09N15E12 | 5 |

Table 1–*Frequency of loop sampling hits on plants at each location*[1] –Continued

| Plant | Location | Frequency |
|---|---|---|
| GAYOPHYTUM NUTTALLII | ELD09N15E12 | 7 |
| GAYOPHYTUM NUTTALLII | ELD09N16E06 | 4 |
| GAYOPHYTUM NUTTALLII | SIS47N09W30 | 18 |
| GAYOPHYTUM NUTTALLII | SIS47N10W15 | 30 |
| GAYOPHYTUM NUTTALLII | SIS47N10W13 | 4 |
| GAYOPHYTUM NUTTALLII | SIS45N11W17 | 10 |
| GAYOPHYTUM NUTTALLII | SIS45N12W24 | 24 |
| GAYOPHYTUM NUTTALLII | SIS45N12W24 | 18 |
| GAYOPHYTUM NUTTALLII | SIS39N09W21 | 6 |
| GAYOPHYTUM NUTTALLII | SIS39N09W17 | 9 |
| GAYOPHYTUM NUTTALLII | SIS46N05E35 | 10 |
| GAYOPHYTUM NUTTALLII | SIS45N05E02 | 5 |
| GAYOPHYTUM NUTTALLII | SIS46N05E35 | 13 |
| GAYOPHYTUM NUTTALLII | PLU30N08E21 | 1 |
| GAYOPHYTUM NUTTALLII | LAS30N08E21 | 2 |
| GAYOPHYTUM NUTTALLII | CAL07N17E19 | 2 |
| GAYOPHYTUM NUTTALLII | CAL07N17E18 | 1 |
| GAYOPHYTUM NUTTALLII | CAL06N17E29 | 6 |
| GAYOPHYTUM NUTTALLII | CAL06N17E29 | 21 |
| GAYOPHYTUM NUTTALLII | CAL06N17E29 | 2 |
| GAYOPHYTUM NUTTALLII | SIE21N12E34 | 20 |
| GAYOPHYTUM NUTTALLII | SIE21N12E14 | 12 |
| GAYOPHYTUM NUTTALLII | SIE21N12E13 | 27 |
| GAYOPHYTUM NUTTALLII | SIE21N12E22 | 10 |
| GAYOPHYTUM NUTTALLII | SIE20N12E13 | 17 |
| GAYOPHYTUM NUTTALLII | SIE20N13E14 | 11 |
| GAYOPHYTUM NUTTALLII | SIE20N13E14 | 13 |
| GAYOPHYTUM NUTTALLII | SIE20N13E14 | 9 |
| GAYOPHYTUM NUTTALLII | SIE20N13E14 | 9 |
| GILIA SP. a | ELD09N16E06 | 2 |
| GILIA SP. a | LAS30N08E21 | 3 |
| GILIA SP. a | CAL06N17E29 | 3 |
| GILIA SP. a | CAL06N17E29 | 4 |
| GILIA SP. a | CAL06N17E29 | 1 |
| GILIA SP. b | SIS45N12W24 | 7 |
| GNAPHALIUM SP. a | CAL06N17E29 | 3 |
| GNAPHALIUM SP. b | SIS45N12W24 | 2 |
| JUNCUS SP. a | SIE20N13E14 | 1 |
| JUNCUS SP. b | SIE20N13E14 | 4 |
| LATHYRUS SP. | SIS45N12W24 | 8 |
| LATHYRUS SP. | SIS45N05E02 | 2 |
| LATHYRUS SP. | SIS46N05E35 | 20 |
| LINANTHUS SP. | SIS46N05E35 | 4 |
| LINANTHUS SP. | SIE20N13E14 | 20 |
| LINANTHUS SP. | SIE20N13E14 | 17 |
| LINANTHUS SP. | SIE20N13E14 | 1 |
| LOTUS SP. | SIS47N10W15 | 8 |
| * LUPINUS SP. a | ELD09N15E12 | 6 |
| LUPINUS SP. a | ELD09N15E12 | 43 |
| LUPINUS SP. a | ELD09N16E06 | 14 |
| LUPINUS SP. a | CAL07N17E18 | 36 |
| LUPINUS SP. b | SIS45N12W24 | 3 |
| LUPINUS SP. b | PLU30N08E21 | 11 |
| LUPINUS SP. b | SIE21N12E14 | 15 |
| LUPINUS SP. b | SIE21N12E22 | 2 |
| MIMULUS BREWERI | ELD11N16E27 | 3 |
| MIMULUS LAYNEAE | CAL06N17E29 | 2 |
| MIMULUS SP. | SIE20N13E14 | 4 |
| MIMULUS SP. | SIE20N13E14 | 2 |
| * MONARDELLA ODORATISSIMA | ELD09N16E06 | 6 |
| MONARDELLA ODORATISSIMA | SIS46N05E35 | 2 |
| MONARDELLA ODORATISSIMA | SIE21N12E14 | 3 |
| MYOSOTIS VIRGINICA | ELD09N15E12 | 1 |
| MYOSOTIS VIRGINICA | ELD09N16E06 | 4 |
| MYOSOTIS VIRGINICA | SIS46N05E35 | 1 |
| MYOSOTIS VIRGINICA | PLU30N08E21 | 5 |
| MYOSOTIS VIRGINICA | LAS30N08E21 | 1 |
| MYOSOTIS VIRGINICA | SIE21N12E14 | 1 |
| MYOSOTIS VIRGINICA | SIE20N13E14 | 1 |
| PENSTEMON ANGUINEUS | SIS47N09W30 | 26 |
| PENSTEMON SP. | SIE21N12E13 | 1 |
| PENSTEMON SP. | SIE20N13E14 | 1 |
| PENSTEMON SP. | SIE20N13E14 | 1 |
| PHACELIA MUTABILIS | ELD09N15E12 | 10 |
| PHACELIA MUTABILIS | ELD09N15E12 | 12 |
| PHACELIA MUTABILIS | ELD09N16E06 | 3 |
| PHACELIA MUTABILIS | ELD11N16E27 | 1 |
| PHACELIA MUTABILIS | SIS47N09W30 | 8 |
| PHACELIA MUTABILIS | SIS47N10W13 | 1 |
| PHACELIA MUTABILIS | SIS45N11W17 | 5 |
| PHACELIA MUTABILIS | SIS45N12W24 | 19 |
| PHACELIA MUTABILIS | SIS45N12W24 | 1 |
| PHACELIA MUTABILIS | SIS39N09W21 | 2 |
| PHACELIA MUTABILIS | SIS39N09W17 | 6 |
| PHACELIA MUTABILIS | SIS46N05E35 | 40 |
| PHACELIA MUTABILIS | SIS45N05E02 | 18 |
| PHACELIA MUTABILIS | SIS46N05E35 | 15 |
| PHACELIA MUTABILIS | CAL07N17E19 | 5 |
| PHACELIA MUTABILIS | CAL07N17E18 | 4 |
| PHACELIA MUTABILIS | CAL06N17E29 | 4 |
| PHACELIA MUTABILIS | CAL06N17E29 | 14 |
| PHACELIA MUTABILIS | SIE21N12E34 | 6 |
| PHACELIA MUTABILIS | SIE21N12E14 | 8 |
| PHACELIA MUTABILIS | SIE21N12E13 | 15 |
| PHACELIA MUTABILIS | SIE21N12E22 | 16 |
| PHACELIA MUTABILIS | SIE20N12E13 | 3 |
| PHACELIA MUTABILIS | SIE20N13E14 | 4 |
| PHACELIA MUTABILIS | SIE20N13E14 | 9 |
| PHACELIA MUTABILIS | SIE20N13E14 | 4 |
| PHACELIA MUTABILIS | SIE20N13E14 | 13 |
| * PINUS CONTORTA | LAS30N08E21 | 2 |
| PINUS CONTORTA | SIE21N12E22 | 1 |
| PINUS CONTORTA | SIE20N13E14 | 3 |
| PINUS CONTORTA | SIE20N13E14 | 1 |
| PINUS CONTORTA | SIE20N13E14 | 1 |
| PINUS JEFFREYI | SIS39N09W17 | 5 |
| PINUS JEFFREYI | CAL06N17E29 | 2 |
| PINUS JEFFREYI | SIE21N12E13 | 1 |
| PINUS LAMBERTIANA | SIE20N13E14 | 1 |
| * PINUS MONTICOLA | SIS39N09W21 | 2 |
| PINUS PONDEROSA | SIS47N10W15 | 2 |
| PINUS PONDEROSA | SIS47N10W13 | 12 |

Table 1 *Frequency of loop sampling hits on plants at each location*[1] –Continued

| Plant | Location | Frequency |
|---|---|---|
| PINUS PONDEROSA | SIS45N12W24 | 1 |
| PINUS PONDEROSA | SIS45N12W24 | 2 |
| PINUS PONDEROSA | SIS45N05E02 | 1 |
| PINUS PONDEROSA | SIS46N05E35 | 2 |
| PINUS PONDEROSA | SIE21N12E22 | 1 |
| POA SP. a | ELD11N16E27 | 1 |
| POA SP. b | CAL07N17E19 | 4 |
| POA SP. b | SIE21N12E13 | 3 |
| POA SP. b | SIE20N13E14 | 2 |
| POA SP. b | SIE20N13E14 | 3 |
| POA SP. b | SIE20N13E14 | 2 |
| POLYGONUM MINIMUM | SIE20N13E14 | 1 |
| POTENTILLA GRACILIS | SIE20N13E14 | 3 |
| PRUNUS EMARGINATA | SIE20N13E14 | 1 |
| *PTERIDIUM AQUILINUM | SIS45N12W24 | 2 |
| RIBES ROEZLII | ELD09N15E12 | 12 |
| RIBES ROEZLII | ELD09N16E06 | 15 |
| RIBES ROEZLII | ELD11N16E27 | 3 |
| RIBES ROEZLII | ELD11N16E27 | 1 |
| RIBES ROEZLII | SIS47N09W30 | 7 |
| RIBES ROEZLII | SIS47N10W15 | 9 |
| RIBES ROEZLII | SIS47N10W13 | 9 |
| RIBES ROEZLII | SIS45N11W17 | 7 |
| RIBES ROEZLII | SIS45N12W24 | 8 |
| RIBES ROEZLII | SIS39N09W21 | 20 |
| RIBES ROEZLII | SIS39N09W17 | 7 |
| RIBES ROEZLII | SIS46N05E35 | 1 |
| RIBES ROEZLII | SIS46N05E35 | 2 |
| RIBES ROEZLII | CAL07N17E19 | 6 |
| RIBES ROEZLII | CAL07N17E18 | 1 |
| RIBES ROEZLII | CAL06N17E29 | 8 |
| RIBES ROEZLII | CAL06N17E29 | 2 |
| RIBES ROEZLII | CAL06N17E29 | 4 |
| RIBES ROEZLII | SIE21N12E14 | 2 |
| RIBES ROEZLII | SIE20N12E13 | 9 |
| RIBES ROEZLII | SIE20N13E14 | 1 |
| RIBES SANGUINEUM | ELD09N15E12 | 1 |
| RIBES SANGUINEUM | ELD09N16E06 | 3 |
| RIBES SANGUINEUM | ELD11N16E27 | 1 |
| RIBES SANGUINEUM | SIS47N10W13 | 2 |
| RIBES SANGUINEUM | SIS45N11W17 | 8 |
| RIBES SANGUINEUM | SIS45N12W24 | 4 |
| RIBES SANGUINEUM | SIS39N09W21 | 6 |
| RIBES SANGUINEUM | SIS46N05E35 | 9 |
| RIBES SANGUINEUM | SIS45N05E02 | 7 |
| RIBES SANGUINEUM | SIS46N05E35 | 1 |
| RIBES SANGUINEUM | LAS30N08E21 | 1 |
| RIBES SANGUINEUM | SIE21N12E34 | 2 |
| RIBES SANGUINEUM | SIE21N12E14 | 5 |
| RIBES SANGUINEUM | SIE21N12E13 | 1 |
| RIBES SANGUINEUM | SIE21N12E22 | 5 |
| RIBES SANGUINEUM | SIE20N13E14 | 2 |
| RIBES SANGUINEUM | SIE20N13E14 | 7 |
| RIBES SANGUINEUM | SIE20N13E14 | 3 |
| RIBES SANGUINEUM | SIE20N13E14 | 14 |
| SAMBUCUS SP. | SIS45N12W24 | 6 |
| STIPA SP. a | SIS47N10W15 | 3 |
| STIPA SP. a | SIS45N11W17 | 21 |
| STIPA SP. a | SIS45N12W24 | 3 |
| STIPA SP. a | SIS39N09W21 | 2 |
| STIPA SP. a | SIS39N09W17 | 1 |
| STIPA SP. a | SIS46N05E35 | 9 |
| STIPA SP. a | SIS45N05E02 | 39 |
| STIPA SP. a | SIS46N05E35 | 19 |
| STIPA SP. a | SIE21N12E13 | 8 |
| STIPA SP. a | SIE21N12E22 | 1 |
| STIPA SP. a | SIE20N13E14 | 3 |
| STIPA SP. b | PLU30N08E21 | 12 |
| STIPA SP. b | LAS30N08E21 | 28 |
| STIPA SP. b | SIE20N13E14 | 2 |
| STIPA SP. b | SIE20N13E14 | 3 |
| SYMPHORICARPOS VACCINOIDES | SIS45N05E02 | 1 |
| SYMPHORICARPOS VACCINOIDES | SIS46N05E35 | 2 |
| VERBASCUM THAPSUS | SIS47N09W30 | 1 |
| VERBASCUM THAPSUS | SIS39N09W21 | 5 |
| VERBASCUM THAPSUS | SIS46N05E35 | 2 |
| UNIDENT. | ELD11N16E27 | 9 |
| UNIDENT. | SIS47N10W15 | 5 |
| UNIDENT. | SIS45N11W17 | 12 |
| UNIDENT. | SIS45N12W24 | 6 |
| UNIDENT. | SIS45N12W24 | 8 |
| UNIDENT. | SIS39N09W21 | 4 |
| UNIDENT. | SIS46N05E35 | 5 |
| UNIDENT. | SIS46N05E35 | 7 |
| UNIDENT. | LAS30N08E21 | 2 |
| UNIDENT. | CAL07N17E19 | 5 |
| UNIDENT. | CAL07N17E18 | 2 |
| UNIDENT. | CAL06N17E29 | 2 |
| UNIDENT. | SIE20N13E14 | 1 |

[1] Location is identified by county, township, and section; county abbreviations are CAL–Calaveras, ELD–Eldorado, LAS–Lassen, PLU–Plumas, SIE–Sierra, and SIS–Siskiyou. Lassen-Plumas county line runs through Swain Mountain Experimental Forest. Red and white fir of all ages are grouped for simplicity, because first-year seedlings are sometimes indistinguishable. * indicates plant is listed by Oosting and Billings (1943, table 9, plant list for virgin forest).

Of the species recorded in sampling of cut and uncut areas, 29 percent were in both, 44 percent were in the cuttings but not in the uncut areas, and 27 percent were in the uncut areas but not in the cuttings. The difference in the number of sampling points between the cuttings (100) and the uncut areas (50) may influence these results to a degree that cannot be determined.

Table 2—*Species recorded exclusively within a single county, and within a single cutting area (*), in sampling of 32 logged areas in red fir type in northern California*

| Species | Sampling hits |
|---|---|
| **Siskiyou Co.** | |
| *Achillea lanulosa* | 9 |
| *Agastache urticifolia* | 5 * |
| *Agropyron* sp. | 16 * |
| *Arenaria macrophylla* | 1 |
| *Ceanothus velutinus* | 28 |
| *Chrysothamnus viscidiflorus* | 4 * |
| *Eriophyllum lanatum* | 11 |
| *Gilia* sp. b | 7 * |
| *Gnaphalium* sp. b | 2 * |
| *Lathyrus* sp. | 30 |
| *Lotus* sp. | 8 * |
| *Penstemon anguineus* | 26 * |
| *Pinus monticola* | 2 * |
| *Pteridium aquilinum* | 2 * |
| *Sambucus* sp. | 6 * |
| *Symphoricarpos vaccinoides* | 3 |
| *Verbascum thapsus* | 8 |
| **Sierra Co.** | |
| *Apocynum pumilum* | 10 * |
| *Arabis platysperma* | 1 * |
| Composite a | 18 |
| *Epilobium* sp. | 2 * |
| *Juncus* sp. a | 1 * |
| *Juncus* sp. b | 4 * |
| *Mimulus* sp. | 6 |
| *Penstemon* sp. | 3 |
| *Pinus lambertiana* | 1 * |
| *Polygonum minimum* | 1 * |
| *Potentilla gracilis* | 3 * |
| *Prunus emarginata* | 1 * |
| **Eldorado Co.** | |
| *Mimulus breweri* | 3 * |
| *Poa* sp. a | 1 * |
| **Calaveras Co.** | |
| *Gnaphalium* sp. a | 3 * |
| *Mimulus layneae* | 2 * |

## General Observations

*Slope and Aspect*—Tabulation of vegetation occurrence according to slope steepness and aspect suggested that our sample sizes, as well as other variables, masked any possible effects of these variables.

*Plant Cover*—Data showed that a high proportion of the surface of the prepared regeneration sites in our sample had become covered with plants in a few years (*table 4*). This finding must be applied with caution, because the loop "... overrates most plants and usually underrates soil surface factors...."[7] Classification of locations as suitable or not for plants is necessarily somewhat subjective, but stumps, cull logs, large rocks, and slash accumulations unquestionably prevent plant establishment. The unsuitability of fine litter (needles and small twigs) in openings as a seedbed for red fir, principally because of heat-killing, has been established.[8,9] Few other plants become established in that soil surface medium, as is shown by the inverse relationship of hits on plants to hits on litter at different cutting areas (*fig. 1*).

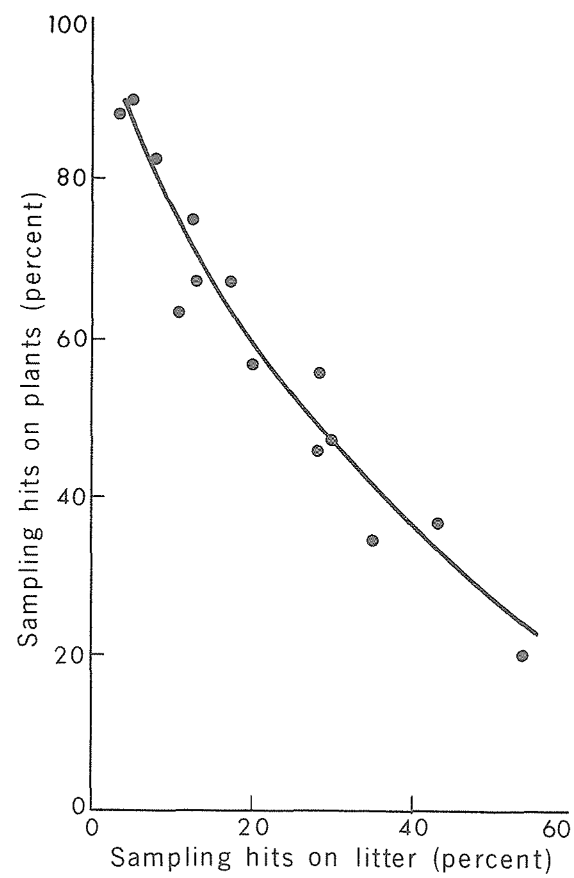


**Figure 1**—Plant establishment in openings tends to be inversely related to the presence of litter. (Curve was hand-fitted through unweighted data from table 4.)

Table 3—*Comparison of vegetation sampled on selected cuttings (C) and adjacent uncut areas (U) in red fir forests, Eldorado and Siskiyou Counties, California*[1]

| Species | Loop sampling hits | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ELD 9N15E12 | | ELD 11N16E27 | | SIS 46N5E35 | | SIS 46N5E35 | | SIS 47N9W30 | | SIS 47N10W15 | | SIS 45N11W17 | | SIS 45N12W24 | | SIS 39N9W21 | |
| | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U |
| *Abies* sp. | 6 | 6 | 4 | 4 | – | – | 0 | 1 | 1 | 10 | 3 | 12 | 0 | 9 | 0 | 5 | 5 | 10 |
| *Achillea lanulosa* | – | – | – | – | – | – | – | – | – | – | – | – | 3 | 3 | – | – | – | – |
| *Agastache urticifolia* | – | – | – | – | – | – | – | – | – | – | – | – | 5 | 0 | – | – | – | – |
| *Agropyron* sp. | – | – | – | – | – | – | – | – | – | – | – | – | 16 | 0 | – | – | – | – |
| *Arctostaphylos nevadensis* | – | – | – | – | – | – | – | – | – | – | 17 | 0 | 0 | 0 | 1 | 0 | – | – |
| *Arenaria macrophylla* | – | – | – | – | 0 | 2 | – | – | 0 | 2 | – | – | – | – | 0 | 4 | 1 | 2 |
| *Calyptridium umbellatum* | 1 | 0 | 1 | 0 | – | – | – | – | – | – | 4 | 4 | – | – | – | – | – | – |
| *Carex* sp. | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 8 | 0 |
| *Castanopsis sempervirens* | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 0 | 2 | – | – |
| *Ceanothus velutinus* | – | – | – | – | – | – | – | – | – | – | 1 | 0 | – | – | – | – | 1 | 0 |
| *Chimaphila umbellata* | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 0 | 7 | – | – |
| *Cirsium* sp. | – | – | – | – | 2 | 0 | – | – | 1 | 0 | – | – | – | – | – | – | – | – |
| *Elymus* sp. | – | – | – | – | – | – | – | – | – | – | 0 | 1 | 5 | 3 | – | – | 2 | 0 |
| *Eriophyllum lanatum* | – | – | – | – | – | – | 0 | 4 | – | – | – | – | – | – | 5 | 0 | – | – |
| *Gayophytum nuttallii* | 5 | 1 | 0 | 3 | 10 | 13 | 13 | 0 | 18 | 1 | 30 | 2 | 10 | 0 | 25 | 1 | 6 | 0 |
| *Gnaphalium* sp. b | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | 0 | – | – |
| *Lathyrus* sp. | – | – | – | – | 0 | 2 | 20 | 14 | – | – | – | – | 0 | 2 | 8 | 13 | – | – |
| *Lathyrus nevadensis* | – | – | – | – | – | – | 0 | 1 | – | – | – | – | – | – | 0 | 2 | 0 | 1 |
| *Linanthus* sp. | – | – | – | – | – | – | 4 | 0 | – | – | – | – | – | – | – | – | – | – |
| *Lotus* sp. | – | – | – | – | – | – | – | – | – | – | 8 | 0 | – | – | – | – | – | – |
| *Lupinus* sp. a | 6 | 4 | – | – | – | | – | – | – | – | – | – | 0 | 1 | – | – | – | – |
| *Monardella odoratissima* | – | – | – | – | 0 | 2 | 2 | 10 | – | – | – | – | – | – | – | – | – | – |
| *Myosotis virginica* | – | – | – | – | 1 | 0 | 0 | 1 | – | – | – | – | – | – | – | – | – | – |
| *Osmorhiza* sp. | – | – | – | – | 0 | 3 | – | – | – | – | – | – | 0 | 1 | 0 | 1 | – | – |
| *Penstemon anguineus* | – | – | – | – | – | – | – | – | 26 | 2 | – | – | – | – | – | – | – | – |
| *Phacelia mutabilis* | 10 | 1 | 1 | 0 | 40 | 4 | 5 | 0 | 8 | 0 | – | – | 5 | 1 | 19 | 0 | 2 | 0 |
| *Pinus jeffreyi* | – | – | – | – | – | – | 2 | 0 | – | – | 2 | 0 | – | – | 1 | 0 | – | – |
| *Pinus monticola* | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | 0 |
| *Pteridium aquilinum* | – | – | – | – | – | – | – | – | – | – | 0 | 6 | – | – | 2 | 0 | 0 | 1 |
| *Ribes roezli* | – | – | 1 | 0 | 1 | 0 | 2 | 0 | 7 | 0 | 9 | 0 | 7 | 2 | 8 | 0 | 20 | 0 |
| *Ribes sanguineum* | 1 | 0 | 1 | 0 | 9 | 0 | 1 | 0 | – | – | – | – | 8 | 5 | 4 | 0 | 6 | 0 |
| *Sambucus* sp. | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 6 | 0 | – | – |
| *Stellaria jamesiana* | – | – | – | – | 0 | 4 | – | – | – | – | – | – | 0 | 1 | – | – | 0 | 3 |
| *Stipa* sp. a | – | – | – | – | 9 | 1 | 19 | 4 | 0 | 3 | 3 | 0 | 22 | 4 | 3 | 1 | 2 | 3 |
| *Symphoricarpos vaccinoides* | – | – | – | – | 0 | 4 | 2 | 2 | – | – | – | – | – | – | 0 | 1 | – | – |
| *Verbascum thapsus* | – | – | – | – | 2 | 0 | – | – | 1 | 0 | – | – | – | – | – | – | 5 | 0 |
| Unidentified | – | – | – | – | 5 | 0 | 7 | 4 | – | – | 5 | 2 | 12 | 0 | 6 | 2 | 4 | 0 |
| Total | 29 | 12 | 8 | 7 | 83 | 35 | 73 | 41 | 62 | 18 | 82 | 27 | 93 | 36 | 90 | 39 | 64 | 20 |

[1] Location is identified by county, township, and section; more than one cutting was sampled at some locations. Dash indicates that the species was not recorded on either cut or uncut area.

Table 4—*Relation of site preparation method to proportion of suitable and unsuitable locations for plant establishment found in sampling of red fir cuttings in northern California, 1972*

| Site preparation method[1] and year | Total sample (number of hits) | Suitable locations | | | Unsuitable locations | | |
|---|---|---|---|---|---|---|---|
| | | Plants | Bare soil and pebbles | Stumps and cull logs | Large rocks | Litter | Slash |
| | | *Percent* | | | | | |
| Burned: | | | | | | | |
| 1964 | 103 | 63 | 22 | 0 | 3 | 11 | 1 |
| Piled: | | | | | | | |
| 1959 | 418 | 67 | 12 | 4 | 0 | 13 | 3 |
| 1967 | 112 | 46 | 8 | 4 | 7 | 28 | 8 |
| 1968 | 107 | 34 | 15 | 6 | 1 | 35 | 10 |
| Piled and burned: | | | | | | | |
| 1958 | 312 | 55 | 9 | 4 | 0 | 29 | 3 |
| 1961 | 104 | 88 | 5 | 3 | 1 | 3 | 0 |
| 1963 | 102 | 90 | 4 | 2 | 0 | 5 | 0 |
| 1964 | 319 | 75 | 7 | 2 | 4 | 12 | 1 |
| 1965 | 314 | 37 | 14 | 4 | 0 | 43 | 2 |
| 1966 | 316 | 67 | 9 | 3 | 2 | 17 | 2 |
| 1967 | 430 | 56 | 15 | 3 | 4 | 19 | 3 |
| 1969 | 206 | 82 | 7 | 1 | 1 | 8 | 0 |
| 1970 | 210 | 47 | 15 | 3 | 1 | 29 | 4 |
| 1971 | 304 | 20 | 18 | 1 | 0 | 54 | 7 |

[1] Burned = surface broadcast burned; Piled = surface cleared to mineral soil, slash piled; Piled and burned = surface cleared, slash piled, slash piles burned.

Tabulation of plant species and frequency according to different site preparation methods and years showed only that there were greater differences within similarly prepared sites than between them.

The loop sampling gave some general indications of the probable erosion potential on the cuttings studied. On the areas we sampled, in those most recently prepared, 52 percent of the suitable locations were occupied by plants by the end of the first growing season. In all other cuttings, 69 percent or more of the suitable spots were occupied by plants, and in slightly more than half of the cuttings this value was 85 percent. The nature and spatial arrangement of stumps, cull logs, large rocks, slash, and litter also retard erosion, as does the form, depth, and arrangement of windrows or other piles consisting of slash, litter, removed vegetation, and soil. Using all data of *table 4* as a rough average of conditions, we find that 88 percent of hits fell on nonerosive locations.

Our study did not pick up direct information on whether red fir seedlings were adversely affected by other vegetation. We can only infer that the high frequency of plants found in the study would reduce available soil moisture during the normal summer-dry period. This effect could reduce the number of specific points at which fir seedlings might become established or grow rapidly.

Time since site preparation for regeneration was found to influence plant presence abruptly. On the three cutting areas which had been through only one complete growing season, an average of half the sample locations suitable for plants were already occupied. All other areas with longer histories had 69 percent or more of the suitable locations occupied. This development, together with increasing plant mass, could affect in one way or another the establishment of conifer seedlings, potential for soil erosion, and the sustenance of wild and domestic animals.

Effects of elevation on species sampled could not be evaluated, and the data indicated that there were more differences than similarities in species from area to area.

## NOTES

[1] Oosting, H. J., and W. D. Billings. 1943. *The red fir forest of the Sierra Nevada: Abietum magnificae.* Ecol. Monogr. 13(3): 260-274. (See table 9.)

[2] U.S. Department of Agriculture, Forest Service. 1969. *Range environmental analysis handbook.* USDA Forest Serv., Calif. Region, Forest Serv. Handb. 2209.21 (pagination irregular).

[3] Parker, Kenneth W. 1951. *A method for measuring trend in range condition on national forest ranges.* USDA Forest Serv., Washington, D.C. 26 p.

[4] Munz, Philip A., and David D. Keck. 1959. *A California flora.* 1681 p. Univ. Calif. Press, Berkeley and Los Angeles.

[5] Little, Elbert L. 1953. *Check list of native and naturalized trees of the United States (including Alaska).* U.S. Dep. Agric., Agric. Handb. 41, 472 p. U.S. Gov. Print. Office, Washington, D.C.

[6] Kilgore, Bruce M. 1971. *The role of fire in managing red fir forests.* 412 p. North Am. Wildl. and Nat. Resour. Conf., 36th, Portland, Oreg. 1971.

[7] Francis, Richard E., Richard S. Driscoll, and Jack N. Reppert. 1972. *Loop frequency as related to plant cover, herbage production, and plant density.* USDA Forest Serv. Res. Paper RM-94, 8 p. Rocky Mountain Forest and Range Exp. Stn., Fort Collins, Colo.

[8] Baker, Frederick S. 1929. *Effect of excessively high temperatures on coniferous reproduction.* J. For. 27(8): 949-965.

[9] Gordon, Donald T. 1970. *Natural regeneration of white and red fir . . . influence of several factors.* USDA Forest Serv. Res. Paper PSW-58, 32 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

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