Vegetation in Group Selection Openings: Ecology and Manipulation[1]

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Abstract: Group selection openings ranging from 0.1 to 2.0 acres in mixed conifer stands in northern and central California were evaluated for effect of site preparation, opening size, kind and amount of vegetation, and release treatment. Small openings, in general, are characterized by less sunlight and lower temperature extremes than clearcuttings. Roots from border trees extend into openings and apparently capture a large amount of site resources. Site preparation is needed for establishment of natural conifer regeneration, but seldom for establishment of planted seedlings. Survival of conifer seedlings tends to be high in small openings, but growth is much reduced, especially near opening edges. Vegetation other than conifers almost always is present but in most instances has low vigor. Release probably will be necessary in that part of openings which receives enough light for vigorous development of sun-loving shrubs and where roots from border trees are not present.

INTRODUCTION

Group selection cutting involves the removal of trees in small areas that range from a fraction of an acre to one or two acres in size. Several of these areas, scattered throughout a forest, usually are harvested together on a cyclic basis, with the cycle being 10 to 15 years. There is no rotation, just a cutting cycle. The group selection system often is perceived as being "gentle", and hence applied where the landowner desires to harvest some trees periodically with only minor impact from logging and stand tending, and only a brief interruption in the the natural processes of soil building and ecosystem development. Smith (1962) noted that "The group selection method is more readily adapted to a wide variety of conditions than any other because the ecological requirements of most species can be met within its framework."

Over 15 years ago, Phares (1978) recognized the need to develop basic principles for uneven-aged silviculture in forest regions of the western United States. Since then, virtually no new studies have been installed and little progress toward developing these principles has evolved. Knowledge of the environment within small openings is sketchy, material on the survival and growth of natural and planted conifer seedlings in small openings is hard to find, and information on the kind, amount, and growth of hardwoods, shrubs, forbs, and grasses is lacking. Basic questions on the need for, and effect of, such operational techniques as site preparation and release remain unanswered.

This paper brings together what is known on group selection in a mixed conifer forest in northern and central California. The information presented is restricted to sites of moderate quality, and to a time frame beginning with

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site preparation and extending through age 15. A few references from other areas are cited to present a point or substantiate an action. Information on the operational environment of small openings, the kind and amount of vegetation that becomes established, its growth potential, and the need for manipulating it are presented. Because little "hard" information is available, the facts in this paper are few and the inferences are many. "Food-for-thought" is the most important ingredient of the paper.

OPERATIONAL ENVIRONMENT

The mixed conifer forest in northern and central California characteristically is made up of three to five conifer species and occasionally may contain up to three hardwood species. The shade tolerance of these species ranges from intolerant ponderosa pine (Pinus ponderosa Dougl. ex Laws. var. ponderosa) and California black oak (Quercus kelloggii Newb.) through moderately tolerant sugar pine (P. lambertiana Dougl.) and Pacific madrone (Arbutus menziesii Pursh) to tolerant incense-cedar (Libocedrus decurrens Torr.), white fir (Abies concolor var. lowiana [Gord.] Lemm.), Douglas-fir (Pseudotsuga menziesii [Mirb.] Franco), and tanoak (Lithocarpus densiflorus [Hook. & Arn.] Rehd.). Although nearly everyone agrees that group selection takes place in small openings, the upper acreage limit of such openings is not well defined. Consensus among silviculturists, however, seems to be that circular openings greater than one acre have an environment closer to that of clearcutting than to selection cutting. Irregular or elongate openings of up to two acres apparently can have an environment which approximates that of selection cutting. Usually all trees are removed in a group selection opening, including those too small to be merchantable. Most often, the openings are bordered by dense forest, occasionally by partially cut stands where single trees have been removed on a tree selection basis. Difficulties inherent in the group selection system include the large amount of time and skill needed to develop the desired stand structure, inadquate slash disposal, inappropriateness of broadcast burning in openings, and the lack of a schedule or methodology for prompt enlargement of openings.

Site Preparation

After the openings have been designated and the merchantable timber harvested, some slash and unwanted vegetation remain. "Some slash disposal will be needed after most partial cuts in western conifers. To minimize damage to residual trees, slash disposal should generally be confined to concentrations, and should generally be done by hand rather than machine. In many cases it will be preferable to lop and scatter rather than burn. However, some hand piling and burning may be desirable in small openings" (Marquis 1978). Hardwood species were particularly vexing when group selection was practiced in the southern pine region of the United States (Wenger and Trousdell 1957).

In California, most slash is from trees much taller than the openings are wide, and this slash generally is lopped and scattered outside of the openings. Undesirable material in the openings has had a variety of treatments over the years. Early trials in small openings on the Eldorado National Forest (Miller, pers. comm.) depended on naturally seeded conifers for reproduction and had no site preparation. After 6 years, only a few incense-cedar and white fir seedlings, along with a few forbs and grasses, were present. The most abundant and tallest species was deerbrush (Ceanothus integerrimus H. & A.), which emerged from long-dormant seeds in the soil, and dominated the openings after 6 years.

Early group selection trials on the Plumas National Forest (Potter, pers. comm.) were quite small (less than one acre) and without site preparation. Stocking by naturally-regenerated conifers was described as adequate, particularly with tolerant species like sugar pine and white fir. In one area, stocking with ponderosa pine was good. On the Shasta-Trinity National Forests (Thornton, pers. comm.), early group selection openings were planted to Douglas-fir seedlings in the areas scarified by logging. No site preparation was performed. Non-scarified areas were scalped before planting. After several years, survival of planted seedlings was described as good and growth as slow.

Early trials on the Sequoia National Forest employed pile and burn site prepartation and planting of Jeffrey pine (Pinus jeffreyi Grev. & Balf.) (Fullmer, pers. comm.). In another trial on the Mountain Home State Forest, all openings were scarified with a brushrake-equipped bulldozer and care taken to concentrate slash and unmerchantable material in the openings, where it subsequently was burned (Stahl, pers. comm.). In trials on the Boggs Mountain State Forest and the Challenge Experimental Forest, site preparation was deemed necessary to dispose of slash and reduce competing vegetation. Larger openings, of about an acre, also were scarified on the Plumas National Forest, using a brushrake or straight blade. Both were effective when coupled with a skilled operator.

Site preparation on the Blodgett Experimental Forest consisted of scarifying entire openings or scarifying only where concentrations of slash needed to be piled. After 10 years, considerably less woody and herbaceous vegetation and fewer conifer seedlings were present in openings where scarification was limited (Heald, pers comm.)

Temperature, Light, Moisture

Small prepared openings in the mixed conifer forest in northern and central California share several environmental characteristics. Other than for occasional sunflecks, the sun shines in the openings only when directly overhead. Trees on the border cast shade, ameliorate temperatures, and lessen the amount of wind in the openings. Warm temperatures, in general, do not get as high and cold temperatures do not get as low as in less sheltered environments. Peak summer temperatures may be reduced by as much as 10 ^{o}F and winter extremes by an equal amount (Geiger 1966). Snow may accumulate in group selection openings and because of the shade, remain longer than in the uncut forest. Relative humidity tends to be higher in small openings, and the moisture content of the surface soil may remain higher later into the summer. Because of cold air ponding in the openings, late spring frosts can be a danger.

Tree Roots

Another key factor in the operational environment of small openings is roots of surrounding trees that extend into the openings. The underground extent of tree roots is not well known because it varies with a host of soil conditions and inherent rooting patterns of individual species. A generalization is that tree root systems are at least as wide as the crowns, and usually wider if soils are shallow. Rooting depth also is variable, again depending on soil characteristics and individual species' rooting capabilities. On a typical forest site with deep soil and full stocking, a safe assumption is that tree roots fully occupy the vertical soil profile and even overlap horizontally in places. On a good site in northern California, Ziemer (1968) measured soil moisture around an isolated 28-inch diameter sugar pine, and found that "soil moisture depletion extended outward to a distance of slightly over 20 feet from the base of the tree and somewhat deeper than 15 feet under the tree." Presumably, this zone of depletion was caused by moisture-absorbing tree roots.

After logging and the creation of openings, existing roots of border trees, already present in the openings, expand rapidly and capture site resources. At a high-elevation site in northern California, for example, Ziemer (1964) studied soil moisture depletion and found that roots of bordering trees extended about 10 feet into newly logged openings and about 30 feet into 5-year-old openings. Roots extended no farther than 30 feet in 10-year-old openings, but soil moisture depletion was higher, apparently because of moisture use by new conifers and shrubs in the openings. After 16 years, soil moisture depletion in the openings was similar to that in uncut stands, supporting the assumption that the openings were fully occupied by roots.

Animals and Diseases

Other factors in the operational environment of small openings include animals and diseases. In Great Britain, group selection was encouraged in one study "to encourage a stable ecological balance with a very varied flora and fauna, possibly even achieving a considerable biological pest and disease control" (Hutt 1974). Because group selection cutting introduces at least a modicum of variability into the forest, it "provides the diversity of habitat needed by many game and non-game animals and birds" (Williston 1978). Group selection also provides the specialized habitats needed by some animals. In Arizona for example, the Abert squirrel needs groups of trees with interlocking crowns for nesting, and trees of various sizes for food. Quality habitat "can be assured if ponderosa pine is regenerated by the group selection method" (Patton 1977). In California, areas cut to group selection criteria resemble those of the uncut forest, at least through the early cutting cycles, and the animals and birds generally are those of the uncut forest. However, two species of woodrats (*Neotoma cinerea* and *Neotoma fuscipes*) seem to prefer group selection cutting and build nests near the openings and feed on conifer seedlings in them. Deer pellets have been observed to be more numerous in group selection openings than in the bordering forest, and damage to conifer seedlings from deer has been observed.

One disease that seems to prosper in group selection openings is western gall rust (*Peridermium harknessii*). Perhaps the higher humidity leads to a higher rate of infection on conifer seedlings. Another disease that is dangerous to conifer seedlings in group selection openings is dwarf mistletoe (*Arceuthobium* spp.).

VEGETATION

Species Composition

The shady environment of group selection openings smaller than one acre generally limits the establishment of sun-loving species. Nevertheless, some of these species attempt to become established, both from windblown seeds and from dormant seeds in the soil. A botanic survey of selection openings that ranged from one-fourth to one and three-fourths acres at Boggs Mountain State Forest in northern California where the site had been prepared by a bulldozer, showed 62 species in 30 families present after 2 years. Included were 44 species of forbs, 8 grasses, 4 shrubs, 3 conifers, 2 hardwoods, and 1 fern.[3] Many species were annuals typical of early seral stages; others were perennials from severed roots, root crowns, or seeds buried in the soil. On a high site at the Challenge Experimental Forest in northern California, with small openings 30, 60, and 90 feet in diameter also scarified by a bulldozer, a survey indicated relatively few plant species, moderate overall plant density, and little development 14 growing seasons after site preparation. Only 16 to 24% of all species were annuals or biennials. Most forbs were represented by scattered individuals, but a few well-adapted species like western star flower (*Trientalis latifolia* Hook.) and wild strawberry (*Frageria californica* Cham. & Schlecht.) had high densities. In both studies, a few more species were present near the centers of openings or in openings with a south aspect.

On the Shasta-Trinity National Forests, sausage-shaped openings with the longest axis on the contour were created on a steep hillside (60% slope) facing a highway (Thornton, pers. comm.). Preserving a "natural" view and removing some timber were best accomplished by group selection and the unusual shape and orientation of the openings. Tall trees in front of each opening kept the openings from being seen by travelers on the highway below. Grasses were commonplace in older logged compartments nearby but absent in the recently cable-logged, group selection area. However, soon after conifers were planted in the group openings, grasses invaded and formed a dense cover. Naturally-seeded conifer seedlings, and shrubs and forbs from buried and blown-in seeds, were surprisingly absent in the openings. Interference by grass was the likely reason.

Development

Slow growth rates are typical of vegetative development in shady environments where roots of established vegetation nearby are capturing most available resources. After 14 years, height growth of normally rapid-growing intolerant shrubs in small openings on the Challenge Experimental Forest was less than one inch per year. Such a rate is indicative of the harshness of the group selection environment for development of reproduction. Not only is height reduced but so is cover. Many shrubs produce only one or two slender stems in shady openings but in clearcuttings nearby produce clumps of eight to twelve stems and much more cover[3].

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[3]Data on file at Pacific Southwest Research Station, Redding, CA.

Size of opening influences vegetative development in direct proportion to amount of sunlight. Development in small openings, consequently, is equally slow throughout. In medium-sized openings, growth of many species, especially the sun-loving shrubs, is greater near the center and in that portion of the opening most exposed to the sun. In openings of an acre or more, growth is best where roots of border trees are absent and where sunlight is greatest.

CONIFER SEEDLINGS

Species Composition

Most of the tree species in the mixed conifer forest have large and frequent seed crops (McDonald in press), and seeds tend to saturate the openings. If the openings have little or no site preparation, they often are covered with a deep layer of organic material. This layer not only is a physical impediment to tiny downward-penetrating roots of newly emerged seedlings, but also harbors damping-off fungi that attack them. Seedlings die by the thousands. In this environment, only a few seedlings from shade-tolerant conifer species become established. Hardwood seedlings, especially of tolerant tanoak, are favored because the energy-rich acorn allows a relatively large taproot to push rapidly through the organic material and into the soil.

In openings where site preparation has created bare mineral soil, the shower of seeds creates adequate and usually excessive stocking of conifer seedlings (McDonald 1966). Not only is the "catch" of seedlings from one seed crop excessive, but additional seedlings become established from each successive crop to the point that the openings become choked with conifer seedlings. After 14 years, conifer seedlings in the small openings on the Challenge Experimental Forest numbered over 7,500 per acre.[3] The species that has the most members near the opening or that produces the most seed is the species that has the greatest seedling density, because all conifer species find the moderate environment of the small, site-prepared openings conducive to germination and early seedling growth.

Development

Excessive seedling density typical of small openings with site preparation and natural regeneration adds to the already inhospitable environment for development of conifer seedlings. The species that has the most seedlings shortly after a given seed crop may not be the species whose seedlings grow best--capability to tolerate shade and low levels of available resources are the primary factors regulating seedling survival. On the Challenge Experimental Forest, for example, the majority of seed trees are ponderosa pine. Ponderosa pine constitutes 90 percent of the sound seed produced by all conifer species (McDonald in press), and over twice as many seedlings as all other conifer species combined (McDonald 1966). From 1965 through 1974, mortality of 9-year-old pine seedlings in group selection openings was 56 percent (McDonald 1976). Growth of five species of conifer seedlings tended to be very slow, with seedlings of white fir (average height 2.6 feet) outdistancing those of ponderosa pine (1.4 feet) after 14 years.

Survival of conifer seedlings planted in group openings tends to be adequate, but growth tends to be slow overall but best where sunlight is greatest and interference from bordering tree roots is least. At Mountain Home State Forest, planted giant sequoia (Sequoiadendron giganteum [Lindl.] Buchholz) seedlings grew well in group selection openings, ponderosa pine height (not diameter) was "good" on south aspects, and that of sugar pine was slightly better on north aspects than on south (Stahl, pers. comm.). Both pine species tended to have a tall, thin form. Natural conifer seedlings in the planted openings also were abundant, and a need for precommercial thinning was noted. Potter (pers. comm.) reported results from a direct seeding trial with ponderosa pine on the Plumas National Forest. The seed was disseminated in fall and poison bait applied in spring and fall for control of pocket gophers and deermice. Good early stocking and growth were achieved.

On the Sequoia National Forest, Fullmer (pers. comm.) reported on planted ponderosa pine seedlings in 78 stands cut to group selection standards each year from 1977 to 1984, and remeasured in 1989. Annual height growth of 13-year-old seedlings averaged 0.4 feet per year. Pine seedlings transplanted into dead spots showed about the same growth rate.

On the Blodgett Experimental Forest, Heald (pers. comm.) noted that larger (2-0) seedlings of white fir and Douglas-fir grew well in openings larger than one acre, and better than natural seedlings. Planted and natural seedlings of ponderosa pine grew at about the same rate. A general finding was that after 10 years, conifer seedlings in openings larger than 1 acre grew within the range of that expected from even-aged management, given similar conditions. Of course, "edge" seedlings were excluded from this general finding.

RELEASE

When group selection is applied in the southern pine region, a suggested practice is that "the cutover area should be treated a year or two after each cut to release pine reproduction in the new openings" (Wenger and Trousdell 1957). No such guideline for western conifers is known.

In California, past treatments to release conifer seedlings from undesirable vegetation seemed to be applied if the vegetation was normally aggressive woody shrubs, chiefly Arctostaphylos and Ceanothus species. Whether the much-reduced growth rate of these species in shady openings was considered is unknown. Herbicides and mechanical and manual release methods were utilized. On the Plumas National Forest, 2,4,5-T[4] from a backpack container was used to control woody shrubs in both large and small openings; at Mountain Home State Forest, Roundup was applied as soon as most shrub seeds had germinated (age 2). On the Sequoia National Forest an ingenious mechanical method was used to control woody shrubs in the many small openings present there. The machine was a small tractor with a combination brushrake-bar attached. The bar operates beneath the soil surface and cuts off young shrubs beneath the root crown (Fullmer, pers. comm.). On the Shasta-Trinity National Forests, the dense grass population was manually grubbed after two growing seasons.

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[4]This paper neither recommends the pesticide uses reported nor implies that the pesticides have been registered by the appropriate governmental agencies.

DISCUSSION AND RECOMMENDATIONS

A basic tenet of the group selection method is that a given area has a certain productive capacity. If relatively large trees of the desired species use most of this capacity to produce merchantable board feet or cubic feet, so much the better. Seedling growth is negatively affected. But seedling growth is not needed to contribute to productivity at this time. The seedlings form a recruitment pool of small trees that use only minimal site resources. It is important that they continue to use low amounts of site resources until the trees suppressing them are removed. Ideally, they will then be in a position to respond well when release occurs. Consequently, the growth potential of a site is concentrated most on trees that will be cut the soonest (large trees) and least on trees that will be cut the latest (the seedlings).

The group selection method tends to favor species that tolerate shade. Many early seral species are present the first few years after cutting, but soon disappear. The plant community shifts toward mostly woody, perennial species. Most are not abundant or well developed, although tanoak can be both, and wild strawberry, western starflower, and some grasses often become very abundant. For conifer seedlings in small openings, the shift is to the more tolerant species--a major effect of this cutting method noted on the Challenge Experimental Forest and by Jones (1971) for a mixed conifer forest in eastern Arizona. For conifer seedlings in larger openings, the shift may or may not occur.

If the shift to shade-tolerant species is to be countered, guidelines need to be worked out for such factors as size of opening, orientation of opening, cutting pattern, and density of adjacent forest. Larger openings, elongate openings with longest axis oriented toward the south, a cutting pattern that places subsequent openings to the south of existing openings, and a thinned forest in which openings are installed are possible means for enhancing the group selection environment for intolerant conifer species. Matching expected size of seed crop to degree of site preparation (if any) is one way of regulating conifer seedling density. Here too, much work and guidelines are needed.

Although sketchy, some trends and recommendations can be drawn from the foregoing material in this paper:

o Survival of naturally-seeded conifer seedlings in small group openings, without site preparation, generally is poor; survival of planted seedlings is good.

o Growth of all vegetation, including conifer seedlings, woody shrubs, and hardwoods in small group openings is slow relative to that in sunlit areas free of roots from large trees.

o Growth of nearly all vegetative species is better near the center of small openings, on south exposures, or where the adjacent forest has been thinned.

o No site preparation and a deep layer of organic material favors establishment of hardwood species that produce acorns, not naturally-seeded conifer species.

o Site preparation favors naturally-seeded conifer species, but the number of seedlings tends to be excessive. All seed crops contribute to seedling stocking, and high conifer seedling density negatively affects growth.

o Site preparation may or may not be needed. At least some bare area results from logging, and scalping can create more area free of duff and litter. Additional bare area from site preparation often results in too many natural seedlings and other aggressive species. Any excessive and undesired vegetation that does develop can be reduced to desired levels by applying release techniques.

o Need for release of conifer seedlings depends on type and vigor of undesirable vegetation, which in turn relates to amount of light and freedom from below-ground competition. In general, if aggressive shrubs or hardwoods are present, seedlings should be released at an early age with the best available technique. In shadier openings, release, particularly of sun-loving species, may not be needed because their rate of development is slow.

o Group selection can be used to regenerate California forests for the types and conditions noted in this report. Adequate numbers of conifer seedlings usually become established, and at least until more information is developed, appear to grow as well as competing species, given current site preparation and release treatments. And at least in larger openings, conifer seedlings also may grow as well as in other cutting methods.

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