An Uneven-Aged Management Strategy: Lessons Learned[1]

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Abstract

Use of an ecosystem approach at a landscape scale to program and guide accomplishments of multi-resource and social objectives has been discussed between researchers and natural resource managers for many years. Presently, great interest exists in the applicability of uneven-aged management practices for such an approach in conifer forests of the Sierra Nevada of California. The Kings River Sustainable Forest Ecosystems Project involves an administrative study by the Sierra National Forest and the Pacific Southwest Research Station that is providing an opportunity to implement and study uneven-aged management over a large landscape. The study was designed in part to answer questions about the effects and costs of implementing the group-selection form of uneven-aged management. With the implementation of several projects, some of these questions are beginning to be answered. We document some of the lessons learned, while implementing small group selections and thinning between those groups.

The Sierra National Forest Land and Resource Management Plan (LRMP) (USDA 1991), like most National Forest Plans, was based on three approaches: zoning to allocate land among competing resource objectives, primarily even-aged management, and a philosophy that the analysis and management of specific local sites would result in healthy ecosystems at a landscape scale. Since these plans were developed, some dramatic changes have occurred that eventually resulted in the current study (Verner and Smith, this volume).

Ronald E. Stewart, Regional Forester of the USDA Forest Service's Pacific Southwest Region (Region 5) from 1992 to 1994, addressed a challenge to even-aged management, especially clearcutting, by designating a committee to investigate uneven-aged group selection in the context of an ecosystem approach that would assure "continuous forest cover" and mimic the effects of small-scale, historical fires. In June 1992, Jack Ward Thomas, then Chief of the Forest Service, directed all National Forests to begin implementing ecosystem management at extensive landscape scales. Finally, in 1993 the LRMPs for all National Forests in the Sierra Nevada were amended to respond to new information about California spotted owls (*Strix occidentalis occidentalis*) (Verner and others 1992). Included in this direction was a provision for administrative studies designed to evaluate the effects of different forest management systems on owl habitat (USDA 1993).

One response to the direction for administrative studies is the 64,000-acre study area for the Kings River Sustainable Forest Ecosystems Project (*fig. 1*), located on the Kings River Ranger District of the Sierra National Forest, in the eastern portion of Fresno County, California. Vegetation types within the study area can be grouped into five categories: Chaparral, Ponderosa Pine (*Pinus ponderosa*), Mixed Conifer, Red Fir (*Abies magnifica*), and Jeffrey Pine

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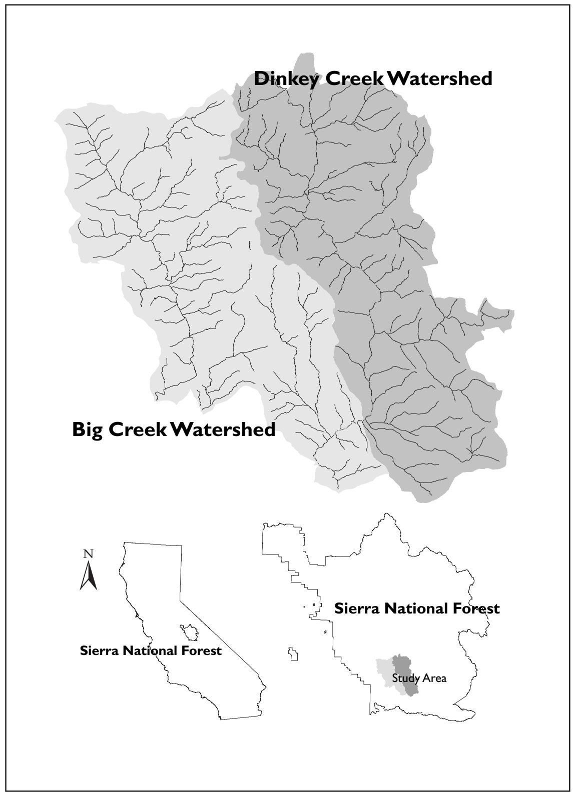

Figure 1—The Kings River administrative study area in the Sierra National Forest in central California includes the 64,000-acre Big Creek and Dinkey Creek watersheds (indicated by shading).

(*Pinus jeffreyi*) (USDA 1994). Elevations range from about 2,400 to 8,100 ft. Two large-scale projects—the 10S18 Fuels Reduction Project (10S18 FRP) and the Indian Rock Upper Tier Project (IROC)—have been implemented within the study area and are in different stages of completion. A third project—the Bear Meadow Basin Project—is still in the planning stage. The three projects cover approximately 8,000 acres of the 64,000-acre study area and fall within the Ponderosa Pine and Mixed-Conifer vegetation types. In this paper, we discuss lessons learned through the implementing of uneven-aged management in these projects.

Approach

"The term, selection system, is applied to any silvicultural program aimed at the creation or maintenance of uneven-aged stands . . . [and]. . . there is not, in the strictest sense of the term, any such thing as an uneven-aged stand. Even when a single large tree dies it is replaced, not by one new tree, but by many that appear nearly simultaneously. This is true even if the new trees are from advanced regeneration. The uneven-aged stand is an artificial entity required for the comprehension of what might otherwise be a chaos of little stands" (Smith 1962, p. 467).

One objective of the study is to develop quickly a forest of uneven-aged groups so that the effects on wildlife and the risk of large-scale wildfires become evident as soon as possible. We therefore decided to use not only the periodic creation and reforestation of small groups but also an initial thinning of the existing matrix of trees to develop an uneven-aged structure and preferred species composition. Our approach for locating reforestation groups and for thinning in the matrix led to our first lesson learned: the forest can be transformed into one with a substantially uneven-aged group structure in a few decades.

Using the J-Curve to Regulate the Stand

When the objective is to have a balanced or regulated, uneven-aged stand, a histogram depicting the diameter distribution of trees in the stand (trees per acre vs. diameter class) approximates a smooth, inverse, J-shaped curve (*fig. 2*) (Alexander and Edminster 1978). It has three key parameters: first is slope, which results from the diminution quotient (Dq—a value that, when divided into the number of trees in one size class, gives the number of trees expected in the next smaller size class); second is the largest size a tree is allowed to grow before being harvested; and third is the stocking level (basal area of trees per acre), represented by the area under the curve.

The numbers of saplings and poles needed to provide adequate growth into the large-tree classes is usually a significant influence on the beginning point of the J-curve (number of trees per acre in the smallest diameter class) and its Dq. In this study, however, two contradictory objectives influenced the beginning point. Silviculturists desired to have sufficient numbers of small trees to assure growth into the larger diameter-classes, but fuels specialists wished to minimize the contribution of seedlings, saplings, and poles to fuel ladders leading into the upper tree canopy. Analysis and discussion lead to the compromise values for reforestation groups shown in *table 1.*

We did not expect a typical acre to be fully stocked with conifers, estimating instead that 80 percent would be occupied by conifers, 10 percent by large oaks, and 10 percent by rock patches and other openings. Thus, the stocking of conifers

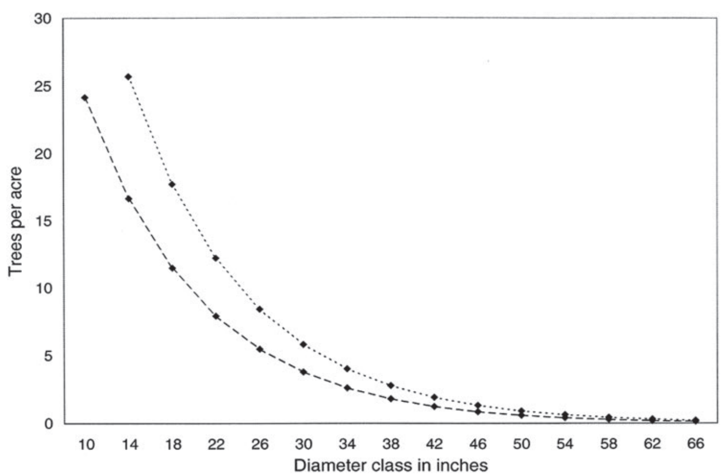

Figure 2—A typical inverse J-shaped curve; closed circles designate a moderately dense forest; closed squares designate a very dense forest.

Table 1—*Compromise numbers of seedlings and poles to be provided for adequate ingrowth into large-tree classes, based on competing silvicultural needs and desired fuel ladders*

Forest type	Site quality	Planting spacing	Resulting seedlings per acre	Estimated percent mortality	First-thin spacing	Resulting poles per acre
Ponderosa pine	Good[1]	9 x 18 ft	270	20	18 x 18 ft	135
Mixed-conifer	Good[1]	8 x 16 ft	340	20	16 x 16 ft	170

[1] Forest Survey Site Class 3.

in the smaller diameter classes (1 to 16 inches) of the J-curve should be about 110 trees per acre in ponderosa pine stands and 135 in mixed-conifer stands.

Different Dq's for a J-curve comprised of 2-inch diameter classes were tried and discarded until we identified the one that satisfied the desired number of saplings and poles. For ease of use in the field, equivalent curves were then developed by using 4- or 8-inch diameter classes.

Our approach to determining the largest size a tree would be allowed to grow before harvest was driven by a desire to maintain the presence of very large trees in the stand. Initially, we estimated the diameter at breast height (dbh) in inches, expected in 200 years, based on professional judgment and data from yield tables (Dunning and Reineke 1933, Meyers 1938). Subsequent modeling with the uneven-aged routine in the Forest Vegetation Simulator (USDA 1996) resulted in the following diameters at 200 years of age:

	Good site[1]	**Poor site**[1]	**Average site**[1]
Thin at 50 years, then every 20	58 inches	49 inches	54 inches
No thinning	39 inches	33 inches	36 inches

[1] Forest Survey Site Classes 3, 5, and 4, respectively.

Substantial public interest in assuring continuous presence of very large trees throughout the forest matrix, for wildlife and aesthetic values, led to consideration of other approaches. Analysis and discussion resulted in the study team's recommending an approach, initially suggested by the Yosemite Area Audubon Chapter, that allows the J-curve to tail off to a point that it represents only a few hundredths of a tree per acre. Summing the parts of trees in the largest diameter classes (>50 inches) suggests a total of about one such tree per acre. Thus, the practical approach to field implementation would be to leave in clumps the largest trees (those >50 inches in dbh) with desired characteristics, producing an average of about one very large, old tree per acre.

The stocking level of trees was taken from even-aged yield tables, based on the suggestions of Curtis (1978) and Foiles (1978). Commercial thinning schemes were developed both for groups of existing trees and for new groups established by reforestation by using the Forest Vegetation Simulator and professional judgment. Desired basal area per acre was set at 65 percent of full stocking (growing space 100 percent occupied) in the applicable yield table, which, according to the Simulator, would result in stands returning to 85 percent of full stocking in about 20 years (*fig. 3*).

Field Techniques

The average size and arrangement of groups of trees of the same age usually is influenced by the structure of the stand needed to provide habitat for particular species, the tolerance of the tree species to shade, and the practicality of maintaining group size and arrangement through management. The J-curve is applicable over a wide range of arrangements and group sizes, from a few acres down to openings that mimic the crown width of the largest tree desired.

Implementing the uneven-aged strategy involved primarily the identification and layout of the reforestation groups and marking for thinning in the matrix. Because the strategy was new to the sale preparation crew, we thought it would be difficult to learn and control work quality if both tasks were attempted at the same time. Initially, therefore, the crew located stand boundaries and reforestation groups so that it was evident which task was to occur in what areas of the stand. Next, the crew marked the thinning, focusing on guidelines for this

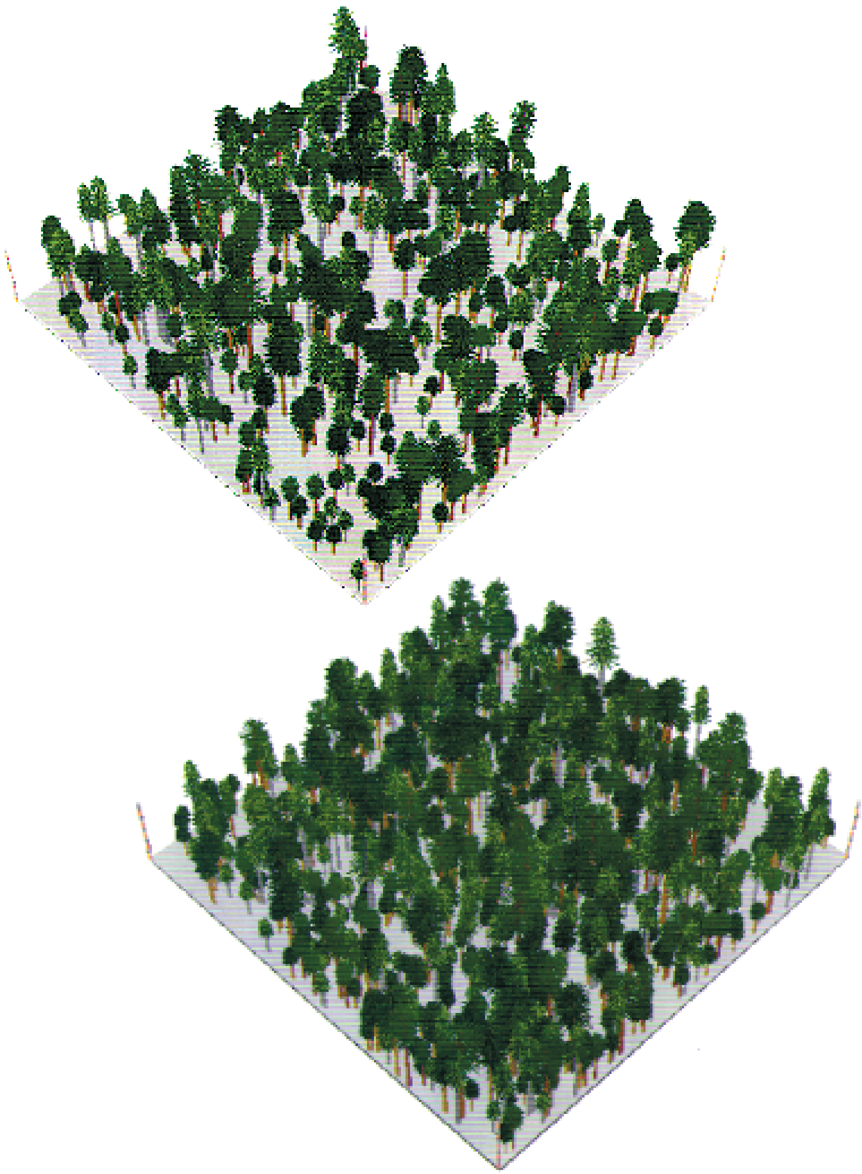

Figure 3—Simulation of a mixed-conifer forest at about 65 percent of full stocking (above) and 85 percent of full stocking (below), by the Forest Vegetation Simulator (USDA 1996).

task, without having to dwell on starting and stopping lines or the guidelines for establishing reforestation groups.

Locations of stands were determined by traditional approaches, like homogeneity of the vegetation, logging systems, and geography. Determination of stand size, however, did not follow the traditional approach. Because the intent is to develop an uneven-aged structure, stand by stand, the structure should be present at all larger scales, even in larger watersheds. The larger the stand, the easier and more efficient it was to implement the approach, resulting in stands of 75 to 150 acres.

Guidelines for locating reforestation groups focused on finding under-stocked areas within a stand that had resulted from past harvest, small fires, and insect-caused mortality. Usually under-stocked areas were evident because the majority of the area in most stands was moderately to densely stocked. Once identified by the crew walking through the stand, the boundary was located by expanding the under-stocked area until edges were located where the stand was at least moderately stocked with trees. Five acres is the largest group allowed under the guidelines (USDA 1995). The technique resulted in only 2 percent of the under-stocked areas expanding to a group larger than 5 acres.

Guidelines for thinning in the matrix focused on a desired basal area per acre where most trees to remain in an area were at least 16 inches in dbh, but on a spacing scheme where trees were mostly 15 inches in dbh and smaller. The split approach stemmed from the stark reality that small trees contribute little to stand basal area, so some other approach, like a spacing standard, is essential. The dbh split could be anywhere from 10 to 16 inches, depending on existing stand structure and the desirability of minimizing the complexity of marking guidelines.

A key to developing the uneven-aged structure and species composition by thinning in the existing matrix of trees was to look for obvious groups by large diameter classes (6 to 10 inches) and then to accentuate them by leaving as many trees as possible from the dominant diameter class in making up the desired basal area. It is important to focus on the obvious groups but not to spend time looking closely at variation in stand structure or debating the extent, boundaries, etc. Focusing on the obvious groups worked well. When groups were not evident, trees were selected to remain in the stand by thinning through all size classes present. The written marking guideline states:

> Working by 10-inch diameter classes, recognize the groups that are obviously dominated by trees in a single class, then make up as much of the desired basal area per acre as possible from favorable trees belonging to the dominant diameter class. When domination by a single class is not obvious, make up the desired basal area from favorable trees belonging to any class or crown position.

Other key marking guidelines were:

1. Disfavor the 1- to 10-inch diameter class.
2. Leave the proportion of oaks specified in the prescription, favoring black oak (*Quercus kelloggii*) over live oak (*Q. wislizenii*). Of the oaks to be removed, cut half and girdle half. Select the half to cut from those surrounded by pole-sized and larger ponderosa pine and incense-cedar (*Calocedrus decurrens*).
3. Select leave trees with at least 30 percent live-crown ratio that are free of damage and have mistletoe ratings of 1 to 2 or less, whenever possible.
4. Favor ponderosa pine over white fir (*Abies concolor*) and incense-cedar.

Implementation

One of the administrative study's tasks is to determine whether a typical Ranger District can implement this uneven-aged management strategy with its existing work force and typical management procedures. Although the first few projects are not yet completed, the answer to this question is becoming apparent. Because the major phases of implementation are sale preparation and sale administration, we focus on these. Two other areas, sale planning and post-sale treatments (reforestation, timber stand improvement, fuels reduction work, etc.) also play roles in implementation but are premature to discussion here. The planning phase has been documented in the Landscape Analysis Plan (USDA 1995) prepared for the study. Because post-sale stand treatments have just begun, we cannot evaluate performance in this area.

Timber sale preparation involves layout (establishing unit/stand boundaries on the ground), marking, and cruising (designating the trees to be cut or left and measuring the amount of wood that will be removed) in accordance with silvicultural prescriptions and other sale planning documents. It also involves appraising the timber (what it will cost to harvest the sale, and setting the asking price) and putting together the timber sale contract (legal document under which the sale operates), along with a prospectus (document describing the sale) and advertisement. Timber sale administration takes over once the sale has been sold and awarded. The sale administration team is responsible for seeing that the contract is followed and executed by the purchaser and that the Federal Government's interests are protected.

Lessons Learned From Sale Preparation

The Need to Test Marking Guidelines

One of the most important lessons learned was the value of practicing and testing the various marking guidelines. Small representative areas of individual stands were set aside as practice areas to test the marking guidelines developed by the silviculturist and the sale preparation forester. They were tested using key members of the marking crew and resource specialists. Results were reviewed on the ground by the silviculturist, timber and resource management personnel, and interested publics. Through this procedure, adjustments were made to the marking guidelines to achieve the desired silvicultural outcomes, while making the guidelines as simple as possible for the marking crew to follow. Practice made a substantial difference.

Supervision is Critical for Quality and Work Efficiency

We learned that the "art" along with the science of applying the silvicultural prescriptions under this uneven-aged management strategy is more important than is true for more traditional, even-aged prescriptions. To facilitate this, we used a coaching technique when marking stands. More experienced sale preparation personnel walked behind the crew and served as observers. They checked basal area and spacing standards, helped identify existing dominant groups of a single size-class, and helped direct the crew in making choices between trees when needed. This paid off and allowed the use of large marking crews. We were able to split crews into groups of three to five markers with a supervisor for each. Careful supervision of the marking helped to identify problems quickly and assist crews in looking for dominant groups, which clearly improved the marking production and resulted in higher quality work. Crew composition and size needed to mark and cruise are important factors to consider. More people were needed to mark and cruise for these uneven-aged prescriptions than would be typical for even-aged prescriptions. A crew-to-supervisor ratio of about 1 to 4 was ideal.

Traverse Regeneration Groups Using a Global Positioning System

Whether to traverse the regeneration groups within the stands was debated due to costs and time constraints. Given the relative ease and low costs of doing traverses with a global positioning system (GPS) device, however, we opted to do so. Consequently, we were able to keep better track of our regeneration acres and accurately map the locations of these groups for our records. Already this has proven to be worthwhile in following up with post-sale treatment work within these groups.

Plan Marking Strategies

We compared marking strategies, either marking "cut" trees (painting a narrow ring around trees to be cut) or "leave" trees (painting trees that are to remain after the sale). Aho (1983) recommended marking leave trees when dealing with fir, based on comparisons of the two marking methods from the standpoint of residual stand damage. We found, however, that additional factors needed consideration (*table 2*).

Stands need to be examined carefully before determining whether to mark them as a leave-tree unit or as a cut-tree unit. Also, applying both systems in different units may be advantageous, although mixing strategies requires vigilance by the sale administrator and the logger to avoid confusion about the marks. We found that cut-tree designation had a higher cost, but this may be offset by higher cruise costs for leave-tree marking. Smaller acreages definitely favor cut-tree marking. Dense stands of small trees favor a leave-tree mark. A cut-tree designation with a 3P cruise (probability proportional to prediction, a modification of variable probability sampling in which the chances of a tree's being selected to measure in the sample varies directly with the size of the tree) offers the best way to control the coefficient of variation (CV) of the cruise, if meeting sampling error standards is a problem.

Table 2—*A comparison of the relative advantages and disadvantages of "cut-tree" vs. "leave-tree" marking for thinnings*

Cut-tree marking	Leave-tree marking
Need clearly designated boundaries.	Need clearly designated boundaries.
If the number of cut trees/acre is less than about 1.5 times the number of leave trees/acre, cut-tree marking is more efficient and economical.	If few leave trees/acre to mark, leave-tree marking is efficient. Leave-tree marking tends to be slightly slower.
Because every tree must be marked, apply a tree-based cruise such as the 3P method.[1] Using a 3P cruise can minimize the coeffficient of variation (CV) of the cruise and result in efficient measurement costs.	Leave-tree marking favors an area-based cruise for measuring the harvest trees. It does not require that all cut trees be visited.
For small acreages, cut-tree marking is more and economical.	Area-based (plot) cruise methods generally have high coefficients of variation (>70 pct) and require many plots. The number of plots is a function of the CV, not acres. Need to have a large acreage to avoid overlapping plots.
Does not require the unit to be traversed.	Requires the unit to be traversed.
Need only one preparation entry into the unit.	Need three preparation entries (mark, cruise, traverse).
Little risk of not meeting the sampling statistics for the cruise if insurance trees are measured (3P).	More plots needed if cruise misses the sampling error percentages allowed.
Skips in mark simply leave more trees in the unit.	Skips in mark may understock the stand from prescribed levels.

[1] The 3P (probability proportional to prediction) method is a sampling method in which the chance of a tree's selection in the sample varies directly with the relative size (volume) of the tree being measured.

Lessons Learned from Sale Administration

Mark Sale Boundaries Unambiguously

Administration of the timber sales affirmed principles that we already knew. It pays to put effort, time, and money into sale preparation because it reduces headaches encountered during sale administration. One of the few sale problems we encountered during preparation for the 10S18 FRP contract involved boundary designations. As pointed out by Fiske and others (1993), marking of boundary trees is important to prevent theft and to maintain accountability with group-selection harvesting. Although these were not issues in our case, the fact that we marked boundaries of units (stands) and regeneration groups (group selection) with paint of the same color caused some confusion for the logger and the sale administrator, especially when regeneration groups were located near a unit boundary. This could have resulted in theft and accountability problems, except that we mapped each unit and regeneration group with GPS, providing a good map for each unit and an accurate location of each regeneration group. The sale was sold as a "scaled" sale (trees measured and paid for after they were cut into logs and hauled to a designated scaling location) rather than as a "tree measurement" sale (trees measured prior to sale and paid for before cutting). Each method has pluses and minuses, of course, but our experience with group-selection harvesting indicated that a scaled sale presents fewer problems when administering the contract and less temptation to cut undesignated trees.

A Need for Flexibility

Flexibility was found to be a key ingredient for accomplishing the work on the ground. Given the mix of timber sizes (dbh ranging from about 10 inches to over 70 inches), species, and topography (slopes to 75 percent), we tended to be more open to suggestions from the timber sale contractor about the types of log-skidding and processing equipment and methods that he wanted to use. So far, these have included conventional tractor skidding and hand falling, mechanical harvesters, in-woods processors, delimbers and processors at the landings (slopes <35 percent), helicopter yarding (slopes >60 percent), and skyline yarding (slopes 40-60 percent). Only by using this mix of different technologies and methods were we able to get some of the results that we desired at an economical price.

Some significant lessons were learned from working with mechanical harvesters. They have better control on directing and placing cut trees and are able to process small timber faster and more efficiently than conventional falling methods on slopes <35 percent. On the other hand, we experienced a slightly greater chance of cutting undesignated trees because of the "dog hair" thickets of pine and incense-cedar within stands. Also, we found that chances of damage to designated leave trees increased with the simultaneous operation of more than one piece of machinery in the woods. Most tractor-based units on these sales required at least two entries, one with mechanical equipment (such as a feller buncher) and another with conventional falling (chainsaws) and skidding, due to the various sizes of the trees to be removed.

More Inspection Time Required Than With Even-aged Harvests

We found that the logger covered more land at a time than during traditional timber sales because of the low volumes per acre. As predicted by Fiske and others (1993) this required more time walking more ground than on other timber sales, so timely inspections could be made and problems identified early. Also, it paid off to have our sale preparation personnel and other resource specialists spend some time with the sale administrator during harvesting activities. Experiencing first hand what works and what does not with the various types of equipment often leads to significant improvements in the marking, layout practices, and resource protection measures. Good communication is a key with everyone involved in the sale, including the contractor, resource specialists, and researchers.

Involve Sale Administrators Upfront

The key lesson learned is that sale administration personnel need to be involved in the planning and preparation phases of the project. They are responsible for carrying out the intended actions of the project, so the more they know about the project the better. Sale administrators can also provide valuable input into the design of the project, including legal aspects of a timber sale contract and the practical aspects, such as logging capabilities, practicality of certain practices, and various ways to accomplish a desired condition.

Costs

A major and continuing question for the study involves the cost of timber sales when implementing uneven-aged management. The cost includes creating small group selections and thinning between the groups to accentuate the existing uneven-aged structure of the overall stand. Sale preparation costs that are being tracked include salaries, vehicle costs, paint, and miscellaneous supplies needed (flagging, signs, etc.). Sale administration costs include administration and clerical salaries, vehicle costs, and miscellaneous supplies needed.

We assumed at the start that implementing uneven-aged prescriptions would entail a higher cost than even-aged prescriptions. Sale preparation costs were higher for uneven-aged prescriptions, using 1996 as the base year and a 4 percent discount rate for cost calculations (*fig. 4*): 10S18 FRP at $9.33 per thousand board feet; IROC at $11.25; and other (average for even-aged, sanitation, and typical thinning sales) at $8.09. Although the costs were higher, the difference was not as high as many of us expected. Factors such as the complexity associated with these sales, the lower timber volumes harvested per acre, and the amount of ground that needed to be covered all tended to inflate costs. We expect costs to decrease, however, as our experience with these sales increases.

Estimates of the sale administration costs were $5.83 per thousand board feet for the 10S18 FRP, $6.49 per thousand for IROC, and $5.55 per thousand for the other sales types (*fig. 4*). These estimates are preliminary, with the exception of the "other" costs shown, because the 10S18 FRP and IROC sales are still being harvested. Sale administration costs may increase for these two sales because of the complexity of the ground yet to be harvested and the fact that helicopter and skyline yarding remain to be used. Based on past experience with these harvesting systems, we expect sale administration costs to increase.

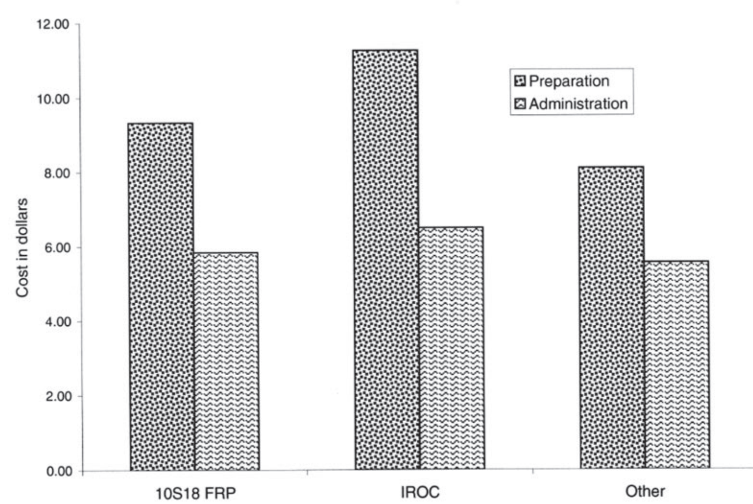

Figure 4—Costs in dollars per 1,000 board feet (MBF) for sale preparation and administration: 10S18 Fuels Reduction and Indian Rock Upper Tier projects are applying uneven-aged management strategies; "other" includes even-aged, sanitation, and typical thinning sales.

Administration costs have typically ranged from $5.30 per thousand board feet for an easy tractor-yarding operation up to $10.00 per thousand for helicopter yarding operations, where steep terrain makes all tasks more time-consuming.

The two sales sold to date have been cost-effective. Both had at least two prospective bidders and both sold for more than their appraised rate. Generally speaking, we have received few complaints by purchasers on the way these sales were packaged. Continued attention to sale economics, along with resource objectives, needs to be emphasized for all projects if one expects them to be successful.

Summary and Recommendations

The willingness to try new ideas, a major principle behind adaptive management, is probably the most important factor in our success with these projects. This principle is sometimes hard to accommodate, especially in a bureaucratic setting. Support from management and being open minded are effective in bringing about a willingness to try new ideas. It is important to be willing to listen and to discuss ideas from a wide variety of sources, including the public, academic community, and management, then to build on the ideas that work and learn from the ones that fail.

The more complicated and varied the expected outcomes or desires, the harder it will be to implement the project, especially through a timber sale in which market forces typically play a critical role. Other avenues to accomplish multiple resource objectives, such as those described by Ringgold (1998) in his paper on stewardship contracting, need to be considered and tried. Economic viability is a key to successful implementation of any package involving the market for services or commodites.

What have we learned so far, and what still needs to be explored? Preliminary results from the 10S18 Fuels Reduction Project have shown that we can successfully implement the desired silvicultural prescriptions. On the units logged with a tractor, the desired basal areas per acre have been attained, and canopy covers meet the minimum of 40 percent for spotted owl foraging habitat. Vertical structure within the groups became less diverse, however, tending to become single storied with little to no understory, especially after post-sale treatments. Thinning of the forest matrix between regeneration groups accentuated their existing group structure, as planned, so stands are conspicuously more patchy and uneven-aged than before thinning. What effect, if any, the stands with little or no understory, but more diversity in horizontal structure, will have on spotted owls and other wildlife species remains to be determined.

Although it cost more to implement uneven-aged prescriptions than is typical for even-aged prescriptions, the difference was less than expected. Spreadsheets developed for the costs of sale preparation and administration need to be expanded to capture time spent in the office and to more accurately track overhead costs. Time and funding permitted, production time and cost studies would add much to our assessments of costs from an operations standpoint.

The project has given us the opportunity to test implementation of an uneven-aged management strategy at a landscape scale. Although the study is still in an early stage, we are already gaining important insights. For example, we now know that a typical Ranger District probably can implement the uneven-aged management strategy across a large landscape, and at costs comparable to traditional even-aged management.

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