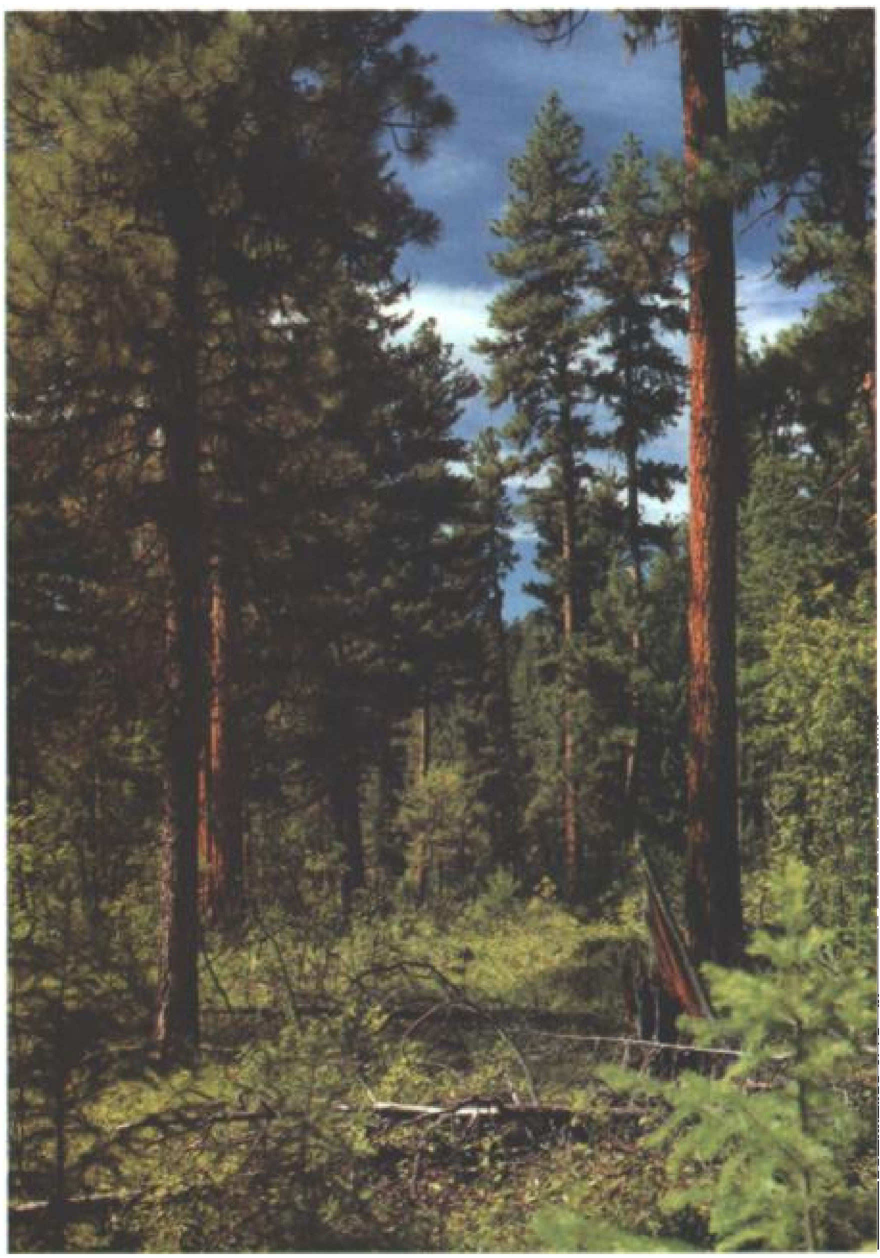
Resetting the Clock with Uneven-Aged Management

By Rolan R. Becker and Thomas S. Corse

The list of resource values of the Confederated Salish and Kootenai Tribes reads much like that of other Native American nations: large trees, diverse species composition, and a continuous tree cover for cultural practices; plants for medicine and ceremonies; economic benefits for income to sustain both individuals and community programs. One silvicultural tool that helps the Salish and Kootenai meet all those objectives is uneven-aged management, and in its implementation, the tribes are directing the forest toward conditions that existed before European settlement.

The Salish and Kootenai live on the Flathead Indian Reservation in northwestern Montana. In their approach to ecosystem management, harvesting simulates the effects of the frequent, low-intensity fires that were ignited by lightning or deliberately set by the aboriginal peoples of this region. Besides establishing and maintaining the forest structures that existed before fire-exclusion policies remodeled the forest, uneven-aged management also provides income each cutting cycle—especially attractive to individuals who own small tracts, or allotments.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Uneven-aged silviculture is used on the ponderosa pine forests of the Flathead Indian Reservation in northwestern Montana to provide income to the tribe and to restore the area to pre-European-settlement conditions. Experience on the reservation has demonstrated that harvesting by single tree selection requires recruitment of desired species, planning within biological limits, and measurement and manipulation of stocking levels.

Historical Development

The use of uneven-aged silvicultural tools has deep historical roots. The Indian Reorganization Act of 1934 required that harvests on Indian lands follow sustained-yield principles. In 1943 Harold Weaver, forest supervisor for the Colville Indian Reservation, attributed the uneven-aged nature of many ponderosa pine forests (Weaver 1943) to the ecological role of fire and called for research to consider fire as a silvicultural tool. The first management plan prepared for the Flathead Reservation in 1945 prescribed selective harvest and included a modified version of Keen's tree classification for ponderosa pine (Historical Research Associates 1977) to help determine which trees would be harvested. A considerable inventory of large old-growth pines survives on the Flathead in part because of these early attempts at selection management.

Uneven-aged management on the Flathead Reservation has evolved by trial and error, and both success and failure have stimulated further interest and investigation. At Flathead, unique among surrounding private and public forests, managers broadened their focus from harvesting to a more comprehensive view.

The earliest selective cutting would not fit today's definition of the selection system—a planned sequence of treatments with adherence to such control elements as density, structure, and species composition. Between the mid-1940s and late 1950s, most harvesting was done to salvage damaged or dead trees or reduce risk in otherwise healthy stands. These harvests increased growth rates, funded a road network, and established a 15- to 20-year cutting cycle.

During the next 20 years, more emphasis was placed on stocking control and forest health. By the mid-1980s the need for regeneration at each entry was recognized, along with the traditional elements of an uneven-aged prescription: structure, residual density, maximum tree size, and species composition. Relationships among habitat types, forest health, and success of the method were being formulated. Increased interest in uneven-aged management from other land managers led to formal training efforts in collaboration with the University of Montana beginning in 1989.

Today, efforts focus on individual tree and group selection—two regeneration systems that mimic natural processes and maintain structural goals within historical ranges of vegetative variability. The application of uneven-aged silviculture to more moist sites, the problem of climax species encroachment, and the use of prescribed fire are also being examined.

The Wilcox Case Study

Although the Bureau of Indian Affairs (BIA) promoted uneven-aged management, there were few scientific data to evaluate its effects. Prompted by Chief Forester Earl Wilcox, in 1970 the BIA established an uneven-aged stocking study in an irregular ponderosa pine–Douglas-fir stand on the Flathead Reservation. The measurements made on the Earl Wilcox Demonstration Forest have not been replicated and are thus properly termed a case study. The purpose of the study was to determine the optimal residual growing stock levels necessary to maximize board-foot growth and to ensure the creation of a new age class of adequate reproduction with each cutting cycle.

Several concepts basic to uneven-aged management were addressed in the study design:

1. Selecting a target residual stocking level and a target largest-diameter tree. Both were needed to calculate the number of stems desired in each diameter class, although one can be somewhat flexible about larger trees, since larger trees with desired phenotypes may be retained to influence the genetics of the future crop as well as to satisfy cultural needs.

2. Selecting a structural goal based on the Q ratio concept advanced by de Liocourt (1898). A balanced structure would have a certain percent more trees in each smaller-diameter class than in the next larger class. For instance, a Q ratio of 1.3 would have 30 percent more stems in the 2-inch class than in the 4-inch class. The magnitude of the ratio depends on such things as expected mortality, width of the diameter class, big game hiding cover, or the desire to have excess trees for thinning.

3. Establishing adequate regeneration after each harvest entry, or cutting cycle.

4. Determining the desired species composition.

The 1970 installation was primarily concerned with target residual stocking levels as measured by basal area. The goal, a Q ratio of 1.4 applied to 2-inch-diameter classes, was not achieved because of the irregular nature of the existing stand. Several 2-inch-diameter classes were underrepresented, and the basal area was made up in other classes. Six 4.9-acre plots were installed. Five basal area targets were selected, along with an uncut control plot.

The plots were cut to target residual basal areas of 25, 35, 45, 55, and 60 square feet per acre. An uncut control plot was also established. All plots received a commercial harvest, but the 60-square-foot plot did not receive stocking control by thinning in the lower-diameter classes. Plots were measured every five years until 1989, when the plots were again harvested.

Interim Results

Because the original plots did not achieve structural goals, it is too early to draw final conclusions about the stocking levels and their performance. The following tentative conclusions will be evaluated as the study continues and the stands approach a more balanced structure.

- It appears that 25 square feet of basal area underutilizes the site *(table 1)*. The quality of the crop trees is good, and even at this understocked level, the managed stand is superior to the unmanaged control plot in tree quality, although growth is about the same.
- There is no clear difference in volume growth among the three best-performing plots. The plots with 45, 55, and 60 square feet of basal area each produced more than 6,000 board feet per acre over the cutting cycle. The effects of drought and insect mortality may have masked any true advantage of one plot over another.
- Stocking control through thinning is a valuable and necessary treatment for these stands. The unthinned stand had high mortality (24 percent) based on tree numbers. The energy used to grow these suppressed, non-

crop trees could have been better spent on the growth of selected, thinned trees The control plot had an even higher mortality rate of 32 percent.

• The quality, not just the quantity, of the regeneration that will make up the youngest age class appears critical. The plot with 55 square feet of basal area produced sufficient regeneration but was of poor quality, with thin crowns and small diameters. This poor quality may indicate that residual basal area stocking on similar pine-fir sites should be less than 55 square feet.

• Based on the first cutting cycle alone, it appears that the target stand for this type of site should be between 45 and 55 square feet of basal area A Q ratio of 1.1, based on 2-inch-diameter classes, appears sufficient to compensate for mortality. There is no way to determine the optimal residual tree diameter because that was not a selected variable in the first cutting cycle.

• As implied above, the sites appear to be fully utilized in the basal area range of 45 to 55 square feet. If this observation holds true through future cutting cycles, it is a significant departure from conventional even-aged stocking guides, which suggest much higher residual basal areas.

Given these tentative conclusions, the basal area targets were modified for the harvest in 1989. The 25-square-foot plot was cut to 35 square feet because it appeared underutilized. Similarly, the 60-square-foot plot was cut to 45 square feet because the quality of the regenerated trees at the former density was poor. Maximum tree diameter was also varied so that the effects of large trees (≤28 inches dbh) on growth could be evaluated.

The plots were remeasured in 1993 *(table 2)*. Based on past performance, growth rates may be expected to increase for all treatments in successive five-year periods.

In 1984 two additional stocking studies were established on wet Douglas-fir and grand fir habitat types on the Flathead Reservation. The original study focused exclusively on timber production but nevertheless provided valuable insight into the dynamics of forest growth that will be useful in achieving forest structures to meet the broader objectives of ecosystem management.

Table 1. Growth per acre, 1970 to 1989.

Plot	Basal area target	Board feet per acre per year	Cubic feet per acre per year	Total board-foot growth over 20 years
1	25 sq ft	258	43	4,907
2	35	303	50	5,750
3	55	338	57	6,424
4	45	333	53	6,318
5	60	340	57	6,451
6	control	266	52	5,045

Table 2. Growth per acre, 1989 to 1993. Q ratio was 1.1 in all cases.

Plot	Basal area target	Maximum diameter target	Board feet per acre per year	Cubic feet per acre per year	Total board-foot growth over 4 years
1	35 sq ft	24 in.	147	25.0	588
2	35	20	178	34.5	712
3	55	24	257	43.5	1,028
4	45	24	270	46.2	1,080
5	45	28	204	35.8	816
6	control	—	208	34.5	832

Field Implementation

Experience suggests three considerations for implementing the selection system.

Regeneration. The desired species must be recruited periodically, preferably with each cutting cycle entry. Careful attention must be given to site and plant unions and to site preparation. The unreliability of natural regeneration in many western conifers is the greatest practical hindrance to the use of this selection system.

Stand tending. The entire diameter distribution must be periodically manipulated through commercial harvest, precommercial stocking control, and other treatments commonly applied to even-aged systems, such as weeding, cleaning, and release. These treatments maintain growth, vigor, and species composition of all age classes.

Planning. Uneven-aged management must be planned within the context of the ecosystem. Fire intensity and frequency and plant succession profoundly shaped past forest structures and give clues to where uneven-aged prescriptive tools might work. The forest plan must integrate those biological realities and limits with social objectives.

Developing the specified structures takes time. Managers should not become discouraged if they are unable to achieve their target stand in a single entry. After nearly two and a half cutting cycles of both selective harvesting and the use of the selection system on the Flathead Reservation, very few target stands yet exist.

When manipulating stands toward a structural target, managers should set priorities. Experience at Flathead suggests the following:

1. Species composition and forest health.
2. Site occupancy.
3. Structure: Q or diameter-class distribution.
4. Maximum residual tree size after harvest.

In ecosystem management, forest health is viewed from a broad perspective; still, the majority of individual stands should show reasonable levels of vigorous, healthy trees of the desired species. Species composition and forest health become the basis from which to develop the future forest along a variety of possible successional pathways. Once vigorous, healthy trees of the desired species are established, subsequent treatments can focus on structure development and the eventual selection of a target maximum diameter.

Managers should aim for broad age and diameter classes. In the literature, stand structures are often calculated on 1- or 2-inch-diameter classes. Such calculations are primarily of academic significance. The age and diameter classes should be a function of cutting cycle length and site potential to allow a manageable number of age classes. If, for example, the entry period is 20 years and the average crop tree can be expected to increase 4 inches in diameter under the prescribed densities, then the existing crop trees should be partitioned into 4-inch classes. Such a procedure presumes that each size grouping will move up, on average, one age or size class between cutting cycles.

Managers should target relatively low Q ratios. Qs of 1.5 to 1.9 or higher are often cited in the literature as the condition found in natural stands. There may be little justification for maintaining such high ratios in managed stands unless a prescription addresses a specific need, such as providing hiding cover for big game. Frequent, low-intensity fires typically kept Q ratios low on dry sites, where uneven-aged management is most likely to be successful (Fiedler 1988).

Stands should be managed for relatively low densities. The objective of site occupancy is to maintain enough growing stock to capture the full site potential and provide for consistent seral species regeneration. Local observations on the Wilcox study plots suggest that for ponderosa pine, these two needs are fulfilled between 35 and 55 square feet of basal area. Research with loblolly pine on the Crossest Experimental Forest in Arkansas suggests a similar range of 40 to 60 square feet of basal area (Baker et al. 1995). Recent work by O'Hara (1996) addresses the problems of intertree competition, growth, and the allocation of growing space in uneven-aged or irregular stands of two to five cohorts.

Managers should not slavishly apply mathematical aspects of uneven-aged management, such as maximum tree size or structure. In fact, O'Hara suggests that strict application of a Q ratio may be inconsistent with presettlement, fire-maintained structures. Uneven-aged management is a tool with a wide range of applications: one could choose to leave several large trees per acre that exceed the target maximum tree size to increase site diversity, preserve some unique tree feature, or simply ensure enhanced seed production. Extra numbers of small trees could be retained for a portion of a cutting cycle to provide cover for big game.

Managers should select the regeneration method to be used and continue with it for a given prescription. Individual tree selection is best implemented using some measure of density, such as basal area, as a means of control. Group selection is best implemented using area-based techniques. The two methods should not be used together because confusion with tree markers often occurs and an overallocation of growing space to new regeneration is common.

Uneven-aged prescriptions are very sophisticated. The people who apply the prescriptions on the ground must be well trained and closely supervised. Ideally, those who write the prescriptions should mark the timber.

"Marking to leave" works better than cut-tree marking. Characteristic of the selective harvests of the past, cut-tree marking assigns any error in marking, such as missed trees of poor quality, to the reserve stand. By contrast, leave-tree marking is futuristic and will result in a superior reserve stand, both in quality of reserve trees and in control of stocking and structure.

Forest operations should be closely supervised. Designated skid trails and directional felling are usually necessary The use of feller-bunchers can also help protect the reserve stand by properly orienting logs for skidding.

The future success of uneven-aged management on the Flathead Reservation will depend on refining underburning techniques, identifying historical fire regime patterns, monitoring uneven-aged study plots, training personnel, and applying the techniques and information developed over the last three decades. JOF

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