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UNIT AREA CONTROL - - -
ITS DEVELOPMENT AND APPLICATION

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William E. Hallin

Definition of Unit Area Control

The development of unit area control was the culmination of a lifetime of work by Duncan Dunning. It is a silvicultural concept in which the essential characteristic is "detailed control of stocking on small areas." The basic idea is not new. In some localities it has been referred to as forestry by the acre.

"Unit area" and "control" -- the two parts of the term -- are the keys to understanding this concept. "Unit area" was selected because silviculture must fit stand conditions that are natural units. Most forests are composed of homogeneous stand units, or unit areas, varying in size from a fraction of an acre to many acres. Characteristics commonly determining the homogeneity of these unit areas are: age class, species composition, stocking, and presence or absence of seed trees.

"Control" was selected because it most aptly describes the aim of silvicultural treatments applied to the unit areas. Control of the ground by a desirable or valuable tree species rather than by brush or inferior tree species is of first importance. Also, control means continuously maintaining adequate stocking of desirable species of trees that are growing at rates commensurate with the site. Silvicultural treatments applied at the proper time are the means by which the forester controls the stand.

I wish to emphasize these two points: (1) Forest stands are made up of unit areas and (2) the forester controls his stand by applying silvicultural treatments.

Unit area control is in sharp contrast to the widely used forms of tree selection. Silviculture is applied according to the needs and conditions of each unit area of the stand rather than tree by tree according to generalized rules. An improvement cut by individual tree selection may, however, be appropriate for unit areas of young age class of some species before the final harvest cut.

Unit area control as a term was first used in connection with a cutting trial in a sugar pine-white fir forest; consequently many

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1/ Paper presented at the Annual Meeting of Columbia River Section Society of American Foresters at Portland, April 18, 1953.

California foresters first thought the term referred merely to the technique used in sugar pine management. This is not the case; applying silviculture by unit areas is appropriate and desirable for other major types as well.

Large-scale trial and demonstration of these applications are under way in ponderosa pine at the Blacks Mountain Experimental Forest and in a mixed conifer forest at the Stanislaus Experimental Forest. At both places small-scale studies are being carried on to implement and improve the application of unit area control.

Basis of Unit Area Control

Thirty years of research in the ponderosa pine and mixed conifer forests of the Sierra of California by Dunning and his associates have shown that previous methods of silviculture were not providing adequate restocking of pine. Analysis of records indicated a new approach was necessary. From this work, new procedures that gave most promise of success were formulated by Duncan Dunning. These procedures are techniques for applying unit area control in the ponderosa pine and mixed conifer forests.

What the forester does in managing his stand is to analyze (1) the objectives of the land manager or owner, (2) the silvical characteristics of the species, and (3) the condition of the stand when treatment starts, in order to select and apply the appropriate treatment.

Objectives of Management

Obviously what the land manager wants is the first controlling factor in determining what is done to the forest. The land manager must decide the species desired, the acceptable degree of stocking, the size and kind of product desired, and make the other customary managerial decisions.

Customarily in the ponderosa pine or mixed conifer types a primary objective of land managers is to grow large size ponderosa or sugar pine peeler logs or sawlogs. If sustained production with a growth rate commensurate with the site capacity is desired, conversion of the unmanaged stand to a regulated stand -- a forest with each age class through rotation or harvesting age uniformly represented, and adequately stocked -- is an essential objective.

Silvical Characteristics

Some of the important silvical characteristics of ponderosa and sugar pine that affect its management are: (1) They are

intolerant species and grow best in even-aged groups. (2) They germinate best on bare mineral soil. (3) If pine starts free of competition, its initial growth is rapid, and it usually is able to compete successfully with fir, brush, and other vegetation that may subsequently become established. (4) For best growth, thinnings and cleanings are usually necessary. (5) Pine seeds are the preferred food of numerous rodents commonly found in our forests. (6) Pine does not prune itself of branches naturally during practical rotation periods.

As a result of characteristics (1) and (2), ponderosa and sugar pine do not readily establish themselves under brush and white fir. Where they have become established under brush or white fir, they do not develop properly unless released from this competition.

Site quality, through its effect on growth rates, has an important effect on acceptable stocking, length of rotations, and final yield.

Condition of the Stand -- Condition Classes

Ponderosa and sugar pine stands when considered by large areas are all-aged; however, when the forest is examined closely the trees are seen to occur in even-aged groups, usually small in size and homogeneous in respect to stocking, species, and other characteristics. Dunning has called these groups condition classes.

The objects of a classification by condition classes are: (1) To subdivide the forest or working circle into natural units sufficiently small and homogeneous for practical, uniform treatments such as harvest cutting, regeneration, and stand improvement. (2) To determine (a) which unit areas have existing stands adequate to carry as growing stock and, if they do, whether or not they should be subjected to an improvement cut, and (b) which unit areas have stands that should be clearcut and the unit regenerated. (3) To provide the basis for the cutting plan, the cutting budgets, the allowable cut, and other steps in a working plan that is most likely to accomplish stand regulation in the conversion period.

The basis for a condition classification is the prevailing, naturally occurring group stand structure. Dominant trees are used as indicators in condition classification because they make up more than 80 percent of the stand in board foot volume, but require counting or considering only about 40 percent of the stand in numbers of trees. The criteria for recognizing and classifying condition classes are age, species, degree of stocking relative to the stand aimed for in regulation, and -- for unit areas needing regeneration -- the presence or absence of seed trees and the presence or absence of brush or other vegetation needing eradication.

The age classes we have commonly used for the overstory are: (1) Overmature -- 300 years plus -- Dunning's tree class 5 or Keen's tree class 4; (2) mature -- 150 to 300 years -- Dunning's tree classes 3 and 4 or Keen's tree class 3; (3) immature -- 75 to 150 years -- Dunning's tree classes 1, 2, and 6, or Keen's tree class 2. Age classes commonly used for the understory are: (1) Young -- 25 to 75 years -- usually poles 4 to 12 inches diameter breast high (d.b.h.); (2) seedlings and saplings -- 0 to 25 years -- usually trees less than 4 inches d.b.h.

This age class breakdown has been adequate for deciding on the appropriate treatment. In preparing management plans and regulating the cut, however, it has been found desirable to have a greater breakdown of age classes for those ages below rotation age.

The species classification of a unit area is based on the relative number of dominants. If the most desirable species makes up one-third or more of the dominants, the unit area is designated as that species. If the most desired species makes up less than one-third of the dominants, the next most desirable species is considered; and so on down the list of species in their order of desirability. Although this species designation is for the purpose of classifying the unit area at the time of inventory or treatment, it commonly indicates the species to be favored on the particular unit area for the conversion period. With favorable conditions, however, the forester may treat some unit areas so as to change the species to more valuable ones. Although species consideration is not a problem on much of the ponderosa pine type, less desirable species occur and present a problem on some unit areas in most localities.

Stocking is rated as adequate or inadequate on the basis of a minimum stocking that is acceptable to the land manager. On our Blacks Mountain Experimental Forest in the ponderosa pine type we ordinarily use 25 percent stocking as the minimum. The minimum size unit that will be segregated must be decided upon by the land manager also. One-fifth acre is the minimum sized unit area which we try to regenerate, although for practical operating reasons one-fifth acre may sometimes be too small.

Foresters often ask what should be the minimum, optimum, and maximum sized unit areas. Nature has already established the present sizes of unit areas. The forester, of course, can change the size of the unit areas by silvicultural treatments. But during the early stages of converting the wild forest to a managed one, he can make very few such changes. It is possible, for example, to cut and regenerate a small mature unit area at the same time an

adjacent overmature unit area is cut and regenerated, thus making one unit area of a more desirable size. In practice, however, the lack of adequate young components in the stand usually makes this undesirable. If unit areas are larger than desired they can be subdivided and the parts cut and regenerated at different times. In California pine stands, unit areas over five acres in size are not common; consequently we have not had to set a maximum size in our pine stands.

Seed trees are rated as adequate or inadequate for old or mature unit areas without adequate advance growth. Seed trees should be distributed around the border of the unit area to be regenerated. The number and size required varies with the species.

Shrub or other vegetation requiring eradication is rated as present or absent on unit areas needing regeneration.

Recognition of condition classes is not unduly complicated when it is viewed in terms of these few criteria. For any specific unit area the following questions should be answered: (1) What is the age class of the overstory? (2) What is the species composition? (3) For immature and mature age classes, is the stocking acceptable to carry as a reserve? (4) Is an understory present? (5) What is the species composition of the understory? (6) Is the stocking of the understory adequate? (7) If the understory is inadequately stocked or absent are there adequate seed trees? (8) If the understory is inadequate or absent do shrubs or other competing vegetation need eradication?

Treatments

In the application of unit area control each unit area of a specific condition class is given its appropriate cutting and all other necessary treatments at the proper time. I wish to emphasize the importance of applying all treatments. The immediate objective is to keep control of the ground with trees. As previously mentioned, the long-time objective is to convert the forest into a regulated stand with each class through rotation age uniformly represented as even-aged groups, or unit areas with adequate stocking and proper growing conditions. This means even-aged management. Ultimately, of course, all unit areas will be harvested and regenerated when they reach rotation age. Timing is especially important in securing either natural or artificial reproduction. Once an area has been prepared for reproduction, it should be restocked at once, otherwise brush and other competing vegetation will invade and rapidly take control of the ground. Hence, it is vital that planting

stock be available when regeneration cuts are planned, either for planting the entire area or for fill-in planting where natural reproduction fails. The main initial treatments to be applied are:

Cutting for natural restocking is carried on in unit areas of overmature condition classes with inadequate advance growth, with suitable seed trees present, and during a year of a good seed crop. These units are clearcut, but seed trees are left around the border of each unit. Rodents are controlled with lethal bait. Slash and brush are piled and burned. Competing vegetation is eradicated, and the bare mineral soil exposed as a seedbed. If natural regeneration fails the unit area is planted at once before brush and other vegetation invades it.

Cutting for artificial restocking is carried out in the unit areas of overmature condition classes with inadequate advance growth, but with no suitable seed trees or no seed crop in sight. These condition classes are clearcut. Slash is piled and burned. Competing vegetation is eradicated. Because of the infrequency of good seed crops, a high proportion of the overmature classes may need to be regenerated by artifical means.

Cutting for release is carried on in unit areas of overmature classes with adequate advance growth. The overstory is clearcut to release young growth; cutting is followed up with pruning, thinning, and other stand improvement measures.

Improvement cuts are made in young but merchantable stands (immature and mature age classes). The occasional old, malformed, or defective trees are removed to improve the quality and vigor of the stand. At this point it is well to point out that there is distinction between an intermediate harvest cutting and a final harvest cutting. Even though the final harvest cutting is in some form of clearcutting, any intermediate harvesting or improvement cutting must be some form of individual tree selection.

Risk Cutting

How does sanitation-salvage, or risk cutting, tie in to unit area control? Where risk trees can be readily recognized and the proportion of them is small, a risk cut the first time around is desirable. Under these conditions, by removing a low volume per acre the working circle or forest property can be rapidly cut over and the stand protected from serious insect loss. This should be followed by silvicultural treatments as indicated by the needs of the stand. In unit areas for which the final harvesting is deferred until later cutting cycles the risk trees should, of course, be removed when nearby unit areas are harvested.

In species and types where risk trees cannot be readily recognized or when the proportion of risk trees is large, the first cut should be based on silvicultural objectives other than sanitation-salvage.

Application of Unit Area Control

I will now briefly discuss some of the problems in the application of unit area control.

Inventories and Management Plans

Adequate inventories and preparation of suitable management plans are desirable and necessary with any method of cutting if a continuous forestry enterprise is the objective of the land owner. Unit area control can be started without inventories, as can any other type of cutting. On any forest working circle, the desired progress toward a regulated stand depends on an adequate inventory and management plan. The application of unit area control perhaps makes the need more obvious.

Adequate reserves for short cutting cycles are maintained by deferring the final harvesting on some unit areas. A knowledge of the area and volume in each condition class is necessary to make the best decision on the amount of reserve to carry and to decide which unit areas to harvest now and which ones later. These decisions can be made on the basis of a general knowledge of conditions for the working circle. However, in order to make adequate progress towards a regulated stand, an adequate inventory cannot long be delayed.

The area and volume for each condition class can be estimated by customary sampling procedures. In the more open types, such as many ponderosa pine stands, aerial photos can be used for area determination, and volumes can be determined from sample plots within the different condition classes. Areas can also be determined by the line-transect method.

Calculating the allowable cut and preparing the cutting plan are simplified with an inventory by condition classes. The deficiencies or excesses in the different age classes are readily shown. By using a combination of area and volume regulation, the condition classes can be sorted into their proper place in the cutting plan in order to provide for a sustained cut and progression toward a regulated stand. The younger age classes with or without an overstory are allocated to cutting cycles at the end of the rotation and the overmature age class to the first part of the rotation. The mature and immature age classes are fitted in between. With

this type of picture, priorities of cut can readily be set up. Because condition classes are usually even-aged, conventional yield tables can be used for predicting growth.

Short cutting cycles are desirable in order to maintain proper control of the stand. In converting virgin old-growth stands to a regulated condition, the large volume of overmature trees appears to present somewhat of a problem if initial cutting cycles are to be kept short. This can be quite satisfactorily handled by deferring the final harvest on some of the overmature unit areas. The analysis of stand structure by condition classes will give the first indication of kinds of condition classes on which the final harvest should be deferred. If during certain periods planting is not feasible for one reason or another, cutting of overmature unit areas needing artificial regeneration can be deferred until such time as planting or seeding can be carried out.

Overmature condition classes vary in age from 300 to 600 or 700 years. Usually the decision on whether to cut or defer a unit area will be based on its relative thriftiness. The older and more decadent unit areas will be cut now, and the more thrifty and less decadent ones cut in a later cutting cycle. The proportion of risk trees in a unit area also is a guide. Unit areas with a large percentage of risk trees should be cut rather than deferred. Risk trees should be removed from the unit areas on which final harvest has been deferred.

On the Blacks Mountain Experimental Forest release of poles was given first priority after risk trees had been cut. As a result more than two-thirds of the pole stand had been released at the time of the inventory in 1949. Since then the overwood has been removed from most of the remaining unreleased pole stands. Consequently most of our present cuts in overmature unit areas are coming from unit areas with a seedling and sapling understory or from areas needing regeneration. Therefore the condition of the overstory is the main controlling factor in selecting unit areas for cutting. In order to provide for a cut in each compartment in each 20-year cutting cycle, we have set up 8,000 board feet per acre as the desired reserve after our current cuttings. Although the reserve has fallen below this on some compartments because of a preponderance of very old condition classes, on most compartments we have had no difficulty in keeping a heavier reserve. The original volume averaged about 18,000 board feet per acre. All compartments now being cut have been cut over once or twice in the past.

Marking

The complexity of the forest prevents drawing up hard and fast cutting or marking rules that will cover all situations encountered in the forest. Consequently marking rules should be in the nature of guides only, and emphasis should be on objectives. The marker should use his silvicultural knowledge and his ingenuity in order to best meet the objectives rather than slavishly following detailed rules.

During marking some kind of mapping is desirable in order to locate areas where subsequent work such as rodent control, site preparation, and planting is to be done. A high degree of accuracy is not required because the main purpose of the map is to identify the areas so that they can be readily found.

Regeneration

Regeneration quite often is the most critical problem facing the forester. If his efforts to secure prompt restocking fail, his forestry enterprise will, of course, ultimately fail. If artificial methods are necessary, regeneration can be one of the most costly phases of forestry. This is the most compelling reason to take advantage of means of securing natural regeneration whenever possible.

When seed years are infrequent, as they commonly are in ponderosa pine, some means of artificial regeneration are necessary. Insofar as is practical, then, regeneration cuts should be made during years of a good seed crop. Unless there are units of the working circle with a concentration of unit areas needing regeneration it is not practical to save up areas for regeneration cutting in seed years. Consequently the usual procedure would be to have a regular planned program for regeneration cutting and secure regeneration by natural means during seed years and by artificial means in other years.

I would like again to emphasize the importance of timing for natural reproduction; cutting, slash disposal, eradication of competing vegetation, and rodent control must be completed before seed fall.

Various types of so-called brush rakes or tractors have been quite successful in site preparation. In order to keep costs low highly skilled operators are essential.

Why not cut and then wait for a seed crop? In most areas brush and other vegetation would reinvade. The advantage of freshly exposed seedbeds would be lost.

Logging

Basically logging is the same as with other types of cutting. However, a large part of the cutting consists of complete removal of the overwood to release poles, seedlings, and saplings. Consequently an adequate logging plan and careful supervision to prevent logging damage are essential.

One last caution in the application of unit area control. Most timber types are relatively uniform throughout their range. Within that range, however, there will be local differnces in such things as climate, subordinate vegetation, and rodent population. A fundamental principle of unit area control is that treatments must fit stand needs or requirements. Therefore you must consider your own stand conditions when adopting or adapting silvicultural treatments that are successful elsewhere.

Summary

1. Forest stands break down in small homogeneous stand units -- unit areas.

2. The forester keeps desirable tree species in control of the ground by means of silvicultural treatment.

3. What the forester does in managing his stand depends on (a) objectives of the land manager, (b) silvical characteristics of the species, (c) condition of the stand when treatment starts and (d) treatments required to obtain the desired results -- all the treatments and at the proper time.

4. Intolerant species grow best in even-aged groups, consequently even-aged management is desired.

5. In stands predominantly overmature in character, adequate reserves for short cutting cycles are maintained by deferring the final harvesting of some overmature unit areas.

Stripped to essentials, unit area control is, with due consideration of the silvical characteristics of trees, the common sense application of silviculture to the individual unit areas of the forest stand.