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# PRINCIPLES OF SILVICULTURE: CURRENT TRENDS AND THEIR SIGNIFICANCE

by

ROBERT E. BUCKMAN[1] and MICHAEL NEWTON[2]

*(United States)*

## SUMMARY

A public debate is underway in the United States about forest management practices in general and silvicultural practices in particular. The debate stems from environmental concerns for forest land, especially esthetics and watershed protection. It also stems from sharply differing views on the uses to be made of forest land, highlighted by wilderness and recreation use on one hand and timber production on the other. Added to the controversies are rapidly increasing uses of forest lands for a variety of purposes.

Clearcutting practices on National Forests in three States –West Virginia, Wyoming, and Montana– have been the focal point for the debate. There is question whether clearcuting is needed, and if it is needed, cannot the workmanship be improved? Regeneration failures have attracted concern. There is much criticism of watershed management practices and road building techniques. And the charge is made that the Forest Service (the Federal agency administering the National Forests) favors some uses of the Forests and slights others.

The Forest Service has appointed study teams to review the various situations and to make recommendations to improve forestry practices. Independently, there have been reviews of the situation by groups outside the Forest Service including one by a Committee of the United States Senate.

The Forest Service has responded to these concerns and recommendations in a number of ways including: improved clearcutting practices with special attention to esthetics, deferral of harvesting if prompt regeneration cannot be assured, searching for alternatives to clearcutting, and striving for better balance in multiple use practices. There is also recognition that the scientific foundation must be strengthened for silvicultural and related forestry practices.

Changes are taking place, too, in the administration of public policy for forest land. Administrative and professional discretion is being curtailed and centralized. The courts increasingly have rendered decisions that were once made by administrators. There is a search by land administrators for better decision-making methods, including more public involvement and better land use classification.

Although the controversies have focused on the National Forests and the Forest Service (custodians of about one-fifth of the forest land in the United States), changes are being made in the silvicultural and forestry practices of other public and private owners of forest land as well.

[1] *Director. Pacific Northwest Forest and Range Experiment Station, USDA, Forest Service, Portland, Oregon.*

[2] *Associate Professor of Forest Ecology, Oregon State University, Corvallis, Oregon.*

## THE NATIONAL DEBATE

There were and continue to be many separate controversial forest management incidents on public and private land to fuel the debate. However, the National debate took shape and substance from silvicultural practices on National Forests in three States: the Monongahela National Forest in West Virginia; the Bitterroot National Forest in Montana; and several National Forests (Teton, Bridger, Shoshone, and Bighorn) in Wyoming. The issues at stake have involved the three principal divisions of United States Government--Congress, the Executive Branch, and the Courts; thus silvicultural practices and the political and judicial fabric of the Nation have become entwined.

All three controversies arose from concerns of local citizens about questions of clearcutting--in mixed hardwoods in West Virginia, ponderosa pine in Montana, and lodgepole pine in Wyoming. The National Forests in all three States are on mountainous terrain, where the clearcut areas are glaringly obvious. The clearcuts were in areas where timber cutting was new to nearby residents: The last previous harvest on any significant scale on the Monongahela National Forest in West Virginia had been 30 or more years ago and, in the other two States, virgin forests were involved. In all three States, non-timber commodities of the forest--principally wildlife, water, and recreation--were highly important to local citizens. Finally, the silvicultural practices in question all had a reasonable but perhaps incomplete scientific foundation and all were administered by professional foresters, thus suggesting that expectations of citizens were not in harmony with contemporary professional practices.

In each of these instances the Chief or other administrative officers of the Forest Service appointed study teams which issued reports including recommendations for corrective action (1, 2, 3). Even as these studies were nearing completion, the Chief appointed a team of senior Forest Service officials to examine and report on silvicultural practices on all National Forests in the United States (4).

All of these study teams were drawn from the Forest Service itself. This has resulted in complaints from critics who felt that such teams could not objectively evaluate programs of their own agency. Reviews of the individual situations have included such independent studies as the one prepared by Dean Arnold Bolle and associates (5 the Bolle Report) of the University of Montana about the Bitterroot National Forest. The situations have also included much attention in the National and local news media, and hearings before the Subcommittee on Public Lands (hereafter called the Church Committee after its chairman, Senator Frank Church of Idaho) of the U.S. Senate (6, 7).

## INTRODUCTION

A public debate rages around forest management practices in general and silvicultural systems in particular in the United States today. Although the debate centers on policies of the Forest Service, U.S. Department of Agriculture (Custodians of about one-fifth of the forest land in the United States), it has direct implications for other Federal and State agencies which administer forest land and indirect implications for owners of private forest land as well. Much of the debate focuses on the practice of clearcutting. And, since the criticisms are directed at clearcutting, inevitably we must examine alternative silvicultural systems.

Why should this debate be important to silviculturists? It is of major interest because lay-citizens and various political and social institutions of the United States are concerned about forestry practices that heretofore were largely the responsibility of professional land managers. There is resentment and bewilderment on the part of some foresters to the questions and criticisms, and an uneven, oftentimes reluctant, response to them. An outgrowth of the debate is that some of the administrative discretion formerly in the hands of professionals is being replaced by laws and regulations and by court decisions.

Although political and social institutions of the industrialized countries of the World differ, it appears that debates and reviews of the kind described herein are being conducted in, among other countries, Finland, Canada, Russia, and a number of the West European countries. Similarly, public concern over land management is apparent in the developing nations, for example, the Philippines.

Although the causes of the controversy in the United States are complex, at least two loom large: (1) environmental concerns, especially questions of esthetics and watershed protection, and (2) strongly conflicting views of land use epitomized by recreation and wilderness groups on one hand and by commodity groups, especially those oriented towards timber, on the other. We should also add that both commodity and non-commodity demands on forest land all over the United States are increasing rapidly, thus adding to the dilemma.

In addition, the Council of Environmental Quality (created by Congress in 1969 to advise the President on environmental questions) commissioned deans of five highly respected forestry schools to report on clearcutting practices in various sections of the country (8). The debate was further heightened when the President seriously considered and then declined to issue an Executive Order placing restrictions on the practice of clearcutting[2/] (9). And finally, legislation has been introduced in Congress that would place a moratorium on clearcutting on Federal lands, pending completion of a 2-year study by an independently appointed commission. While the legislation has not come before the U.S. Congress for a vote, and is not likely to do so in the near future, informed opinion at the height of the controversy suggested that a moratorium on clearcutting on Federal lands might indeed be enacted were it to be voted on.

## CRITICISMS OF FOREST MANAGEMENT PRACTICES

The problems arising from these individual issues and the national debate stemming therefrom have already had a considerable impact on silvicultural practices on Federally owned forest land and have resulted in altered practices on other ownerships as well. In the remainder of this paper, we will touch on specific issues, describe trends in forest management and silvicultural practices, and speculate about what this means for public policy related to forestry in the United States. The summaries reported here, except as identified by individual reports, represent widely held views.

## CLEARCUTTING AND ESTHETICS

With few exceptions, professional and scientific participants (though not necessarily laymen or politicians) recognize clearcutting as ecologically sound and economically desirable in many situations for many commercial forest types of the United States. There is also agreement that the workmanship of all forestry practices, and especially clearcutting, must be improved.

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2/ The Executive Order would have applied to forestry practice on Federal land. In the main it would have enunciated policies already used by the Forest Service, Department of Agriculture, and the Bureau of Land Management, Department of the Interior. However, as an Executive Order, it would have permitted court tests and litigation over each Federal timber sale involving clearcutting.

Visual impacts draw most complaints because clearcuts often are large, fail to blend with natural features, are angular or symmetrical, and exhibit highly visible soil disturbance due to logging and road construction. Windthrow often adds to visual impacts on edges of clearcuts. Unsightly site preparation methods and slash handling techniques are also criticized. Particularly objectionable are terracing activities preparatory to planting on the Bitterroot National Forest, and the use of large crawler tractors to push logging debris into prominent piles and windrows.

## WATERSHED MANAGEMENT PRACTICES AND ROADS

Much concern has been voiced for protection of streams from logging equipment and debris, and from destruction of riparian vegetation. Sedimentation resulting from road construction, from outright road failures, and from logging disturbances were also major sources of concern.

Perhaps the most startling single contention surrounding the controversy was the assertion before the Church Committee by Dr. Robert R. Curry (6, pp. 157-174) that as few as one to four cycles of clearcutting would lead to virtual elimination of the nutrient capital of forest soils. Dr. Curry's hypothesis was based in large part on the nutrient losses experienced in the planned but drastic watershed treatments of the Hubbard Brook Experimental Forest in New Hampshire. His claims have since been tempered and modified by others to such an extent that his conclusions are largely rejected by the scientific and professional community. Nevertheless, the implications of his assertion have focused attention on soil and water problems surrounding forestry practices as have few other events.

Much of the concern over silvicultural practices stems from the design and placement of roads used for timber harvesting. The concerns include:

--excessive number of temporary logging roads, often associated with logging by short-reach cable systems or crawler tractors.

--failure to abandon temporary roads after timber harvest.

--road failures resulting from inadequate attention to soil and geological characteristics.

--excessively wide roads poorly fitted to the topography.

--inadequate landscape considerations.

--inadequate stabilization of cuts and fills, and failure to clean up rights-of-way.

## REGENERATION

Regeneration failures also account for much of the attention of the various task forces and of the critics. These lands generally are the droughty sites on south-facing slopes in the West, upper elevation areas with high solar insolation, frost-pocket areas, and areas with high potential for invasion by brush species.

Forest types, identified in various reports, that are especially prone to regeneration failures include the true firs of the Sierra Nevada Mountains of California; true fir-Englemann spruce type of the central and southern Rocky Mountains; lodgepole pine stands in the central Rocky Mountains; and the mixed conifer types (Douglas-fir-Englemann spruce-ponderosa pine) of southwestern United States. Eastern forest types that present special regeneration difficulties are the oak forests of central United States and the black cherry-sugar maple subtype of northeastern United States.

## MULTIPLE USE VALUES

Forest Service study teams found much to criticize in the practice of multiple use on National Forests. Non-Forest Service participants are even more vehement in their criticism. The charge is made that the National Forests are managed primarily for timber production; watershed, wildlife, recreation, and the other uses of forests receive short shrift.

There was widespread recognition that multiple use planning is not the integral part of Forest Service activities that it should be, and that multiple use must be incorporated into the day-to-day decision-making process of the Forest Service. There was also widespread recognition that neither funds nor manpower have been provided the Forest Service or other public agencies to carry out a balanced program of multiple use.

# TRENDS IN SILVICULTURAL AND FOREST MANAGEMENT PRACTICES

## QUALITY OF MANAGEMENT AND CLEARCUTTING

Even as the stirrings of controversy began, steps were being taken to improve the quality or workmanship of forestry practices by the National Forests and by various other land managing agencies as well. Implicit in these procedures was the admonition that the quality of the forest environment must not suffer at the expense of timber production goals. So stringent has this admonition become that forest administrators are reducing allowable cuts in many areas of public timber, thereby arousing concerns for the well-being of forest industries in timber-dependent communities. There is also concern by officials in the Executive offices of the President that timber supplies may impede construction of new housing.

Clearcutting is but one part of the quality question, albeit the most prominent one. The report of the Church Committee (10) perhaps best sets the stage for what may well be the future role of clearcutting on Federal lands. The report states that clearcutting should not be used where:

a. Soil, slope or other watershed conditions are fragile and subject to major injury.

b. There is no assurance that the area can be adequately restocked within five years after harvest.

c. Esthetic values outweigh other considerations.

d. The method is preferred only because it will give the greatest dollar return or the greatest unit output.

The report further states that clearcutting should be used only where:

a. It is determined to be silviculturally essential to accomplish the relevant forest management objectives.

b. The size of clear-cut blocks, patches or strips are kept at the minimum necessary to accomplish silvicultural and other multiple-use forest management objectives.

c. A multidisciplinary review has first been made of the potential environmental, biological, esthetic, engineering, and economic impacts on each sale area.

d. Clear-cut blocks, patches or strips are, in all cases, shaped and blended as much as possible with the natural terrain.

## ALTERNATIVES TO CLEARCUTTING

Aside from reducing the size, shape, and placement of clearcuts, the search for alternative silvicultural systems has been intense. The Bureau of Land Management has adopted the term "continuous canopy management" to describe a concept of timber management. The concept incorporates the traditional goals of providing for and enhancing regeneration of the forest and future productivity. However, a new dimension is added: That forest land shall be continuously occupied by visible trees. In over-simplified terms, the concept can be described as a shelterwood system wherein the final cutting of overstory members of the original stand is postponed until regeneration is established and has grown to a height that covers previous stumps and debris.

Shelterwood systems are being used elsewhere whenever they are suitable; indeed, it is likely that shelterwood systems are being used in such questionable situations (for example, in areas subject to windthrow or in areas prone to diseases such as dwarf mistletoe) that the practice later will have to be modified or abandoned.

The single tree or group selection system often is used on roadside or scenic zones in order to maintain high forest cover. For several forest types this practice is likely to result in significant changes in forest composition as the proportion of shade-tolerant species increases in the stands. Nevertheless the selection systems are likely to be used in these esthetically important zones with full recognition by foresters that continuous high forest cover is more important than maintenance of several species which may be faster-growing and more valuable commercially.

A form of selection management was recommended in the Bolle Report (5) for old-growth virgin forests of the Bitterroot National Forest. This practice, called "timber mining" by its proponents, would remove the larger, more valuable timber, leaving the inferior trees to provide continuous cover for esthetics, wildlife cover, and watershed protection. The practice recognizes that old-growth timber has high immediate value for local industry, but that these lands, because of low site quality, will be relatively unimportant for future timber production. No matter what are the economic merits of this suggestion, it has been rejected by public land managers as a violation of both the spirit and intent of sustained yield forestry. The term "timber mining" alone is sufficiently controversial to cause rejection of the practice.

A related but more benign form of the selection system called "pussyfoot logging" was recommended by the study team for the National Forests of Wyoming (3). Here light selection cutting would be used as an interim measure in old-growth forests until such time as critical regeneration problems are solved.

Silvicultural practices are being modified increasingly to reflect a growing sensitivity to the nontimber values of trees and stands, including preservation of den trees for wildlife, nesting trees for birds, esthetically pleasing flowering trees and shrubs, and attractively formed but defective trees. There is a much greater willingness by forest managers to leave buffers of trees along roads, trails, and stream courses for screening and environmental protection. For example, the allowable cut plan implemented in 1971 by the Bureau of Land Management for its western Oregon forest lands forewent 48 million board feet of annual production for multiple use recognition and environmental protection.

There is also a much greater willingness, in fact a mandate, on the National Forests to postpone timber harvesting if regeneration cannot be assured, or if logging methods result in excessive soil damage or impaired water quality.

Paradoxically, thus far, there has been relatively little attention to adverse environmental impacts from alternative silvicultural systems. For example, selection and shelterwood systems require more roads than clearcutting to reach the same volume of timber. They require a greater frequency of logging operations. And they often aggravate the problems of slash disposal and brush invasion.

## MULTIPLE USE MANAGEMENT

The Forest Service is charged by law to manage the National Forests under multiple use-sustained yield principles (Public Law 86-517). Other public and many private forestry agencies, either by law or policy, also operate in varying degrees under this concept.

Questions of silvicultural practices quickly involve the multiple resources of the forests. The Chief of the Forest Service has pointed out repeatedly in recent years that Forest Service programs are out of balance in terms of the various resources. From 1954-1970 the Forest Service received from Congress 66 percent of the budget increases requested for timber sales administration, only 20 percent for recreation and wildlife, 17 percent for reforestation, and 15 percent for soil and water management. This budget imbalance has been recognized by both friends and critics of the Forest Service. Better balance in funding has been slow in coming, however.

The Forest Service, and other public and private forestry agencies as well, are taking an increasingly liberal view about using funds and other resources heretofore designated for timber management to perform other of the multiple use activities. Thus, in regenerating a new forest, or harvesting an existing one, wildlife habitats must be provided for, slash removed that would interfere with grazing animals, stream courses protected and restored if necessary, and recreational trails maintained or repaired, all as part of the timber management activity. There are fiscal, legal, and policy limits to these activities in most public and private organizations, however, that preclude an adequate job of multiple use management.

## RESEARCH NEEDS

The inadequacy of professional and scientific knowledge is revealed almost without exception in every recent study of forestry practices in the U.S. Practically no area of silvicultural and related research has escaped notice in the various studies. Among the most frequently cited research needs are:

--A wider array of silvicultural options to meet multi-resource needs.

--Better understanding of the inter-relationships between management of timber, wildlife, water, forage, esthetics, and recreation, including questions of nutrient cycling.

--Improved techniques for prompt regeneration of several key timber types.

--Better control of insect and disease pests that restrict the choice of silvicultural systems.

--Better prescriptions for or alternatives to the use of chemicals and fire as silvicultural tools.

--Reduced soil disturbance, erosion, and esthetic impairment through use of a wider array of logging equipment and techniques, including helicopters, balloons, and long-reach cable systems.

--Better practices to minimize adverse impacts of site preparation, road building, and forest residues.

--More effective decision-making aids to rank and compare alternative management options and their consequences.

## TRENDS IN PUBLIC POLICY

Out of these considerations we see two trends in public policy related to forest land: (1) further reduction of administrative and professional discretion, and (2) a search for better methods to resolve land-use conflicts.

### REDUCTION IN ADMINISTRATIVE AND PROFESSIONAL DISCRETION

The broad discretionary authority over administration of public land by professional foresters is being circumscribed increasingly by legislative, judicial, and executive processes. Many foresters view this loss of discretion with alarm; others see it as a way to give better direction to public policy, thus reducing the seemingly interminable conflicts that surround land-use questions.

Congress in recent years has passed a number of laws to guide better public policy in forestry and conservation in the United States and has additional proposals under consideration. Examples of enacted key laws include (1) the Multiple Use-Sustained Yield Act of the Forest Service (Public Law 86-517),

which prescribes uses of the National Forests; (2) the Classification and Multiple Use Act (Public Law 88-607)[3/] which prescribes uses of unreserved public domain administered by the Bureau of Land Management; and (3) the National Environmental Policy Act (Public Law 91-190), which spells out a national policy of environmental protection, including procedural steps to ensure review of significant Federal actions for possible adverse environmental impacts and to review alternatives. Still another large group of laws have been passed or are being considered which places Federal land, and through purchase or condemnation, other lands as well, in special-use categories including Wilderness, Parks, Wild and Scenic Rivers, Trails, Recreation Areas, and Wildlife Refuges. These classifications severely restrict or eliminate timber harvesting and other forestry practices on the classified lands, thus removing discretion formerly in the hands of the land administrator.

The legislative role goes beyond the passage of laws; it includes a supervisory and investigative function in both Federal and State government. The Church hearings on clearcutting (6, 7, 10) represent one such investigation, and a 5-year study of public lands by the Public Land Law Review Commission (11) represents another. The reports stemming from these investigations do not carry the force of law. However, failure to consider the findings carries with it the risk that laws will be enacted, appropriated funds will be reduced, or additional investigations will be conducted.

The laws passed by Congress (and State and local governing bodies as well) serve as the basis for the increasing numbers of court tests of forestry practices. Several timber sales and other land management activities (e.g., recreation developments, mining operations, dam construction) on Federally owned land have been suspended, pending resolution of questions in courts. Indeed so popular has this route become, that environmental and conservation groups are increasingly challenging many aspects of forest management in courts. There is growing concern in the United States on the part of some administrators of both public and private programs that the courts are increasingly usurping what were formerly administrative prerogatives.

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3/ The Classification and Multiple Use Act (of the Bureau of Land Management) expired in 1970. Congress is now considering an organic act for the unreserved public domain which would continue on a permanent basis the concepts of the Classification and Multiple Use Act.

Heads of all levels of executive governmental units--including elected, appointed, and career (oftentimes, professional) officials--are under increasing pressure to set down more precisely the rules under which they conduct their business. As these rules are spelled out in greater detail and clarity, the discretion of the forest manager and silviculturist is further limited. This trend is likely to continue, with authority gravitating increasingly upward in governmental hierarchy.

State and local governments, too, are in many cases following courses parallel to that of the Federal Government in prescribing improved environmental protection and better forestry practices. And several of the larger timber companies in the United States have sharply curtailed forestry practices that the public finds most objectionable.

## SEARCH FOR BETTER DECISION-MAKING METHODS

Out of the controversies has come a search for better mechanisms for on-the-ground direction of forestry practices. Among these are:

Creation of Multiple Use Teams--These are interdisciplinary groups of varying size. Their job is to inventory the resources of a given tract, identify areas where for one reason or another (esthetics, fragile soils) timber harvesting or other intended uses must be limited, and then recommend alternatives to administrative officers. Public hearings are often a part of this procedure. Following review of recommendations and hearings, administrative officers then adopt an appropriate course of action.

Public Involvement--Review of proposed programs or alternative courses of action at public meetings is used increasingly by public agencies to guide forestry activities. Indeed, many of the special studies of forestry practices pointed to inadequate communication between land managers and the public; recommendations to strengthen public participation in forestry decisions were many. Experience has been that it is difficult to resolve the often conflicting points of view brought out at public meetings or to evaluate the weight of opinion of participants. Nevertheless, public involvement has become a standard procedure; while it has limitations as a decision-making mechanism, it has the virtue of giving the public a sense of direct involvement in deciding how forest land is to be used.

Better Decision-making Models--There is a search by both scientists and administrators for better decision and resource allocation methods through the use of economic, mathematical, and computer techniques. These methods thus far have had only peripheral impact on forest management practices, because they have been unable to cope with the breadth and complexity of problems or have lacked the necessary forest resource data.

## IMPROVED LAND-USE CLASSIFICATION

Much of the acrimony over public land stems from conflicting land uses. The Public Land Law Review Commission (11) and four of the five deans (8) recommended better land classification systems, within the overall concept of multiple use. Implicit in their recommendations is dominant or primary use (either timber, or livestock, or wildlife, or recreation) with such secondary uses permitted as are compatible with the primary use. These recommendations have not yet been implemented. There is concern on the part of many, including forest administrators, that dominant use might become exclusive use and that rigidities will be introduced into land use that will become a liability as public needs change. Nevertheless, while not yet implemented, these recommendations indicate that conflicting land use is at the heart of many of the dilemmas facing forestry, that multiple use concepts provide little guidance about how public lands should be allocated among many various uses, and that some hierarchical assignment of uses among individual parcels and tracts is needed.

## IN PROSPECT

The involvement of the public in silvicultural decisions has major implications for future silvicultural developments. These debates have required foresters to examine silvicultural systems with new perspectives. In responding to challenges, foresters have either identified weaknesses in their own analyses or have found new supportive evidence for existing practices. Challenges by the public and by their political and social institutions have clearly been among the important stimuli for new approaches.

We can expect the debates to continue. At this time the National Academy of Science is examining the questions of clearcutting and nutrient cycling. Former Secretary of the Interior, Fred Seaton, is heading a committee appointed through the Executive Office of the President to study questions of timber supply and forest environment. Forest practices will be continually updated, with an increasingly broad basis in physical and social science. Foresters will be increasingly responsible for communicating to the public as to necessities, compromises, and mutual benefits of various practices.

The increase in communication between foresters and the general public is expected to have two important consequences. Users and managers of forests will have more opportunity for discussion of mutual problems, hence, to generate mutual respect. Also, new forest practices will be adopted as the result of such free discourse. We hope that these developments will insure the application of broadly based multiple use management, and that this can be accomplished with minimal compromise of scientific or economic excellence.

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