Silviculturists have had less influence on the early development of "New Forestry" than other resource specialists. As management objectives become more clearly defined and desired stand conditions are identified, silviculture will play a major role in developing practices to attain them. Silviculturists can provide several contributions to on-going discussions: knowledge regarding the heritage of conventional practices, techniques for developing new practices, and other information pertinent to resolution of many issues and problems. The latter may include information on stand dynamics, silvical traits and silvicultural systems, opportunities afforded with planting, and rotation age and mean annual increment.

Silviculturists and other resource specialists must work together and develop an array of sound practices and strategies, which in combination, can provide the commodities and amenities desired in our forests.
INTRODUCTION.

Our assigned task is to discuss the role of silviculture in the development of New Forestry—or New Perspectives in Forestry—in the Pacific Northwest. Actually, there has been relatively little influence to date of either silvicultural science or silviculturists in these movements. And understandably so. Silviculturists traditionally have been assigned to timber staffs, and they are viewed by many (and perhaps some silviculturists view themselves) as advocates of timber programs. Because a major thrust of New Perspectives is to move away from management philosophies dominated by timber production toward greater consideration of other values, it is fitting that other resource specialists—ecologists, hydrologists, and wildlife biologists—have been the major contributors in developmental stages of these movements (Franklin et al. 1984; Franklin 1989). But as specific objectives become more clearly defined and desired stand conditions are identified, silviculturists and silvicultural science can be expected to play a major role in developing technology needed to attain them. And silvicultural activities will be the primary mechanism by which forest habitats are manipulated.

But even during this present, rather fuzzy stage in the evolution of forest management and land-use decisions, silviculturists can play a useful role—at least in a general sense. There are contributions that silviculturists can make and should be making in the current quest for an improved and sustainable forestry—one that is more socially acceptable, more economically viable, and more ecologically sound than what we have today (cf. DeBell 1990). Silviculturists can contribute information and
perspectives which are to some degree unique and are lacking in much of the present discussion. These include:

(1) the history or heritage associated with current forest management practices.

(2) techniques and approaches for development of new management practices, and

(3) information pertinent to the resolution of many current issues or problems.

HERITAGE OF CURRENT FOREST MANAGEMENT PRACTICES

Much if not most of the institutional memory with regard to the heritage of forest management in the West resides in the silvicultural community. Other resource specialists--and even many young silviculturists--commonly lack such background understanding. This forest management heritage includes a knowledge of major obstacles and problems overcome (the hows and whys of both problems and solutions) and of the many and very real accomplishments of the past 75 years. It also includes a cautious attitude that comes from past embarrassments associated with widespread adoption of untested practices, and from major changes over time in what is deemed to be good stewardship as well as marked changes in the inferences drawn from well-designed, long-term experiments.
The greatest obstacle to management of western forests in the early decades of this century was the threat of catastrophic fire. Suppression techniques and fire control organizations were prerequisite to any form of management. Approaches also had to be developed for seedling production and planting. Early on, decisions were made to replant and suppress fire on burned-over and cutover lands on National Forests. The growth capacity of young Douglas-fir was not well-defined until McArdle published Bulletin 201 on growth and yield of unmanaged stands in 1930. This publication led to similar decisions by private owners to replant, protect, and manage their timber lands after harvest. Such decisions to stay and invest—rather than cut and run as had been done elsewhere in the country—were milestones in forest conservation. Unfortunately, the current controversy over preservation of additional amounts of residual old-growth on federal lands—and the rhetoric associated with it—has all but obscured such significant accomplishments and investments by the forest industry, states, and other landowners. As an aside—any solutions to current forest management issues that do not provide a favorable environment for investments in non-federal timberlands are likely to create more problems—ecological, social, and economic—than they resolve. For example, we have already seen accelerated, premature cutting of young timber on private holdings in some parts of the Northwest, presumably caused by the uncertainty of future harvest restrictions and very high stumpage prices created in part by severely limited public timber sales.

Another aspect of our forest management heritage is humility and skepticism developed as a consequence of past mistakes. Some of the biggest blunders were associated with widespread adoption of untested and
sometimes highly touted practices. One of the most embarrassing was the selective cutting episode of the 1930's and 1940's (Smith 1970). It was proposed as a remedy to economic problems of the 1930's, and it was launched with a persuasive publication touting its merits and prefaced with a glowing endorsement by the Chief of the Forest Service (Kirkland and Brandstrom 1936). Although selective cutting became Standard Policy in Region 6, it was found wanting on a number of accounts—ecological and economic (Isaac 1955). Finally, it was buried with a minimum of ceremony—so much so that many young foresters are not even aware of it. In the 1960's, another blunder was committed: the attempted transfer of management technology that had been very successful in low- and mid-elevation forest to upper-slope forests—namely clearcut, burn, and plant Douglas-fir. Many of the harvested areas in the high elevation true fir-hemlock types are now occupied by well-stocked young stands, thanks to natural seeding from adjacent stands. The planted Douglas-fir in most areas, however, are few in number and undistinguished in growth rate. Of lesser importance, but equally pertinent was the containerized regeneration fad of the 1970's. Theoretically, plug seedlings had several advantages over bareroot stock, and advocates convinced many decision-makers that reforestation was best accomplished via such technology. Some forest landowners discontinued long-established arrangements for bareroot production, much to their later dismay. Time and research revealed the advantages and shortcomings of various stock types and also led to improved methods for producing both container and bare-root stock. Containerization may be desirable for some species and some sites, but it appears that bareroot stock will continue to occupy a dominant place in reforestation in the Pacific Northwest.
Such past mistakes and embarrassments foster a bit of healthy skepticism when practices—though theoretically useful and desirable—are highly touted and widely implemented prior to any preliminary testing.

Some silviculturists have drawn parallels between certain aspects of New Forestry and these old embarrassments. Such remarks have not always been offered in the most diplomatic manner, nor have the rejoinders from advocates, but they do provide useful background to aid in evaluating current problems and proposed solutions.

A closely-related matter is the perspective provided by long-term experiments. Silviculturists in the Pacific Northwest are fortunate to have a number of studies that provide 60-80 years of record. These experiments involve topics ranging from selection of species and seed sources to questions related to stocking and to the influence of associated vegetation such as red alder on forest and soil development. It is an odd study that does not include evidence of drastic changes in interpretation over the years—sometimes the take-home lesson has reversed. Early performances and/or appearances were not good indicators of conditions as stands approached maturity. The magnitude and importance of such changes argues for a system of well-designed and implemented studies to assess the merits and drawbacks of current and newly proposed practices.

The knowledge of forestry heritage should help us to retain the gains already made in forest conservation and prevent problems already solved from reappearing. It should also help us avoid new problems as new approaches are devised to meet additional management objectives.
The second general contribution that silviculturists should be making is in assessment and development of new forest practices. This contribution will occur primarily at the stand level; other resource specialists have more experience—and greater need—to work at the landscape and forest levels. Most silvicultural knowledge rests on experimental science—that is, research involving manipulation of factors in designed studies with quantitative assessments of biological responses. In contrast, much of the science that now provides the foundation for New Forestry can be characterized as descriptive ecology, and most proposals for specific practices are based largely on hypotheses derived therefrom. Considerable speculation is involved in statements as to what is and what is not ecologically desirable (e.g., spotted owl habitat), and what may or may not be socially acceptable (e.g., aesthetic or recreational value). Matters relating to economic effects are even more uncertain. Such descriptive work and speculations have been useful in broadening thinking and developing interest in changed or improved forestry practices. There are, however, many questions related to benefits, costs, and risks of various kinds. These questions can best be resolved with a well-designed network of planned comparisons.

Unfortunately, experimental work on some questions (for example, wildlife habitat) may take decades to obtain reliable answers. Yet in the near term, management decisions must be made; thus shortcuts are needed to provide a reasonable base for them.
Silviculturists can help with methods to provide such interim information more quickly and efficiently. They have made considerable use of retrospective studies; that is, studies which analyze the characteristics and past development of stands already in existence. This is commonly done by historical reconstruction techniques such as stem analysis. Such studies should be conducted in stands now manifesting desired attributes and perhaps also undesired attributes; these will provide information on how the stands arrived at their present state and what might be favored—or avoided—in the way of silvicultural interventions at earlier stages of stand development.

Another matter to consider is far more general—research and development cooperatives. For the past 25 years, much if not most of the development and refinement of intensive cultural practices has been accomplished through formal research cooperatives. These cooperatives are commonly based at public universities and consist of many organizations interested in specific topics or cultural practices. Examples include the Tree Improvement Program at North Carolina State University, the former Regional Forest Nutrition Research Program at the University of Washington (now part of the regional Stand Management Cooperative), and the recently established Hardwood Silviculture Cooperative at Oregon State University. Such cooperatives provide for pooling of financial, human, land, and biological resources; and through them it has been possible to collect data and test or model relationships far more effectively than could have been done by any single organization.
In short, silviculturists have considerable experience with experimental science at the stand level, retrospective analyses, and multi-organization research cooperatives. These approaches will undoubtedly be useful in the quest for new and improved forest practices.

INFORMATION PERTINENT TO CURRENT ISSUES

The third area for silvicultural contributions involves existing information that is pertinent to many current forestry issues. Many examples could be discussed, but we have selected four: (1) stand dynamics, (2) silvical traits and silvicultural systems, (3) options and opportunities afforded with planting, and (4) rotation age and mean annual increment. Information on these subjects should contribute importantly to decisions and practices involving management of the tree component of forest ecosystems. But there seems to be a lack of general understanding surrounding each by many individuals and organizations—even within the ranks of professional resource managers.

Stand Dynamics

Information on stand dynamics does not reside exclusively in silviculture; in fact, it could be argued that the subject is primarily population ecology. Unfortunately, participants in the old-growth controversy and other forest issues have given short shrift to this subject of continuous change in the forest. Photos and films of old-growth forests have depicted cathedral-like groves and relatively intact stands. The public has been offered few, if any, illustrations of old-growth stands.
where little or no Douglas-fir remain; where most of the residual dominant hemlock and true fir have broken tops and extensive heart rot; and where the developing understory thickets of true fir and hemlock are heavily infested with dwarf mistletoe. The contrasts generally provided have been between beautiful intact old-growth stands and new clearcuts. This is unfortunate because, in actuality, we cannot provide cathedral groves for our grandchildren and great grandchildren by simply preserving more of today's old growth. Rather, the magnificent stands of the 21st century will have their origin in today's 120- to 180-year-old stands, many of which were established following severe fires in the early 1800's. If we want to ensure the old-growth experiences that we enjoy for future generations, we should turn our attention to these "mature" stands of today. Similar shortcomings exist in relation to portrayals of young forests, particularly plantations. Illustrations and descriptions have tended to focus on the most uniform phase of stand development—that which occurs soon after crown closure; and before differentiation among trees sizes and competition-related mortality have resulted in considerable horizontal and vertical diversity. The latter developments are inevitable as evidenced in most older, unmanaged stands. It is also important to realize that the rate and nature of change can be profoundly affected by silvicultural practices. For example, one of our long-term thinning studies was established in a 40-year-old stand some fifty years ago. Plots which remained unthinned were quite dense at age 90, with little undergrowth or multiple layering of the canopy. In contrast, plots that were thinned periodically have developed a diverse, lush understory and multi-layered, multi-species tree canopy.
We need to foster greater understanding among forest resource professionals and interested publics of the following facts: that each stand goes through varying stages of forest development, that each stage provides for some values better than is provided by other stages, and that sustainability of all values will require a balanced distribution—in time and space—of many stages. Actually, the opportunities to provide such a mix are far greater today than they were 50 years ago when old growth dominated many forest drainages on public lands. We believe such general appreciation of stand dynamics will be helpful in reaching consensus on forest management issues, but it will not be fostered by a continued focus on cathedral-like groves of old growth, new clearcuts, and 20-year-old plantations.

Silvical traits and silvicultural systems

The major point to be made relative to silvical traits and silvicultural systems is that there is far more latitude in the management of forest tree species than many people think; certainly more than can be inferred from observations of species traits in unmanaged environments. Some natural constraints are easily overcome by management, and at times even those of us who are professional foresters tend to forget it. The notion, for example, that western redcedar is slow-growing and has limited management potential has been fostered by the fact that in most natural stands the species became established as a late-arriving component of the understory in mixed stands that contained rapid growing, long-lived species. Our studies suggest that young-growth cedar established in pure stands—or established concurrently with other species in mixed stands—may
equal the growth and yield of Douglas-fir and western hemlock on many sites (Nystrom et al. 1984). Every time a news article refers to Pacific yew as an extremely slow-growing tree found almost exclusively in the understory of old-growth forest, we can't help but wonder if management opportunities similar to those with western redcedar may not also exist for Pacific yew.

At any rate, the silvical characteristics of the species and the environmental conditions of the Douglas-fir region offer latitude for much greater differences in silvicultural approaches than one would surmise from viewing presently managed forest landscapes. A wide variety of silvicultural systems have been used successfully over the years throughout the world, but for the past 30 years North American foresters have relied mostly on even-aged systems (and primarily on one of these--clearcutting) in both research and practice. This is particularly true in the southern pineries and in the Douglas-fir region. We have done this because clearcutting is the system of choice on most sites if our primary interest is wood production. Yet we suspect that the continued intensive attack on clearcutting is due at least in part to the fact that we are not using a wider range of silvicultural systems, even when such alternatives are suitable. And we further suspect that the survival of clearcutting as a viable tool may hinge on the willingness and ability of foresters to apply other systems when circumstances permit. One example of a system that can be--and has been--applied successfully in the Douglas-fir region is shelterwood cutting, with and without planting. We need to experiment with new applications of different systems. It seems unlikely that we have achieved the only or the best practical solution to sustained tree production on many sites, and even less likely that we are providing an
optimum mix of forest conditions and values on public lands and other lands where such multi-purpose management is deemed appropriate.

The Planting Option

It may seem peculiar to discuss so simple a topic as planting. A discussion of planting, however, can serve as a surrogate for other cultural practices—such as genetic improvement, fertilization, and growing stock control—all of which currently suffer from lack of appreciation in many environmental circles for the opportunities they provide. This problem is due in part to the recent spate of misleading and erroneous information on plantation forestry, and in part to the naturalistic ideology that permeates much of the current debate over forest management (e.g., Maser 1988; see also response by Aune et al. 1990). In some minds, such ideology is also a keystone of the "New Forestry" and "New Perspectives" movements. This view—that nature knows best—has resulted in some management plans with very fuzzy objectives; it has also restricted thinking regarding practices to attain them. In some cases, forest managers appear willing to ride the "do-nothing" wave—hoping to reduce costs. The end results may be far from those desired. There are many examples throughout our nation's forests where such cost savings in decades past provide examples of what many people would consider poor stewardship; such situations have sometimes been referred to as "Green Lies" because the vegetation, although abundant, is not desirable for wildlife habitat, wood production, or whatever objective one may choose.
Certainly there are situations where natural regeneration is the method of choice, and it should be used in such situations. There are also many situations where the planting option is most desirable. Besides having greater control of spacing and genetic composition of the next stand, there are additional reasons for planting. These might include: a desire to establish stands of different and more varied species composition than those now present (Note: Today many of the most extensive areas of pure, single-aged Douglas-fir forests are of natural origin.); a desire to minimize the period between harvest and re-establishment of tree cover; or a desire to reduce the exposure of mineral soil that would be required for natural establishment of some species.

Another factor to consider is the gain in wood production attained by planting. In the Douglas-fir region this is substantial. Although some gain has been assumed for a long time, few attempts were made to document it until recently. The philosophical attacks on plantation forestry as well as concern about productivity of the ever-dwindling commercial forest land base have stimulated interest in such documentation. And scientists at the Olympia Forestry Sciences Laboratory recently completed two studies:

1. One by Miller and others (1991) showed that volume production of seven 35- to 38-year-old plantations averaged 40% higher than that of adjacent and similarly aged, natural stands. The stands were all established on slashburned clearcuts, located on National Forests in the western Cascades; the planting stock in these comparisons had not been genetically selected and nursery procedures were those used 40 years ago. Today with the improved
seedling production technology and genetically selected seed, gains from planting are likely to be even greater.

2. The second study relates to "cornfield" forests. It is unfortunate that the misleading "cornfield" metaphor has been used to belittle forest plantations. In most of the western United States, one must look hard and long to find this "bogeyman" of extremely uniform, mono-specific stands with negligible shrub or herbaceous understories. In much of the Douglas-fir region, they are rare, and usually are either progeny tests or plantations established on former farmlands. Growth and yield of such stands, however, may be outstanding! A recent paper by Murray and Harrington (1990) indicated that volume production of 24- to 27-year-old plantings on former farmland was 40 to 150% higher, depending on utilization standards, than projected yields of typical natural stands on cutover lands. Possible reasons for such increased productivity include greater site and stand uniformity and fewer problems caused by biological legacies from past forest growth. These potential problems may include nutrients tied up in large organic matter, competition from understory species, and presence of endemic root diseases.

We have not mentioned such findings because we think "cornfield forestry" is an ideal to be implemented widely. Certainly it does not provide some of the values desired by human society. Nor have we drawn attention to the probable relationship between reduced biological legacies on former farmland and improved wood productivity because we wish to
belittle the value of such legacies for other purposes. Rather we mention these topics because they are indicative of a need to broaden thinking about such things in current discussions about management objectives and tools for achieving them. Few things—whether they be "cornfield forests" or "biological legacies"—are all good or all bad. We must evaluate each in terms of desired objectives, assess various trade-offs, and with such information develop better, more acceptable strategies and combinations of strategies for forest land management. Planting and other intensive management practices—and single-use or dominant-use intensively-cultured plantations should be tools—just as are Wilderness Areas and Habitat Enhancement Areas—in the general toolbox as we attempt to meet the multitude of needs and provide the many values that can be derived from forest lands.

Rotation Age and Mean Annual Increment

Rotation or harvest age merits thorough scrutiny in any assessment or reassessment of management alternatives. Many of the issues in forestry today are linked—at least in part—to rotation length and recent trends toward short rotations. Extended rotations, in combination with other practices, offer prospects of:

(1) reduced fraction of land in regeneration and early developmental stages (aesthetically more appealing landscapes; possible hydrological benefits; reduced slash burning; reduced herbicide use).
(2) larger trees, higher quality wood, higher values per unit of volume, and reduced management and harvesting costs.

(3) lengthened thinning cycles, more naturally occurring snags, greater opportunities to manipulate understory and shrub layers; thus better habitat for some wildlife species, and perhaps improved forest productivity.

(4) increased carbon storage (a possible component of policies for mitigating climatic change).

Of many changes in forest practices that could provide additional values, extending harvest age would be the least disruptive. Depending on current age distribution, however, it could result in a temporary reduction in supply from some ownerships and may not be feasible for some owners. But it is something that can be applied to existing stands (i.e.; one does not have to wait till time of harvest). It can utilize existing technology, including well-established techniques of thinning and regeneration, and growth and yield projection systems; thus it poses the least risk.

The feasibility of longer rotations depends in part on effects on timber yields. On National Forest lands, minimum rotation length is set by law to approximate the age at which mean annual increment culminates. Private and industrial owners use rotations based on financial criteria, supply and policy constraints, and additional constraints associated with tax laws and established accounting practices. Many people seem to assume
that mean annual increment patterns and the age of culmination are more or less fixed characteristics for a species and site, and that there is a well-defined peak or age at which culmination occurs. Recent work has indicated that this is not so. Such characteristics are strongly affected by management, and stocking control tends to lengthen the time to culmination. Projections by the DFSIM model (Curtis et al. 1982) suggest that mean annual increment commonly does not show a clearly defined maximum prior to age 100 years in stands that are repeatedly thinned. The curve seems to have a broader plateau than most of us had envisioned. This permits considerable flexibility in the selection of rotation ages that provide essentially similar increment and yield. The projections suggest that mean annual production may be within 5% of maximum for rotation ages that differ by 30 to 35 years or more. With thinning, this may be considerably longer; present models have not been built with data on older ages.

In addition to matters related to non-timber values, we should be concerned about the impacts of short rotations on timber supplies. With 50-year rotations, a regime common on intensively managed industrial lands in the Pacific Northwest, mean annual production may be only two-thirds of that obtainable with longer rotations. The yield reduction associated with short rotation is greater on poor sites than on high sites, and in stands with low stocking than with high stocking. Similarly the reduction is greater if repeated thinning is possible--and it becomes greater as higher standards of merchantability and log quality are considered.
For the past several decades, decisions about rotation length on non-federal ownerships have been influenced heavily by net present value analyses. Several groups in the Douglas-fir region are beginning to question both the net present value approach and the decisions resulting from it. The Washington Department of Natural Resources has wondered if maximizing annual net income and cash flow over the long term may be a more appropriate guide than net present value for managing state trust lands. The needs of trust beneficiaries are not expected to diminish in the future, so why discount them? And although large industrial owners have not made similar statements, a longer-term outlook may be more fitting in their situation also. As the opportunities to meet mill needs from public timber become more restricted and as the overall commercial forest base dwindles, alternative investments will be less attractive to firms if they want to stay in the forest products business. And based on recent news reports, industrial representatives on commissions developing land use regulations want their lands treated as though they will be in perpetual forest production.

Many foresters are concerned about the economic and ecological effects of removing more land from the commercial timber base. The credibility of warnings about such matters, however, is diminished if our most productive land is intentionally harvested at an age where only 65 to 80% of its potential is realized. Tax laws and other aspects of our socio-economic structure may need modification to make longer rotations financially feasible. But one may ask—why not? Governmental incentives and tax structures have been devised to affect many segments of our economy, including timber production.
With regard to societal structures affecting forest management decisions, there is an even more general point to be made. Certainly we need to recognize and accommodate differences between private and public forest ownerships and objectives. We also need to consider that what happens on one ownership can have positive and negative impacts on other ownerships. Many of the issues we now face—in conservation biology and hydrologic functioning—cannot be dealt with solely on public lands. Thus, as our society and professional resource managers consider decisions about management and allocation of forest land, we need to think more broadly. Although the emphasis may be on public forests, the context of the analysis should include basic socio-economic as well as ecological matters that may affect management of all forest lands.

CONCLUSIONS

How can silviculture contribute to "New Perspectives"? How might silviculturists influence the quest for improved forest management? Silviculturists can:

- Provide knowledge about the heritage of forest conservation and current management practices. We need to take advantage of what we now know, retain the gains already made, and avoid re-creation of problems already solved.
- Suggest approaches that will help in developing and refining new practices and techniques to provide data quickly to guide near-term decisions.

- Foster an understanding of the dynamic nature of forest stands and how changes can be affected by management, and the desirability of a balanced distribution—in time and space—of various age classes or stand stages.

- Work within the inherent biological traits and forest environment conditions to implement a variety of silvicultural systems—systems that may be more effective for meeting non-timber or multi-purpose objectives than those in common use today.

- Contribute information and technology pertinent to many current decisions and practices—to questions related to planting vs. natural regeneration and effects of harvest age on wood production.

- Join with wildlife biologists, ecologists, hydrologists, or social scientists, and work together to develop a broad array of sound practices and strategies, which in combination, can provide the commodities and amenities desired in our forests.

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LITERATURE CITED


Miller, R. E., R. E. Bigley, and S. Webster. Volume and other characteristics of planted vs. naturally regenerated Douglas-fir stands in the Cascade Range. (Submitted to Western Journal of Applied Forestry and on file at the Olympia Forestry Sciences Laboratory.)


