Chapter 30

Nurseries in the Northwest: A Unique Opportunity for Improving Forest Yield

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Abstract

Nursery management represents the greatest concentration of technology and investment in the forest growth cycle and rivals wood processing in capital and labor intensity. Northwest nursery managers are thereby in a unique position to increase forest yield by (1) using environmental control techniques unavailable elsewhere in forestry operations to tailor their product, (2) by taking advantage of diverse and productive Northwest conifer species, and (3) by producing stock types adapted to specific site conditions to improve regeneration success. Current nursery research and information transfer have been Inadequate to fully realize potential yield increases because of (1) poor communication between researchers and nursery managers and (2) lack of stimulating and well-articulated goals. Future challenges to nursery managers will result from (1) the use of genetically improved seed. (2) the need to produce a wide array of species, and (3) the introduction of new systems and concepts for growing bareroot seedlings.

30.1 Introduction

Nursery management represents the greatest concentration of technology and investment in the forest growth cycle and rivals wood processing in capital and labor intensity. On an area basis, any effect on subsequent seedling or tree growth wrought by nursery decisions and investment is multiplied many fold (Table 1). This extraordinary leverage given to nursery managers' decisions not only makes those decisions the focus of land managers' attention but also provides an unusual (in forestry) opportunity for using research to improve productivity. Furthermore, because the nursery production cycle is short relative to many other forestry operations, the impacts of managers' decisions usually can be quickly seen, and the effects of new research information applied to nursery operations can be rapidly evaluated. Precisely the same factors that make nurseries logical and potentially profitable places to improve yield make them good places to concentrate research investment.

Table 1. Small acreages in the nursery produce many thousands of seedlings to be outplanted on many-times-larger acreages. Data from OSU Nursery Survey (see chapter 1) and U.S.D.A. Forest Service [16].

	Nursery area, acres (ha)	Seedling production, 1,000s	Field area planted. acres (ha)
Oregon	1,745 (727)	92,554	220,987 (92,078)
Washington	1,209 (504)	103,939	147,504 (61,460)
Total	2,954 (1,231)	196.493	368,491 (153,538)

30.2 Management Opportunities

Northwest nursery managers can manipulate a small area—the nursery-to significantly increase productivity over the much larger area to which seedlings are outplanted (1) by taking advantage of environmental control techniques within the nursery and of the productive conifer species native to the Northwest and (2) by selecting for stock types adapted to specific site conditions.

Environmental control is routinely greater in the nursery portion of the production cycle than elsewhere (Table 2). Although control of weeds and animal damage is typical for both nurseries and field sites, the considerable biological, chemical, and physical manipulation of soil and careful monitoring of water levels through irrigation and land drainage are commonplace only in nurseries.

Table 2. Application of intensive practices in Northwest nurseries (OSU Nursery Survey) and on even-aged, Northwest field sites planted to Douglas-fir.

Practice	Nursery	Field site
Mechanical cultivation	C[1]	U
Chemical weed control	C	C
Hand weed control	C	U
Soil fumigation	C	N
Microbiological inoculation	U	N
Land leveling	C	N
Organic amendment	C	U
Fertilization	C	C
Crop rotation	C	U
Irrigation and drainage	C	U
Animal-damage control	C	C
Precise stocking control	C	U

[1]C = common, U = uncommon, N = rarely or never.

The major native conifer species of the Northwest are uniquely large. Individuals may reach the greatest sizes and standing volumes found in any natural ecosystem [18], and natural stands have the greatest productivities (highest rates of biomass accumulation over time) [7]. Thus, these Northwest conifers (and hardwoods) have diverse genetic potential for

In Duryea. Mary L., and Thomas D. Landis (eds.). 1984. Forest Nursery Manual: Production of Bareroot Seedlings. Martinus Nijhoff/Dr W. Junk Publishers. The Hague/Boston/Lancaster, for Forest Research Laboratory, Oregon State University. Corvallis. 386 p.

use in production forestry, although their relatively slow juvenile height-growth rates make nursery production cycles longer than those in the southeastern U.S. If nursery practices can be developed to speed juvenile growth of Douglas-fir *[Pseudotsuga menziesii* (Mirb.) Franco] without sacrificing survival ability, then production cycles in the nursery could be shortened from 2 to 3 years to 1 to 2 years, with attendant lower costs, and faster juvenile growth rates in the field would result in lower relative investments in competition control and higher productivity over a fixed rotation length.

Producing stock types better adapted to site conditions will ultimately affect harvest scheduling and allowable-cut calculations by improving regeneration success. For example, in a 5-county area in southwest Oregon, it is estimated that 270,000 acres are withdrawn from the Bureau of Land Management's (BLM) allowable cut base alone because of inability to regenerate them within 5 years after harvest [9]. Similar acreages probably are withdrawn on other public and private lands within the same region. The BLM withdrawal alone results in a direct current loss of stumpage receipts to the area of at least $25,000,000 annually. Hobbs [10] and other researchers have demonstrated the role of stock type and seedling quality in successful regeneration of southwest Oregon problem sites. Obviously, producing nursery stock types better adapted to these sites could have a large, immediate economic effect. Nor is this opportunity restricted to areas usually regarded as difficult or less productive. The Willamette National Forest currently has 85,000 acres withdrawn from its standard component because of regeneration difficulties [pers. commun., 11]. Though not all regeneration problems are traceable to nursery practices, successful artificial regeneration by planting depends absolutely on the availability of hardy nursery stock adapted to specific site conditions and objectives [4].

Obviously, large gains in current harvest levels depend on our ability to produce suitably adapted nursery stock. If this "allowable cut effect"—the effect on harvest of replacing withdrawn acres—were calculated, with the appropriate multipliers, for the entire Northwest, a very large number would result. Any failure to regenerate stands immediately after harvest can have sizable costs; Brodie and Tedder [3] emphasize that, at today's prices for forest products, efforts at reducing regeneration delay will probably be cost effective. The importance of replacing withdrawn acres and reducing delays on timber supply can scarcely be overstated because of the seriousness of countervailing influences such as loss of forest land to urbanization and wilderness. Thus, it is crucial that nursery management make its maximum contribution to sustaining harvests through prompt, efficient regeneration.

30.3 Nursery Research and Development

Because nurseries present such an obvious opportunity for effectively improving yields, one would suppose them to be a major focus of research and development. However, a recent report [13] indicated that nursery research needs were far from being adequately met; indeed, many nursery managers surveyed felt such needs were quite low on researchers' and specialists' priority lists. Relative to field regeneration and stand management, very little research in Oregon and Washington has been aimed directly at nurseries; moreover, much of the work done has been carried out as a "spare time" activity by people—such as nursery managers—who already have too much to do.

Although no really good figures are available, probably no more than 1% of the total research expenditure on Northwest public forestry is directed at nursery practices and problems [pers. commun., 14]. I believe this scandalous situation springs from two important causes:

- **Poor communication between the forestry research community and nursery operators:** Few forestry researchers, as with foresters generally, are trained in nursery operations. In this instance, unfamiliarity breeds contempt. Researchers tend to view economic payoff and professional recognition as resulting from silvicultural activities outside the nursery. Unfortunately, nursery managers have not spoken with a unified voice, as have, for example, people interested in forest fertilization and genetic tree improvement. The latter case is particularly ironic—because nursery effectiveness is an absolute constraint on genetic tree improvement as it is currently practiced; if "superior" seedlings are not raised and handled effectively, investment in selection and breeding programs is futile.
- **Lack of clearly stated "blue sky" targets:** Nursery needs have failed to excite the imagination of those capable of directing investment in research and development to nursery problems. Everyone's attention is focused when publicity is given to substantial projected improvements in yield, such as the percentage figures often quoted for genetic tree improvement and fertilization [l, 12]. Really imaginative nursery-related concepts have been lacking or have not been widely publicized and examined, partly because research on areas closely related to nursery practice has been relatively slight. For example, several comprehensive models of seedling development have been proposed (e.g., [pers. commun., 15]), but none, to my knowledge, has been pursued to completion.

The responses to the OSU Nursery Survey (see chapter 1, this volume) clearly indicate which problems nursery managers want solved. When asked in what areas current information is sufficient, most answered "none." A few named topics in which existing information was adequate, but only one topic was repeated; storage was given 3 votes as an area about which enough was now known. When respondents were asked to list areas where more information was needed, a great variety of interests emerged. Those most repeated were related to (1) seedling physiology, dormancy, and hardiness induction, including topics such as watering schedules and top pruning, (2) seed-sowing equipment and spacing control, and (3) seedling nutrition and fertilization. Many addressed the need for "nursery-specific" information. Also obvious from the Survey was the desire of managers to continue to rely on written information, with workshops and personal contact as necessary, additional research-communication aids. The strong implication was that more focused, briefer, and better illustrated publications were desired, and that scientific journals were not heavily used. A coordinated effort to address these priority problems on a nursery-specific basis will not only solve them more rapidly and efficiently, it will generally improve communication between nursery personnel and the research community at large. Researchers will become aware both of nursery problems and of the recognition that accompanies their solution.

Providing better targets is a more difficult problem—one that depends on an increased level of fundamental research related to nursery concerns. One Survey respondent suggested a comprehensive study of the cost effectiveness and social impacts of nursery practices; if such a study could be carried out, particularly in relation to timber harvest levels, better quantitative targets for nursery research and practice would be one immediate result. Similarly, basic physiological (mechanistic) models of seedling growth and development could be used to screen new or modified practices for impact on costs and outplanting success before expensive, site-by-site field tests are undertaken. These models could also be used to predict maximum nursery production levels and to calibrate practices, at least roughly, to species and stock-type combinations.

Better organized efforts to attract nursery research and development thus will require (1) improved communication between nursery operators and researchers and (2) more clearly articulated and focused targets. One of the most promising methods for achieving both of these—the research cooperative—has already successfully marshalled opinion and resources behind several forestry research programs (e.g., [17]). A cooperative effort focused on nursery practice is now underway in the Northwest [6].

30.4 Future Considerations

As harvests increase from their current low level, there will inevitably be an increased demand for nursery stock. Although it is possible to project a stable demand for stock in the Northwest as sustained harvest levels are realized and backlog regeneration is reduced, several large potential changes in the quality and kind of nursery stock produced can be expected:

- **Genetically improved seed:** The Northwest has not yet substantially shifted to seed-orchard seed but, given current plans, will do so over the next 2 decades. Reliance on this more costly, higher potential seed will intensify the focus on seed handling and sowing and seedbed survival. Nurseries, as the first custodians of this precious seed-orchard commodity, will receive even more attention from high-level managers and the public. In turn, objective evidence of the efficacy of nursery practices will be in greater demand. Thus, more attention will be given to recordkeeping and research substantiation of "obvious" solutions to problems.
- **Other species:** True firs (*Abies* spp.), spruce (*Picea* spp.), and hardwoods may increase radically in importance, relative to current production levels. As higher elevation sites are managed intensively, true firs will be increasingly prescribed and therefore will require more attention from both nursery managers and researchers. If the tip weevil that infests Sitka spruce [*Picea sitchensis* (Bong.) Carr.] can effectively be controlled, that species may be much more widely planted in Oregon and Washington; such control measures are currently under development [pers. commun., 8]. Hardwoods will gradually increase in regional importance, particularly f conifer supply and demand falter, as forecast. Although hardwoods are unlikely to ever constitute a major fraction of nursery stock produced in the Northwest, the transition from none to some, particularly for red alder (*Alnus rubra* Bong.) and black cottonwood (*Populus trichocarpa* Torr. & Gray), will require future attention. As eastern Oregon, eastern Washington, and Idaho produce relatively more timber [2], conifer species other than Douglas-fir will increase in importance. We should anticipate this change now with comprehensive efforts to better understand and grow pines (*Pinus* spp.), larch (*Larix* spp.), and white fir [*Abies concolor* (Gord. & Glend.) Lind]. ex Hildebr.].
- **New systems:** Radically new approaches to bareroot nursery management will be suggested and tried. Many of these will be useful as "blue sky" targets that stimulate thinking, even if their operational impact is not large. An example is Cooper's [5] concept of a bareroot nursery without soil; he suggests that in some places, nutrient film technique—a simple, low-cost hydroponic system—can be used to produce bareroot woody-plant nursery stock without the disease, drainage, and other problems associated with soil. Although certain barriers stand in the way of widespread application of such systems, the idea of a soilless nursery has many attractive points. The future will bring a steady flux of "radical" new ideas and, with it, the need for a well-developed mechanism for screening them and for developing and adapting the promising ones. Again, research cooperatives can play this role effectively.

In sum, nurseries present a unique opportunity to multiply the effects of technology and research on wood yields. Though neglected in the past, nursery research and development should be infused with new purpose and support, perhaps most effectively through a cooperative approach. Widespread use of genetically improved seed and diverse species in conjunction with new systems and ideas will merit the serious future attention of the entire nursery community.

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