Silviculture for the 21st Century—Objective and Subjective Standards to Guide Successful Practice[1]

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Abstract

Silviculture is increasingly being applied in ways that go beyond traditional timber management objectives. Across the National Forest System, on other public lands, and increasingly on private lands as well, foresters are working with professional colleagues and landowners to develop innovative silvicultural prescriptions designed to meet diverse resource management objectives. Some of those innovations involve treatments, timing, or intensity that are not supported by published or ongoing research studies. This can lead to problems over time, especially if the treatments fail to achieve their intended goal. To maintain trust and credibility with other resource professionals, as well as with the landowners they serve, silviculturists must act according to a simple philosophy--say what you'll do, do what you said, and watch what you did. A set of ten quantifiable metrics and subjective tools is suggested as a guide to implementing that simple philosophy. Taken collectively, this set of tools and metrics comprise a subjective decision support framework for silviculturists, especially as practices are proposed that go beyond scientific support in the literature. The degree to which these elements should be quantified depends upon the complications that will arise from failure to detect whether a prescription has been properly prescribed and implemented.

Introduction

The turn of the 21st century has seen shifting paradigms in forest management. Standard practices, such as clearcutting, that were widely prescribed as recently as three decades ago, have been critically examined in light of new conceptual approaches to forestry (Franklin et al. 2002). As a result of these changes in strategic thinking about forest management, the tactics by which management decisions are being implemented have changed as well.

For example, three decades ago, silviculture was applied primarily to timber production, so much so that society generally has come to consider the terms as synonymous (e.g., Spurr 1979, Graham and Jain 2004). Even today, some professionals feel that the term silviculture is inappropriate to use in any context other than that of timber production, and that some other term should be developed for manipulative treatments in a forest in which timber production is not the objective. This has even extended into some university curricula, in which classic

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silviculture courses and textbooks are being replaced by "applied forest ecology," and forestry schools are now "schools of the environment." By that logic, the use of the term "silviculture" in a habitat restoration or stand structural context might be viewed by some as oxymoronic.

Similarly, there have been changes in the tactics that agency critics use to stop timber sales. Appeals and litigation of timber sales are still common, especially in western States. But as agency silvicultural prescriptions become more diverse, appeals and litigation have changed from a stance that advocated cessation of clearcutting to one that proposes to stop all logging in National Forests. And, in a clever response to working within the system, some groups now bid on and purchase agency timber sales, with the intent of not proceeding with the harvest.

A more holistic definition of silviculture, advocated here, speaks to the values retained in forest stands after a harvest has occurred, thereby attaining landowner objectives through greater attention to what is retained in the woods, rather than what is removed (Behan 1990, Franklin 1989, Kessler et al. 1992, O'Hara et al. 1994, Swanson & Franklin 1992). We believe that, over time, this perspective will broaden the constrained view of silviculture as a practice appropriate only for timber production to one that is appropriate for all resource values--wildlife habitat, watershed, ecological restoration, and others--that depend upon silvicultural manipulations to advance desired stand conditions. Adoption of this view has the potential to defuse internal disagreements between professionals over silvicultural prescriptions, as well as to weaken the ecological logic of the stance of agency critics acting to stop all logging.

However, as silviculturists rush headlong into forest stands with paint guns that are targeted on structures and habitats to retain rather than on trees to cut for forest products, they often depart from a firm foundation of research findings to support their decisions. This can be exacerbated in situations where field technical crews have not been baptized with the same fervor as their professional counterparts on the transition from timber goals to habitat and restoration goals. And given the diversity of specific management goals and objectives that may change over time, it is likely that the research support for silvicultural innovations will continue to lag behind the practice.

To maintain the trust of not only the other resource professionals and technicians with whom they work, but also the landowners they serve, silviculturists must act according to a simple philosophy--*say what you'll do, do what you said, and watch what you did.* Fellow coworkers and landowners both will generally tolerate a silvicultural prescription that does not go as intended if the silviculturist is honest about the plans that were made and the outcomes that occurred. Moreover, the rationale for such silvicultural activities needs to be articulated and both the risks and uncertainties of the activities disclosed and documented in a silvicultural prescription.

As the adage goes, "the devil is in the details". An important part of a silvicultural prescription is the exact specification of intensity, timing, and tactics that will help to determine whether a given silvicultural practice is likely to meet the intended goal. These details center on the silviculturist knowing the conditions within the stand or landscape prior to the treatment, the context both physically and socially of the proposed treatment, the conditions under which the treatment is conducted, the conditions that result after the treatment has been completed, and the short- and long-term expected vegetative response to the treatment. Some of these

details require measurement of conditions in some varying sample intensity. Others are subjective guides that will determine the ease with which proposed treatments can be implemented within a stand or across a sufficient area to make a significant change in the resource attributes of interest.

In this paper, we propose a set of five quantifiable metrics and five subjective considerations to consider when implementing silvicultural practices for any landowner goal on public or private forest land, and which can be applied to encompass diverse goals of ownership--from habitat management, ecological restoration, specific configurations of stand structure, and even timber production.

Quantifiable Metrics

Quantifiable metrics are variables for which measurements can be taken. Those measurements produce data from which simple statistics, such as a sample mean and variation about the mean, can be calculated for the variable of interest. The intensity of the sample used to quantify the variable depends upon the ease with which the variable can be measured, the inherent variation of the variable, and the degree to which measurement of the variable gives biologically meaningful and practical information to the silviculturist. For example, in some situations, a cruise or inventory of acceptable sampling intensity should be conducted. Other situations might be acceptably quantified using a visual estimate, which is itself a subjective determination of sample mean and variation for key variables (such as stem density, basal area, and stand structure) based on practical experience and insight.

In the five quantifiable metrics that follow, the degree to which sampling or visual estimation is sufficient to provide data of suitable rigor will vary. But assessing these metrics themselves provide feedback to the silviculturist about whether silvicultural prescriptions will be or were successful, and if the desired conditions and/or stand development trajectories were achieved.

Pre-Treatment Inventory Information

Pre-treatment inventories are used to quantify the current conditions in the stand or on the landscape, to estimate how the silvicultural prescription will change those conditions, and to guide the imposition of the proposed treatment. Variables typically include stem density, basal area, species composition, the current structural stage of the stand, canopy layers present or absent, presence of pathogens or insects, edaphic and physiographic conditions, forest fuel conditions, and also the larger context of how the stand contributes to the large landowner goal (biologically, socially, economically).

The pre-treatment condition contains all the elements available to attain the post-treatment stand condition, either directly or through stand development over time. An awareness of what exists now and what must be retained for future needs provides the necessary information about that portion of the biomass--for example, overstory trees, understory vegetation that competes with desired species in the understory, or invasive exotics--that is superfluous to the post-treatment condition. The greater the degree to which the silviculturist can understand the pre-treatment condition, the greater the degree to which the post-treatment stand can be described, and the better the planning that can be done to enable the transition from the exiting to the future condition.

The appropriate sampling method for a particular resource relates to the value of that resource relative to the landowner's ownership objectives. At one extreme, a walkthrough with notes might suffice, in another, plots taken at some predetermined intensity would be indicated. In an extreme example, a 100% tally of high-value products, such as black walnut, or endangered wildlife nesting sites, would be recommended. But some quantifiable or even qualitative understanding of stand condition prior to treatment--soil, vegetative spatial and size distributions--helps not only to decide what treatment to do, but whether or not a treatment is commercially feasible.

The context of operations in the stand being entered is increasingly important in contemporary practice. As recently as several decades ago, silvicultural prescriptions on National Forest land were based on an individual compartment as part of a larger landscape, with no specific requirement for entering adjoining compartments. Typically, about 10% of the compartments on a district were examined annually, their management needs determined, and prescriptions written to achieve desired conditions. And, on districts where rangers and professional staff changed relatively frequently, the order of entry was often directed by an extraordinarily valuable human resource--the field technical crews, who often have the longest tenure on the district, and who remembered when silvicultural treatments had been previously conducted in a given compartment.

The biggest differences today derive from the fact that silviculturists now enter and plan treatment prescriptions on landscapes and/or watersheds of thousands of acres in size, rather than individual 1,000-acre compartments, and desired conditions are locally determined in watershed analyses, or Forest Plans, rather than in agency handbooks. In addition, the complexity of proposed treatments often increases, especially in the wildland urban interface. Increasingly, a soundly-developed silvicultural prescription depends on being able to visualize and document the larger ecological goals on the landscape, and how specific silvicultural practices can be implemented to achieve them.

A Detailed Silvicultural Prescription

A silviculturist whose prescription involves the removal of trees, shrubs, perennials, or herbaceous plants--in short, any biomass in excess of that deemed desirable for retention--must describe how, why, and what is to be removed. That description must be done in sufficient detail such that those responsible for the removal can do so in a way that satisfies both the short- and long-term goals or management direction of the landowner.

For trees of commercial size, some sort of inventory of trees being cut is typically prepared. Similarly, an estimate or description of the non-commercial material to be removed may be needed if that removal costs money, such as through site preparation contracts or fuel reduction treatments.

In some situations, it might be better to mark the trees being retained rather than the trees being removed. Examples include, immature overstocked even-aged stands where designation by spacing or diameter make it easier to implement thinning prescription, the seed cut (cf. Smith 1986) in seed-tree and shelterwood stands where it makes sense to mark the trees to leave as seed producers, and in uneven-aged stands with diverse structural goals to retain after marking.

Marking trees to be retained can be more accurate, especially if marking tallies are generated using sampling methods. A pre-harvest timber inventory has an inherent sample error associated with it. If a 100% tally of trees marked for removal is taken during the marking, the sampling error falls in the unmarked component of the stand. This can lead to errors in achieving the desired prescription goal in the residual stand. However, when marking trees to leave in a stand, the 100% tally is taken of the residual trees, and the sampling error falls in the portion of the stand being removed rather than the portion being retained. Such a procedure would require other means of estimating the number, volume, or other descriptor of trees removed to facilitate their selling in the case of commercial products, or paying for their removal in the case of non-commercial trees.

We suggest that a description of what remains after treatment and how it meets silvicultural objectives or management objectives ought to supercede product sale needs and objectives. In contrast to completing a 100% tally of the residual stand, targeting residual basal areas (e.g., by tree class, by stand, by species, or all combinations) and other stand attributes, such as structural stage distribution, species composition, or canopy descriptions, might be a more meaningful way to describe a stand after treatment.

Another reason to favor the marking of residual trees is that it allows field crews to concentrate their attention on trees, structures, and compositions being retained. This can be of special advantage when non-traditional attributes, such as nesting cavities or potential for development of living and dead snags, are sought for retention. The marking tally becomes the primary point of contact between the intentions of the silviculturist and the actions of the field technical crews responsible for implementation of those intentions. In what is often the greatest single fault with modern forestry, the silviculturist is usually not present when the technical crews mark the stand. The silviculturist must thus ensure that the field crews understand the intent of the prescription, and can act independently in the woods to implement that intended silvicultural objective.

For example, in the free selection approach (Graham and Jain 2005), there is little or no explicit development of quantitative standards for marking. But the qualitative standards are quite well developed, and field crews must have a clear understanding about them in order to mark the stand acceptably. As silvicultural prescriptions become even more innovative to meet targets for stand structure or other ecological attributes, that description and vision must be very clearly defined for the marking crews. And if it can be quantified, so much the better. That is especially important so the field crews can react to local variations of density, structure, and attributes within the stand, instead of forcing predetermined and inflexible standards of basal area, species composition, or spacing in portions of the stand that cannot meet them.

Adequacy of Regeneration

Regeneration of the desired species at the stand level following reproduction cutting is the fundamental stand-level indicator of sustainability. The quantity and quality of regeneration must be appropriate for the stand age, habitat requirement, structural attributes, and species composition sought by the silviculturist for meeting both short- and long-term goals. This implies a survey of appropriate statistical rigor, with a defendable sampling implementation having the power to test an explicitly-

given size of departure from a target stem density, which would allow a forester to conclude whether regeneration density and distribution are adequate.

For example, in longleaf pine (*Pinus palustris* Mill.) stands in the lower west Gulf coastal plain, regeneration is an episodic event (Wahlenberg 1946), and regeneration surveys that use plot sampling are important to determine whether adequate regeneration is present. On the other hand, in loblolly-shortleaf pine (*P. taeda* L.-*P. echinata* Mill.) stands of the upper west Gulf coastal plain, regeneration is adequate four years in five (Cain and Shelton 2001). If other conditions are right, loblolly and shortleaf pine seedlings are both abundant and visible in the second year after reproduction cutting onward. After five years, regeneration surveys are difficult to implement because the density of saplings impedes one's progress through the woods.

Too much regeneration is a far more desirable situation than too little, because reducing stem density is usually easier and less costly than increasing it. The longleaf situation is one in which a rigorous regeneration survey should be conducted. In the loblolly-shortleaf example, a visual estimate might suffice to establish whether or not a stand has been successfully regenerated, and if not, whether a plot-based regeneration survey is needed. In some circumstances, the spatial juxtaposition of regeneration (e.g., groupiness, patchiness, relation to reserve trees) is also important for sustaining specific structural stages (Long and Smith 2000).

Sensitivity Analyses Through Computer Modeling

Computer models of forest growth and yield are useful but occasionally demanding tools for foresters to test the outcomes of silvicultural prescriptions. In the Forest Vegetation Simulator (FVS) and other computer models, the tools are available to run growth projections for a given prescription and for variations on that prescription (Dixon 2002). Where sufficient data are available, models are quite useful, especially if interpreted as comparative models in the context of sensitivity analysis, or in the relative evaluation of alternatives over time. In addition, they often contain visualization tools that can display stand attributes (e.g., structural stages, fire characteristics, etc) through time. These visualizations can be effective communication tools for displaying silvicultural treatment results and how they will most likely develop through time. They can be used to communicate with other disciplines, as well as with the public at large.

This is especially important when communicating silvicultural activities and their inherent degrees of risk and uncertainty. A rule of thumb is to assess the relative risk and uncertainty associated with given conditions, and act accordingly. For example, igniting a prescribed fire during severe winds falls into the realm of high risk and low uncertainty--essentially, a situation where the treatment is dangerous and there is little doubt that it is dangerous. Variations that combine low risk with low uncertainty could be imposed with less fear of unacceptable consequences. Situations that include high uncertainty should include provisions for observation of the treatment and its effects that account for the uncertainty associated with the treatment. Finally, one may not need detailed data to understand this--disclosure and recognition of the question may be adequate to assess the relative risk and uncertainty.

Post-treatment Assessments

The ultimate success of any silvicultural prescription is best judged by whether the intended outcome was actually achieved. That starts with a post-treatment

assessment of residual stand density, basal area, and stand structure, and comparing that residual stand with the target standards originally specified in the prescription before treatment. That can be done quantitatively or qualitatively if the silviculturist has sufficient experience to judge stand metrics by visual estimation. Among the elements to revisit is whether the harvest retained what was intended, whether the predicted vegetation development (growth and yield) is being obtained, and, if a reproduction cutting was imposed, whether regeneration development is acceptable (quantity, quality, juxtaposition). These are simple metrics to judge within acceptable standards for most purposes using simple walkthroughs and visual estimates, especially if one is experienced with fieldcraft in the given forest type. If the target for a given metric is narrow or exacting to meet habitat or silvical requirements, the metric should be sampled, documented and recorded--not only for recording the treatment for the next silviculturist and facilitating the planning of future treatments, but also documented in a manner so that they can withstand a challenge as to the quality of the data.

Too often, silviculturists fail to invest the amount of time needed to determine whether the treatments that were imposed have actually been successful. The dilemma is easy to understand, because follow-up inspections and reviews are often of lower priority on a day to day basis than the preparation of new silvicultural prescriptions for different areas. Thus, not only must silviculturists appreciate the time required to revisit treatments imposed in the past, but their supervisors must also appreciate the need to invest their subordinates' time in such reviews. Moreover, such reviews are excellent learning experiences and, when conducted in an interdisciplinary manner, they can foster learning among disciplines. By doing so, the development of future silvicultural systems that can fulfill a wide variety of objectives may be more readily achieved and possibly accepted in an integrative fashion.

A complicating factor is that the time span with which inspection of past work is meaningful often exceeds the tenure of a silviculturist on the land base, especially on public lands. Consider that a prescription is often written three to five years prior to harvest, and that meaningful evaluation of success can require the passing of five years to a decade or more. Few silviculturists on National Forest lands are in place for that 10-15 year period. It follows that the need to quantify conditions and quantitatively examine the results of previous prescriptions probably is inversely related to longevity on a district. Moreover, part of the training of a silviculturist new to a district should be a review of a handful of prescriptions that the previous incumbent thought were successful, and also (perhaps especially) those that were not.

Repeated exams after implementation of the prescription are better than just one. Repeated visits give field personnel a sense of the rate of change of conditions over time, and whether or not the treatment is doing what was intended over the short-term. Information from those visits can be used with models such as FVS to give an indication of what the long-term prognosis of stand development will be. Such work favors streamlining and preparing better prescriptions for future stand tending. That is a prerequisite for doing what is intended over the long term.

Subjective Assessments

In contrast to the quantifiable assessments discussed above, subjective assessments are also valuable for judging whether silvicultural operations will be

successful. These deal primarily with creating opportunities for sale of the surplus biomass, and to reinvest the proceeds from the sale in operational treatments to further the management objectives. In addition, there are two sources upon which to rely to determine whether a treatment achieves its intended objective--the internal element that allows the silviculturist to decide whether a prescription has been properly imposed, and the external review that allows others to certify the same thing.

Availability of Local Timber Markets

The ability to sell trees to a willing buyer who will harvest them, haul them away, and manufacture wood products from them is a terrific advantage for a silviculturist. Local markets are fundamental to modern forestry, arguably more so today than during the era of timber primacy. When clearcutting was the rule, loggers were assured of large volumes per acre harvested. But harvests today are more likely to have lower volumes per acre because part, if not most, of the trees are retained after the harvest. In addition, fuel reduction and restoration prescriptions often target trees of small size, inferior quality, and low value. Thus, the ability to sell small volumes of products (often inferior in quality) removed during partial cutting is essential to the success of those prescriptions.

Two kinds of markets are needed to enable the future implementation of harvests with low volumes per acre. The first, of largest scale but marginal economic reward, is a fiber market for small diameter products harvested during thinning or other intermediate treatments. However, small diameter products will never generate much more financially than a break-even profit for the land manager, which is still an advantage relative to the costs of conducting a similar treatment non-commercially. The second, of smaller potential by area but of far greater financial opportunity, is a market for large sawlogs of high quality and relatively old age, taken during even-aged reproduction cutting, late-rotation thinning, or uneven-aged cutting cycle harvests. Such products are becoming increasingly scarce as a result of the reduction of rotation age and maximum harvested diameter found on forest industry lands. In essence, the potential exists for a niche market to develop in which some manufacturers of high value products increasingly rely on a sustainable supply of large-diameter trees harvested from public lands. This is a utilization approach that in essence maximizes the financial return per tax dollar spent in forest management--a good place for Federal forest managers to be.

We believe it is especially important that the non-silvicultural professionals on the staff understand the value of market opportunities. An unfortunate legacy of the program of timber primacy that existed within the Forest Service two decades ago is the alienation of many of the other professionals in the agency against the timber program. But there are examples within the agency in which all of the resource professionals on a management staff cooperate to fulfill a complicated set of management objectives, and that use a viable timber program selling trees at high value in local markets to fund the achievement of those objectives.

Operable Harvest

The availability of a local market provides an opportunity for removal of the excess biomass, but enough biomass must be available for sale to interest a local buyer. Sufficient superfluous ecological material surplus to the desired condition will allow either for a commercial sale to be feasible, or allow a contract to be written that will attract a bidder. The question is one of efficiency of operations, and whether

the surplus biomass is available, either so someone will buy it, or so someone will be willing to be paid to dispose of it.

As silviculturists, a treatment prescription proposes a change in condition, from an existing condition to a different one. The silvicultural goal is the redistribution of biotic influence within the stand, such that conditions after the treatment better reflect the desired conditions than those that existed prior to the treatment. But if a silvicultural goal is to be met, doing the treatment is better than not doing it. As a practical matter, being paid to execute the treatment is better than paying someone to do it. Both, in turn, are better than not having the treatment done, if it is in fact a priority treatment to conduct. This is why the practice of having an environmental group buy stumpage but not cut the trees is a management failure--the desired treatment effect is not being achieved.

This is currently an important issue in the debate about the Sierra Nevada Forest Plan. Questions exist about whether large trees ought to be included in timber sales in order to attract a willing buyer. The answer to this depends upon the degree to which the large trees contribute to the desired ecological condition of the residual stand. The answer to this debate is beyond the scope of this paper, especially in light of the site-specific conditions that must be considered to make a management decision on the question. But there is nothing innately improper about the sale of biomass surplus to the needs of the stand (most often defined ecologically but may also contain social and economic elements), especially if that sale promotes opportunities to conduct additional treatments that would be beneficial to the eventual attainment of the desired stand condition.

Plans to Reserve Proceeds from Harvest to Enable Additional Treatments

When an operable harvest is made on public or private lands, other opportunities become available for a landowner or manager to reinvest some of the proceeds of the sale in paying for supplemental treatments that bring the stand closer to its desired condition. On National Forest lands, the Knutsen-Vandenberg Act of 1933 and its administrative implementation procedures allow for the development of planned activities for improvement of the sale area. These sale area improvement (SAI) plans allow the reserving of funds received for the harvested timber in order to pay for necessary follow-up activities, such as additional silvicultural treatments. Similar opportunities exist through salvage sale collections and stewardship contracts on National Forest lands.

A classic example is the shortleaf pine-bluestem (*Andropogon* spp.) restoration on the Ouachita NF in western Arkansas to restore floral and faunal diversity associated with those open woodland habitats, including nesting and foraging habitat for the endangered red-cockaded woodpecker (*Picoides borealis*) (Guldin et al. 2004). The first step in implementation of the restoration prescription is a commercial timber sale that thins the overstocked pine overstory. SAI plans prepared for the timber sale allow collection of funds from the proceeds of the sale to use in subsequent removal of the hardwood midstory, and the conduct of a program of prescribed burning for the first decade after the timber sale. Relying on sale proceeds rather than appropriated dollars increases the area that can be restored by several orders of magnitude, making this truly a landscape-scale restoration program.

The concept is equally appropriate for private landowners, too. Reinvestment in the stand for activities that might not have been affordable without a timber sale is a

hallmark of clever management planning on private forest land. Some landowners are more comfortable with this idea than others, and whether a given landowner has the wherewithal to divert cash proceeds from a sale to pay for additional silvicultural treatments on the land depends on the wisdom of the landowner (short- and long-term views), and on the quality of advice being given to the landowner by the professional with whom he or she is working.

In a nutshell, the argument here is simple--what is retained is more important to future stand conditions than what is cut. But what is cut can help pay for treatments to optimize ecological condition of what is retained. That's a tradeoff that is unwise to ignore, whether on public or private lands. An important characteristic of disclosing the tradeoffs is presenting the risks and uncertainties associated with each scenario considered.

Including Monitoring Standards in the Implementation

Monitoring standards are a tool used by the silviculturist to codify the plans by which successful implementation of the prescription can be judged. The questions about whether a treatment did what it ought to have done fall along three lines, as recognized by the Forest Service and others:

(1) Implementation monitoring—meeting the standards for implementation. In other words, such monitoring verifies whether the standards relevant to the implementation of the prescription were properly imposed.

(2) Effectiveness monitoring relates to what is being done to achieve the intended silvicultural effect. Here, the question is whether maintaining standards as specified in the prescription actually achieved the effect that was intended.

(3) Validation monitoring attempts to quantify the observed effect with respect to testing whether modifications in the standards should be made. This category is where experimentation can occur to evaluate whether the standards as imposed are actually effective in addressing the questions that they were intended to address, but are seldom applied for individual projects.

The value of conducting one or more of these classes of monitoring relates to the opportunity to conduct an internal process check or review of the implementation of the silvicultural prescription. At the very least, the silviculturist would like some assurance that the treatment was imposed as planned, and implementation monitoring provides that. The larger and more interesting questions, such as whether the treatments that are imposed actually work, or should be modified to work better, are equally important, if not more so, over the long term. Even with the knowledge of the importance of monitoring, it is often one of the most neglected functions occurring in forest management. When it does occur, it can be an expensive endeavor using dubious design and improper resolutions of data chasing ill framed questions. Under such circumstances, these monitoring efforts are often the source of litigation and make no one pleased about the outcome.

External Professional Review of Plans and Products

Related to the importance of monitoring and post-treatment assessment is the concept of internal and external review of silvicultural activities. Such reviews evaluate whether the goals and objectives of a particular silvicultural practice have been achieved. Procedures are currently in place to conduct internal agency reviews. For example, the management review process of the National Forest System gives the local Supervisor's Office an excellent opportunity to review practices at the Ranger

District level, in a constructively critical environment. Similarly, Regional Office and Washington Office reviews meet similar goals.

However, when compared to internal agency reviews, the overwhelming advantage of external review is independence and impartiality. It carries a connotation that success in attainment of objective standards is of greater value, especially if there is no implicit benefit to the reviewer. Outside the agency, third party audits of industrial silvicultural treatments under the AF&PA's Sustainable Forestry Initiative, of other private forest management under the Forest Stewardship Council, or the BMP compliance audits available through many state forestry agencies for non-industrial private forest lands, achieve a similar intent.

These reviews bring credibility to programs and can also highlight areas in which improvement is needed. The reviews from outside the organization can be an effective tool to develop, strengthen, and redirect programmatic support within the organization. Silviculturists can thus secure renewed commitment to the objectives of treatment and to the techniques used to make the treatments happen. Reviews also provide an opportunity to learn the strategies and tactics that others might recommend to meet the intended goals as well.

Summary

The key for a silviculturist to maintain the trust of not only fellow resource professionals and technicians, but also the landowner, is to act according to a simple philosophy--say what you'll do, do what you said, and watch what you did. Factors such as short position tenure and pressures to implement new treatments often conspire against living up to this philosophy. A simple set of protocols is presented here to guide silviculturists in regard to careful implementation and observant follow-up activity over time. The greater the degree of experience a silviculturist has with the place identity and the forest types under his or her management, the more comfortable that silviculturist will be in stretching the application of innovative silvicultural practices, and with watching them over time to see how the residual stand responds to the treatment. But even if a silviculturist is brand new to a region or a forest type, attention to the objective and subjective standards presented here will allow for a more rapid assessment of success or failure to achieve the intended silvicultural goal. In essence, these ideas serve as a beta-testable model for an operationally meaningful program of adaptive silviculture, toward the goal of meeting ownership objectives in a sustainable manner.

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