INDIAN FOREST

MANAGEMENT HANDBOOK

53 IAM 9-H

SILVICULTURE

53 IAM 9H
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SILVICULTURE
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CHAPTER 1. INTRODUCTION

1.1 General. Silviculture is that segment of the Forestry program that addresses the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values on Indian trust lands on a sustainable basis. Silviculture encompasses planning and investing in future resources by manipulating existing stands, which either intentionally or unintentionally have become established in a given species composition and spacing because of historical reasons, in order to meet some future objective (Oliver, 1996, p 7).

1.2 Purpose. This *Handbook Volume* is designed to provide procedural guidance and minimal standards relevant to the application of sound silvicultural practices to manipulate stands as efficiently and effectively as possible across lands in trust or restricted status under the jurisdiction of the Bureau of Indian Affairs (BIA). Hereafter, all mention of Indian forest lands implies forest lands that are either held in trust or restricted from alienation by the United States. See the Glossary of Terms, List of Acronyms, 25 CFR Part 163.1 definitions, and 53 IAM 5-H for additional assistance. The 25 CFR Part 163.11 states "The harvest of forest products from Indian forest land will be accomplished under the principles of sustained yield management and will not be authorized until practical methods of harvest based on sound economic and silvicultural and other forest management principles have been prescribed." In recent years the focus of silvicultural practices has moved from sustainability of timber harvest to the sustainability of all resources and their ecosystems. For additional guidance on statutory, regulatory, and policy requirements, the user should refer to 25 CFR Part 163, General Forestry Regulations; and 53 IAM Chapter 9, Silviculture. Additional guidance on silvicultural practices and procedures may be available from Regional handbooks and policy memoranda for Regional guidelines as well as agency/tribal specific guidelines.

There are several good books on the practice and science of silviculture which should be part of every silviculturist's library. This handbook should not be considered a substitute for those books that focus on the stand-development processes which are the results and objectives of silvicultural treatments. Some of the older books have been revised to incorporate current research and the evolution in the science of silviculture that has taken place during the past 30 years. A fair number of these textbooks are listed in Chapter 3 as part of the bibliography.

Although this handbook addresses silviculture and silvicultural systems, it is very important to keep in mind that tribal goals, objectives, preferences and possibly feelings play a primary role in the practice of silviculture on Indian lands and essentially are the starting point for all forest management. Tribal direction tells us whether they want employment and /or income from the forest and may impose definite constraints on the options and tools a silviculturist may use. Prescriptions should be based first on what the tribal public is asking of their lands and secondly on forest condition in order to determine how silvicultural practices can meet those goals.

1.3 Policy. It is the policy of the BIA that all Indian forest lands shall have effective management and protection through the application of sound silvicultural principles. These management actions should maintain or improve the genetic qualities of forest stands. All Forest Management Plans (FMP) will include silvicultural guidelines and all forest treatments that affect the present and/or long-term character of a forest stand (including woodlands) will be guided by a silvicultural prescription (Rx). Forest vegetation treatments may include harvest of forest products, hazardous fuels reduction projects (including prescribed fire), forest development projects, watershed restoration projects, insect and disease prevention or rehabilitation projects, and all other projects that will impact forest vegetation within the forest land base. If a forested area is being converted to a non-forest land use (e.g. housing, range, agriculture, etc.) an Rx is not required.

Prescriptions will be developed that identify and quantify existing stand conditions, including stand structure and composition; provide a basis about how the Rx will change those conditions; and provide guidelines to implement the proposed treatment. Include appropriate monitoring plans as part of the Rx.

1.4 Scope. This Handbook Volume deals with the principles and procedures of sound forest vegetation management prescribed in silvicultural prescriptions on Indian lands. It is meant to give the user a broad national perspective concerning the development, implementation and documentation of silvicultural and forest vegetation altering treatments on Indian forest land. More site specific guidance may be available from regional, agency, and/or tribal offices. Regardless of the means of program execution, the appropriate Line Officer shall assure that the practices and procedures prescribed herein are followed. Compact tribes may not be required (refer to the Tribe's Compact Agreement) to abide by the practices and procedures contained in this handbook Volume, but may find it useful as a guiding document.

1.5 List of Acronyms The following list of acronyms and terms are not all used in this handbook. Several acronyms commonly used in forestry are included.

B/C	Benefit/Cost
BIA	Bureau of Indian Affairs
CFI	Continuous Forest Inventory
CFR	Code of Federal Regulations
CFSI	Commercial Forest Stand Improvement
CRR	Composite Rate of Return
DC	Desired Condition
DBH	Diameter (at) Breast Height
EA	Even-aged
ESA	Endangered Species Act
FD	Forest Development
FHP	Forest Health Protection
FMD	Forest Management Deduction
FMP	Forest Management Plan
FRCC	Fire Regime Condition Class
FS	Forest Service
FVS	Forest Vegetation Simulator
GS	Group Selection
GPS	Global Positioning System
HFR	Hazardous Fuel Reduction
IAM	Indian Affairs Manual
IRMP	Integrated Resource Management Plan
IRR	Internal Rate of Return
NEPA	National Environmental Policy Act
NPV	Net Present Value
PCT	Precommercial Thinning
QMD	Quadratic Mean Diameter
Rx	Silvicultural Prescription
SDI	Stand Density Index
SEV	Soil Expectation Value
ST	Seed Tree
STS	Single-Tree Selection
SW	Shelterwood
TPA	Tribal Priority Allocation
tpa	Trees per Acre
UEA	Uneven-aged
WUI	Wildland Urban Interface

1.6 **Frequently Asked Questions (FAQs).** The most commonly asked questions include:

A. Why do we need a Silviculture Handbook? Forest management treatments have the potential to affect the condition of Indian lands for decades or even centuries. Therefore it is imperative that any forest management treatments be implemented using sound and state-of-the-art scientific and ecological principles. The direction for implementation of forest treatments are contained in what the professional forestry community calls a silvicultural prescription. The silvicultural prescription is the site or stand specific document that prescribes vegetation altering treatments to modify existing vegetation to meet current and future targeted/desired conditions as outlined in supporting planning documents such as FMPs and project environmental assessments. Individual prescriptions, at a minimum, will address the current stand diagnosis, prescribed treatments, implementation guides, and monitoring requirements. The development of individual prescriptions must take ecological, economic, and societal constraints into consideration. During the development and implementation of silvicultural prescriptions, vegetation altering decisions and actions are proposed and taken on individual stands to pursue tribal objectives as identified in supporting planning documents. In order to do this effectively, a systematic professional methodology that addresses all components of the silvicultural process is recommended. This handbook has been developed to give a national perspective on how to best meet this need while integrating Bureau policy, Tribal policy, and science in the decision-making process. Consider this a 3-legged stool consisting of science, tribal policy, and federal laws. This handbook provides procedures and protocols for the development, implementation, documentation and monitoring of silvicultural prescriptions. It addresses training opportunities, personnel requirements and the option of silviculturist certification. It informs decision makers, provides consistency and accountability, and documents the reasoning behind specific treatments for the benefit of Indian land owners and the historical record.

B. What is the difference between the silvicultural process and the silvicultural prescription? The silvicultural process is a loosely defined term used to describe all steps involved in the forest vegetation treatment strategy and decision making. At the reservation or program level the silvicultural process entails and documents such activities as assignment of silvicultural duties; silvicultural input into FMPs and IRMPs; assessments of overall forest health; methods of communicating forest conditions and treatment needs to the tribal leaderships and publics; training of staff; storage of records; quality control guidelines; the participatory role of the silviculturist in the project National Environmental Policy Act (NEPA) process; monitoring requirements, etc. The silvicultural process, in effect, is a silvicultural program outline. Specifics would vary considerably by agency or tribe.

The silvicultural prescription is the site or stand specific document that prescribes vegetation altering treatments to modify existing vegetation to meet current and future targeted/desired conditions as outlined in supporting planning documents such as FMPs and project environmental assessments. Individual prescriptions, at a minimum, will address the current stand diagnosis, prescribed treatments, implementation guides, and monitoring requirements. The development of individual prescriptions must take ecological, economic, and societal constraints into consideration. In effect, the silvicultural prescription is a part of the silvicultural process.

C. What does this Handbook replace? This is the first such national handbook for the BIA; it complies with current statutes, regulations, and policy, and is to be used as a guide. It provides minimal standards for a process of decision making and silviculturist qualifications. Many regions, agencies and tribes have developed and utilized various forms of silvicultural handbooks for many years. This practice is strongly commended and needs to continue. Localized handbooks attain more site and issue specific detail not appropriate in a national level handbook.

D. What is a Silviculturist? The silviculturist is a forester with detailed knowledge of silviculture and related sciences. At the same time, the silviculturist is a generalist with a working knowledge of a wide range of virtually all other components of natural resources management, including ecological, social, and economic issues. Framed within management direction, the silviculturist needs to be able to analyze site, vegetation and other variables, and develop action plans in the form of treatment prescriptions.

E. How do you become a Silviculturist? To become a silviculturist, one first needs a degree in forestry followed by a mixture of continuing advanced education, and practical on-the-ground experience in diagnosing forest conditions and implementing forest treatments. A forester does not need to attend any special silvicultural educational programs to be considered a silviculturist. Rather he/she must have demonstrated the ability to convert academic knowledge and practical experience into ecologicially sound forest treatments.

F. What is Silviculturist Certification? Silvicultural Certification is a program that a forester may elect to undertake. It has historically consisted of attending several weeks of specific graduate level education, and then, preparing a silvicultural prescription which must be presented and defended before a certification panel. If the forester adequately defends the prescription, he/she is considered a certified silviculturist. The certification process is an exercise that requires aspiring silviculturists to thoroughly demonstrate and defend their understanding of complex land management issues and technologies.

G. How and why did the Silviculturist Certification process get started? The Silviculturist Certification process as implemented in some BIA regions today was largely developed by the USDA Forest Service (FS). It was initiated after reviews of commercial timber harvest prescriptions on FS lands in the 1970s showed a lack of consistency and at times environmentally damaging practices. Debate ensued between FS leadership and academia as to the cause of the inconsistency among practices implemented by professional foresters. The FS felt academic preparation of forestry graduates was not adequate. Academia felt the federal foresters were working independently without sufficient professional guidelines, they did not have adequate access to continuing education, and that they needed more professional interaction. As a result, it was determined that silvicultural prescriptions should be prepared by experienced individuals with advanced training that had been reviewed by their peers. Regional training programs were developed specifically for advanced silviculture studies and a certification program was implemented. All along, the intent of silviculturist certification was to develop and maintain a professional staff capable of making the best possible decisions concerning the management of forest vegetation.

H. Is Silviculturist Certification required in the BIA? Silviculturist certification is encouraged and recommended but not required in the BIA. See the training chapter of this handbook for more information.

I. How does the sustained yield concept compare to the broader characterization of ecosystem sustainability? Sustained yield emphasizes wood and fiber production in providing an income for the tribe. The concept of sustained yield management was required by law and has been implemented on Indian forest land for many decades. It emphasizes the production of a consistent supply of forest products from Indian lands for extended periods of time, and originated from the concern that over-harvesting the forest would damage long-term forest volume production, with dire repercussions to both the environment and local communities or economies. Sustained yield management requires considerable monitoring of forest growth and yield, and extensive knowledge of harvest scheduling techniques.

The broader term "ecosystem sustainability" incorporates sustaining the whole ecosystem including the components we don't fully understand. Tribes have always had this holistic ecosystem sustainability view of the land. Sustainable forest management links environmental protection, economic prosperity, and social well-being in the forest management planning and decision-making process.

J. Do hazardous fuel reduction projects (HFR) require silvicultural prescriptions? Yes. HFR projects in forest land need to be included as part of the general prescription for the stand. Stand-alone prescribed fire projects also need to go through the silvicultural process and an Rx developed, which must be reviewed and signed by the silviculturist. Fuels staffs need to coordinate closely with the silviculturist, the timber sale section, and the interdisciplinary community to minimize conflict with other resource objectives and optimize the outcome of the hazard reduction work.

K. How do the Silvicultural Guidelines in the FMP/IRMP differ from the treatment Rx? Silvicultural guidelines in the IRMP or FMP address broad landscape conditions, objectives and future desired conditions. Treatment-level prescriptions are specific to a particular stand or groups of stands. Stand-level treatment Rxs describe the pathway of the stand towards a desired future condition and must be consistent with and support the broader landscape goals identified in the FMP or IRMP.

L. Is there special funding for silviculture? No, there is no funding appropriation specific to silviculture. The application of sound silvicultural treatments is not optional and is regarded as a mandatory task that must be included in the planning and implementation of virtually all types of forest management activities. Work must therefore be funded dependent upon the type of project such as a combination of: tribal priority allocation funds (TPA); Forestry Project funds, such as forest development, timber harvest initiative, woodland, forest management inventory & planning, and IRMP; fuels project dollars (HFR/WUI); Forest Health Protection (FHP) a.k.a. insect and disease funding; along with all other potential sources. With limited funding it is critical that projects be prioritized, program efficiencies regularly reviewed, and that every source of funding and/or treatment is pursued. For this to be possible Reservation timber programs need strong leadership, clear direction, and good cooperation among all involved.

M. Does the harvest of other (special or traditional) forest products require a silvicultural Rx? Yes, if the forest treatment/harvest affects the present and/or long-term character of a forest stand (including woodlands). If this is not the case, then an Rx in not necessary. In either case, harvest of special and/or traditional forest products will usually be addressed in some form of a local forest products use policy statement. The silviculturist should be consulted during the development of this policy statement to determine if conflicts with other resources objectives will occur and to assess if the practice is sustainable.

N. Does the Silviculturist have a role in community education and outreach concerning land management issues? The implementation of sound resources management requires the integration of environmental, social, and economic principles and sciences. Land management conflicts are usually the result of different perspectives and objectives of stakeholder groups. The silviculturist has a role in providing sound information on the past, current and predicted future conditions and processes in the landscape to as broad an audience as possible. Armed with better knowledge it is hoped that conflict would be reduced and commitment to sound decisions would improve. With the ongoing shortage of trained natural resource specialists it is especially critical to participate in outreach to tribal youth in hope that more will pursue continuing education in natural resource fields.

CHAPTER 2. SILVICULTURAL ROLES, RESPONSIBILITIES, and INTERACTIONS

2.1 General. It is critical that particular individuals carry out their roles and responsibilities, and interact with others in order to effectively manage and protect Indian forest land through the application of sound silvicultural principles. This chapter describes those roles, responsibilities, and interactions.

2.2 Regional Director. As per 53 IAM 9, the Regional Director, is responsible for: developing regional policies, standards and silvicultural guidelines for program implementation; assuring that silvicultural standards and policies are met; and providing assistance in the implementation of Reservation silvicultural program direction, oversight and guidance.

2.3 Agency Superintendent. The Agency Superintendent will: plan and budget for silvicultural program needs; prepare, organize and conduct silvicultural activities; assure silvicultural quality control; and maintain silvicultural data and document archive for all Indian forest lands.

2.4 Silviculturist. A silviculturist will: prepare prescription (Rx) documents and review Rx documents prepared by others; help ensure that the Rx documents properly diagnose stand and forest-level conditions and generate cost effective and practical management prescriptions; ensure that other resource specialists are involved during the Rx development as intended by guidelines set within the FMP and/or IRMP; ensure that the Rx document contains all of the elements described in Chapter 4 of this handbook; ensure that Rx documents are filed and maintained in accordance with the current Bureau of Indian Affairs (BIA) filing system; take appropriate measures to ensure Rx documents are readily retrievable for future reference.

2.5 Interactions. In order to have an effective silvicultural program, silviculturists need to carry out methodical communication and professional interaction with other resource specialists. The silviculture program has two levels of planning: strategic and operational; and the interactions needed for these planning levels are described below.

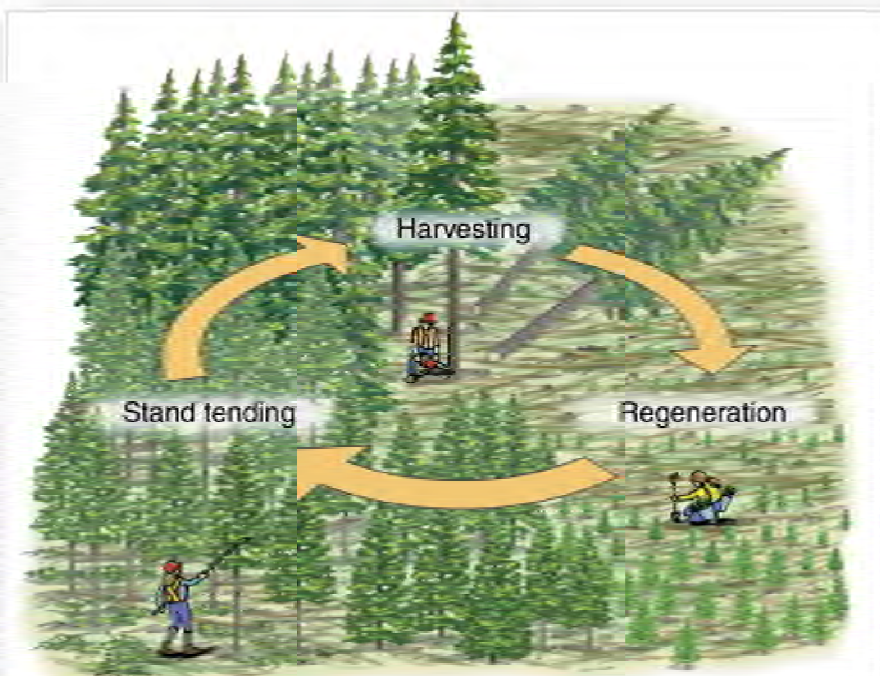
A. Strategic Planning. An FMP or IRMP provides tribal forest-wide goals and objectives and often describes the desired future condition for the entire forest. These goals, objectives, and desired conditions frame the development of project or stand-level Rxs that the silviculturist must address. A silviculturist will be involved with the development of any IRMP, FMP, or other Bureau approved strategic-level plan on reservations that includes trust forest land. The silviculturist will prepare or review the silvicultural guidelines (general strata-level prescriptions) required during the planning process (see Forest Management Planning handbook Volume 2).

B. Operational: Project or Stand Level Planning. Resource Specialists that propose any forest vegetation treatment (timber sale, fuels reduction, forest development, water resource projects, etc.) need to involve a silviculturist early in the project planning stages. During the NEPA process, through interdisciplinary discussions, the silviculturist will need to incorporate other Resource Specialists' views in the development of stand-level silvicultural prescriptions. Project-level planning will vary depending on scale and regional methods.

CHAPTER 3. SILVICULTURAL SYSTEMS AND THEIR APPLICATION

3.1 General. A silvicultural system is a planned series of treatments for tending, harvesting, and re-establishing a stand to meet management objectives. These treatments are applied throughout the life of the stand and are combinations of *regeneration methods* and stand tending, called *intermediate treatments*. The terminology herein is consistent with that in *The Dictionary of Forestry* by Helms, 1998, as well as *Silviculture Terminology* prepared by the Silviculture Instructors Subgroup of the Silviculture Working Group (D2), Society of American Foresters, September 1994. Writers of silvicultural prescriptions and other documents should use these consistent terms to avoid confusion of intent and to adhere to the professionalism of the craft.

3.2 Policy. Sound silvicultural treatments must be biologically feasible, socially acceptable and economically possible. Numerous items such as tribal goals and objectives, past disturbance patterns, forest health, site attributes, stand attributes, plant communities, economics, and the desired resource(s) emphasis should be considered. Determination of the best silvicultural system must first rely upon sound ecological principles. Since it is not within the scope of this document to include all of the principles of applied silviculture, it is incumbent upon the silviculturist to provide additional detail and variation to these guidelines from other sources when writing a specific prescription.



Forest Practices Code of British Columbia, Silvicultural Systems Guidebook, 2003

3.3 Silvicultural Systems Overview. All silvicultural systems include three basic component treatments or functions: timely regeneration, tending and harvest in a stand (Nyland 2002, p. 19). The system, with its attendant regeneration methods, distinctively shapes the structure, either uniform or variable; tending requirements; and yield schedule of the future stand. Because of the decisive imprint of the initial regeneration method, silvicultural systems are named after the regeneration method, e.g. the shelterwood system. A systematic approach to silviculture should:

- harmonize with the goals and specific objectives of the tribe;
- provide for timely regeneration of the desired species;
- effectively and efficiently use growing space and site productivity, making wise use of forest capital;
- manage forest pathogens and damaging agents within acceptable limits;
- protect soil and water resources;
- produce predictable harvests over the long term (sustained yield); and
- balance ecological and economic concerns to ensure a sustainable ecosystem.

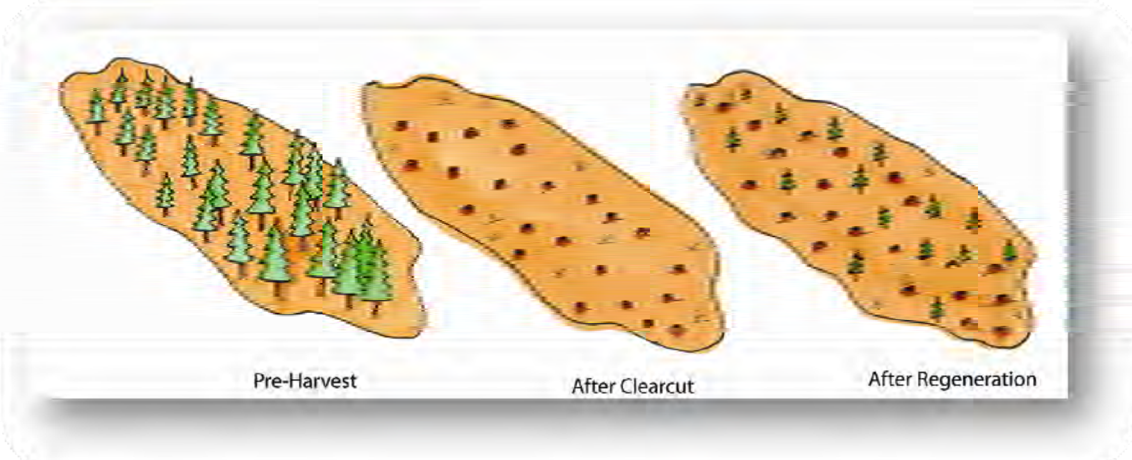
Areas considered for treatment must fall within the above-listed guidelines and follow Forest Management Plan (FMP) criteria. Once a decision is made that treatment is desirable, the first question should be: "What *system* is appropriate here, and why?" The Forest Management Plan (FMP) should offer clear criteria to answer these questions, based upon ecological and administrative policy. The second question then is "What is the appropriate treatment(s)?" Finally, "Can the present stand be manipulated to meet stated FMP goals?" If so, either an intermediate treatment of some kind or deferred treatment is required. If not, then a regeneration method will be called for. See section 3.4 for some discussion and guidance on what system may be appropriate.

A. Even-aged (EA) Systems. These result from regeneration methods designed to regenerate a stand with relatively uniform sizes in a single primary age class (See Figure 3.0). The range of tree ages is usually less than 20% of the rotation. Methods that produce even-aged structures include clearcutting, seed tree, shelterwood, and coppice.

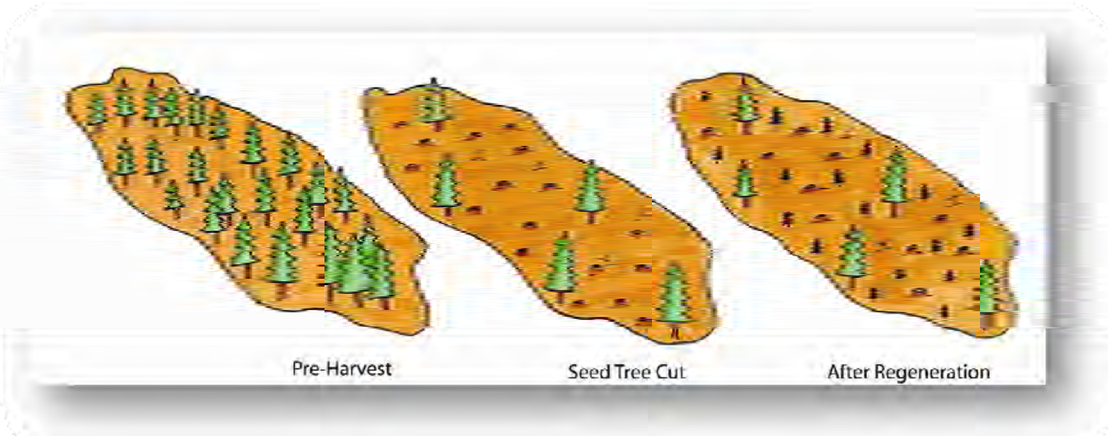
Figure 3.0. An illustration of the structure of an even-aged stand (Baker, 1950).

Regeneration Methods

1. Clearcutting (CC) is a method of regenerating an even-aged stand in which a cohort, or new age class of seedlings, develops in a fully-exposed microenvironment after removal, in a single cutting, of all trees in the previous stand. Regeneration is from natural seeding, direct seeding, planted seedlings, and/or advance regeneration. Cutting may be done in groups or patches (group or patch clearcutting), or in strips (strip clearcutting). In the clearcutting system, the management unit in which regeneration, growth, and yield are regulated consists of the individual clearcut stand. When the primary source of reproduction is advance regeneration, the preferred term is "overstory removal" (SAF, 1994).



2. The seed-tree method (ST) is an even-aged regeneration method in which a new age class develops from seeds that germinate in virtually a fully-exposed microenvironment after removal of the entire stand except for a small number of widely dispersed trees (≈ 10 tpa) retained for seed production. Seed trees are usually removed after regeneration is established.



3. The shelterwood (SW) is a method of regenerating an even-aged stand in which a new cohort, or age class of seedlings, develops in a moderated microenvironment beneath the residual trees. The sequence of treatments can include three distinct types of cuttings:

a. an optional **preparatory cut** to set the stage for regeneration and accomplish one or more of the following:

- Enhance conditions for seed production by releasing future seed trees.
- Develop wind-firmness of future seed and shelter trees.
- Provide for the efficient removal of merchantable suppressed and intermediate trees thereby reducing breakage during the establishment cut. This would be a goal in high-volume old-growth stands.

Care should be taken to keep crown closure high enough to discourage expansion of grass, shrub or forb competition.

b. an **establishment cut or shelterwood seed cut** to prepare the seed bed and to create the new stand; and

c. the final **removal cut** to release the established regeneration from competition with the seed and shelter trees.

Cutting may be done uniformly throughout the stand (uniform shelterwood); in groups or patches (group shelterwood); or in strips (strip shelterwood). Alternately, the final removal cut may be deferred, creating an irregular shelterwood, where regeneration occurs over a considerably longer period than a traditional shelterwood.

4. Coppice is a method of regenerating a stand in which all trees in the previous stand are cut, knocked over, or injured at the root and the majority of regeneration is from stump sprouts or root suckers. This is primarily used in hardwood stands; however, coastal redwoods may also be regenerated using this method.

Principles of Application. Regeneration is a critical and often costly phase of the prescriptive cycle. The Code of Federal Regulations, CFR § 163.12 (a) states:

> *"Harvesting timber on commercial forest land will not be permitted unless provisions for natural and/or artificial reforestation of acceptable tree species is included in harvest plans."*

Choosing the right reproductive method is the first step toward assuring adequate regeneration. Also note that the regeneration is the desirable species.

1. Considerations for choice of regeneration method: The choice of regeneration method (CC, ST, SW or Coppice) is dependent upon a potential host of silvical, ecological, and administrative factors:

a. Artificial or natural means of regeneration. Generally, natural regeneration should be considered first if it can effectively meet stocking objectives of the desired species in a timely and cost-effective manner. This method will also assure that native genetic stock and site-adapted seedlings become established. Reasons to consider artificial reforestation methods include:

- investment analysis indicates that the net present value (NPV) (or other measure) of planting or seeding is significantly greater than the natural regeneration option. This might occur due to site severity factors, infrequent cone crops, stiff vegetative competition to seedlings, or the development of vegetative competition in stands where site preparation will likely be administratively delayed (e.g., while waiting for

- burning windows, etc.);
- there is a need to upgrade genetic potential of the new stand;
- the vigor, health or age of the existing stand may not afford natural regeneration of the desired species; or
- there is a need to restore species diversity or ensure full stocking of desired species.

b. Size and shape of harvest unit as related to the effective seed dispersal distance of desired species.

c. The need for site amelioration on hot, droughty or cold-air “ponding” sites, etc. On droughty sites, shelter trees may be used in conjunction with planting, in lieu of natural regeneration, or supplemental to natural regeneration.

d. Silvical characteristics of seed trees such as the periodicity, reproductive method (coppice or seed producer or both), method of seed dispersal, fire resistance, wind-firmness, etc.

e. Slope steepness; site preparation methods; and cost, including the capability to protect reserve trees, especially from fire, as well as the economic removal of seed or shelter trees.

f. Aspect effects on burning windows and the probability of timely site preparation. Aspect also affects wind-throw, depending upon the prevailing direction of storm tracks.

g. Elevation and its effect on springtime survival of the developing (primordial) cone.

h. Topographic position, elevation, and soil as they affect the probability of windthrow of seed or shelter trees.

i. Topographic position, adjacent terrain and prevailing wind direction during seed dispersal period as they affect the direction of seed dispersal.

2. Components of a successful regeneration system. While seedling production or procurement and reforestation is usually carried out by a Forest Development Section at most locations, it is important that the prescription writer have a good understanding of the reforestation strategy and how it will relate to the larger context of the silvicultural prescription.

It is equally important that the forestry program provide evaluation or monitoring of prescriptions as written. Silvicultural prescriptions should be treated as a contract, binding upon all departments of the agency who have a hand in carrying it out. This may include presale staff, sale administrators, forest development staff or others. Unless the organization is very small, a prescription database accessible to all key staff should be established.

The regeneration phase, because of a host of necessary considerations, often requires a “prescription within a prescription” that addresses details such as planting method, stock type, stock transport and storage, stock size, seedling protection, planting method, or season of planting. For a detailed discussion of reforestation techniques, refer to 53 IAM 5-H, *Forest Development.* The goal of the prescription is to provide a fully stocked stand with established seedlings of the desired species;

however, a prescription should not be implemented without careful consideration of these important items:

- Species selection: Consider existing insect or disease problems in the area such as root rot or mistletoe to determine appropriate planting schemes.
- Long-term site protection: Consider large woody debris retention, long-term nutrient capital, soil compaction and displacement issues, and cultural resource protection.
- Site preparation: Consider cost effectiveness; silvical needs of target tree species; protection of seed or shelter trees; response of the tree, shrub, and grass community; and consistency with historical disturbance patterns.
- Hazardous fuel disposal or treatment: This is generally accomplished during the site preparation process and those same items listed above should be considered. If prescribed fire is the treatment of choice, early coordination between the silviculturist, forest development forester, fuels forester, and implementation unit is critical.
- Harvesting: Felling, skidding, and processing methods should be consistent with all of the above important items. Mechanized harvesting provides numerous options and good silvicultural planning will disallow the use of machinery and harvesting techniques that might be counter-productive to the achievement of one or more of the above items.

Intermediate Treatments

Intermediate treatments include all cultural treatments occurring in stands that are between regeneration periods. Intermediate treatments are performed in order to ensure the desired species composition; improve stem quality; or adjust stand density (spacing) to regulate growth in a developing stand. These treatments have the primary emphasis of correcting stand defects and increasing the volume and value of usable forest products. **There is no intention of establishing regeneration through the application of an intermediate cut.** Care must be taken during any intermediate cutting to protect the residual stand from injury.

A common classification of intermediate treatments is as follows:

1. Release Cuttings. These treatments are designed to free young, target trees from undesirable, usually overtopping, competing vegetation. The emphasis is upon stand improvement and species composition, rather than growth effects, although increased growth rates are an advantageous outcome. The types of release treatments include:

a. Cleaning - A release treatment made in an age class <u>not past the sapling stage</u> in order to free the favored trees from less desirable tree species of comparable age.
A cleaning might be applied to release young ponderosa pine stands from competing juniper trees or oak sprouts in the southwest; or to free white pine from overtopping by inferior hardwoods such as aspen, in eastern regions (Fig. 3.1).

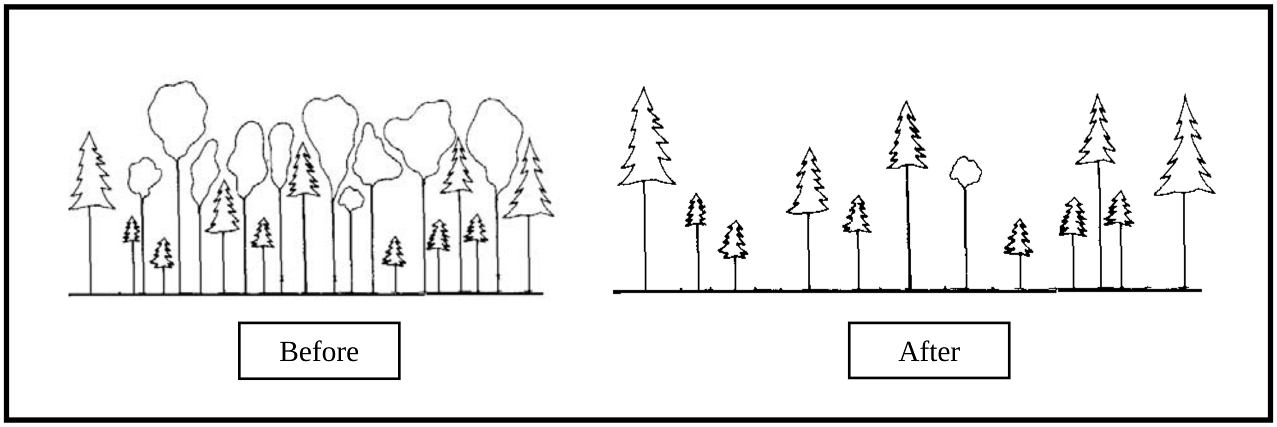


Figure 3.1. Cleaning treatment. (Graphic (modified) from Daniel, T. W.; Helms, J. A.; Baker, F. S. 1979).

b. Weeding - A release treatment made in stands not past the sapling stage that eliminates or suppresses any undesirable vegetation regardless of crown position and may include grass, vines, or shrubs. Undesirable competing vegetation in the southwest includes oak, grass, or locust; and in the northwest may include mountain and vine maple. This term is typically used to describe a more thorough removal of all plants competing with the crop species regardless of whether their crowns are above, beside, or below the desired trees (Smith, 1997).

c. Liberation cutting - A release treatment made in a stand not past the sapling stage to free the favored trees from competition with older, overtopping trees (Fig. 3.2). This treatment differs from a cleaning in that the trees removed are from a much older age class. This method may resemble the final removal cuttings of the seed-tree or shelterwood regeneration methods. The difference however is that generally undesirable trees are removed, rather than ones left intentionally for seed and or additional growth.

Liberation cuttings often yield low harvest volumes per acre, and may be passed over within a treatment area for that reason. However, they may be one of the *highest* priorities for treatment if the understory will not only be liberated, but protected from pathogens such as dwarf mistletoes.

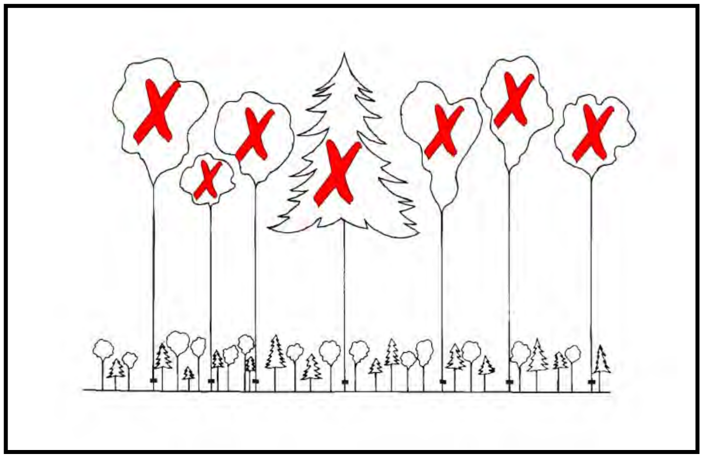


Figure 3.2. Liberation Cut. (Graphic (modified) from Daniel, T. W.; Helms, J. A.; Baker, F. S. 1979).

2. Improvement Cutting. This is a cutting made in a stand beyond the sapling stage for the primary purpose of improving composition and quality. Trees of undesirable species, form or condition are removed from the main canopy. The need for improvement cutting often results from a lack of an earlier application of a needed release cutting.

Such cuttings are extremely important, and utmost care should be taken to mark the very best leave trees. Little effort is needed to make dysgenic selections and degrade the stand genetics while a great deal of effort is required to increase genetic potential (Howe, 1989).

3. Thinning. Thinnings are cuttings made in a stand between regeneration and final harvest to reduce stand density for the purpose of stimulating the growth of remaining trees to increase the yield of desired products, enhance forest health, or recover potential mortality. Its primary focus is on *growth redistribution* on the selected leave trees. Traditional emphasis has been on release, but a silviculturist needs to be forward looking and specify a thinning to *maintain* already good growth as well. Thinning may not increase total stand yield, and in fact may reduce it if treatments are severe, but it will increase certain merchantable products and thus total stand value. Unlike site quality or precipitation, density can be controlled easily and profitably (Zeide, 2008 Web Site).

a. Stocking and Stand Density. These two terms are sometimes used interchangeably, but each has a distinct meaning necessary to convey particular silvicultural concepts. Density is quantitative, such as the number of trees per acre, basal area per acre, or volume per acre. Stocking is a relative term comparing what is there (density) with an optimum that is set by management objectives and usually expressed as a percentage. Assuming that full stocking has been determined for a given site, 325 two-inch trees per acre might represent full stocking on one site and 80% stocking on a better site. Stocking also considers distribution or tree placement within a stand.

Typically, in natural stands, high stocking percentages imply very high densities. Conversely, low stocking figures generally, but not always, imply lower average stand densities. A low stocking percent with a high average tree/acre count would imply that the stand has a large amount of unstocked area with clumps of very high density.

b. Methods of Thinning. Historically, foresters have recognized four distinct methods of thinning to determine which trees to favor and which to remove. A fifth method, free thinning, can be any combination of the other four methods applied simultaneously in a single operation, usually in stands of irregular structure (Smith et al. 1997, pg. 99). For the first three, foresters select trees to cut or leave based largely on crown position (Nyland, 2002, p. 409). While each method is briefly mentioned below, it is recommended that that a silviculture text be consulted for further information on the intricacies how each method influences natural patterns of growth, development, structure, and yield.

(1) Crown Thinning - The removal of trees from the dominant and co-dominant crown classes in order to open the canopy to favor the best trees of those same classes (Fig. 3.3). This is usually applied where intermediate and suppressed classes are minimal or their removal would provide little benefit to the upper crown classes. Remove dominants with poor crowns or stem form to prevent dysgenic effects. In any crown thinning, it is usually best to identify the final-crop trees and then eliminate the most vigorous competitors of each (Smith, 1997) to prevent dysgenic effects.

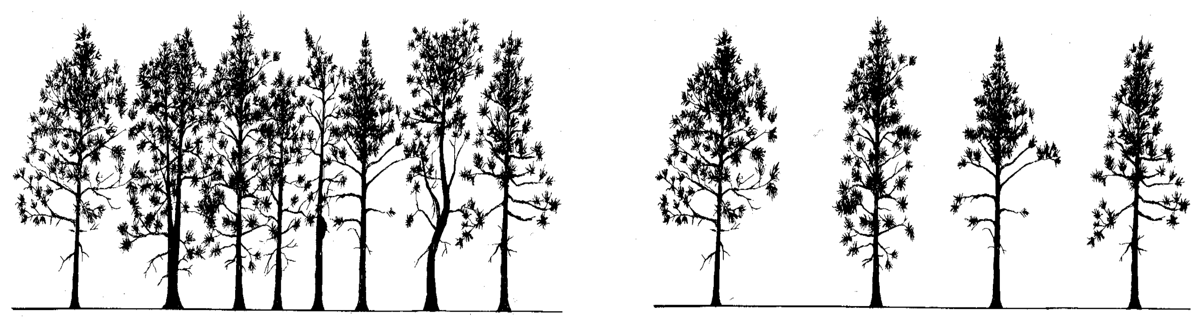
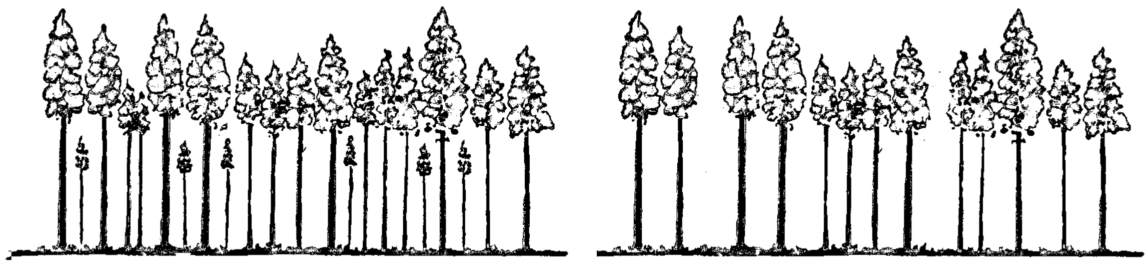


Figure 3.3. Crown Thinning – favors the best within the same canopy class.

(2) Low thinning - The removal of trees from the lower crown classes in order to favor those in the upper crown classes. Figure 3.4 depicts a light thinning from below. This method simulates mortality by cutting the weakest, overtopped trees which would die first. The focus is on the trees that have the greatest potential for growth. A heavy low thinning simplifies the stand structure of even-aged forests by removing the smallest trees. Low thinning has application in areas prone to drought in that it protects some of the larger trees which might otherwise succumb to drought-induced mortality due to competition.



Before *low thinning* After *low thinning*

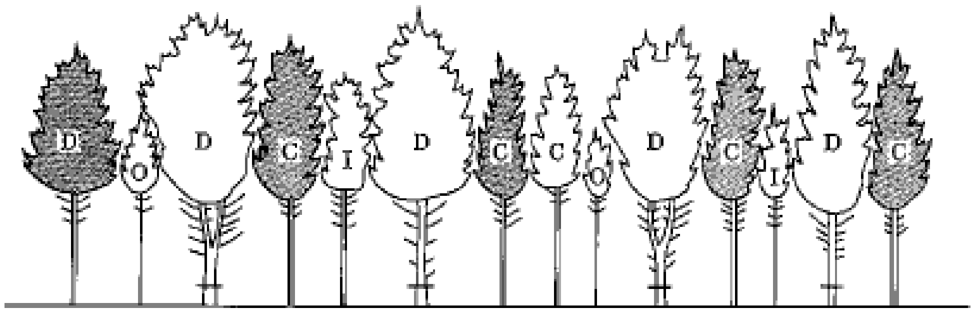
<u>Figure 3.4</u>. Thinning from below favors the upper canopy classes. (Graphic (modified) from Baker, 1950).

(3) Selection Thinning. Selection thinning, or thinning of dominants, is a treatment designed to carefully and thoughtfully remove selected dominant trees in order to stimulate the growth of desirable trees in the lower crown classes (Fig. 3.5). Selection thinning differs from and has no relationship to the selection method of regeneration applied to uneven-aged stands and the silviculturist must be familiar with the different objectives of both to avoid semantic confusion. Selection thinning, if not used with great care, can very easily lead to the destructive practice of high-grading by releasing trees with less than optimum vigor or poor-quality stems by removing the best. Many current texts on silviculture address this method of thinning and of the problems and concerns one should astutely be aware if choosing to implement this method.

Selection thinnings are best implemented as early as possible in the life of the stand and replaced by other thinning methods as soon as the crop trees approach the dominant position (Smith, 1997). In the most common use, low-value species or poorly formed dominants (wolf trees), are removed to favor quality crop trees chosen from the highest possible level in the stand. This type of thinning will have the most application in hardwood forests where species grown for furniture-grade clear wood is desired and where the codominants and the intermediates have grown tall yet have fewer branches than the dominants. Codominants with a higher first fork would be favored in the thinning.

In stands of shade-tolerant species with strong epinastic control such as spruce and true firs, dominants are removed to favor codominants with enough live-crown (at least 30 – 40 percent) to respond. Epinastic control is the control exhibited by a trees terminal bud over the length and orientation of lateral branches. When the terminal bud of many conifers (including Douglas-fir) is lost, the uppermost lateral branches grow upward and reassert epinastic control. Stands of intolerant species **cannot** withstand more than one or two selection thinnings before most of the trees capable of useful response are gone (Smith, 1997). In shade-tolerant plantations, selection thinning followed by artificial regeneration may occasionally be part of a long-term approach to minimize any unintentional dysgenic effects (Nyland, 2002, p. 418).

Caution is again emphasized if selection thinning is being considered. This kind of cutting can lead to a stand of poor trees that cannot be harvested economically (Smith, 1997).



An example of selection thinning taken from Smith, 1997. (-) indicates cut tree. Rough.

Figure 3.5. Selection thinning.

(4) Geometric (Proportional) Thinning - This type of thinning removes trees in rows, strips, or with fixed-spacing intervals with no regard for their species, position in the canopy, vigor, or form. This is the least desirable type of thinning because form, phenotypic quality, and species composition are at best neutral after treatment. It may be justified in uniform, healthy plantations or in previously unthinned, extremely dense stands where other thinning methods are cost-prohibitive; there is little or no product recovery; and the work can be accomplished by using machinery at a reasonable cost.

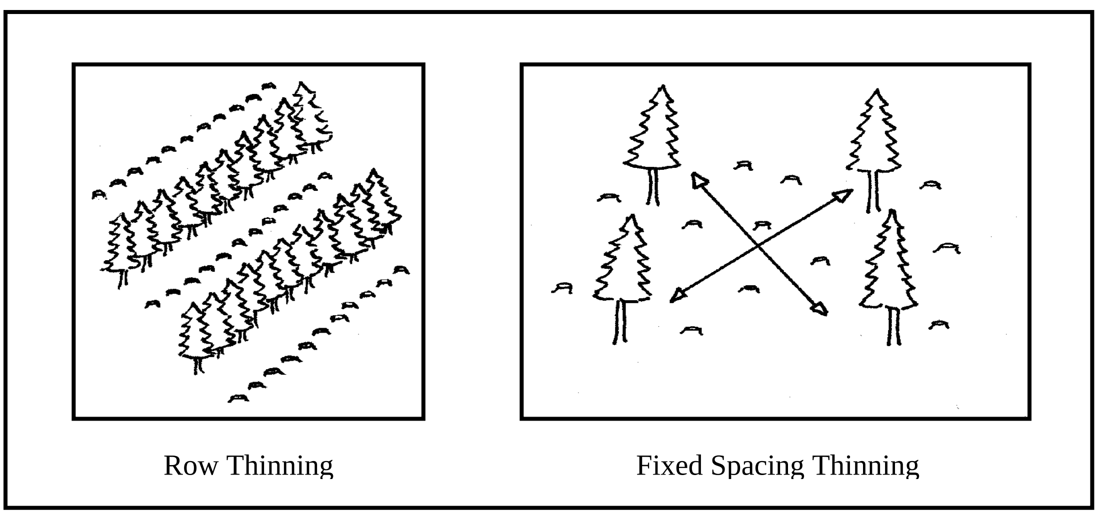


Figure 3.6. Two examples of geometric thinning.

Fixed-spacing thinning is generally applied only to overcrowded, young stands that have developed from dense natural regeneration or artificial broadcast seeding. Ordinarily geometric thinning is done only in the first thinning of the stand and sets the stage for subsequent selective thinnings, especially where machines can maneuver in less dense stands. Figure 3.6 shows examples of geometric thinning.

(5) Free Thinning. This method releases selected crop trees by using a combination of the above thinning methods. The free thin, also known as the free selection method, is a form of uneven-aged management that recognizes the forest and each stand as a mosaic of conditions and tree groupings, and applies the desired forest treatment objectives appropriately to each encountered condition and grouping. For example, over-mature groups of trees may be removed as a group or thinned to a seed-tree configuration in order to promote shade-intolerant regeneration. Adjacent to one or more of these groups there may be maturing groups of trees in need of commercial thinning in order to redistribute growth to the residual trees. Adjacent to the maturing groups there may be juvenile components of trees that are in need of both overstory release and precommercial thinning. The free thin method takes full advantage of the variability of the forest, but requires a very well trained forester to apply the treatment on the ground. This method is applicable in all situations where uneven-aged management is intended and where a variety of stand conditions exist (e.g., stands that are irregular in age, density or species composition) so that using only one method is not appropriate. Even though "free thinning" may be the method, the silviculturist should use technical terminology to convey as much of the thinning description as possible. "Modified crown thinning," "crown and selection thinning," or "crop tree release" would be more informative terms.

c. Thinning Regimes. This refers to the interaction among the post-treatment density; the timing and interval between future treatments; and the type of thinning employed. Regimes affect not only stand yield and value through time, but also individual tree architecture such as taper, bole quality, and crown ratio.

(1) Density or Spacing. The objective of thinning is to keep the site as fully occupied as possible through time while vigorously growing the desired product. The stand will be kept in a density *range* by reducing tree numbers as trees grow in size. Foresters can use available stocking or relative density guides to monitor when the stocking rises above some predetermined threshold. Consideration of the desired average stand diameter (quadratic mean diameter, not simple mathematical average) at the next entry and the timing of that entry must be given when applying spacing guidelines.

In his ninth edition of *The Practice of Silviculture*, Smith (1997) describes some "rules of thumb" regarding spacing of the trees left after thinning. According to the "$D + x$" rule, the average square spacing in feet should equal the average stand diameter D in inches plus a constant x. The values of x that are suggested for various situations range from 1 to 8, with 6 being the most common. The rules of this form provide for steady increases in basal area. The "Dx" rule provides for constant basal area; the values of the factor x for basal areas of 90 and 120 square feet of basal area per acre are 1.61 and 1.4 respectively.

Another way of regulating tree spacing described by Smith is to set the average spacing equal to a constant fraction of the height of the dominant trees. It has been suggested that the spacing for tolerant species such as spruce and fir be one-sixth of the height and that for intolerants such as red and jack pine be one-fourth of the height (Smith, 1997). Note that dominant height is an excellent indicator of stage of stand development and, unlike DBH, is independent of the effects of thinning.

Detailed consideration of density, site utilization and density management is given in the section entitled "Site, Site Utilization and Thinning Decisions" following this thinning regime discussion.

(2) Timing Considerations. Thinning schedules are based partly on the best biological, economic and mathematical analysis available and partly on intuitive art designed to integrate these considerations (Smith, 1997). The following is a partial list of items the forester must consider when formulating the timing of treatments, or the "when to thin," for the thinning regime.

(a) Merchantable threshold size and markets. The opportunity to remove smaller roundwood products or hog fuel in a stand targeted primarily for sawlog production will alter the timing and intensity of thinnings. The smaller the material that can be sold, the earlier, more frequent and less intense thinning may be, while still being profitable.

(b) Vigor and health. Does the subject stand have enough vigor to respond to treatment? While some low-vigor stands might be candidates only for a regeneration treatment, others may be close enough to the merchantable threshold that a thinning will be cost effective even though release may only be moderate to poor.

(c) Current stand density. This must be viewed in terms of where the stand should be at the next entry, given the current and projected growth rate and time to next probable treatment.

(d) Site class. High sites with faster growth may require more frequent stocking adjustments than do poor sites.

(e) Onset of suppression. It is desirable that the first thinning occur prior to suppression, unless some special bole quality objectives can be met by allowing stem crowding. Very early, intense suppression can reduce visible differentiation (g), below.

(f) Administrative capability to revisit the site. If it is not practical to do stand tending more often than every 25 years, current spacing should reflect that the stand not approach suppression by the next entry.

(g) Differentiation. Several factors influence the competing process of differentiation into crown classes. Among these are silvical differences among species, genetic variation, microsite variability, and average site quality. Some delay in initial thinning might be considered appropriate if it will aid in spotting tree dominance by the marker or thinner.

(h) Species. Intolerant species will be less likely to withstand suppression or a delay in treatment than would a mid-seral or climax species for the site.

(i) Commercial thinning costs. If costs of treatment are high due to terrain or other limitations, wider spacing with longer time intervals between treatments may be the most economical approach. Heavy, infrequent thinnings will tend to reduce total yield, but may be the best financial choice.

(k) Windfirmness and breakage. If thinning is too severe in stands where suppression is too advanced and the height-to-diameter ratio is high, there will be an increased likelihood of stem breakage and windthrow. In such a stand, a closer spacing with a return on a shorter time interval, if needed, is advised. Note: stands in this condition typically release slowly (if at all) and tighter spacing along with a standard return interval may work out fine.

(l) Operability. For commercial thinning, consider damage to the reserve stand. While a 12' by 12' spacing may be ideal, mechanized equipment available may require a 16-foot spacing to keep residual tree damage at acceptable levels.

(m) Other resource needs. The need to maintain big game hiding or thermal cover may require density and timing adjustments.

(n) Relative financial returns. Prescriptions written for unmanaged stands typically have a compelling forest health, vigor or related issue that dominates the decision process. However, treatment decisions in semi-managed or fully managed stands often present alternate and viable regimes that need to be analyzed and compared.

When comparing alternative regimes, an investment analysis is an essential tool. It levels the "playing field" with regards to the timing, amount, and value of yield and costs so that the 'best' regime is evident in terms of current dollars. When using financial tools, the assumption is that ecological and social side boards have already been imbedded into the decision matrix and yet there remains doubt that may be resolved in economic terms. While foresters often talk of biological yield optimization, it is financial yield that is most relevant where wood production is a commercial venture.

There are several decision tools available including **Net Present Value** (NPV or PNV = present net value of benefits – present value of cost), **Benefit/Cost Ratio** (BCR = present value of benefits ÷ present value of costs), **Internal Rate of Return** (IRR = the discount rate that sets the present value of the benefits equal to the present value of the costs), or **Composite Rate of Return** (CRR). These tools/formulas are good for comparing options for a single rotation of an even-aged system. Comparisons could be between natural regeneration using a shelterwood versus a clearcut that must be planted, or might simply be a comparison of two thinning intensities at the same point in time.

Soil Expectation Value (SEV) analysis is used to *value* land, but is essentially the net present value of a particular treatment regime, start to finish, repeated into infinity.

(3) Type of Thinning. The thinning method prescribed at any point will be the most intuitive of the three aspects of decision making. It will largely be a function of the structure and species composition of the stand, as one considers what to leave and what to remove to promote the crop trees of choice.

d. Site, Site Utilization, and Thinning Decisions. "In spite of generations of attempts, it is not possible to precisely define how dense any stand should be left after each of a series of thinning (Smith, p. 100, 1962)". This statement, made over 45 years ago, still stands today. The problem in part stems from the great numbers of variables with which foresters must contend. Site specific stocking and density data that are verified over long periods are rare and often compromised by study design defects or unclear assumptions.

Determining desired site occupancy (number of trees, size, and species) at a particular point in time assumes some prior knowledge of where full site occupancy begins, what constitutes maximum site occupancy, and how both relate to growth and yield. Attempts to develop stocking guides and thinning schedules without the ability to precisely define the optimal relationship between stocking and growth can be frustrating. This coupled with varied site quality and the variables mentioned above, means that guidance may be sketchy in some locales. The lack of published stocking and growth data for an area should not be an excuse to bypass a needed treatment. Following are a number of concepts and tools that will aid the silviculturist in taking an analytical approach:

(1) Simple field measurements. Armed with some basic stand dynamic principles and an increment borer, the silviculturist can go a long way towards stand improvement. Field observations of radial growth and crown spacing will suggest the need for treatment, if not the actual spacing. The relative pattern of radial growth (declining, constant, or increasing), combined with the probable time until the next entry will also help determine if a thinning is due now or could be postponed. Be careful that weather data are included in the analysis; otherwise, weather patterns rather than density influences might be measured.

(2) "Langsaeter's Plateau." In 1941, Langsaeter proposed the generalized curve shown in Figure 3.7 that shows the relationship between stocking density measured in cubic volume (x axis), and growth in cubic volume (y axis). This curve suggests that once a stand is beyond a certain density, the yield of the stand will not vary much and at some point, typically 55% relative density, crowding causes significant density-induced mortality. The actual quantitative curves will vary by site, species and age, but the form of the curve is what is most useful. The combined use of "Langsaeter's Plateau" and a relative density formula can supply some helpful starting information.

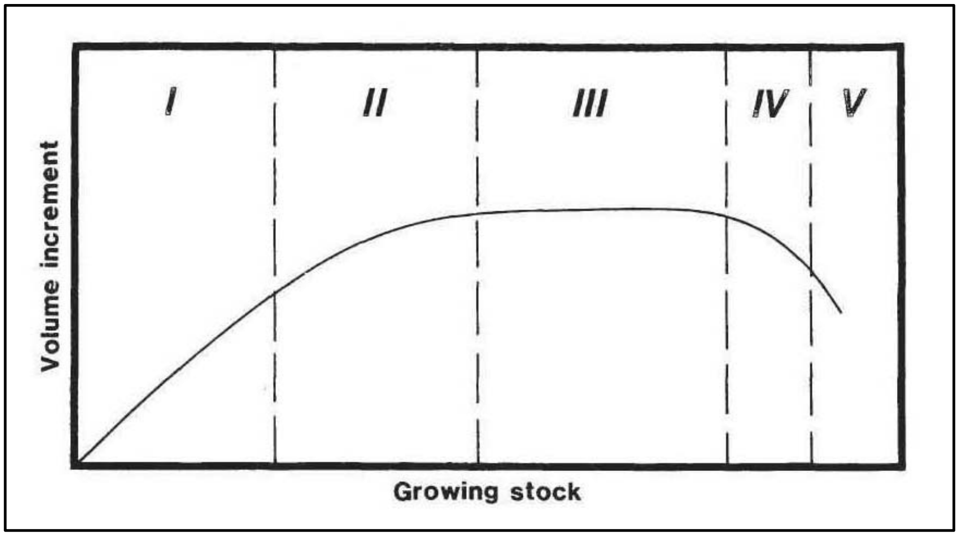


Figure 3.7. Langsaeter's Plateau.

Relation between volume increment (growth cubic feet per acre per year) and growing stock (volume per acre), as hypothesized by Langsaeter (adapted from Braathe 1957). Roman numerals denote Langsaeter's "density types."

Recent work on extremely high sites in the Douglas-fir region of the northwest suggests that gross and net growth may continue to increase in Zone III, suggesting that on these sites the 'plateau' may be a gently inclining slope and wider than originally thought, with the beginning of the density-related Zone IV yet to be determined. However, on more moisture-limiting sites, this relationship is deemed to be a valuable one.

(**3) Stand Density Index (SDI).** A density index such as the Stand Density Index (Reinecke 1933) is a useful tool to help estimate a probable thinning level. In even-aged stands, SDI can be calculated using the quadratic mean diameter and the number of trees to find the stand density index of the stand:

$$SDI = TPA * (\text{stand dbh} / 10) \wedge^{1.605}$$

This equation calculates stand density with any combination of size and density and re-expresses it as if the stand had an average diameter of 10 inches.

The highest possible relative density for a given species is termed Maximum SDI (SDImax). Since the maximum SDI has been determined for numerous species, one can calculate the current relative density (actual SDI / SDImax) and also estimate where the stand will grow in average diameter, and thus basal area, in a fixed time period. Researchers including Drew, Flewelling, Long, Reinecke, and others suggest specific "zones" of density which will implicate the need for treatment (see Table 3.8). These zones are not hard and fast but rather tend to be thought of as bands or ranges that allow for some first approximations of treatment schedules.

Zone	Relative Density	Description and Theory of Growth (Silvicultural Significance)
I	0 - 15% *Prior to crown closure*	• Site not fully occupied - no competition • Individual tree growth near maximum and unaffected by stand density (free growth period) • Stand volume growth (net and gross) increasing across range and proportional to stand density (site potential underutilized)
II	16 - 30%	• Crown closure and onset of inter-tree competition • Individual tree growth decreases with increasing stand density • Stand volume growth is increasing. • Stand growth increases at a decreasing rate Crown closure starts: 25% SDImax
III	31 - 55%	• Site is fully occupied • Trends as in Zone II continue. • Reductions in tree growth are considerable as tree numbers (stand density) increase. • Net and gross stand growth relatively constant and modest across range. Lower limit of full site occupancy: 35% SDImax
IV	> 55% *Zone of Imminent Mortality*	• Density-dependent mortality (self-thinning) is imminent • Reductions in tree growth are considerable. • Gross stand growth is high, but net growth declines with density-related mortality. Mortality is from insects and disease as well as suppression. Lower limit of self-thinning: 60% SDImax

Table 3.1. Density zone descriptions.

The intent is to keep an even-aged stand within Zone III most of the time, dipping into Zone II right after thinning. It must be remembered that these are only rough ranges. For example, Zone II may range from approximately 16% to 35%, or to as low as 25% on the upper end. Also refer to figure 3.8 where the letters A – D correspond to zones I – IV, respectively.

Note from the figure that as the density of a stand increases, individual tree growth decreases rapidly while stand growth continues to increase until it reaches a plateau at which time mortality increases, causing a fairly rapid decrease in stand net growth. (Stand Gross Growth = Increment + Ingrowth; while Stand Net Growth = Increment + Ingrowth – Mortality).

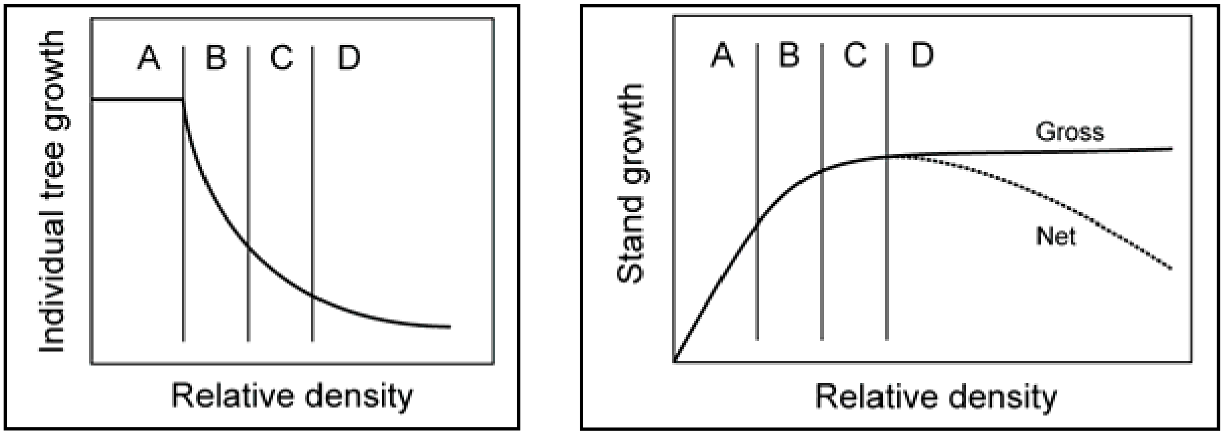


Figure 3.8. Growth-growing stock relations (Long, 2003).

A key factor in any density management regime is deciding upon the appropriate upper and lower limits. These choices are directly dependent upon management objectives. For example, if you want to delay self-pruning, you would set the upper boundary at less than 25% SDImax. If you wanted to maintain vigor and avoid self-thinning, you would keep the stand at less than 60% SDImax.

Density Management Diagrams (DMD) are simple graphical models of even-aged stand dynamics (Long and Shaw, 2005) developed for mostly western species that can also be used for designing a density management regime. An example is shown in Figure 3.9. The most common application of DMDs is in determining what post-thinning density will result in the type of stand desired at the next entry (Long and Shaw, 2005).

There are many measures of relative density and one should be familiar with what is most commonly used in their area. For example, Drew and Flewelling (1979) have included height as a way of incorporating the relationship between tree volume and numbers of trees per unit at maximum density for Douglas-fir in the Pacific Northwest.

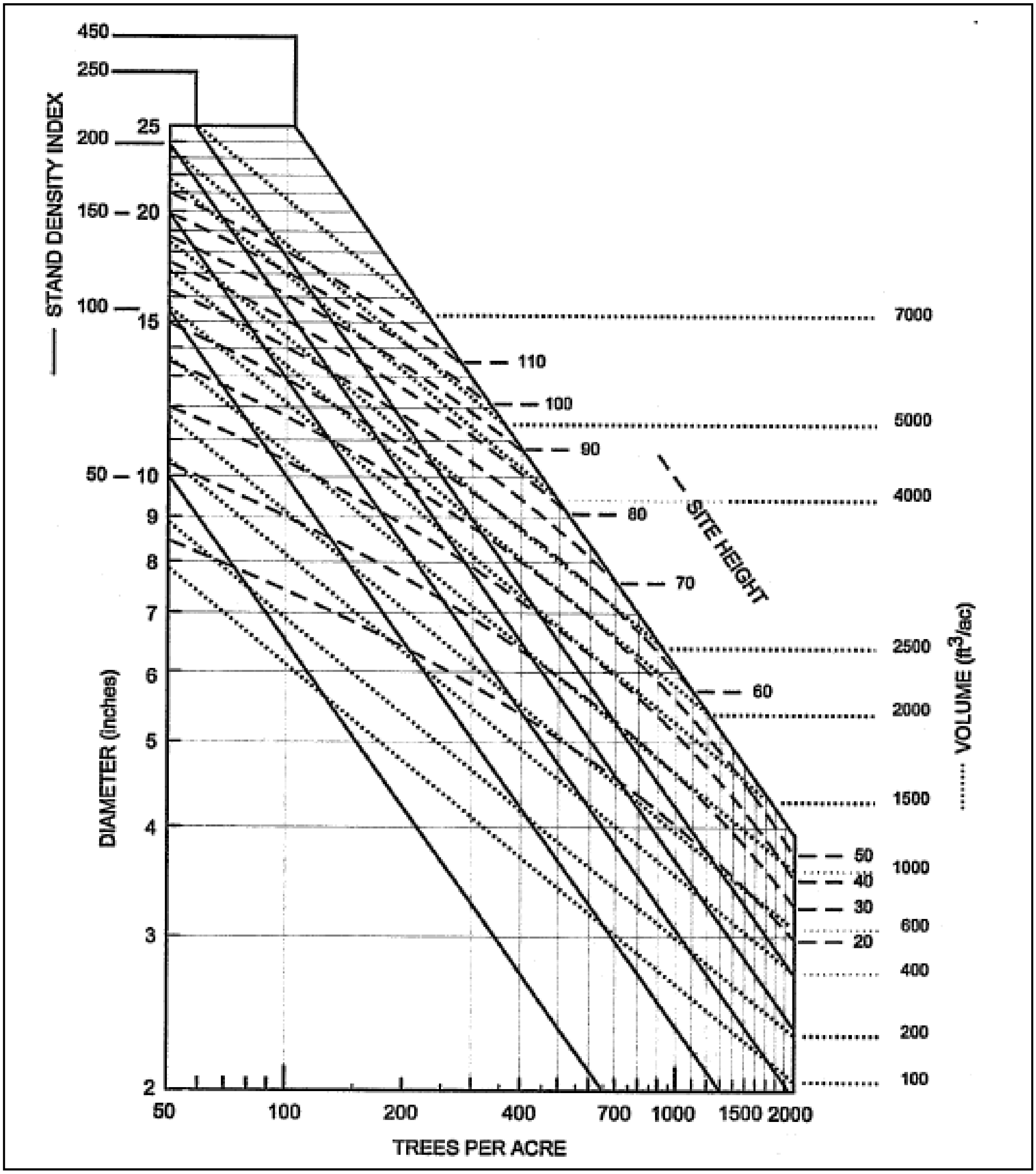


Figure 3.9. Density Management Diagram for even-aged ponderosa pine stands (Long and Shaw, 2005).

(4) Regional Stocking guides created by other Agencies or private industry. These guides, such as Buckman's red pine bulletin (Buckman, 1962 and 2006), give yield information for a variety of spacing regimes. Stocking guides have been developed for most of the major forest cover types and species in North America. Virtually all of these guides use number of trees or basal area per unit area as expressions of stand density along with quadratic mean diameter as an index of stand development. Contact your regional office or search the internet if you need assistance in acquiring these guides.

(5) CFI data. Analysis of this data may provide some preliminary clues as to the relationship between growth and densities, as well as the upper levels of site occupancy.

(6) Uneven-aged Stocking Plots. These occur primarily in the western regions. Many of them are currently more even-aged, or irregular, yet may be helpful in the interim in the in the absence of any other data for even-aged stands. One study in the southeast is the "Good Forty-Bad Forty" on the Crosset Experimental Forest in Arkansas. It has nearly 70 years of yield information for uneven-aged stands of loblolly pine.

(7) Modeling. Both stand and individual tree models, especially if based on local or regional growth measurements, will be helpful in establishing thinning regimes. Models that accommodate a range of silvicultural treatments will allow the user to tie together both stocking and timing of treatments, creating managed yield tables. The most widely used model in the United States is the Forest Vegetation Simulator (FVS), supported at the national level by the US Forest Service. Long term projection models should be used with skepticism; their strength is in short projections and comparison of alternatives.

4. Sanitation and Salvage Cutting. These two treatments are often applied in conjunction with each other; the combined treatment is referred to as a Sanitation-Salvage cutting.

a. Sanitation. Sanitation consists of the removal of trees to reduce the actual or anticipated spread of insects or disease. In many cases economic return from the harvest is not a high priority. An example might be the removal of bark beetle brood trees before they affect more trees or the removal of all visible and suspected latent dwarf mistletoe in a stand.

b. Salvage. This method is used to harvest dead, dying, or deteriorating trees to recover their value that would otherwise be lost. Economic return is a main objective of this treatment.

High Risk Trees Suitable for Salvage

When prescribing an intermediate treatment, name the treatment after the *primary* effect desired. It is obvious that a commercial crown thinning will have aspects of an improvement cut, as the best phenotypes will be left, and may accomplish some sanitation objectives. However, if the prime purpose of the treatment is to redistribute growth, it should be termed a thinning.

5. Other Intermediate Treatments. These are treatments other than cuttings that may take place between the establishment of regeneration and the regeneration cutting.

a. Pruning. Artificial forest pruning is a silvicultural operation, distinct from ornamental pruning, fruit tree pruning, and Christmas tree pruning, performed to improve wood quality or to remove dead or diseased limbs. It is labor intensive, costly, and requires a certain degree of judgment and skill. Pruning may be used to remove mistletoe infections from young trees. Pruning is sometimes applied to increase the wood quality and value by promoting the growth of clearwood on the lower boles of crop trees, particularly in short rotation crops.

There are many additional benefits that are related to the changes in stand structure that result from forest pruning. Pruning, in conjunction with thinning, can be prescribed to perpetuate the growth of understory vegetation and thereby enhance wildlife habitat. The growth of some food and medicinal plants may be improved as a result of increased light reaching the understory following pruning. Pruning may be prescribed to control white pine blister rust infections and alter microclimate in five-needle pine stands. Pruning can be done to remove dwarf mistletoe infections from young trees. In addition, hazardous fuel reduction prescriptions often include pruning to remove ladder fuels.

Artificial pruning is expensive enough that is must be limited to a small number of trees per acre and there must be a substantial premium for knot-free wood. This usually exists with species that have wood suitable for cabinet work, interior finish, furniture, or high-grade surface veneer. Ordinarily, the premium has been regarded as insufficient in the case of species that are used primarily for framing timbers and building construction (Smith, 1997).

Commercial pruning has been demonstrated to be economically viable on conifers such as white pine, red pine, loblolly pine and Douglas-fir. Other species such as ponderosa pine may also be likely candidates. Interest in pruning has been cyclical over the years and successful pruning requires a number of items to be in place, such as:

- the ability to make substantial initial investments
- the ability to track stands through time based upon good record keeping
- good sites - accrual of clear wood must be substantial enough to offset the capital carrying costs of pruning. (i.e., costs may have to be carried 30 to 50 years)
- uniform stands or plantations of conifers with ample selection of 'crop' trees to prune
- commitment to perpetual intensive management to support the pruning investment
- labor pool - hand labor has been shown to be more effective than mechanical means substantial clear wood premium for future markets

The literature includes ample information on the technical aspects of pruning. Pruning in conjunction with fuels treatments to reduce fire hazard is becoming a more common treatment on trust lands.

b. Fertilization. The application of fertilizer in forests is usually done: (a) to maintain or improve soil properties such as organic matter and the ability to supply nutrients, and (b) to improve tree growth and yield. Remember that it is more effective to preserve soil productivity by careful implementation of silvicultural practices than to try to restore soils damaged by intensive site preparation or severe fires, for example (Tappeiner et al, 2007). Of all nutrient elements, nitrogen (N) is by far the primary growth-limiting nutrient in North America. Fertilization is not a common practice on Indian lands, especially large-scale commercial applications. Fertilization is expensive and because of this, the net gain from treatment must be recovered and capitalized relatively quickly. It is typically applied within 5-7 years of a final harvest. Other considerations are:

- Stands should be even-aged.
- Stands should be uniform, without large holes.
- Stands should be moderate to high in vigor.
- Sites should be moderate to high in yield.
- Local experts should be consulted to determine what types of geomorphology and soil types will best respond to specific nutrient mixes. While nitrogen is usually the limiting factor, this is not always the case. If water or phosphorous is the limiting factor, adding N may not cause trees to grow. Additionally, adding N may actually increase mortality due to Armillaria (Tappeiner et al, 2007).
- Good silvicultural practices should first be in place before fertilization is contemplated.
- Stands selected for fertilization should be committed to future intensive practices.

In general, forest fertilization will not be practical on most trust lands. Regional experts should be consulted for detailed recommendations when the silviculturist sees an opportunity. Fertilization will more often be used as a spot treatment to repair, protect, and enhance vegetative cover, such as on exposed soil, burned or degraded sites, or heavily used areas.

While fertilization may not often be attempted on a commercial scale, tree and forest nutrition should be on the mind of every practitioner. The type of silvicultural system or intermediate treatment used and how it is implemented will affect both short and long-term site productivity. Slash treatment or disposal method after a regeneration harvest or intermediate cut will affect short-term nutrient capital, as the fine material captures the greater part of those nutrients.

The relative nutritional effect of any treatment on future stand growth will be due to a great number of factors including such things as soil depth, soil type, fertility, severity of treatment (clearcut vs. low thinning), treatment type (burning, slash trampling, removal, etc) rainfall, site severity, etc.

c. Prescribed Burning. Prescribed burning is a silvicultural technique or tool used to accomplish some aspect of a regeneration or intermediate treatment, and as such, is an integral part of the silvicultural prescription. The agency needs to work hard at coordinating burning projects rather than separating forest management from fire management planning and execution.

To maintain the control and ensure positive effects, foresters must plan why and how to burn. The detailed prescription, based upon analysis of the site and its needs, should have clearly stated objectives when fire is prescribed in forest stands. These might include: fuels reduction; site preparation; or the reduction of an undesirable tree species or an overabundant species.

If site preparation for seedling survival or seed germination is the objective, thought should be given to the grass, forb and shrub species present, as well as the tree species to be managed. Seasonal timing and the intensity of the burn will affect both, with possible unintended consequences. The site: www.fs.fed.us/database/feis/plants, provides valuable insight into plant response to fire.

d. Application of Pesticides. Broad scale application of pesticides occasionally occurs, generally in conjunction with spraying for defoliators such as spruce budworm or tussock moth. These projects typically cover large areas, are costly and affect numerous other forest resources.

Because the need is created by catastrophic outbreaks, there will not be an environmental document to tier from, and thus will require their own stand alone analysis. Input of a number of specialists including entomologists, foresters, hydrologists, public, etc. will be required. In some cases, inter-agency efforts should be considered.

Smaller scale operations may include brood tree or trap tree treatments, or the use of pheromones to manipulate insect populations. These intense measures are only cost effective if considered “holding actions” and are associated with near-term silvicultural treatments to remedy the situation that caused the problem in the first place. For example, pheromone trapping may be used in some instances as a stand-alone treatment designed to get plantations to an age of resistance without excessive damage from pine shoot borer. If the root cause(s) of the stand condition is not being addressed, then these types of treatments *should not* be attempted.

e. Other Chemical Applications. Use of herbicides for site preparation and conifer release may be the most cost-effective solutions for some sites; however, public perception of their safety has generally limited that use on public and Indian forest lands. Chapter 5 (Forest Development) covers this topic in more detail.

B. Two-aged Systems. Two-aged systems are relatively new additions to silvicultural terminology, born out of a concern that traditional even-aged regeneration methods, as typically applied, did not mimic the natural or historic regeneration process. The pure application of the common reproductive methods left clean stand edges; simplified mensurational computations; and provided little vertical or horizontal diversity after the seed or shelter trees were removed.

The “New Forestry” movement of the 1990’s underscored the importance of leaving legacy elements (snags, thickets, down woody material, etc.) and ragged edges to promote the web of life forms not easily noticed but critical to the maintenance of long-term site health and diversity.

A two-aged regeneration system is designed to maintain and regenerate a stand with two age classes by borrowing from both even- and uneven-aged silviculture. The resulting stand may be two-aged or tend towards an uneven-aged condition as a consequence of both an extended period of regeneration establishment and the retention of reserve trees that may represent one or more age classes. Foresters subdivide the even-aged systems into the clearcutting, shelterwood, seed-tree, or coppice cutting methods, the uneven-aged systems are subdivided into the single-tree or group selection cutting methods, and the two aged systems are the clearcut/shelterwood/seed tree/coppice with reserves and the leave-tree cutting methods.

Methods for developing a two-aged stand

1. Clearcutting with reserves is a clearcutting method in which varying numbers of reserve trees are not harvested to attain goals other than regeneration. These goals might be related to visual retention, or to maintain a few good-growing trees, as well as ecological reasons cited above. These retention trees may be dispersed or grouped.

2. Seed-tree with reserves is a seed-tree method in which some or all of the seed trees are retained after regeneration has become established to attain goals other than regeneration. This retention may be dispersed or grouped.

3. Shelterwood with reserves is a variant of the shelterwood method in which some or all of the shelter trees are retained, well beyond the normal period of retention, to attain goals other than regeneration.

4. Coppice with reserves (coppice with standards) is a coppice method in which reserve trees are retained to attain goals other than regeneration. The method normally creates a two-aged stand.

The same intermediate treatments and concepts discussed above for even-aged systems will generally apply to two-aged systems. A word of caution is in order. When reserve trees are left to fulfill legacy tree, wildlife habitat, or specialized niche needs, care should be taken to find leave trees that will not be infectious and are not genetically inferior. While this determination may not be easy to make, obvious evidences of poor form or disposition to disease or insects should at least be avoided on commercial lands.

C. Uneven-aged Systems. Uneven-aged (UEA) methods of reproduction (selection methods) are methods of perpetually regenerating a forest stand in order to maintain trees of three or more distinct age classes by removing some trees in all size classes either singly or in small groups while maintaining an uneven-aged structure. Uneven-aged regeneration methods include single-tree selection, group selection, and group selection with reserves.

1. Single-tree selection (STS). STS is a method of creating or perpetuating new age classes in uneven-aged stands in which individual trees of all size classes are periodically removed more-or-less uniformly throughout the stand to achieve desired stand structural characteristics (Figure 3.10). Under this method of uneven-aged management, only individual undesirable or excess trees are harvested. Their removal releases established understory trees from suppression and helps establish new regeneration through exposure of mineral soil and increased penetration of light and moisture to the forest floor. Care must be taken to select a desired residual level of stocking that will permit the establishment of the desired species of regeneration.

Figure 3.10. An example of a stand with an uneven-aged structure (Baker, 1950).

When practically applied, this method will often result in the removal of more than one tree in a location, creating small gaps in the stand. Occasionally stand conditions will dictate the removal of a larger group; however, if these occurrences are few, the system should still be considered single-tree selection. A stand should have at least three age classes and each would develop like a single even-aged cohort.

One practical means to distinguish STS from its sister regeneration method, **group selection** (GS), is to consider how decisions are made to designate leave or cut trees. If each tree is considered for retention or removal based on its own merit, then one is applying STS. If trees are removed based on group characteristics, then GS is being applied.

Although a desired stand structure is developed for each STS Rx, the exact structure is rarely ever achieved during implementation of the prescription. This is not an important concern. By following the dictates of species, tree quality, and over-all target stand density, natural variation, which is desirable for ecological, visual and regeneration needs, will occur.

2. **Comparison to even-aged management.** STS as a reproductive method is unique and best understood by contrasting it to a simple even-aged system, such as the clearcut or seed-tree system.

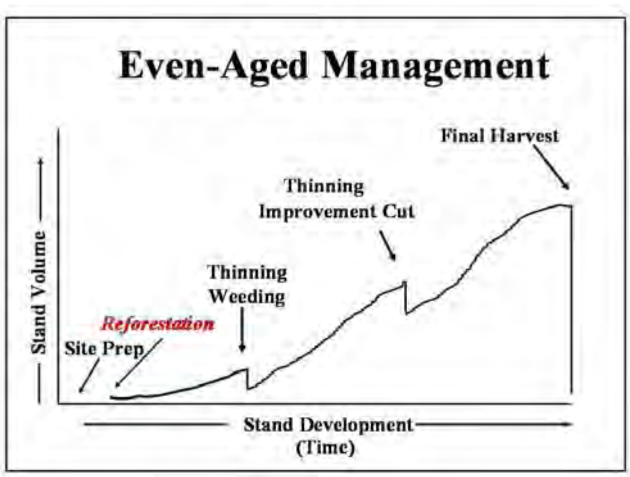


Figure 3.11. Stand development in EA stands with treatments.

In an **even-aged** system, stand development is sequential. Likewise, the applied treatments are also sequential. Within a rotation there is one intense period of re-establishment, followed by combinations of intermediate treatments that aim to keep the site as fully occupied as possible for the target-size tree. The initial stand density begins at zero, climbs into some managed range where it is maintained until final harvest. Usable volume increases as displayed in Figure 3.11.

With **uneven-aged** management, particularly STS, controlling stand density and harvesting mature trees occur simultaneously (Figure 3.12). Both commercial as well as non-commercial trees are removed in order to move the stand toward a regulated condition in terms of structure and density. During each cutting cycle, rotation size trees are cut as well as excess trees from each size/age class. The "rotation size" tree size (in terms of dbh) is determined by calculating the post-harvest target stand scenario. The amount of trees harvested/removed from each age/size class is based on stocking goals of the target stand. Since single tree selection generally employs a leave tree mark, trees within each age/size class which exhibit superior attributes are chosen, and all other trees become excess to stocking requirements and are consequently removed."

Any high-grading or exploitative cutting that only removes certain species, large, high-value trees or generally disregards silvical requirements and sustained yield principles is **never** a recommended silvicultural practice and should not be confused with uneven-aged management.

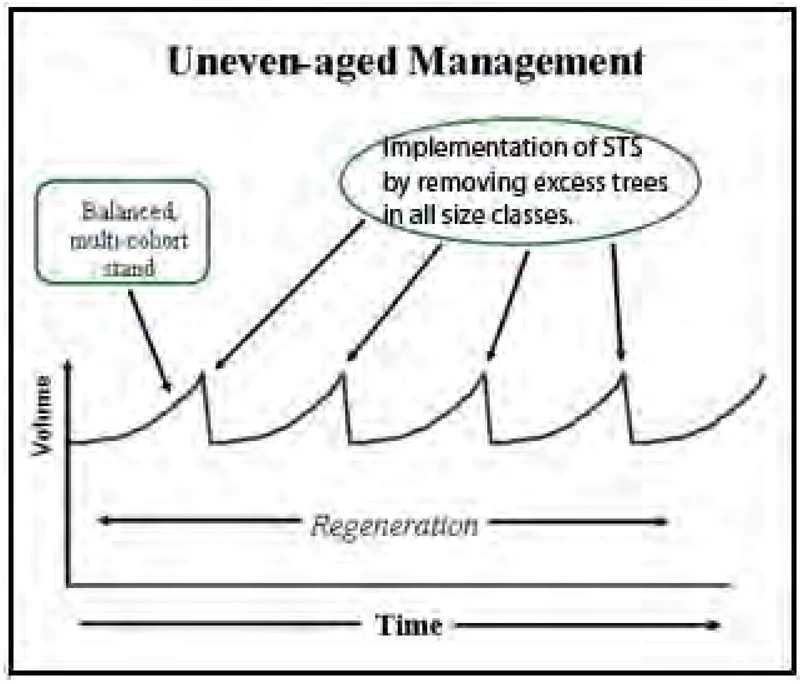


Figure 3.12. Stand development in UEA stand between cutting cycles.

With uneven-aged management, the various stages of stand development occur simultaneously and the need to manage each through the progressive developmental stages makes uneven-aged silviculture somewhat complex. Tree establishment, early juvenile growth, competition, and dominance struggles resulting in stand differentiation all occur continuously and each must be balanced by:

- harvesting an appropriate number of large (financially mature) trees to open adequate space for a new age class and to recover sufficient volume for a commercial harvest;
- regenerating a new age class of appropriate species and density in the space previously occupied by mature trees; and
- tending to the immature age classes to reduce crowding, maintain the balance among them, focus the growth on the best trees, and recover the yield in excess ones (Nyland 2002, p. 217).

There is no rotation length for the stand, only for individual trees, which are the oldest age class in the stand and removed with each entry. Although a popular practice is to retain a small number of reserve trees in the oldest age class for ecological reasons. The practical implication of this is two-fold: first, stands managed under this type of system must necessarily be kept at much lower densities than might occur in an even-aged stand later in its "life;" and second, each cutting cycle or stand entry must consider treatment throughout the diameter range, whether profitable or not!

Another comparison worth noting is that the "stand" concept in uneven-aged systems cannot be as neatly defined as in EA management where a stand is fairly uniform in age and composition, having been initiated by the same disturbance. Keep in mind that monitoring and tracking systems based on stand identity are then similarly problematic.

3. Regeneration is the critical element. The "Achilles heel" of the selection system, particularly STS, is seedling and young tree management. Reliable natural regeneration of the desirable species is absolutely critical. If past records or field observations indicate that regeneration is not dependable, then an even-aged method incorporating planting should be evaluated. An example of this might be where mistletoe exists in the older age classes or when regeneration of very intolerant species is desired.

Off-setting the uncertainty of natural regeneration with the STS system are two positive factors: 1). very few established seedlings are needed at each cutting cycle; and 2). the regeneration period may essentially be continuous. Natural regeneration may tend to occur in pulses, when all three legs of the regeneration triangle are in place (see Figure 3.13). The probability of this synchronicity is increased after harvest since some site preparation is achieved through logging or may be expressly called upon as a separate operation.

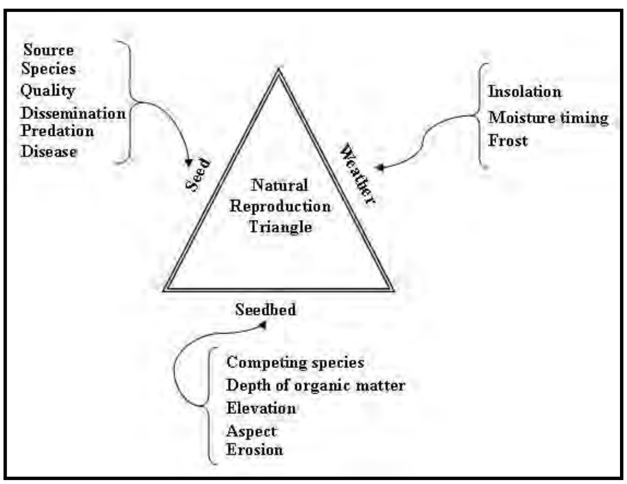


Figure 3.13. Regeneration Triangle.

Regeneration tends to occur throughout the cutting cycle. Since stand density is relatively low even at the end of the cutting cycle, there is potential opportunity to select from a good number of new recruits, most of which have not been seriously suppressed. These will make up the youngest age class. A continuous regeneration period is a double-edged sword. If regeneration is not a problem, then over stocking tends to be one. On mesic sites, where there are several species possibilities, an over abundance of climax species must be addressed at each cutting cycle. Managing overstory species composition and thinning/weeding the understory must occur.

There is a program tendency to bypass cultural treatments in STS stands compared to even-aged stands in need of thinning as the uneven-aged stands often do not appear to be overstocked. However, since their optimal stocking is considerably lower than young, even-aged stands, they become "overstocked" with fewer trees. Inattention to the smaller diameter class deficits or surpluses will have its payback in future cutting cycles expressed in terms of reduced yield or competition induced mortality.

4. Prescriptive elements. There are several ways to establish a target stand. Some have used stand density index (Long, 1995), leaf area index (O'Hara, 1995) or the "BDq" method, referring to basal area, diameter, and structure (q). All methods concern themselves with allocating growing space to the different diameter classes represented and providing for surplus tree numbers in each lower diameter class.

The BDq method is described below because it is simple in concept, relatively easy to apply on the ground, has been used for over a century, and is the method most commonly used and supported on Indian forest lands. A single tree selection prescription requires five items to describe both the existing and target stand. These elements are:

a. Residual (post-treatment) stand density. This critical element, usually described in square feet of basal area, is the most important of the three structural elements and must reflect a balance between stand growth (capturing the site's full potential), regeneration, and subsequent performance of the most intolerant species desired. Thus the need for sustained, vigorous, early tree development will cap the growing-stock level selected, regardless of site. Silvical characteristics of the chosen species will be important when selecting this figure.

Residual stand density is best determined by stocking studies in uneven-aged stands of the species. Western regions have both replicated and un-replicated stocking studies for ponderosa pine. Research in the southeast has given direction for loblolly pine. Residual stand densities recommended for regenerating particular species in even aged stands might also be considered. In the absence of any uneven-aged stocking guides, various models might be considered, and as a last resort, normal yield tables could be adjusted.

b. Stand structure - often abbreviated as "*q*." This is from de Liocourt's law (1898) and is the ratio of the number of trees in one diameter class to the number of trees in the next smaller class. Late in the nineteenth century, de Liocourt observed the negative exponential curve or "reversed J-shaped" curve for natural uneven-aged stands in Europe. In this country, Meyer observed the diameter distribution in all uneven-aged stands tends to follow the *q* concept. In a study to determine "natural" *q*-factors in nature, unmanaged stands of Southwestern ponderosa pine were found to have a stand structure with an approximate *q* of 1.24 (Daniel, Helms, & Baker, 1979) In stands of intermediate or tolerant species or in stands where a prescription focus is hiding cover for big game species, the q-factor could be quite high, such as q = 1.8 or even q = 2. Be sure to consult local experts on which q-factor is appropriate for your forest cover type.

(1) Selection of *q*-factor. Larger q-ratios allocate a higher percent of the available basal area or growing stock space to smaller trees than does a lower q-ratio. In other

words, the higher the q, the greater the number of small trees; the lower the q, the flatter the diameter distribution and the more basal area allocated to larger trees.

Very high values of *q* produce a stand with a greater proportion of small trees and reflect the slow attrition (mortality) that occurs in natural stands and is impractical and inefficient in managed stands if larger products such as sawlogs are the end goal. Such structures lend themselves to forest health issues such as defoliators. A good ratio should leave enough trees to allow for mortality between cutting cycles, damage during harvest, and phenotypic selection opportunity, especially in lower diameter classes. A *q* of 1.1 to 1.2, based on operational diameter classes, is suggested for a timber management prescription in the Northwest (Becker, 1995).

(2) Selection of diameter class width. The width of the diameter class has a great effect upon the number of trees for a given *q*-factor and on the "number crunching" necessary to compute calculations. Although many textbooks use a one- or two-inch width, this is impractical to apply on the ground. A more pragmatic approach is to use the average diameter growth of quality trees across the diameter distribution for the length of the desired cutting cycle. This method could yield class widths of 3, 4, or 5 inches depending upon site quality and species. The concept is that the trees in the stand must be able to grow from one age/size class to the next larger class within the cutting cycle. This approach is valid if the average radial growth is relatively constant over the range of desired diameters. Measurement studies in ponderosa pine have shown this to be true (Wilcox, 1990).

b. Maximum diameter, "D". This will be determined by site and in part, desired product. As an example: if a 20-inch sawlog can reasonably be grown in 100 years, then 20 inches may be selected as the 'target' or maximum diameter, with trees over that diameter harvested at each entry. Rates of growth by diameter class should also be considered since value often substantially increases with larger diameter logs. The maximum age and size should also reflect physiological maturity to the extent that adequate seed production and natural regeneration is assured.

c. Species composition. This decision should reflect the need to maintain species diversity, fend off any prevalent forest pest issues, as well as consider economic preference.

d. Cutting cycle. This is typically administratively determined. Biologically, it should reflect the time it takes for a tree to grow from one age/size class to the next. For larger forests, it is often a reflection of the ability of the staff to revisit the sites and could be in the range of 15 to 25 years or more. Longer cutting cycles will increase the probability of missing the opportunity to harvest some trees of imminent mortality. Site will also play a role in determining the cutting cycle. Some southeastern sites require cutting cycles of 6-8 years because of rapid growth that will deter regeneration if longer cycles are deployed. In western forests, where fire is the predominant disturbance element, average fire return interval may be a factor in setting the cutting cycle.

5. Target Stand Calculation. A simple target stand can be calculated using the following steps:

a. Determine assumptions (keep in mind this is an example).

(1) Desired basal area in square feet = 55 (stand density right after harvest).
(2) Cutting cycle = 20 years.
(3) Maximum tree size = 20-inches. This size can be grown in 100 years and trees greater than this will be harvested at each cutting cycle.
(4) Desired number of age classes (just prior to each entry). Since selection cutting recruits a new cohort/age class with each entry, foresters can say that the:

- Number of age classes = Age at maturity / Cutting cycle or 100 / 20 = 5 age classes.

(5) Diameter classes: 2 - 6 inches, 6 - 10 inches, 10 -14 inches, 16 – 20, 20+ inches.

- Determined by: Max tree size / Number of age classes or 20 / 5 = 4-inch classes.

b. Create a spreadsheet as shown below and populate:

(1) Calculate the basal area of the diameter-class mid-point:

BA = dbh^2 * 0.005454

(2) Start at the bottom of "TPA" column and enter "1" (tree) for the largest diameter class. Work from the largest diameter class to the smallest diameter class; and for each of the descending classes, multiply the number of trees per acre in the larger size class by the chosen "q." For example, the "1" 20-inch tree times the *q*-factor of 1.24 (4-inch classes) = 1.24 trees in the 16-inch class. 1.24 x 1.24 = 1.54, etc. NOTE: q-factor 1.24 for 4" size class does not produce the same stand as a q-factor 1.24 for 2" classes.

(3) Multiply column "BA per Tree" by number of TPA for the trial basal area per class. Divide the target BA of 55 by the summed BA per class (55 / 5.99) to get a multiplier of 9.18 for this example.

(4) Multiply the "multiplier" by the trial stand TPA. This gives the numbers of trees per acre per diameter class and represents the "target stand."

Check: To verify that your tree numbers per diameter class approximates the target basal area, multiply the "target" TPA by the basal area of the average tree. The sum of these should give the desired, post-harvest basal area. Small differences are due to rounding.

This gives the ideal target stand. The silviculturist may allow additional basal area, such as 5 square feet, for 1-3 old-growth trees per acre or for oversized, phenotypically superior seed trees.

SAMPLE TARGET STAND CALCULATION: STS STAND

B = 55 SqFt	D = 20”		q = 1.24			
Trial Stand				Multiplier	Target Stand	
DBH	BA per Tree	TPA	BA per class	"B" / BA	TPA	BA
4	0.09	2.36	0.21	9.18	21.7	1.9
8	0.35	1.91	0.67	9.18	17.5	6.1
12	0.79	1.54	1.21	9.18	14.1	11.1
16	1.40	1.24	1.73	9.18	11.4	15.9
20	2.18	1	2.18	9.18	9.2	20.0
			5.99		73.9	55.0

Figure 3.14. Calculation of the target stand table using specified levels of the BDq parameters.

Although there are advantages to the BDq method, there are also disadvantages. The silviculturist should study textbooks and scientific papers that discuss this method as well as approaches well established in your Region. A list of good silviculture texts and informational sources can be found in the “Literature Cited” section at the end of this chapter.

6. Unregulated portions of an STS stand - or the application of “art” to STS. Single-tree selection prescriptions provide a myriad of stand structures to meet both commodity and non-commodity needs. A fundamental understanding of the prescriptive elements, how calculated, and how they affect each other when one or more are changed provide the scientific basis for the system. Yet, successful application of the system deploys much art, and the opportunity to further enhance diversity in the forest as well as meet special needs.

While a simple structure, as determined by the sample calculations, provides the underlying ‘chassis’ to a prescription, many adaptations are possible and include:

- leaving trees larger than the ‘max diameter’ for visuals, wildlife habitat, general structural diversity;
- leaving trees above the max diameter because they are phenotypically outstanding and should be given more time to contribute to the seed bank; and
- deferring thinning in the lower diameter classes to provide hiding cover or visual screening.

Increasing the desired stand density by carrying extra trees in a diameter class for special mitigations comes at the expense of the maximum sustainable density. In the figure 3.15 below, the area under each curve represents the sustainable density for a species. Both prescriptions shown deviate from the “target” diameter. Prescription A has a higher *q*-factor, carrying many more trees in the lower diameter class. However, the number of large trees is fewer in order to compensate. Prescription B demonstrates a lower *q*-factor, with more density concentrated in the larger size classes.

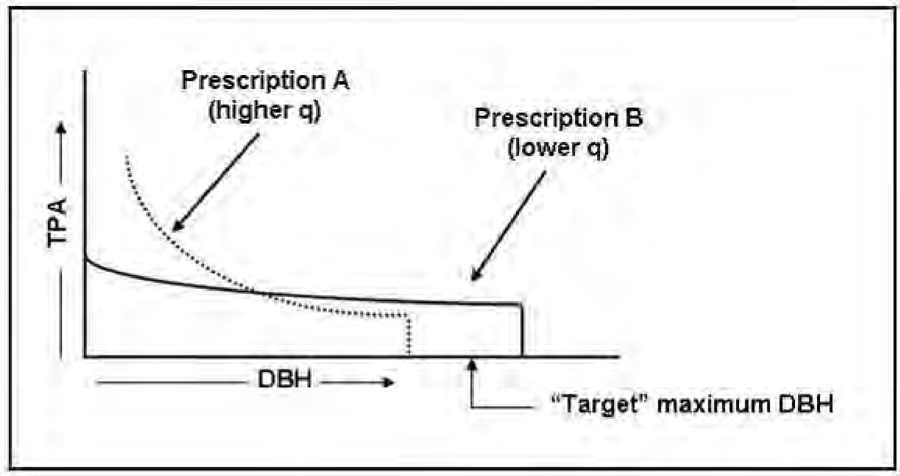


Figure 3.15. Target Stand - Diameter distribution

Prescription C is displayed in figure 3.16 and shows a target prescription that allocates 10% of the stand density to featured old, large trees. If the target basal area was determined to be 55 square feet per acre, 5.5 square feet would be left in large, old-growth trees/acre, with the remainder of the basal area allocated at or below the maximum diameter line.

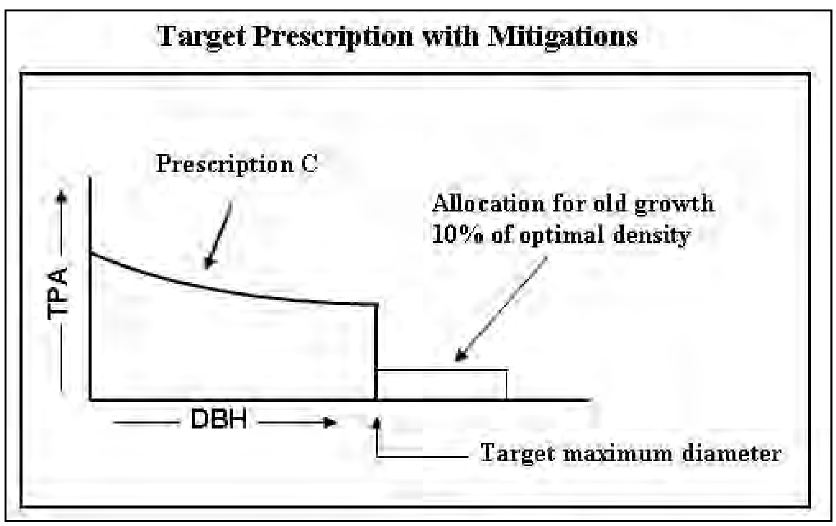


Figure 3.16. Target Stand Diameter distribution.

7. Density management. Controlling tree density and preventing the development of over-dense stands is important in uneven-aged stands to ensure enough vigorous trees with large crowns in the smaller size classes to replace trees harvested from the larger size classes. As mentioned before, the STS method will generally be applied utilizing some form of density control such as basal area or trees/acre/dbh class. This is required since all phases of stand development are occurring simultaneously, including regeneration and early tree development. Over-all stand densities will be quite low, dependent upon desired species. This is in contrast to group selection in which an area-based approach is needed to apply the prescriptions to the ground. In uneven-aged or two-storied stands, the stand density index (SDI) can be calculated using the diameter of individual trees or the mid-point of the diameter class of groups of trees (summation method) (Long 1995, Shaw 2000):

$$SDI = \sum(TPA_j * (D_j/10)^{1.6})$$

Where: D_j is the diameter (in inches) of the jth tree in the sample, and
TPA_j is the number of trees represented by the jth tree.

The summation method can be modified to where Dj represents the mid-point of diameter class j and TPA_j is the number of trees per acre in that diameter class. All SDIs for individual trees or groups would be added to determine the SDI of the stand. Note that the summation method of calculating SDI will always be lower than the SDI calculated from Reineke's equation using QMD for the stand mentioned earlier in the even-aged section. For populations showing an even-aged structure, or normal distribution, the outcomes of the two methods are equivalent (same SDI). As the diameter distribution becomes more irregular, or uneven-aged, the two SDI estimates tend to differ (Long 1995).

8. Implementation of STS system.

(a) Inventory and stand analysis. Often walk-through type stand exams are sufficient for even-aged systems and their prescriptions, especially for mature or diseased stands where cutting options are few and obvious. Uneven-aged systems with STS prescriptions require some quantitative data, most notably when there are legitimate age classes and excess vigorous trees in more than one age/size class.

The inventory data can be displayed as a simple matrix of diameter classes and tree vigor categories by tallying the sampled trees in pre-determined diameter classes based on diameter estimates. Such plots can be installed in minutes and the important data quickly summarized in a spreadsheet along with a graphical presentation. Below is an example of such a dot tally form:

Quick Stand Exam for Single Tree Selection Plot # _____ Stand# _____ Date _____ Crew _____				BAF or fixed plot: _____	
DBH (inches)	POOR QUALITY (Always remove)	OPTIONAL QUALITY (Remove, unless needed to achieve stocking)		GREAT QUALITY (Always leave unless excess to stocking needs)	
	ALL SPECIES	TOLERANT	INTOLERANT	TOLERANT	INTOLERANT
< 0.1					
1 - 4					
4 - 8					
8 - 12					
12 - 16					
16 - 20					
20 +					

<u>Figure 3.17</u>. Simple Stand Exam Form - Uneven-aged Stands.
(Always include inventory design information – fixed plot size or basal area factor).

The quality categories should be defined with some simple but measurable criteria such as crown ratio, form, and defect parameters. If tracking species is important, then additional columns can be added.

The most common mistake is to assume that a stand is multi-aged because it has a wide diameter range. When trees are grouped by rigorous quality standards, it becomes apparent when suppressed, poor quality trees are occupying a diameter class and not a legitimate age class. Since height growth is much less affected by stocking than diameter growth, the height ranges in the stand should be the first clue as to the probable age variation of the stand. Foresters will still use tree diameter as an interim surrogate for age and cut the stand to a balanced structure. After two to three cutting cycles, tree vigor in the stand should increase with that vigor apparent across all diameter classes and the correlation between age and size becomes much more dependable. (Wilcox 1990 and Nyland 2002, p. 218).

(b). Tree marking for harvest. 'Leave-tree' marking is the preferred method for most stands designated for uneven-aged management. There are two compelling reasons to do so. First, marking a tree to leave forces a conscious evaluation of the tree and seldom does a marker designate an obviously poor phenotype. By contrast, it is easy to miss a poor phenotype or an infected or infested tree in 'cut tree' production marking. This 'error' is then consigned to the reserve stand of the future. Secondly, leave-tree marking gives a clearer sense of the reserve stand's characteristics in the process of marking and allows the marker to focus on the future stand. It is also easy to tally leave-trees by diameter class to determine if structural goals are being met, thereby monitoring the target stand during the marking process. The illustrations found in the Appendix show simple tally sheets that can be used during marking to maintain control of structure, i.e., the relative numbers of trees per diameter class. The marker simply puts an "X" in the appropriate square every time they mark a leave-tree and in the end each diameter class should have the same number of "Xs."

Tree marking will need on-going evaluation and periodic quality checks by the silviculturist or marking supervisor. Markers must carry a prism or similar device to periodically check the average basal area being attained while marking. A considerable variation of tree density should normally be evident.

The following Figure 3.18 illustrates the slope of a 1.2 *q*-factor (dashed line), the target diameter distribution. As trees are marked by diameter class, they are recorded as a "dot tally" or "X" on the form. Each band of little squares should be filling up at approximately the same rate. If the markers are leaving an excess or shortage of one diameter class, it should soon become apparent.

The sloped 'double lines' represent a more realistic prescription where the leave stand will not be balanced yet the best trees available are left. The determination of the leave ratios should come from the stand inventory. After two or three cutting cycles, the stand may approach the idealized target as represented by the dashed lines.

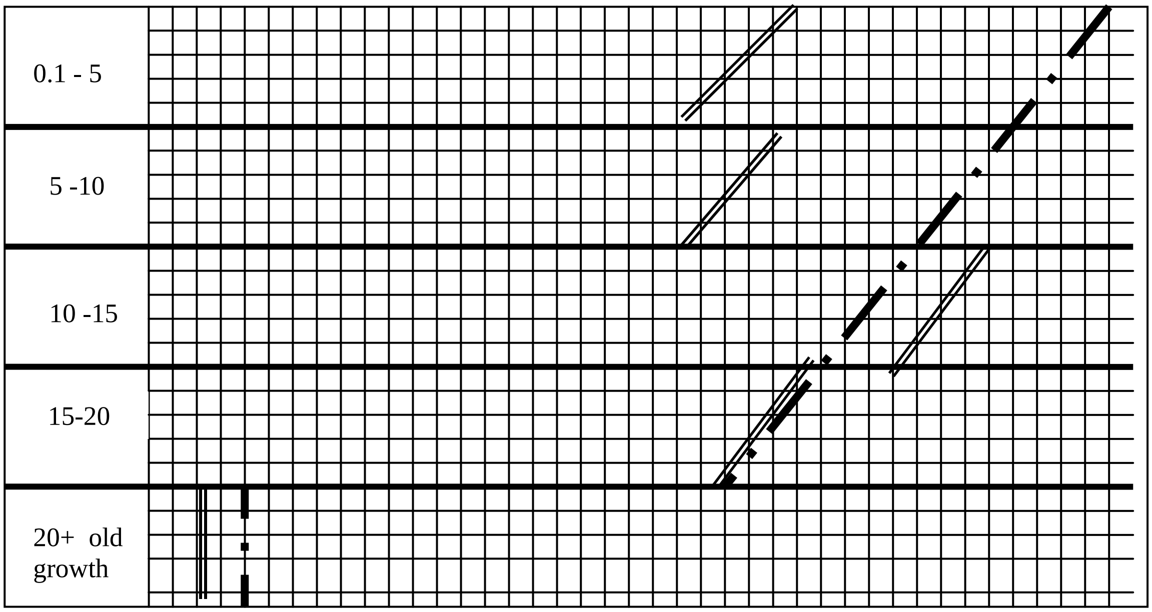


Figure 3.18. Marking aid with 1.2 q and irregular UEA stand.

9. Group selection (GS) is a method of regenerating uneven-aged stands in which trees are removed, and new age classes are established, in small groups (See Figure 3.19). The maximum size of groups is ecologically limited to the size that will assure that the complete opening is within partial protection of the seedwall during the day. Typically, the maximum group width ranges from ¼ to 2 acres, with smaller openings providing microenvironments suitable for shade-tolerant regeneration and larger openings providing conditions suitable for more shade-intolerant regeneration. Circular openings equivalent to one or two times the height of a mature tree will brighten the ground sufficiently to recruit a wide range of species (Nyland 2002). Consideration of slope and aspect may cause the openings to vary somewhat. For example, the opening should be a little larger for north and east slopes than for south and west slopes.

Group selection with reserves is a variant of the group selection method in which some trees within the group are not cut to attain goals other than regeneration within the group.

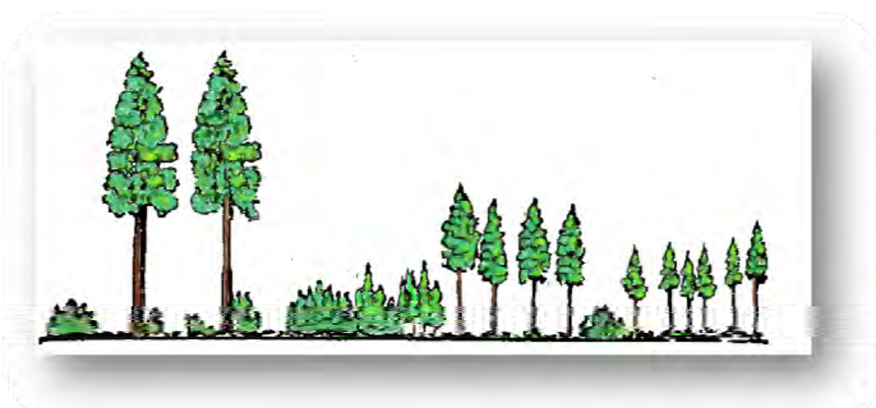


Figure 3.19. An Example of a stand with an uneven-aged structure suitable for Group Selection.

10. Comparison to even-aged management. In the group selection system, the management unit or stand in which regeneration, growth and yield are regulated consists of an area containing an aggregation of even-aged groups. It has sometimes been described as micro even-aged silviculture with an uneven-aged management framework.

Like even-aged regeneration methods, it is applied on an 'area' basis. Like STS, all silvicultural treatments are concurrent (occurring at each stand entry), but confined to identifiable age groups. Regeneration openings need to be monitored to assure that timely stocking occurs while other groups need to be assessed by size/age classes for intermediate treatments.

11. Prescriptive elements. Only two elements are essential to set up a regulatory plan for group selection: cutting cycle and percent area establishing new regeneration via the groups at each entry. Like STS, tree species is also considered a prescriptive element. Thus, if a 15-year cutting cycle is chosen, and five age classes are desired, the oldest trees will be 75 years old at harvest.

12. Management considerations. Group selection is simpler in concept than STS but is more time consuming and complex with regards to layout and administration of harvest operations. It is also very difficult to track all of the individual groups through time and to ensure that intermediate treatments are occurring as originally prescribed.

This regeneration method should not be contemplated as a 'quick fix' for visual, forest health or other problems. If used as such, the GS method is not really being deployed. Regeneration groups may be used in conjunction with the STS system to rectify one-time problems with insects or disease, especially during the first or early entries. However, if there is no intent to continue the practice, the groups should be considered remedial, and the treatment STS.

Single-tree selection and GS deploy different methods of ground application, and possibly different mensurational approaches during management planning. Single-tree selection can be applied using a prism or similar tool to regulate average stand density; GS will be applied using area-based methods.

It is recommended that the silviculturist determine a single method for a given stand, and use it. A free-style approach may be used successfully by an exceptionally skilled practitioner, but such an approach is more difficult to replicate, and it is difficult to know if one is proceeding towards the balanced target stand structure. The silviculturist also needs to keep in mind that prescriptions are long-term by design and should be continued 40, 60 and 100 years in the future.

a. **Applicability**. Consider GS under the following circumstances:

- an already to mimic clumpy spatial pattern in the stand;
- in a mixed-severity fire regime where a fire periodically leaves the ground, runs through the crowns, and then drops back down, creating discernible openings;
- where there is a need to change species composition or upgrade genetic quality of the existing stand on a site suited for uneven-aged management, and where planting is required;
- where a clumpy structure is desired to meet special wildlife or other resource needs;
- where natural regeneration is dependable but vigorous site preparation is needed; or
- where desirable intolerant species will not regenerate within a stand treated by STS.

b. Group size and shape. Groups must be kept small enough to provide favorable site conditions for the establishment of adequate regeneration of the desired species. The size and shape of the openings should be based on shade tolerance, slope, aspect, and site severity. Practical application may require groups larger than twice the height of surrounding mature tree heights, but groups generally should be kept smaller than 2 acres. If there is a need to install openings larger than this on a consistent basis for purposes of dealing with forest health or other issues, the silvicultural system is suspect.

c. Seed trees. Consider leaving phenotypically superior seed trees within a group if they are available. This is to be distinguished from group selection with reserves.

d. Stand Tending. While the focus of groups tends to be on the regeneration component, silvicultural prescriptions should consider the appropriate intermediate treatments in all other age groups represented in the stand each cutting cycle. Approximations of even-aged stocking guides may be used to estimate desired leave densities.

e. Stand inventory considerations. If group selection is to be used, the most important item to evaluate is the ratio of the existing age classes and their vigor and health within the stand. Normal fixed- or variable-radius plots will blend or average the differences. A design that clearly separates out the quantity of structural components is necessary.

If age classes are widely separated and age classes tend to be distinctly clumped, some remote sensing products might be helpful. If these tools are not available or are at unsuitable scales, a simple line transect technique may be used for stand inventory and post-treatment evaluation. This method can be used to estimate the acreage in various size components of the existing stand, or other stratification, such as vigor rating. Knowing this will allow the silviculturist to prioritize the location of the next set of regeneration groups. The steps in this process are as follows:

(1) Walk through the stand and determine the types of age structures and conditions that are distinct enough to break-out and describe.
(2) Create a simple tally sheet that lists all the strata with room to record the various segment lengths that will be sub-tended by the line transect. If one chain is to be the shortest distance recorded, a dot tally could be used.
(3) Using a map or photo, lay out a series of parallel lines that will adequately sample the stand and represent its variability.
(4) Using a compass, pace through the stand along the established cruise lines. As each defined stratum is entered, begin to tally the distance. When end of the stratum is evident, record the traversed distance and begin a new segment.
(5) Periodically stop in each category of structure, and put a plot in that type to describe its attributes. These could be a formal stand exam plot or a descriptive estimate, depending upon the information needed. If the stratification proves to be acceptable, these secondary descriptive plots may only be done once or twice for each stratum.
(6) Tally the distance for each stratum and calculate the grand total. Divide the summed distance of each stratum by the total distance traversed in the unit to get the percent of the area in that stratum. Once unit acreage has been determined, the acres of each stratum can also be estimated. The results of the tally might look like this for a large unit:

Strata	Chains	%	Acres
Seedlings & openings	13	5	15
Saplings 1-6 inch	84	32	95
Sawlogs 7 - 16+	100	38	113
Sawlogs 7-16 (diseased)	34	13	38
Old growth	32	12	36
Totals	**264**	**100**	**297**

This then gives some area allocation to begin determining where the next regeneration groups will be placed. If 20 percent is the target at each entry, all of the diseased clumps (13%) could be harvested, along with some old-growth (2%). These, combined with existing openings, would make the required 20%. Additionally, there would be enough descriptive data to write a thinning guide for the sawlog, sapling and seedling components.

If high-resolution aerial photography or 3-meter resolution satellite imagery is available, it might be possible to make these delineations remotely, after field checking; however, in the example above, such tools would not delineate the diseased sawlog component, where most of the cutting is to be directed, from the healthy. Depending upon the type of disease, there might be other spectral band imagers that might assist.

The line transect is a simple tool that can be combined with other data to assist in developing a group selection prescription. After harvest, the process could be used again to see if the 20% “target” was achieved. If this is not done, remote sensing could likely be used to estimate past groups during the next entry, and adjustments made in that cutting cycle. A good map should be digitized in GIS to assist in future planning.

f. Layout. This process is mostly art. However, the first and early cutting cycles likely will have obvious priorities for cutting to establish the regeneration groups. In the above example, the next entry may focus more on removal of old-growth patches if serious decline has developed.

Typically, the layout process is best achieved in a two-step process. First, locate and flag the regeneration groups; then mark for stocking control around the groups.

3.4. Choosing the right regeneration system: Even-aged or uneven-aged? The uneven-aged (UEA) regeneration system is one of the least understood systems and the most likely to be misapplied. Its application requires careful thought and commitment through time to secure regeneration of the desired species and ensure continual stand tending across the entire diameter distribution. As such, it is the more intense of the two families of systems. The Forest Management Plan should provide direction as to where it should be applied. Some stand factors that should be considered are listed below.

A. Historical disturbance regime. Past disturbance patterns should give the first clue as to what the appropriate silvicultural system should be. Frequent but relatively benign disturbance suggests that some application of the UEA system would be appropriate, while infrequent but catastrophic events suggest even-aged systems.

B. Site classifiers. Various ecological classifications are available, depending upon region. Examples include terrestrial ecosystems (southwest), habitat types (northwest) and native plant communities (Minnesota). Often these classification systems are surrogates for disturbance regimes, and may serve to indicate other useful information such as brush and forb response to treatments or ease of natural regeneration.

C. Current stand structure. An already diverse structure will easily lend itself to the UEA system, provided stand vigor and available species are present. This is especially indicative of likely success if the desired species, often seral or mid-seral, are present in the lower and mid-sized diameter classes. However, an even-aged stand could be converted to an uneven-aged one over time, if other stand factors as listed herein are present.

D. Species. One of the five prescriptive elements of the UEA system is species. General ecological stability is enhanced if there is a majority mix of early and mid-seral species. If the current stand is dominated by climax species that are prone to particular forest pathogens, then the *present* stand will not be suitable for immediate application of the UEA system. An even-aged regeneration is indicated; however, if the stand fits into a non-lethal, frequently disturbed site, uneven-aged management would be possible in the future.

E. Ease of natural regeneration. The UEA system primarily relies upon natural regeneration and periodic regeneration of the desired species is one of the critical elements. If the silviculturist has indication that natural regeneration is not reliable or difficult on the site in question, an even-aged system should be considered where site preparation and artificial regeneration can be more efficiently applied.

F. Stand Vigor. A viable uneven-aged stand must have vigorous trees in *all* age classes. A stand exam in these stands should be designed to easily portray the vigor of all diameter classes. Often a diameter distribution of a proposed treatment area will show a classical “J” shaped diameter distribution, but be more even-aged than uneven-aged. In these types of stands, suppressed trees should not be retained to fill a diameter class; they will not perform and grow into the next higher class on schedule.

An even-aged intermediate treatment may be indicated if the larger size classes are vigorous enough to be released, and are of the desired species. If general stand vigor is low, then even-aged regeneration treatment should be carried out.

G. Forest Pathogens. Severe levels of insects or disease present the same challenges as low stand vigor. Root-rots for example may require a rotation of even-aged treatments with non-host species before the site is ready for application of uneven-aged management. Dwarf mistletoes are especially problematic, given their unique spread mechanism and life cycle. Insect, disease and vigor issues may not preclude the application of the UEA system in a stand if there still are enough healthy trees of the desired species.

H. Slope. Uneven-aged systems are typically more practical on gentler slopes where supplemental site preparation can occur if needed. On slopes less than 35%, mechanical spot-scarification may be cost effective, or under-burning feasible. As slope increases, there is less chance of a successful underburn that would allow acceptable survivors in the smaller diameter classes. An exception might be on steep, rocky, southerly facing and marginally productive sites, where STS may always be the treatment of choice. Skyline logging systems on steep slopes are conducive to even-aged systems due to safety and damage to residuals unless care is taken.

I. Landowner preferences. Landowner preference may play a large role in the selection of the chosen system. A silviculturist, especially in Indian Country, must understand the Tribe's desires for the resource just as he or she must understand the silvics and ecology of the tree species being managed (Miller 1994). There may be a range of site conditions where both types of management could be applied, giving opportunity to honor both ecological feasibility and desires of the landowner.

3.5. Converting from one system to another.

A. Converting from uneven-aged or irregular stands to even-aged stands. Numerous instances can be found where attempts to apply the UEA system have failed, and there is a need to revert to an even-aged system. This process is simple. At the next commercial entry a CC, ST, SW, or occasionally an intermediate treatment may be applied.

B. Converting from irregular and even-aged stands to uneven-aged stands. This process, unlike that above (A) may be a lengthy one. There are several situations.

1. Stand has ample stocking but is of low vigor, diseased, and has a high percentage of climax species for the site, which otherwise is suitable for uneven-aged management. In these cases, an even-aged regeneration harvest should be made. Seed trees or shelter trees that otherwise might be harvested after stand establishment would be retained, if vigor permits, to hasten the development of stand vertical diversity. After one or possibly two commercial thinnings or improvement cuts when the desired leave species become dependable seeders, the first uneven-aged treatment would be applied. At this time, the basal area of the stand would be reduced to post-treatment targets. Successive entries would be repeated to continue age class development.

2. Under-stocked, irregular stands on the right site. Many encountered stands do not appear to fit into the even-aged or uneven-aged classification schemes. The question as to what to do with them is closely tied to the forest management plan. The FMP should provide broad guidance, based on site factors or historical fire regime, indicating the future direction of stand development from an administrative or regulatory aspect.

In prescribing for an under-stocked, irregular, or diseased stand that meets site requirements for uneven-aged management, efforts should be made to retain any viable, non-infectious components of the stand. Retention of these trees will reduce the time to full regulation where all desired age classes are represented. Given the cost of establishing and nurturing a seedling to a sapling, pole or small sawlog, considerable effort and money is merited to retain already existing trees.

A suggested strategy is to establish specific thresholds for residual stocking; above which, the treatment is considered uneven-aged, even if under-stocked. For example, if a subject stand has any two of the following, it might be considered uneven-aged for planning purposes (TPA figures will, of course, change depending on species and location; this is given as an example only):

- Saplings – 60 crop trees per acre
- Pole – 40 crop trees per acre
- Sawtimber – 15 crop trees per acre

- Old Growth – An additional component of high-vigor, low risk, old-growth trees will be retained for visuals, wildlife, etc., as needed to meet other resource objectives or to supplement volume deficits in smaller size classes to support the next entry.

A more stringent policy might be to classify the treatment as uneven-aged if it has two *non-adjacent* age classes that meet or exceed criteria similar to the above list.

3. Vigorous, even-aged stands on an adequate site. The key consideration for this situation is to delay the first uneven-aged regeneration harvest until the stand is old enough to produce a reliable quantity of seed. A second consideration is to delay the conversion until the culmination of mean annual increment is approached. Conversion to an uneven-aged structure creates a disruption of yield; to minimize this, the even-aged stand's capacity is retained until a biological culmination is within a cutting cycle. If the stand has an irregular structure, three or more cutting cycles may be required to create the requisite age classes. Such a conversion strategy will minimize the retention of larger trees for extended periods.

4. Priorities in conversion. Changing the structure of the forest takes time. Focus on developing the five prescriptive elements in the following order:

- Site specific desirable species
- Good or excellent quality
- Site occupancy (B)
- Structure (q)
- Upper diameter (D). This is the least important factor and should never be rigidly adhered to at the expense of genetic conservation. It must, however, be set in order to mathematically determine a "target" stand.

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CHAPTER 4. SILVICULTURAL EXAMINATIONS, DIAGNOSIS and PRESCRIPTION

4.1 General. While silviculture is an art, it becomes science when there is a systematic application of basic sciences to a specific stand condition; a testing of possible treatment alternatives; and an evaluation of treatment effects.

4.2 Policy. The role of the silvicultural prescription is to ensure the implementation of silviculturally sound treatments that will meet management objectives. Silvicultural prescriptions shall be required for all forest treatments that affect the present and/or long term character of a forest stand (IAM 53, Chapter 9). Forest vegetation treatments include timber harvest, hazardous fuels reduction, forest development, watershed restoration, insect and disease prevention or rehabilitation projects, and any other treatment that will impact forest vegetation within the forest land base. If a forested area is being converted to a non-forest land use (housing, range, agriculture, etc.) a prescription is not required. The prescription must specify in silvicultural terminology the intermediate objectives and adhere to the broad FMP silvicultural guidelines. All silvicultural prescriptions should be prepared or reviewed by a silviculturist. Each prescription must be dated and signed by the author. In addition, if the author is not the designated silviculturist, the reviewing designated silviculturist's name, signature, and date of review and approval must be included. Preparers of silvicultural prescriptions should have knowledge of silviculture, forest ecology, insects and diseases, and the silvicultural prescription process as well as work closely with the silviculturist in developing the prescriptions.

The goals of the silvicultural prescription are to:

- Assess the condition of forested land and its capability to meet management objectives.
- Identify areas where silvicultural practices may affect resource uses and prescribe appropriate enhancement, coordination, and/or mitigation measures.
- Develop treatment alternatives that are science-based, technically sound, and cost-effective.
- Show how the alternative treatments will develop a stand that can meet tribal land management objectives.
- Determine the type and timing of silvicultural treatments needed to accomplish the objectives.
- Provide specific direction for implementation and monitoring of the prescribed treatment.

4.3 IRMP / FMP Silvicultural Direction. On Indian lands, Tribal and/or allottee management goals and objectives should always provide a starting point for the development of prescriptions. Although this chapter discusses the preparation of a prescription, keep in mind that Tribal and/or allottee goals and objectives direct any forest management or forest treatment on Indian forest lands and consideration of these goals must be first and foremost in mind during Rx preparation. These goals and objectives are developed through a process that includes tribal leaders, allottees, the tribal public, and other resource professionals. Resource goals and objectives as well as silvicultural guidelines are typically outlined in an Integrated Resources Management Plan (IRMP) which may contain the Forest Management Implementation Plan or the Forest Management Plan (FMP). (To avoid unnecessary verbiage, FMP will be used to indicate an IRMP which contains the FMP). An FMP also describes resource priorities; stand treatment priorities; and treatment restrictions in forest areas, watersheds, or resource emphasis zones managed for specific resources such as timber, wildlife, riparian, aesthetics, cultural benefit, etc. For example, wildlife emphasis zones may specify 20 percent thermal cover retention if harvesting is permitted. If emphasis is placed on forest health and timber value, treatment areas may be prioritized and selected based on overstocking, insect and disease problems, low growth rates, or general dysfunction within the designated resource management zone. Examples of resources that may be emphasized over other resources in a treatment area may include the following categories:

- Timber
- Wildlife
- Fisheries
- Water quality
- Aesthetics or visual
- Recreation capability
- Threatened or Endangered Species
- Fuels Management
- Cultural
- Conditional use or Wilderness

Normally the forest resource goals and objectives in these plans are broad in scope and stand-level objectives must be developed and refined. This allows an appropriate, site-specific silvicultural system and treatment to be chosen. To aid in developing specific silvicultural prescriptions, some plans have developed general forest management guidelines, from planting to final harvest, for each resource management zone. These plan prescriptions are somewhat generic and may discuss possible pathways necessary to meet the resource objectives.

> *A silvicultural prescription is usually stand specific but can encompass several stands, cover or forest type where the desired treatment result is the same* (IAM 53, Chapter 9).

4.4 Coordination with Environmental Analysis. The silvicultural prescription is an integral part of the National Environmental Policy Analysis (NEPA) process whenever vegetation treatments are proposed in forested lands. More information on the NEPA process can be found in 59 IAM 3 and associated handbook. The silvicultural examination and diagnosis provide information to help describe the affected environment and evaluate the effects of alternatives. The detailed prescription, implementation, monitoring and evaluation help ensure that the NEPA decision is effectively applied to specific stands.

4.5 Prescription Process. This section will list and describe the steps involved in the silvicultural prescription process. These steps progress in a logical sequence of data collection, data analysis, comparison of present condition to desired future condition, detailed preferred silvicultural prescription, implementation guides and monitoring requirements. Each step serves a specific function and supports the next step in the process. Terminology used in labeling or describing each step may vary by region or reservation and this chapter will endeavor to include as many regional variations of describing these steps (they will be in parentheses) that it can. This chapter will cover in greater depth the silvicultural prescription process that includes the following steps:

- Pre-survey or pre-recon (Optional)
- Silvicultural stand exam (data collection)
- Diagnosis of existing condition
- Detailed Silvicultural prescription and treatment selection which includes:
- Desired future (stand) condition
- Prognosis and alternative development
- Implementation guidelines
- Monitoring and evaluation requirements

4.6 **Silvicultural Stand Examination.** The silvicultural examination is the process of obtaining data necessary to identify existing stand conditions for stand diagnosis and prescription development (IAM 53, Chapter 9). The pre-treatment stand inventory quantifies the stand's current conditions and provides a basis about how the silvicultural prescription will change those conditions and guide the implementation of the proposed treatment toward the desired future condition. Enough information at the appropriate scale should be obtained to adequately describe the site and current condition of the analysis area. The sampling intensity designed to quantify or describe desired variables depends upon the ease with which the variable can be measured and the degree to which measurement of the variable gives biologically meaningful and practical information to the prescription preparer or silviculturist.

In addition to collecting stand data it is important to review all data sources that are specific to the treatment area. This may include past Forest Officer's Reports (FORs), previous Rxs, prior stand exam summaries, logging or fire history, Geographic Information System (GIS) data, aerial photos, Insect Detection Surveys (USFS), fuel surveys, or any other survey or report that aids in describing the stand or area and how it has developed to this point.

A. Stand Examination/Reconnaissance

Aerial photographs should be pre-stratified to identify units potentially suitable for different silvicultural systems and/or treatments. Proposed treatment units will be based on species composition, stand structure, soils and ecosystem units, and possibly other pre-existing site-specific information.

Aerial photograph stratification is the initial process to check existing stand structure, block boundary location, road access, potential ecosystem units and slope stability, and to verify product merchantability. Within and outside the proposed block boundary, the following types of units need to be stratified and/or identified:

- Environmental units (forest cover, physiography and landforms)
- Physical features (man-made structures, gullies, watercourses and natural barriers)
- Resource features (for example, riparian reserve zones or riparian management zones).

Aerial photos of different strata in the area may indicate the potential for using different silvicultural systems, by providing visual evidence of differences in stand structure, broad forest cover types (tree species composition), and variations in stand height and density.

After photos and maps are studied and appropriate stand/strata boundaries are determined, the stands should be examined on the ground to collect information necessary to prepare sound silvicultural prescriptions. The intensity and amount of data collected will depend on the complexity of the stand/strata. Any broad management objectives outlined in a higher-level plan may also dictate the intensity of the exam

B. Types of Exams (Surveys)

1. Formal Stand Exams. Stand examinations are the primary source of vital stand level information needed to develop silvicultural prescriptions at the project level. Individual tree data is collected using an unbiased sampling scheme during a formal stand exam. The sampling design may involve a series of plots, variable, fixed or a combination of both, as well as strip cruises. Basic tree data collected in these exams typically include species, diameter at breast height, total or merchantable height, 10-year growth increment, age, crown ratio, tree vigor, insect and disease problems, and severity of the problem. For specific volume equations or models, additional data such as taper and defect may be required.

The stand exam summary gives a snapshot of the stand's species composition, structure, diameter distribution, density, insect and disease problems, volume, etc. In addition, growth and yield models can project the stand several decades into the future and aid in developing silvicultural prescription alternatives. There are several growth and yield models, as well as locally developed spread sheets, used for stand projection and development. The Forest Vegetation Simulator (FVS) is the Forest Service's nationally supported framework for forest growth and yield modeling that has several variants across the United States.

Continuous Forest Inventory (CFI) plots may be used to provide some baseline stand information, however, statistical accuracy will depend upon the number of plots located in the projected treatment area. (Refer to 53 IAM 8H, Inventory and Monitoring.)

Formal stand exam data collection is a choice that each reservation makes to develop their stand database. Stand exams can be expensive depending upon the types of forest stands to be examined. For example, the cost may be higher for dense forest stands on steeper hillsides when compared to open pine forests. Stand exams are generally a long term commitment with the data being viable for about 5 – 10 years, after which another stand exam should be performed on the same stand. Some regions or reservations collaborate with the USFS to collect stand exam data or utilize the FS Forest Inventory Analysis (FIA) data.

2. Walk-through Exam Walk-through exams collect less extensive baseline stand and tree data; are conducted prior to developing a silvicultural prescription; and are performed in stands with little or no available information. They are generally performed in conjunction with quick plots. The quick plot data should be a representative sample of the stand where the intensity and amount of data collected depend upon the complexity of the stand/strata. Quick plot summaries should describe the stand in terms of species composition, basal area, diameter distribution, insect/disease problems, as well as provide any information concerning natural disturbances. Depending on the type and amount of tree data collected, the quick plot data may be entered into a growth and yield model for stand projection analysis and comparison with other alternatives or other stands.

Walk-through exams can also be conducted in stands that have formal stand exam data. This type of walk-through exam provides the silviculturist/prescription writer an on-site view of the stand to locate possible root disease centers or other problems not found in the stand exam. In addition, there is an opportunity to collect additional data (e.g. down woody material for a fuels treatment prescription). These surveys should also cover the entire stand or area of concern.

Walk-through stand exams may also incorporate the use of GPS to record stand observations and insect and disease conditions with sufficient spatial precision to develop maps of draft treatment areas. Point observations which are entered into a GPS unit may include such stand information as species mix, size class, density (as a basal area reading), approximate age, health problems, harvest system, habitat type, and recommended treatment. The clustering or these various attributes (as displayed in GIS) can be used to create a variety of map layers which can be used to lay out treatment units on the ground, or provide background information on stand conditions for marking crews.

4.7 <u>Data Analysis and Stand Diagnosis.</u> **(Present Stand Condition)** The stand diagnosis is a tabular and/or descriptive discussion of the current stand conditions and an interpretation of what the data reveals. This includes relevant environmental conditions such as insects and diseases, harvest history, environmental variables, age, stand structure, species composition, stand vigor, potential vegetation, site data, soil-type, geophysical conditions, and the relationship to the landscape. All pertinent data collected from old timber sale files, stand exams, and walk-through exams are displayed in both a tabular (quantitative) and descriptive format. A description of the current conditions should involve as much information as necessary to describe the healthy components as well as the problems affecting the stand. Important in this description are the interactions occurring within the stand (e.g. insects and diseases, species composition, and stand structural components). Each site has an inherent potential for stand development; and an evaluation of the site capabilities, either restrictive or enhancing, must be considered by the silviculturist. These data are the baseline for the silvicultural prescription process. (A sample silvicultural prescription is in Exhibit 6).

4.8 <u>Desired Condition (DC).</u> **(Target Stand, Achievable Stand, or Stand Treatment Objectives).** Overall direction of the FMP is translated into a description of how the stand or group of stands should develop and function in the future. Given our better understanding of the dynamics of disturbance on forest ecosystems, the “desired condition” of the stand must be developed with a landscape perspective. This focus on the interplay between spatial patterns and process is important for the silviculturist to understand since any stand treatment can alter landscape context and the relationship between patterns and processes. A silviculturist must have a thorough understanding of how historic and recent disturbance patterns influenced stand development; how disturbances might influence the stand in the future; and what portion of the landscape composition and structure the site being considered for treatment represents. Stand-level objectives must be characterized in terms of stand composition and structure and often, objectives have much to do with structure and less to do with species composition. The silviculturist/ prescription writer must be able to describe how desired stand conditions will benefit resources at the stand and landscape level.

The primary attributes used in describing the DC are species composition, age, density, and structure although others may be added based on the resource needs (i.e. Thermal cover, fuels (down woody material), or riparian habitat). The treatment objectives are brief, measurable statements describing the desired condition of the future stand. This description provides the writer an opportunity to develop a pathway for the treatments to follow over the “life of the stand” (normally a rotation period or several cutting cycles) and gives specific attainable objectives for the stand(s). Development of the DC should have some flexibility to allow for options that are innovative while meeting management goals. Stand treatment objectives have the following characteristics:

- They are subordinate to higher level management goals
- They are narrow and short range
- They have a high probability of attainment
- They specify a time period for completion
- Their achievements are measurable and quantifiable

4.9 <u>Prognoses and Alternative Development.</u> (**Stand Treatment Alternatives**). This is the synthesis step where the present condition is compared to the desired condition (DC) and the developmental pathways are explored. Although a formal, written comparison and discussion of all alternatives is unnecessary in the Rx document, the silviculturist needs to consider the full range of available alternatives as part of the prescription process. At this stage the silviculturist/ prescription writer should answer the following questions:

- Can the present stand satisfy the requirements of the land management objective?
- How can the present stand be treated to develop a desired stand condition that will best satisfy management direction?
- If the existing stand cannot be treated to meet the management objectives, how and when can it be harvested and replaced with a more desirable stand that will achieve a desired stand condition?

To answer these questions the silviculturist must be able to visualize and describe one or more desired stand conditions that can meet the objectives for the stand or group of stands. The silviculturist/ prescription writer should base the comparison on those stand attributes that are important to the resource objectives described in the FMP for the site and the ecosystem. The comparison of the existing stand to the DC must follow a logical sequence and consider a full range of alternatives or pathways. All data compiled during the earlier steps are reviewed and compared. Basic comparison includes species composition, structure, density, and age as well as stand functionality.

A. Development of Treatment Alternatives. In developing specific stand treatment alternatives the silviculturist/prescription writer must determine which silvicultural systems and methods are applicable. These systems and methods are discussed extensively in Chapter 3, Silvicultural Systems, in this handbook. The FMP may have constraints concerning which system may be used by forest type or potential vegetation. For example, the Rx for low elevation ponderosa pine forest type may require an uneven-aged system while a high elevation mixed conifer type may require an even-aged system. Managed stand prescriptions or forest management plan prescriptions used in developing the allowable annual cut are developed using FMP constraints.

Factors such as climate, potential vegetation, slope, aspect, elevation, soil-type, and fire regime can influence vegetation interactions and eventual successional patterns. Competition, insects, diseases and other disturbances also influence the successional patterns. Relying upon their knowledge of silvics, forest and landscape ecology, earth science, and biometrics, the Rx writer/silviculturist will describe the sequence of forest conditions throughout the “life of the stand” that are necessary for achieving resource objectives. The silviculturist/Rx writer must frequently involve other resource disciplines for this determination and timely interactions with other disciplines are key to developing silvicultural prescriptions that can be understood, implemented and meet the FMP objectives. Other agencies such as the USFS Insect and Disease specialists may provide on-site reviews and recommendations during this stage.

Very similar sites may have more than one developmental pathway leading towards the DC depending on landscape level composition, structure, and desired condition objectives. For example, some Northern Hardwood forest types in the Northeast and Lake States may be treated as either even-aged or uneven-aged, depending upon the stand density and structure. Many Regions, Agencies and Tribal Forestry programs have specific decision trees and/or management Rx guides to aid the silviculturist in determining the appropriate Rx.

The following steps describe a *thought process* that should be followed when comparing the existing stand to the desired condition to ensure that reasonable silvicultural treatments are considered. Careful consideration should be given to each of the following steps before moving on to the next alternative:

1. No Action - The comparison should first consider if the existing stand is similar enough to the DC that no treatment is needed. In making this comparison the silviculturist should base judgment upon acceptable limits for the desired stand conditions. For example, the optimum stand density for a young stand may be 110 ft^2/ac, but acceptable limits may range from 80 to 130 ft^2 /ac. Similarly an optimum species composition for a given resource objective may be 70 percent seral species in the overstory, but a minimum of 50 percent would be acceptable. Determine acceptable limits before comparing to the existing stand and base the limits on resource management requirements and an understanding of the historic range of variability of composition, site potential and structure in the ecosystem.

2. Modify - The comparison should next determine if the existing stand can be modified by intermediate cutting, planting, burning, or other appropriate measures to restore composition, structure, density and ecosystem function, and to better meet resource objectives. Knowledge of silviculture, silvics, stand density, site quality, etc. is critical in developing alternatives in this step. It is also necessary to have knowledge and experience in prescribed burning inorder to understand and predict species survival and reaction following a burn if that is what is prescribed. Treatments must be operationally feasible and ecologically sound.

3. Regenerate – If the existing stand does not compare favorably with the desired stand conditions and cannot reasonably be modified to do so, the silviculturist must consider alternatives to regenerate or replace the existing stand. All regeneration options, including uneven-aged, two-aged, even-aged and coppice methods must be considered. Keep in mind, however, some options may be precluded by the requirements of the FMP. The justification for clearcutting must relate primarily to resource objectives and requirements and only secondarily to stand condition. Since clearcutting is a method of regenerating a forest stand, it must be determined that the existing stand cannot meet resource objectives and must be replaced. It must also be determined that an even-aged silvicultural system is an appropriate way to meet management objectives and that clearcutting is the optimal regeneration harvest method. These determinations must be tiered to the FMP; and while an FMP may find clearcutting to be an optimal treatment to meet objectives under certain conditions, the silvicultural prescription and associated analysis must find that it is currently the best option for a specific stand.

Chapter 3 discusses all the available options of regeneration methods. Knowledge of these methods and experience in prescribing them are key factors in developing treatments that will cost-effectively meet the resource objectives and desired condition. In prescribing even-aged regeneration treatments, one objective is to reforest the site in a timely manner with the desired species such that the stocking level meets at least the minimum number of required seedlings per acre and that these seedlings are above the competing vegetation and “free to grow.” It is important to know the silvics of the desired tree species and whether natural, artificial, or coppice type of reforestation should be prescribed. Factors to consider while selecting regeneration methods include amount of shade or size of opening needed, frost protection, shrub competition, disease problems, and chance of windthrow.

In addition to standard even-aged regeneration treatments, two-storied even-aged regeneration treatments that bring structure and visual quality to a stand may be considered. These treatments have the added designation “with reserves.” If the FMP requires uneven-aged stand conditions, then the stand or area can be converted to an uneven-aged stand over a period of time using either a group selection or single tree selection treatment.

If the existing stand is uneven-aged and not functioning to meet management objectives because the stand or area is missing age-classes and/or has high stocking levels in other age classes, then a regeneration harvest for a new age class coupled with density reduction in other age-classes may be prescribed. Selection harvests should always regenerate a new age-class for each entry (cutting cycle) whether single tree or group.

In an uneven-aged stand where the desired species is infected with dwarf mistletoe and the stand is not functioning or progressing towards the desired condition, an even-aged treatment should be prescribed. In stands with only one tree species, dwarf mistletoe will spread from the overstory trees to understory trees and regeneration. Eventually, the understory trees will become suppressed and die (refer to any insect and disease handbook). In many cases a shelterwood treatment would regenerate a new mistletoe-free stand if the overstory is taken off before the understory becomes infected. Clearcut and seed tree treatments may also be prescribed.

4. Stabilize - If the existing stand cannot be modified to achieve the target conditions and cannot be replaced because of reasons external to the stand, the silviculturist should consider the opportunity to stabilize or improve the existing condition. Alternatives may include sanitation, salvage cuttings, or "mature stand maintenance thins" that will help to hold the stand until a regeneration cutting can be carried out. Intermediate cuttings must leave the stand in a condition that is favorable for the allocated resources regardless of opportunities to capture imminent mortality. The diagnosis should derive alternatives that are related to stand conditions that will exist following the proposed harvest.

5. Defer - Finally, the silviculturist/prescription writer may consider deferring treatment because conditions external to the stand do not permit any treatment at the time of diagnosis. In this situation treatment is deferred not because the existing stand meets resource requirements, but because a treatment of any kind is not possible. An example of this situation may be a stand in an area with severe hydrologic limitations. When defering treatment, the Rx should specify what conditions will allow the treatment to proceed and when that might be expected. Additionaly the prescription should include a discussion on the tradeoffs for not treeating the stand at the present time.

Consider a reasonable range of viable alternatives from the foregoing comparisons of the existing stand to the desired stand condition. A reasonable range of alternatives should usually include consideration of both even- and uneven-aged systems. The silviculturist must consider how each treatment alternative will produce a stand that is like the desired stand condition and will function to meet management objectives. All alternatives should be attainable with current practices and technology. The emphasis should be on how the stand will function after treatment rather than focusing on what is harvested.

When alternative treatments have been identified, actions that will move the stand through the next regeneration period or several cutting cycles should be specified. This must be done to assure that the direction set by the treatment need is reasonable, to give a roadmap to future foresters, and to develop information for an economic comparison of alternatives completed during the NEPA process.

Volume yields for the sequence of management actions identified for each alternative should be estimated unless adequate consideration to this has been provided by the FMP. Assignment of incurred costs and harvest volumes will provide the basis for an economic analysis to be completed for the project in the NEPA document.

The silviculturist/prescription writer should recommend a preferred alternative with a brief explanation for the selection.

B. Growth and Yield Models. There are many analytical tools available to help analyze the alternatives. One of the most important is the growth and yield model. Growth and yield models such as FVS, Forest Projection and Planning System (FPS), ORGANON, CACTOS/CRYPTOS, DFSIM, PPSIM, TWIGS and Stand Projection System (SPS) are just a few programs that predict forest stand development under various management alternatives. Each program requires a specific input format as well as specific tree data to run.

FVS is a public domain (free), highly integrated analytical tool that allows the silviculturist to include disturbance agents such as insects, pathogens and fire in the simulations. The basic FVS model structure has been calibrated to unique geographic areas to produce individual FVS variants. (A list of FVS variants and a locator map can be found on their website: http://www.fs.fed.us/fmsc/fvs/). The Fires and Fuels extension to FVS evaluates the effectiveness of proposed fire and fuel management treatments in the context of potential fire effects on short- and long-term stand dynamics (Reinhardt 2003).

There is also a Climate Extension to the FVS that provides forest managers a tool for considering the effects of climate change on forested ecosystems. The original Forest Vegetation Simulator (FVS) components predict performance in the absence of climate change. To accommodate the effects of climate change, Climate-FVS modifies these components rather than replacing them with new climate estimators. In this respect, the primary intrinsic components of FVS and its empirical heritage remain intact. The core tree growth, mortality, and regeneration components in FVS are modeled as functions of site capacity, tree size, and competition. With the introduction of Climate-FVS, there is now the ability to use information regarding climate change to affect site capacity and estimate the effects on tree growth, mortality, and regeneration potential. Climate-FVS is currently available for the western half of the conterminous United States; however, work has been initiated to expand Climate-FVS to the eastern half of the United States.

Spreadsheets can be developed to grow stands into the future but these are neither as robust nor as defensible as the peer reviewed and developed software. Computer models of forest growth and yield provide a superb way for silviculturists to test the outcomes of silvicultural prescriptions. The modeled results should not be thought of as a guarantee of prescription effectiveness, but rather as a comparative tool for evaluation of alternatives or variations in implementation. The Branch of Forest Resources Planning (BOFRP) may provide technical assistance during the analysis stage, specifically FVS support or on-site reviews.

C. Economic Analysis. Another important tool for evaluating treatment options is the economic analysis. At the strategic level, forest management plan prescriptions are developed for the FMP and, in some cases, an economic analysis accompanies the prescriptions. For those directed to do a financial analysis, various economic measures such as the Benefit/Cost Ratio, Net Present Value, Soil Expectation Value (SEV) and Internal Rate of Return (IRR) are available. Spreadsheets may be developed to calculate these values, however not all measures are always appropriate. For example, IRR and SEV are specific to an initial condition, such as stand establishment, rather than an existing stand condition. Software programs, such as the integrated ECON extension to FVS (Martin 2008) or Quicksilver (Vasievich 1984) are available. If a true benefit/cost analysis is necessary for ranking alternatives, refer to 53 IAM Forestry Handbook Volume 5, Forest Development. Procedures for the economic analysis should be developed locally. The *Forest Management* textbook by Davis and Johnson as well as the *Forestry Handbook* (Society of American Foresters 1984) are good references for the economic analysis methodology; both are listed in the Bibliography at the end of this chapter.

Following the analysis, one preferred alternative will be selected that meets the goals and objectives for the stand while providing a positive return, or less negative return, to the landowners. An exception to a positive return would be fuels treatments. The other alternatives may be mentioned with a brief statement of why they were not selected.

4.10 Silvicultural Prescription. (The Written Rx) This step of the process is usually done only for the selected treatment and describes the silvicultural system and the treatment's effect on the stand through time. It includes a description of the stand parameters after treatment, the follow-up assessment, supplemental treatment(s) and the contingency plan. In developing the treatment, the site and stand data as well as walk-through data can be used to develop the requirements for each stand. It is understood that because of natural variability, forest stand conditions seldom, if ever, fit under one precise description. There will always be subtle or marked differences in structure, age, forest health, terrain, etc. within stands. Consequently, seldom will current stand structures or conditions allow the application of "classic" silvicultural cutting methods or treatments throughout entire stands. In these cases where a stand or stands do not "fit" under any one particular treatment, the silviculturist is advised to select the treatment that best fits the needs of the majority of the stand, and then thoroughly describe in the written prescription in what areas of the stand, or under what conditions a different or modified treatment should be applied.

Coordination and interaction with other disciplines are vital for development of the specifics required to meet the desired future condition. For example, the timber sale and engineering sections can aid in determining the harvesting system; forest development and fire/fuels management can assist in site preparation; or forest development can assist in reforestation needs such as species composition, planting density and site amelioration.

The written prescription shall list the sequence of actions required to accomplish the treatment need. The timing of each action will be listed with a brief description to ensure successful implementation of the intended prescription. Use specific objectives or evaluation criteria that are measurable; show an understanding of the path that the stand will take after the treatment; and describe the effects that the treatment will have on the stand, including the age classes within the stand. Well chosen objectives and evaluation criteria

- focus and sharpen thinking about the desired outcome or condition of the resource;
- describe to others the desired condition;
- set the stage for adaptive/alternate management if the objectives are not met;
- provide direction for monitoring; and
- provide a measure of management success.

Below is a list of additional prescriptive elements to include in the detailed prescription:

Description of Residual Trees
- Species composition
- Description of desired stocking (TPA, basal area, SDI, RD, etc.)
- Size/age
- Condition
- Spatial distribution

Multiple Resource Requirements
- Snags, wildlife trees
- Buffers
- Seasonal restrictions
- Aesthetic requirements

Special Features and Recommendations
- Water sources
- Fences, structures
- Archeological/cultural sites
- Roads, trails

Harvesting Restrictions
- Harvesting method (ground-based, cable, etc.)
- Equipment requirements
- Seasonal restrictions

Future Treatment Schedule
- Reforestation
- Prescribed fire
- Monitoring surveys
- Thinning needs
- Final harvest

Slash Disposal Method
- Desired arrangement (piled or scattered)
- Prescribed burning objectives and requirements
- Equipment needs
- Down woody material needs

Site Preparation
- Prescribed fire objectives and requirements
- Method (mechanical, fire, chemical)
- Target vegetation

Reforestation
- Natural or artificial
- Desired species
- Planting method
- Spacing guidelines
- Protection needs

4.11 **Implementation.** This step bridges the gap between the conceptual prescription and the field project. If the prescription is sound and the process is followed, few changes will be needed. However, there may be circumstances where minor changes have to be made during the implementation stage. If these changes alter the treatment or develop a stand that is different than the desired stand, then the silviculturist should approve or amend the prescription.

A prescription involves the removal of trees, shrubs, or any biomass in excess of that deemed suitable for retention and therefore must describe what is to be removed. That description must be done in sufficient detail such that the people responsible for the removal can do so in a way that satisfies the silviculturist. The implementation plan is a written set of rules that direct the field crew on how to implement the prescription on the ground. It should be brief, concise and provide enough detail that the crews can understand and complete within the tolerances set. Marking guidelines describe which paint color should be used and whether it is a leave- or cut-tree marking. It describes the desired density, whether it be basal area, trees per acre, or spacing; tree species in order of preference; and tree characteristics, such as crown position, crown ratio, disease, tree form, or evidence of cone production, for leave- or cut-tree marking. Desired snag size, species, and number may also be listed. Any other resource needs should also be identified and quantified for the field implementation crews.

The implementation plan should be checked for workability with transportation systems, logging systems, and other resources before handing to the field crew. Direction and assistance in the field by the silviculturist is essential and field visits should be scheduled to ensure markers follow the marking guidelines. Special provisions to the timber sale contract can be developed at this time.

Implementation guidelines for fire and fuel reduction prescriptions can be written using the same format as a harvest prescription.

4.12 Monitoring and Evaluation. Monitoring is the collection of information over time, generally on a sample basis by measuring change in an indicator or variable, to determine the effects of resource management treatments over time (Helms, 1998). Monitoring and evaluation are done to determine whether the treatment is implemented and completed as prescribed; the stand is moving toward the desired future condition; that management objectives are being met; if remedial treatments are needed; and if prescriptions can be improved. Monitoring should begin early in the process, primarily during layout, tree marking and cruising, but may be made at any step in the process. Because monitoring is such an integral part of silviculture, the following chapter of this handbook covers a more extensive discussion of monitoring.

A formal field examination should be made and documented following the silvicultural treatment. Actual measurements may be necessary in order to determine whether or not the objectives have been met. For example, a stocking survey following a regeneration harvest would determine whether the area is restocked with the desired species at an acceptable level and shows suitable growth rates for the site. Such monitoring is essential since adequate regeneration is the fundamental stand-level indicator of sustainability.

Monitoring is an important step that is often overlooked due to time, money or personnel constraints. There are creative ways to monitor without monitoring every single acre. For example, if standard prescriptions on similar cover types are typically prescribed, you may consider monitoring 20% (arbitrary number) of your treatments to ensure the prescription objectives are being met. Satellite imagery may be useful in certain situations.

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CHAPTER 5. MONITORING the PRESCRIBED TREATMENTS

5.1 General. Monitoring can be defined as the orderly collection, analysis, and interpretation of environmental data to evaluate management's progress towards meeting objectives and to identify changes in natural systems. Predetermined variables are measured to determine the effects of resource management treatments in the long term. Regional Offices and Agencies/Tribes should develop monitoring procedures to assure that the treatment was implemented as prescribed; that the appropriate prescription (Rx) was applied; and that the prescribed treatments are achieving the objectives of the Rx.

Monitoring is an integral part of the adaptive management process and requires forethought and careful design. What is left in the woods after the treatment has been applied or what replaces what was harvested is more important silviculturally than what has been removed; and monitoring helps the forest manager evaluate the success or failure of the Rx. The prescription must include a detailed monitoring plan that evaluates proper implementation of the silvicultural treatment and the over-all effectiveness of the prescription through time. Quantifiable variables and associated thresholds must be identified that measure the success of the treatment. The quantifiable objectives describing the conditions of the future stand should be used to evaluate the silvicultural treatment and determine whether the treatment was valid, applied as prescribed, and accomplished the objectives of the prescription. As multiple objectives of forest management become more complex, it is important to keep in mind that silvicultural prescriptions are effectively working hypotheses, as Smith (1986) emphasizes, and monitoring must continue to be a strong component of the silvicultural process. Monitoring results provide evidence for forest management modification if objectives are not being met. For this reason, a contingency plan should be included as part of the monitoring plan.

5.2 Strategic (Forest Level) Monitoring. This type of monitoring is connected to the Forest Management Plan (FMP) and is a measure of the effects that all forest treatments as well as natural occurrences have had on the landscape. Category 1 Reservations have a Continuous Forest Inventory (CFI) in place and this periodic inventory provides information on forest trends, growth, health, mortality, condition, landscape mosaic, and adherence to the allowable cut. All other reservations through Category 4 have a periodic inventory that aids in trust monitoring. (See Handbook 2 and Handbook 8 for specifics). Other forms of periodic strategic monitoring include:

- Insect and disease detection flights
- Vegetation layer updates (cover type mapping)
- Aerial photo/ satellite imagery (remote sensing)
- Wilcox or other study plots

5.3 Operational (Project Level) Monitoring. This level of monitoring should be described in the prescription and occur during and after the treatment to assure that the desired results are achieved. As part of the prescription, three or four well stated objectives of the future condition are developed and described. These should be the basis for the monitoring plan and have certain characteristics:

- They are subordinate to higher level management goals,
- They are narrow and short in range,
- They have a high probability of attainment,
- They specify a time period for completion, and
- Their achievements are measurable and quantifiable.

As part of the adaptive management cycle, stand or landscape objectives are the key to the monitoring plan. The monitoring plan is written during the prescription process and a critical review of the management objectives is necessary.

A. Design monitoring methodology. The method of monitoring can be qualitative or quantitative depending upon the objectives to be measured. A carefully thought-out and effective monitoring plan should clearly state or describe:

- what will be monitored;
- which attributes will be measured;
- what are the acceptable thresholds or threshold ranges for each attribute;
- what action will occur over time (will the measured attribute decrease, increase, or stay the same);
- a contingency plan if the outcome deviates substantially from prediction (e.g. if natural regeneration does not occur, "x" number of trees per acre will be planted); and
- how much time is necessary for the treatment to prove itself effective.

If the monitoring approach is quantitative, it is also important that the monitoring plan:

- carefully defines the population (e.g. are you only checking regeneration in the gap portion of an un-even aged treatment?);
- describes the sampling design including well distributed plot placement and data collection schedule;
- describes the sampling unit size and shape (fixed or variable radius);
- estimates the number of samples necessary to achieve the desired sampling error;
- provides a data collection sheet;
- determines and states the monitoring frequency; and
- describes the data analysis techniques and evaluation procedures.

B. Implement Monitoring Plan. There are two general types of monitoring. The first monitors the *implementation of the prescription* and starts with the marking phase to ensure that the silviculturist's intent is being interpreted by the markers in a way that is satisfactory to the silviculturist. Spending time with the marking crew and the person responsible for quality control (QC) is crucial in ensuring success at this phase. Equally important is that the results of the QC be reported to the silviculturist and documented in the monitoring records. Implementation monitoring continues throughout the duration of the timber sale or treatment activity to determine that the management activity is in compliance with the design. The Sale Administrator/Harvest Inspector should advise the silviculturist or Forest Manager when substantial changes to the harvest plan and prescription are proposed. Some monitoring measures include residual stand quality, residual stand basal area, and environmental condition of the stand (soil erosion). Implementation monitoring should be documented and included as a tracking reference for the project.

The second type of monitoring determines the *effectiveness* of the prescription and whether or not the treatment objectives were achieved. Post-harvest assessment of the residual basal area, stand density, average diameter, species composition, and stand structure (diameter distribution), are quantifiable variables that can be measured and compared to the treatment's target objectives to determine whether the objectives were achieved or if additional management action is necessary to meet the objectives of the Rx. A timetable describing future monitoring needs must be included to determine future stand development towards the desired condition, adequate regeneration or the need for reproduction thinning. Please note that the results of effectiveness monitoring may not become apparent until many years down the road. Refer to Figure 5.1 for a graphic display of the monitoring process.

C. Analyze and report findings. Collected data should be analyzed and reported to the land manager as well as circulated to other resource specialists involved in developing the treatment objectives. The analysis should summarize the data, evaluate success or failure and provide necessary recommendations. Keep in mind that photos present a very clear picture for future foresters and one should consider including them. Location and direction of photo are helpful pieces of information.

D. Management implications. Management implications of monitoring should be considered and identified before monitoring begins. What are you going to do if monitoring results are not positive, but rather indicate a need for change? Management implications should be an integral part of pre-monitoring planning and a contingency plan should be in place. Contingencies are more likely to be applied if they are identified beforehand and if all parties agree to the objectives.

5.4 <u>Monitoring Needs for Various Treatments.</u> Regeneration of the desired species at the stand level following reproduction cutting is the fundamental stand-level indicator of sustainability and monitoring treatment outcomes is very important yet something that is often overlooked. Establishment of regeneration is probably the most critical portion of any forest management scheme as it sets the stage for available treatment options long into the future. Accordingly, monitoring regeneration treatments is essential to assure that regeneration is occurring successfully when and where needed. This section will provide some general guidelines for monitoring various regeneration treatments.

A. Even-aged. Under even-aged management monitoring can effectively be done by performing post-treatment survival studies and stocking surveys at some pre-determined interval(s) after the treatment is completed. Survival studies are designed to provide early feedback on the success of artificial regeneration (planting) treatments and typically occur the first, third, and fifth season after planting. Stocking surveys are applied to natural and artificial regeneration prescriptions and typically occur at a longer interval after treatment (i.e. 5 – 10 years). The stocking survey objective is to either certify the success of the treatment or identify a need for corrective action.

B. Uneven-aged. The use of uneven-aged systems is founded at least in part on an underlying assumption that natural regeneration will occur where and when needed without any site specific management interventions. This does not preclude the need for monitoring regeneration; rather the monitoring objective is to validate the assumption that regeneration is occurring and to guide future prescriptions. The nature and distribution of regeneration in these stands presents challenges which require more creative approaches to monitoring than are needed for even-aged management.

In uneven-aged systems, regeneration is by design more dispersed across the landscape and the specific areas where regeneration is desired will not be confined to identifiable units as is the case with even-aged regeneration areas. This necessitates a monitoring program which targets portions of the stand where recent harvesting activities have created space for regeneration, as opposed to sites which are still dominated by growing stock. A monitoring plan should include guidelines which identify stand structures where regeneration must be occurring for management to be considered successful.

1. Single Tree Selection. With STS systems, a simple stand exam covering 100% of the area once every management cycle may provide sufficient monitoring data. In forest types dominated by very shade tolerant species, the goal may be to find regeneration occurring evenly everywhere. With less tolerant species, regeneration standards may require targeting areas in which the overstory basal area is below a prescribed level for plot placement.

2. Group Selection. With group selection management, anticipated regeneration may be quite patchy and limited to a minor proportion of the acreage (e.g. 10 – 30%). In this case, an extensive stand exam might not place sufficient numbers of plots within the groups to provide an adequate assessment of regeneration. As an alternative, stocking surveys might be used to intensively sample some randomly selected groups to assess the levels of regeneration occurring there. Comparing pretreatment and post treatment orthophotos would aid in identifying openings created by group selections for placement of intensive surveys.

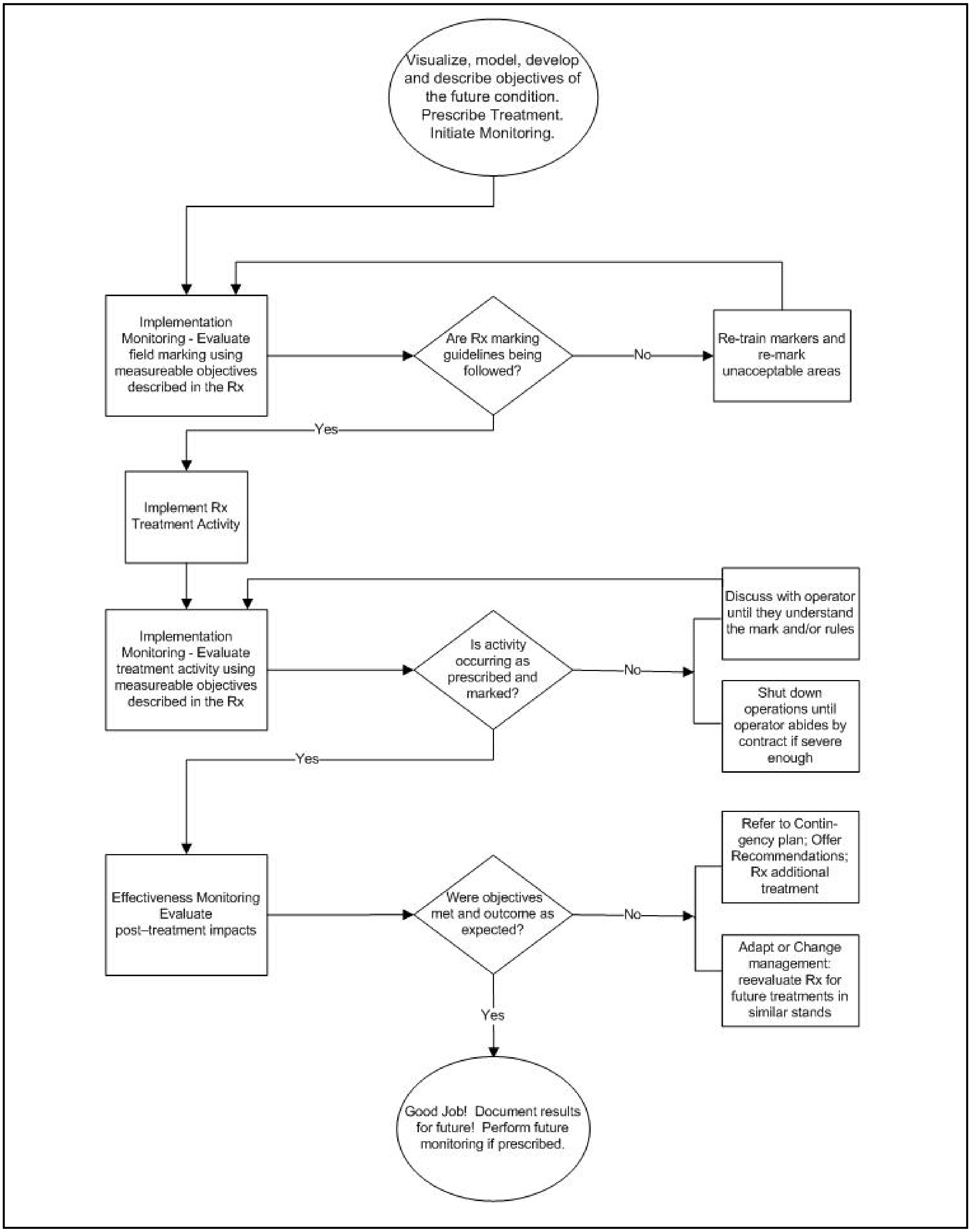
Timing of monitoring surveys for regeneration treatments in uneven-aged management might be done after a longer interval than would be used for even-aged prescriptions, since natural seeding is likely to be either gradual and continuous or episodic. However, to be relevant, it must occur prior to reconnaissance and planning for the next entry into the stand.

5.5 <u>Concluding Thoughts on Monitoring.</u> The treatment objectives for the stand are the basis on which the silvicultural treatment will be monitored and evaluated. A post-harvest assessment of the residual stand density, basal area, function, and structure should be compared to the target standards originally specified in the prescription to determine successfulness of the Rx. Monitoring is an internal, constructively critical, management review that should help answer the following questions:

- Was the treatment implemented (marked and/or harvested) according to specifications?
- Did the treatment achieve the intended results? Is it effective?
- Was there unexpected mortality, insect or disease outbreak, or windthrow?
- Should the prescription be changed for similar stands in the future? Is the Rx valid?

As silviculturists across the Nation retire over the next few years, the monitoring plans that are in place help preserve the corporate knowledge of successful treatments for future foresters. Treatment records should be maintained for the long term and time spent in review of these files should be encouraged.

A silviculturist must be observant and wise in order to explain or answer any silvicultural question by examining the end results of natural disturbances or earlier treatments.



<u>Figure 5.1</u>. Monitoring Flow Chart.

CHAPTER 6. RX RECORDS

6.1 General. A sound silvicultural treatment often requires years, even decades, of persistent work, monitoring, and evaluation. For continuity purposes, document retention is vital to ensuring that the prescribed treatments and future recommendations are followed. Silvicultural prescriptions and related documents are important for future reference and assessments of project areas. This chapter documents methods of document retention and retrieval.

6.2 Silvicultural Prescriptions. These records are to be retained indefinitely. In order to monitor and evaluate forest activities and facilitate future management actions, a system to track and readily retrieve silvicultural prescriptions should be in place at each reservation.

> **A. Prescription.** The Rx and all supporting information will be retained throughout the duration of the project, including the monitoring and evaluation stages of the project (which may be years after the treatment activity is complete).
>
> **B. Other Silvicultural Records.** In addition to the Rx document, each forest treatment will have in its permanent file a record of the silvicultural stand examination, post-treatment monitoring exams, and appropriate maps.

6.3 Maintaining and Retrieving Silvicultural Prescriptions and Records. Relying solely on the required BIA filing system to track and retrieve silvicultural documents is not advisable. This is because the different document series and the different filing arrangements currently required makes the retrieval of Rx documents difficult and inefficient. A separate system to track, and easily retrieve Rx document's, is needed at the reservation level (or where ever the silviculturist(s) is located). This tracking system needs to allow for the easy retrieval of the Rx documents by Tract ID, legal description, scheduled treatment dates, or scheduled survey/monitoring dates.

Typically the Rx goes into the Forest Officer's Report where it resides onsite until the sale is closed and then it goes into the federal archives along with the scale and contract records. An official silviculture program copy along with all supporting records could be filed and retained on site for future reference at least until the next management cycle in that compartment (20 years ±). It is also advisable that all documents related to silvicultural treatment be put in an electronic format, specifically a pdf file, for future electronic access.

6.4 Complying with the Bureau of Indian Affairs Records Schedule - 16 BIAM. Currently the revised 16 BIAM is the manual which explains the BIA filing system and the disposition of official records. The last major revision of the BIAM was in 2003 and a minor revision in 2005. This manual will be replaced by an appropriate IAM and subsequent handbook in the future, but at this writing the IAM has not yet been drafted. The current 16 BIAM (2003 version) does not specifically address silvicultural prescriptions, but it does identify four Forestry/Fire documents where a prescription would be an important part of the document series:

> TR- 4402-P5 - Timber Sales
>
> TR- 4406-P5 - Cutting Permits
>
> TR- 4432b-P5 - Wildland Urban Interface (WUI) Project File
>
> TR- 4433b-P5 - Hazardous Fuels Reduction (HFR) Project File

All four of these document series are "Permanent" records which are to be maintained in the office of record for a maximum of 5 years. The records would then be moved to the American Indian Records Repository (AIRR) - Lenexa, Kansas for permanent retention. See memo dated March 24, 2006 from the Director, Office of Trust Records (OTR), for detailed instructions.

The filing arrangement for each of these document series differs slightly:

Timber Sales and Cutting Permits: files are arranged numerically by contract or permit number

WUI and HFR projects: files are arranged chronologically by fiscal year.

Please see 16 BIAM or its' subsequent IAM, if available, for more information.

CHAPTER 7. TRAINING

7.1 General. Adequate training and continuing education is critical to the successful application of silvicultural practices and principles on Indian forested lands. This not only includes the silviculturist but may include field implementation crews; general forestry and fire staff; harvest inspectors; timber sale officers; site preparation crews; other resource specialists; and possibly contractors. Different groups require different levels of training and/or orientation to be determined at the agency level.

7.2 Technical Training. Technical training and assistance will be provided by Central Office to forestry staff to qualify as a Silviculturist as long as budgets allow. The amount and level of training provided will depend on the background training and experience of staff responsible for implementing field projects and the level of experience and training required for staff to successfully carry out their project responsibilities.

Technical training to maintain silviculturist certification is highly recommended.

7.3 Silviculturist Certification. As previously stated, silviculturist certification is not required, but is strongly encouraged. Some Regions require certification and final determination to participate in a certification program shall be made at the Regional level. The Certification or peer review program for silviculturists is designed to ensure that practicing silviculturists have the knowledge, skills and abilities needed to prepare adequate silvicultural prescriptions for all trust lands. The certification process is just one piece contributing to the complex issue of providing quality management to trust lands.

As a form of peer review and evaluation, the certification process is an exercise that requires aspiring silviculturists to thoroughly demonstrate and defend their understanding of complex land management issues and technologies. Certification involves three phases which collectively attest to the qualifications of a candidate. These are work experience, formal education and a prescription examination and review. Individual mentoring of employees seeking silviculturist certification by an experienced silviculturist may be an effective way to help the candidate through the process of identifying and completing requirements. Upon *successful* completion of all three phases, candidates are "certified" to prepare and approve silvicultural prescriptions for all forest vegetation treatments; including but not limited to reforestation, timber stand improvement, prescribed burning, hazardous fuels reduction, habitat/resource enhancement, and timber harvest activities.

A. Work Experience: Recognizing that certain practical skills and the ability to deal with complex resource situations can only be attained through experience in observing success and failure, certification candidates should have a minimum of 36 months of recent professional forester (GS-460 series) experience in silviculture, forest management, or closely related fields. See Table 7.1 for recommended experience. At least one year should be at the field level. Practical field experience is critical for professional development and the ideal situation is to have seasoned professionals mentor entry level foresters. Work experience in different operational categories can accrue simultaneously. Additional experience in any one category should not be substituted for a lacking category.

B. Formal Education: Knowledge of silvicultural concepts and application techniques in order to prepare and defend a prescription in addition to the skills and abilities acquired through experience is essential for certification. This knowledge is attained through formal course work required to earn an undergraduate forestry degree, in-service training, and formal graduate-level education in specific subject matter areas.

1. Suggested regional (local) training - either BIA, Tribal or outside agency – include the following

subjects:

a. Insect and disease identification and control

b. Local silvics

c. Habitat typing or potential vegetation

d. Animal damage control

e. Road design and layout

f. Logging systems

g. Cultural awareness

h. Visual management

i. Fuels management

2. Familiarity with the current revisions of the following handbooks is also required:

a. 53 IAM 5-H, Forest Development Handbook - including Regional Supplements.

b. 53 IAM 6-H, Forest Pest Management Handbook – under development.

c. 53 IAM 8-H, Inventory and Monitoring - under development.

d. 53 IAM 9-H, Silviculture Handbook - including Regional Supplements.

3. Knowledge of the concepts supporting forest ecology, silviculture and related subjects must be based on formal course work taught at the undergraduate and graduate level. This course work shall be in the following broad topics areas:

Category	Course/ Training
Ecological Systems	Forest and grassland ecology, forest stand dynamics, geology, meteorology, climatology, soils, cultural history, woody plant anatomy, plant physiology, species adaptation, conservation biology, geomorphology, hydrology, disturbance regimes, genetics, and silvics.
Landscape Ecology: Ecosystem Structure and Function	Landscape ecology, management of ecosystems at multiple scales, landscape models, and disturbance ecology.
Inventory, Monitoring and Decision Support	Resource policy/ law, growth & yield, economic theory, statistics/ sampling, forest regulation, wildlife/ range/ watershed models
Advanced Silviculture Topics	Silviculture prescription development, forest stand development, GIS, tree improvement, and reforestation.

This knowledge may be gained through undergraduate education and continuing education courses such as the National Advanced Silviculture Program (NASP or equivalent program) or independent graduate study. Those with prior graduate degrees or continuing education courses may already meet, or be able to supplement their education to meet these requirements. Requests to use an advanced degree for the educational requirement should be made to the Regional Forester and include the type and date of degree; institution awarding the advanced degree; a listing of the courses taken with a short description of the content of each course; and a copy of a transcript showing the grades received for each course.

As of 2011, the topics and hours covered in the 9-week National Advanced Silviculture Program are displayed below.

NASP Course Overview

Ecological Systems – 10 days		**Inventory & Decision Support – 10 days**	
Topics	Hours	Topics	Hours
Forest ecology	16	Growth and yield	8
Geology, landforms, soils	16	Site quality and productivity	4
Hydrology and watershed	8	Statistics/Sampling/Inventory	32
Tree physiology	12	Economic principles	8
Silvics of forest trees	4	Forest regulation	4
Genetics	8	Forest planning	4
Fire ecology, fire behavior	8	Legal rqmts / Mgmt direction	4
Course evaluations, tests, etc.	4	Monitoring	8
		Course evaluation, tests, etc	4
Total:	76 hrs	Total:	76 hrs

Landscape Ecology – 10 days		**Advanced Silviculture Topics – 15 days**	
Topics	Hours	Topics	Hours
Introduction to Landscape Ecology	2	Silvicultural systems	14
Concepts of Scale	2	Regeneration	20
Characterizing the landscape	6	Stand and forest dynamics	24
Processes that structure landscape	6	Integrated pest management	4
Disturbance ecology	10	Fish, wildlife, TES	6
Focus on fire ecology	8	Rangeland management	2
Ecological implications	10	Scenery management	2
Landscape dynamics	4	Timber, markets, utilization	2
Landscape modeling	12	Harvest systems	4
Management applications	12	Prescribed fire	4
Course evaluation, tests etc	4	Diagnosis process	4
		Prescription preparation practice	26
		Course evaluation, test, etc	4
Total:	76 hrs	Total	116 hrs

Table 7.1. Recommended work experience for aspiring certified silviculturists.

Minimum Required	Work Experience	Dates
Stand Examination 1 season (about 3 months)		
Timber Sale Layout 2 seasons (about 6 months)		
Timber Sale Administration 1 season or more (about 3 – 6 months)		
Reforestation / Site Rehabilitation 2 seasons (about 6 months)		
Timber Stand Improvement 1 season (about 3 months)		
Forest or Project Level Planning / NEPA 1 season (about 3 months)		
Silvicultural Prescription Preparation, 1 season (about 3 months)		
Supervisor's certification of candidate's completion of work experience	Supervisor's Signature	Date

Table 7.2. NASP or equivalent Graduate-Level Education Record.

Training Program	**Date Completed**
Candidate's Signature:	Date of signature:

C. Formal Prescription Defense – Preparation and Examination Instructions. The final phase of silviculturist certification is the evaluation or peer review of a formal prescription. Please note that this prescription is more detailed and extensive than typical prescriptions due to the certification process. After experience and educational requirements have been met, the silviculturist candidate is to select a local stand or several similar stand conditions within a timber sale area which is within the bounds of Indian forested land (federal trust status), and prepare a detailed prescription. After the prescription is complete, the Regional Office is to be contacted and the Regional Forester will organize a Certification Panel and an evaluation presentation will be scheduled. Candidates should submit the work and educational experience record along with their request for oral exam of their written prescription through their chain of command to their Regional Forester. At that time a certification panel would be convened to complete the certification process. Coordination is important in order to assemble the panel in the event of multiple candidates. Six copies of the prescription should be delivered to the Regional forester for dissemination to the panel members.

Upon successful completion of the prescription defense and with recommendation from the reviewing panel, the Regional Director will certify the candidate. *Certifying Regions may have a similar variation to what is presented here. Be clear on their process if it is different than what is presented here.* The general prescription defense process is as follows.

1. Objective – The objective of the prescription examination is to test the candidate's ability to integrate and apply the knowledge, concepts, analysis techniques learned through training and experience. To demonstrate this ability, each candidate will develop and defend a silvicultural prescription for a forest stand of their choosing. The candidate should view the prescription and oral defense as a technical argument for the treatment proposed. The candidate should not consider the prescription as a report for which they provide an oral explanation. The defense will be judged on its technical merit and logic. The candidate must integrate and apply silvicultural concepts to develop alternative treatments that satisfy land management objectives for a specific timber stand. The Certification Panel (see Part 4 for composition) uses the written document, the candidate's oral presentation, and responses to oral questioning to determine if all appropriate and relevant concepts were addressed. The panel also checks that the concepts were applied in a technically correct and logical manner.

2. Stand Selection - The selected stand must be complex enough, in terms of management objectives and stand characteristics, for the candidate to effectively demonstrate analysis proficiency. Candidates should not choose a stand that is so complicated they cannot provide a logical and convincing defense of the prescribed treatment. Beginning silviculturists are not expected to solve the most challenging stand management problems, but they must be able to integrate several management objectives and resource concerns into a treatment prescription for typical stand compositions, structures and conditions. The stand must contain two or more common tree species. Stands should be carefully selected so that a reasonable range of alternatives can be examined. Do not select stands for this exercise that are extremely limited in the range of treatment alternatives by biophysical or statutory factors. (Examples: extreme disease or management plan direction prescribes management)

The area chosen for this prescription exercise should be a single existing stand, 25-100 acres in size, representing a logical and realistic unit for management. (An acceptable alternative would be several similar stand conditions within a timber sale boundary). The criterion for stand delineation is general uniformity of site and stand characteristics so that one silvicultural system can be implemented with equal success across the entire area **to begin the trend toward a single target**

stand condition. Alternative target stands can be considered for the entire stand during the diagnosis stage; however, the implementation of the Rx will be guided by a single target stand description for the prescription stand. The prescribed treatment may vary with respect to variation in site or stand conditions, but within an alternative, the treatment method must remain the same for the entire stand. If different prescriptions are needed for a stand, it would normally be divided into separate stands, and the prescription written for one of them. The subject stand should not be delineated in a manner that oversimplifies resource management objectives, nor should the stand be arbitrarily subdivided into single use areas in an effort to avoid integration of resource objectives. There may be more than one treatment area designated within the stand but this would necessarily occur in the context of patch, strip or group type treatment methods. The silvicultural prescription is operational in nature. However, the depth of analysis and degree of documentation expected for this exercise is greater than the usual operational prescription.

Because oral examinations will occur in the field, it is recommended that the selected stand be easily accessible, even in inclement weather conditions. It would also benefit the candidate to have the stand easily and quickly accessible, as considerable time will be spent examining and collecting data for the written prescription.

3. Written Prescription Report - The candidate must use and demonstrate an understanding of professionally accepted silvicultural terms when preparing the prescription report and during the oral presentation. The prescription report should be both explicit and concise for a smooth flow from the prescription beginning to the end. The length of the document will generally be between 30 and 40 pages (type written, double-spaced, appendix excluded). Use tables to shorten and clarify the text. All data and references cited in the report must apply to the analysis. Eliminate extraneous material and repetition from the prescription. Make the prescription as brief as possible while still addressing the required items.

Resource specialists should be consulted as the management situation warrants, and their reports may be included in the appendix. However, the analysis and development of a silvicultural treatment is to be the work of the candidate. The candidate silviculturist is responsible for the explanation and defense of all statements, conclusions, and recommendations in the prescription report. Although discussion with other silviculturists concerning this prescription may be helpful, it is not appropriate for the candidate to rely heavily on the opinion or review of other certified silviculturists. The written prescription format is as follows:

A. Cover, front and back.

B. Abstract (executive summary). Briefly state stand condition and size, list treatment alternatives, and identify selected alternative. Limit this to 1 page or less (this isn't included in the overall page limitation).

C. Table of Contents. Include page numbers for the text and the Appendix.

D. Stand Location Map.
   1. Complete legend, adjacent stands (scale from 1:12,000 to 1:24,000 recommended).
   2. Place map in the text near the front.

E. Text.
   1. Double-space, 8-1/2 X 11-inch white paper. Minimize typographical and grammatical errors.

2. Limit text to between 30 and 40 pages. Lengthy background material or printouts should be in the Appendix. Forty pages double-spaced is the absolute maximum length for any prescription (this includes maps, tables, graphs, etc., in the text portion of the prescription, but not including the appendix. The Executive Summary does not count either). The minimum font size shall be 12-point for the narrative portion of the text. Smaller fonts may be used for tables, graphs, or Appendix items.

3. Describe the sampling design used to acquire data, and an indication of population variability and statistical reliability.

4. Prepare a table showing number of live trees in the overstory and understory by species, percent composition by species, and stand dwarf mistletoe rating if applicable. Display snags by species and diameter class.

5. Discuss abiotic and biotic conditions. Describe each condition and list the opportunity and limiting factors that affect vegetation regeneration and growth. Describe climate, soils and the relationship of the stand to local watersheds. Describe the Plant Association (Habitat Type) and the current successional phase as well as potential successional pathways. Discuss historic fire regime and current condition class and fuels. Describe the current presence, distribution and severity of insects and disease pathogens. Also discuss any other site specific observations such as age/diameter relationships, site productivity, sapling age at breast height, etc.

6. Discuss land management direction and tribal/allottee goals and objectives. Discuss only management direction and constraints that affect the selected stand and adjacent stands. Include only pertinent portions of the plan, not the entire plan. The stated management direction will be used to evaluate how well stand objectives, and treatment alternatives will meet land management direction. <u>Be very familiar with your Forest Management Plan.</u>

7. Develop three to five well-stated stand objectives with associated evaluation criteria. Write stand objectives to describe how the selected stand will be used to implement land management direction. The stand objectives are the treatment selection criteria. Stand objectives are also the monitoring statements. In other words, silvicultural treatments will be evaluated against how well they accomplish stand objectives. Stand objectives are brief, <u>measurable</u> statements describing the aim or condition of the future stand. **<u>Important: more errors are made developing stand objectives and evaluation criteria than any other part of the text.</u>**

8. Select at least three, but no more than six alternative silvicultural treatments. In addition, these alternatives **<u>must</u>** include:

a. Deferred treatment (no management)
b. Even-aged silvicultural system treatment
c. Uneven-aged silvicultural system treatment (except for lethal fire regime forest types such as spruce-fir)

Silvicultural treatment alternatives must be more than just comparative stocking level differences (e.g., 20%, 30%, and 40% of SDImax); they should be different cutting methods. It is recommended that differing cutting methods are evaluated for each silvicultural system (example: standard shelterwood vs. irregular shelterwood for even-aged systems and single-tree vs. group selection for uneven-aged systems.) You can also develop a specialized variation of these basic treatments to meet specific stand objectives (example Northern Goshawk habitat guidelines). The deferred alternative will provide the opportunity to look at the stand with no action (an example would be to consider forest insect and disease or fuel loading development, density related mortality and how stand sustainability would be affected over time). Discuss the influences of the habitat type(s) on selection of viable treatment alternatives, and whether any treatment options are constrained by site factors. You must demonstrate that each alternative (except the deferred treatment alternative) was chosen to strive for a silvicultural treatment to accomplish all stand objectives.

Analyze the even-aged treatment alternative for one rotation, plus show establishment of the succeeding stand. Analyze the uneven-aged treatment alternative for at least the same period as the even-aged alternative, longer if necessary to show stand regulation to the target structure (attainment of a sustainable desired future condition). Analyze the deferred treatment alternative for at least the same period as the even-aged alternative.

9. Compare growth and yield projections for each treatment alternative. Use the most appropriate modeling program. Develop a table that summarizes each alternative. Show concise table summaries in the body of your text. Include the entire projection printout and modeling assumptions for each alternative in the appendix of the document. Explain the species basis for SDImax calculations in a mixed-species stand if SDI is used in your Region.

Compare each alternative with the stated objectives and degree of attainment. Discuss measurable parameters such as: species composition, stand density index and growth dynamics, crowning/ torching index, beetle risk, etc… and explain your assumptions regarding how these factors influence accomplishment of management objectives. Be sure to demonstrate that you understand density relationships and how various SDI levels influence stand development and species composition. The proposed treatment must accomplish all stand objectives. The alternative treatments may or may not accomplish all stand objectives. Explain why each rejected alternative failed to fully meet objectives, and how alternatives were modified to develop the proposed treatment alternative.

Choose the alternative that best meets all of the stated stand objectives. Do not make your selection based upon any other factors.

10. Perform a financial analysis and develop a time line for each alternative silvicultural treatment and deferred alternative, considering all implementation costs and benefits. Display calculations for the selected alternative and the time line (linear graph) in the Appendix. For this analysis, assume that future costs and revenues increase at the same rate, so it's not necessary to consider inflation rates.

11. Discuss the selected silvicultural treatment. Be sure to discuss your prescription in the context of management plan direction: *"Will your prescription require a site specific plan revision in the NEPA document?"*

12. Integrated Resource Management must be discussed in the context of adjacent stands. Discuss the management considerations and requirements and how the selected stand treatment relates to adjacent stand treatments. Discuss only the adjacent stands. The idea here is that the candidate should show how the stand helps meet objectives that are dependent on relationships between stands. Briefly describe stand condition, priority for treatment, stand objectives, and proposed treatment for each adjacent stand. The best way to illustrate the stand is with a map.

13. Prepare implementation guides for the selected silviculture treatment only. Selected silviculture treatments involve timber removal, timber stand improvement, reforestation, disease control, snag retention, fuels treatment, logging requirements, site preparation, fence construction, or whatever is

appropriate to implement the selected alternative. Write implementation guides as if you were going to be transferred tomorrow, and as if a nonprofessional work crew will be implementing the guides. Assume that you are not available to help implement. Do not include guides for treatments in future decades. Only include the necessary guides to correctly complete the current recommended treatment activities. Guides should be placed in the Appendix of the document, not within the 30-page text discussion.

14. Number ALL pages at the bottom, both text and Appendix.

15. See Exhibit 1 for suggested text outline.

4. Oral Examination - After education and experience requirements are met, the candidate must contact the Regional Forester and request a field oral examination. The request should be made at least 3-months prior to the anticipated exam date. Check with your Region to see if there is a cut-off date. The field oral examination usually occurs during the mid-summer to fall season, but anytime that is convenient for candidate and panel is acceptable. The candidate may suggest a preferred date. The final date will be determined by panel member availability, logistical considerations, and candidate preference.

The Regional Forester will assemble a panel, schedule time, and conduct the exercise. The panel should include: a Regional Silviculturist/Timber Specialist (or Representative), a peer silviculturist from another agency or reservation, a University representative or scientist from Forest Service Research, a line officer or Forest Manager, and someone from another discipline such as a wildlife biologist, soil scientist, range, watershed or fuels resource specialist. The candidate must send each panel member a prescription copy at least one month before the field exercise date.

It is recommended, but not required, that the candidate request assistance with assembling a **"mock panel"** composed of similar specialists to review and critique the written document and oral presentation, at least one or two months prior to the due date of the final document to the certification panel. This exercise has proven to be highly beneficial to assist the candidate with preparation for a successful defense and obtaining certification. Often simple spelling errors or awkward document flow patterns are recognized and corrected before being passed on to the certification panel. This is an important step and should not be overlooked.

The steps of the field exercise are:

A. Introductory comments and instructions. Even though the examination will be held in a field setting, the candidate should dress like a professional for the review. Neat, clean, casual attire is appropriate.

B. A tour of the stand with the candidate as a guide will be conducted first. The candidate will have 45 minutes to 1 hour to conduct a stand tour and present the prescription. The candidate will summarize work experience, educational background, and the written prescription. During the tour, the panel may only ask questions in order to clarify tour information provided by the candidate.

C. The group will gather in a comfortable and convenient spot, and the **formal examination** will then occur. The Regional Silviculturist or delegate will facilitate the proceedings. The panel will objectively evaluate the candidate's performance based on the presentation and responses to prescription review questions. It is important to consider that while the candidate must be very knowledgeable of his (her) stand and written prescription, the oral questioning will include an in depth evaluation of the candidate's knowledge of silvicultural terminology, ecological concepts, and land management planning and policy. More than one candidate has been unsuccessful in achieving certification because of lack of knowledge or inability to respond to general questions of this nature. A certified silviculturist must demonstrate well-rounded general proficiency in the field of silviculture.

The Examination Record form (Exhibit 2) may be used to document the panel's evaluation. When formal questioning is complete (1 – 2 hours are allowed), the panel will discuss the examination and reach a decision regarding certification in private. The panel should consider the candidate's experience in making their decision. The panel will complete the Examination Record and then inform the candidate of their decision and offer a verbal critique of the examination. This documented review of the examination and the decision concerning certification will be documented by the Regional Silviculturist and filed with the candidate's application and written documents at the Regional Office.

There are three possible outcomes of the exam: the candidate may be certified; the candidate may be certified pending minor re-writes in the prescription (minor re-writes are usually completed within 3 months); or certification may be withheld. If certification is withheld after the first examination, the candidate may apply again for certification within 12 months. A second prescription defense is the final opportunity for certification.

Candidates who successfully complete certification will receive a certificate and letter from the Regional Director and copies will be sent to the candidate's Forest Manager or supervisor.

The following is a suggested timeline for completion of the stand assessment, prescription development and oral defense process (based on working half-time on this process for 6 months):

Month 1	Select stand. Recon stand/design inventory. Collect inventory data/analyze sampling statistics.
Month 2	Model current and projected future-forest conditions. Review stand conditions and walk-through stand with resource specialists. Review Forest Plan and other plan direction and ***develop unique stand management objectives*** (document plan basis and specialists' input). Develop and model management alternatives.
Month 3	Analyze management alternatives and implementation economics. Prepare draft document.
Month 4	Dry-run defense of draft document (written and oral) with local mock panel. NOTE: please complete month 6 tasks for the mock panel. Prepare final document.
Month 5	Distribute final document copies to oral exam panel. Literature and terminology review. Prepare sample marking/implementation guides. Examine document for weaknesses or points that could be strengthened during the oral presentation.

Month 6	Outline oral presentation/select field tour demonstration route and stops. Practice oral presentation/field tour. Prepare field discussion notes. Install implementation demonstration plot and work-up discussion data/handouts. Literature and terminology review. ***Successfully complete presentation and panel review!***

Recertification. Applying for recertification in the BIA is not required. It is highly recommended that the certified silviculturist retain their skills through continuing education and remain current in his/her knowledge of silviculture and forest ecology by reading technical and professional literature. Optionally, a less formal peer review may be performed if desired. This helps hone skills and may consist simply of neighboring silviculturist(s) walking through your treatment areas and discussing stand trajectory and prescription efficacy.

EXHIBIT 1

Suggested Text Outline

I. Overview An overview of the stand. Discussion of the stand in relation to location, adjacent stands, entire drainage considerations, past history, etc.

- A. Location
- B. Adjacent stands
- C. Landscape Consideration (include watershed description)
  1. Landscape Ecosystem
  2. Watershed
  3. Immediate Vicinity
- D. Stand History

II. Existing Stand Condition

1. Abiotic conditions (Physical environment)
   - a) Soils, Drainage, and Productivity
   - b) Topography (slope, aspect, elevation, landform)
   - c) Climate
   - d) Wind
   - e) Management implications related to the above

2. Biotic conditions (Biological environment)
   - a) Ecological Classification (Habitat Type/Plant Association)
   - b) Wildlife use
   - c) Vegetative Composition
   - d) Stand Structure, Competitive Stresses, Successional Stage
   - e) Forest Health
     - (1) Decay Fungi
     - (2) Stem Disease
     - (3) Insects
   - f) Results of the sample inventory that describe these conditions

III. Management Considerations (all factors/constraints that should be considered)

- A. Forest Health
- B. Fire as Veg. Mgt. Tool
- C. Fuels/Slash Management
- D. Soils
- E. Regeneration
- F. Plants
- G. Wildlife Habitat
- H. Fisheries
- I. Cultural Resources
- J. Recreation/Visuals
- K. Transportation System

IV. Objectives

- A. Management Direction
  1. Forest Plan – tribal goals and objectives
  2. Any pertinent midscale plans

3. Project level NEPA

B. Silvicultural Objectives / Desired Condition
   1. Specific resource objectives, measurable evaluation criteria
   2. Criterion weight factoring

V. Data Collection and analysis
   A. Methodology
   B. Stand Inventory
   C. Site Index

VI. Silviculture Treatment Alternatives
   A. Prescription Development
   B. Stand Projection Simulation Methods description (actual simulations in appendix)
   C. Assumptions of Using Stand Projections
   D. Preferred Alternative
   E. Alternative 1 – No Action
   F. Alternative 2 (etc)
   G. Alternatives Considered but Eliminated from Detailed Study
   H. Economic Analysis Methods
   I. Evaluating and comparing Silviculture Treatment Alternatives (Decision matrix)

VII. Preferred Treatment Recommendations (Include implementation/marking guides)
(TSI, reforestation, fuels management, logging and other mitigation requirements, record keeping)

VIII. Monitoring / Contingency Plans

IX. Literature Cited

X. Consultation with Others

XI. Appendix (include economic analysis, FVS runs, resource reports if available, stand exam output etc)

   A. Prescription
   B. Inventory Data
   C. Specialist's reports / letters
   D. Economic analysis formula and calculations (assumptions) for alternatives.
   E. Stand Data Base Information (record keeping list of the complete sequence of all treatment activities planned for the current entry period.)
   F. Relevant forest plan or management unit data.
   G. Growth and yield modeling reports (label each with treatment alternative).
   H. Other support data or information, as you deem appropriate.
   I. Listing of other treatment alternatives considered and rejected

Description of Suggested Components of Certification Prescription

I. Timber Stand Location

Identify the location of the stand with regard to the Reservation Forest, District, legal description, watershed, logging access and proximity to product mills. Describe the criteria used to delineate the subject stand and discuss why it was identified as a logical management unit in relation to the stands that surround it. Refer to maps and aerial photography.

II. Forest Plan Objectives and Tribal Goals

State the specific Forest resource management objectives and multiple-use coordinating guidelines for the general area which includes the subject stand.

The objectives should be summarized. State any identified broad ecosystem objectives and landowner goals that may have been identified through the Forest Plan or Forest Plan implementation analysis process. In any case, the intensity of current Forest management practice and the planned resource yields from the site in question must be described as this is an objectives driven process.

III. The Physical Site and its Environmental Setting

The physical site which supports the stand should be described in terms of climate, physiography, geology, soils, slope hydrology, habitat types, fuel loading, and fire hazard. While this section provides a general description of the site, it focuses on management considerations and constraints associated with the site characteristics. Specific site productivities are described later in Section VI.

IV. The Forest Community and its Ecosystem Setting

A complete description of the Forest community occupying the site that is "nested" in the ecosystem should be presented including the ecological setting, the timber stand under study, understory vegetation, insects and diseases, wildlife, and fisheries. Because actions taken in the subject stand can influence the broader ecosystem, those surrounding communities and populations which are potentially affected should also be described.

A key question to be addressed is: *Why here, why now?*

V. Stand History and Development

A description of the history of the stand including how it became established, its successional status, disturbances, and any past cultural treatments should be provided. The most probable development of the stand without treatment should be projected into the future. This projection includes a description of community dynamics deduced from the present stand and site characteristics coupled with knowledge of general successional patterns. A quantitative projection of the current stand is also made using the Prognosis model or other appropriate stand specific growth models. The analysis of stand history provides insight into the genetic constitution of the stand and disturbances that might be expected to recur.

VI. Site Productivity Potential

The potential of the site to produce Forest resources should be described. Based on the stand examination and interpretation of that data, the potential productivity of the site for timber, water, forage, wildlife, fisheries, recreation, and aesthetic/scenic values is assessed as a means of detailing and quantifying the resource production goals established for the site in land management plans. If any resource is not to be featured in the subject stand, that exclusion should be supported in this discussion.

VII. Stand Objectives

Based upon knowledge of the site and potential stand development on that site, the silviculturist specifies stand attributes that are optimum for the resources to be managed. These attributes are described in terms of a target stand with species composition, density, growth and other characteristics important to all resources. The target stand attributes are specified by stating acceptable minimums, maximums or desirable ranges of values at time periods pertinent to the resources being managed. Do not identify targets that are incompatible with the combination of resources to be managed. The stand targets should not be based upon the existing stand but rather upon the potential of the site in question. The range of conceivable target stands should be limited to those that are feasible and practical to attain.

VIII. Alternative Treatments

A documented comparison of the present stand to the described target stand(s) provides the basis of identifying silvicultural treatment alternatives. Silvicultural treatments are suggested that will modify the present stand to better satisfy management objectives or replace it with a more desirable stand. The target stand is the objective, and silvicultural treatment-sequences that will achieve the objective are presented. The alternatives presented are treatments for the next most logical entry in the stand.

However, subsequent treatments that will carry the stand through to the next regeneration period must be specified for each alternative in order that the analysis in the following section can be completed. Hence, the specification and analyses of alternatives focus on the current treatment need while recognizing the interrelatedness of the subsequent series of treatments among alternatives, unless the current treatment dictates such a variation. Details of implementing alternative treatments are discussed in Section X of this outline.

IX. Analysis of Alternatives

The alternative treatments are discussed and evaluated in terms of ecosystem processes and functions, silvicultural considerations, productivity enhancement and economic considerations. Ecosystem process are those that developed and maintain the system such as fire, insect and disease, and nutrient cycling. Function refers to how the components of the system interrelate and function to maintain the entire system. Silvicultural considerations have to do with the biological correctness of treatments. Productivity enhancement refers to how well each alternative will satisfy resource management objectives. Economic considerations involve a monetary comparison of product yields and costs associated with all specified treatments through at least the next regeneration period. A quantitative projection of each alternative using the FVS model, or other appropriate stand growth model, is required to assess productivity enhancement. Based on silvicultural productivity and economic considerations, a preferred treatment is selected. The reason for the selection must be clearly stated.

X. The Prescribed Treatment

The details of the preferred treatment are specified in sufficient depth so that someone with a forestry background could implement the prescription. As well as marking and layout information this may include discussion of logging method, site preparation method, wildfire hazard reduction, insect and disease protection, and genetic implications. In addition, a monitoring and treatment evaluation plan should be given.

XI. Effects of the Treatment

The projected effects of the treatment on the ecosystem and all Forest resources, including timber growth and yield, soils, slope hydrology, wildlife, fisheries, recreation and scenic qualities, are described. This discussion should be consistent with information developed under Sections VI and IX.

XII. Literature Cited

An alphabetized list of publications cited in this prescription is made with proper technical format. Personal communication with the NASP instructors or anyone who is not a recognized authority should not be listed. Do not cite textbook references unless specific pages are noted.

XIII. Appendix

The Appendix should include supportive technical material such as soil profile descriptions, water balance calculations, watershed analysis computations, stand and stock tables, growth model outputs, and appropriate maps. All appendix pages must be numbered and major sections tabbed to allow easy reference.

EXHIBIT 2

SILVICULTURIST CERTIFICATION EXAMINATION RECORD

Candidate: ________________________ Agency: ________________________

Date of Review ________________________ Reservation: ________________________

Stand: _

Reviewer	Name	Signature	Date
Regional Representative			
University Professor or Scientist			
Line Officer			
Other Resource Specialist			
Reviewing Silviculturist			

Recommendations:

Withold Certifcation: ________

_____ Full Certification

_____ Conditional Certification pending minor re-writes (by ________________).

____ Re-examination (pending re-write/analysis or new Rx within 12 - 18 months)

____ Withold Certifcation

The review and evaluation was discussed with me.

Candidate Silviculturist ______________________________________ Date: ________________
(Signature)

THIS PAGE IS TO BE USED TO RECORD STRONG POINTS AND AREAS OF IMPROVEMENT

Candidate: ______________________________ Date: ________________

Questioning Format for the Prescription Examination – Peer Review

Examination standard:

The objective of the prescription examination is to test the candidate's ability to integrate and apply the knowledge, concepts, and analysis techniques learned through training and experience to an actual field problem that involves meeting a specified set of resource objectives.

The questioning format used may draw from emphasis items included in the handbook or in the Regional Handbook. The defense will be judged on its technical merit and logic. Beginning silviculturists are not expected to solve the most challenging stand management problems, but they must be able to integrate several management objectives and resource concerns into a treatment prescription for typical stand compositions, structures and conditions. The stand should be within lands classified as Commercial Timberland or Commercial Woodland to provide a full range of management options to choose from when developing alternatives in the prescription report.

The candidate must be able to demonstrate expertise in the following key areas:

A**.** Can the silviculturist develop alternative treatments that are technically correct and environmentally sound?

B. Can the silviculturist clearly show how the proposed and alternative treatments will develop a stand that can meet landowner and land management objectives?

C. Can the silviculturist give the necessary direction for implementation of the proposed treatment?

To evaluate the candidate's ability to meet the standards for this exercise, the following format for the detailed questioning during the exercise may be followed. Questions in the section below should be answered by the panel prior to an evaluation of how well the candidate met the above key areas.

Each panel member will document their evaluation on the form provided and a composite evaluation will be documented and forwarded to the candidate.

I. Forest Stand Location

1. Does the candidate understand the concept of a forest stand as a management unit?

Evaluation:

Adequate [ ] Inadequate [ ]
Comments:

II. Forest Plan Objectives

1. Does the candidate understand how land management objectives are related to the subject stand? For example, you should key-in on items such as vegetation, even- or uneven-aged structural sustainability, or visual quality.

Evaluation:

Adequate [ ] Inadequate [ ]
Comments:

III. The Physical Site and its Environmental Setting

1. Does the candidate understand how the described site data and attributes, are related to management of pertinent resources?

Evaluation:

Adequate [ ] Inadequate [ ]
Comments:

IV. The Forest Community and its Ecosystem Setting

1. Can the candidate adequately evaluate the examination results of the existing stand?

2. Can the candidate explain why the inventory sample is designed correctly and why the reliability of stand data is adequate?

3. Does the candidate understand the structure and composition of the forest community for which the treatment is being prescribed?

4. Does he or she understand the processes and functions that influence the subject landscape? (Such as fire, insect and disease.)

Evaluation:

Adequate [ ] **Inadequate [ ]**
Comments:

V. Stand History and Development

1. Can the stand successional stage and trend be correctly described by the candidate?

2. Does the candidate understand past and current potential for insect, disease, fire, fire regime, and any other processes and functions such as nutrient cycling and windthrow patterns, that have played a role or may do so in the future of this stand?

3. Does the candidate have an understanding of the concept of a natural range of variation of composition and structure?

4. Has the candidate correctly evaluated the role insects and pathogens play in stand dynamics and in reaching resource objectives?

5. Has prediction of tree growth included appropriate use of growth and yields models? Does the candidate understand concepts of forest stand dynamics?

Evaluation:

Adequate [ ] **Inadequate [ ]**
Comments:

VI. Site Productivity Potential

1. Can the candidate use various resource potentials and capabilities and relate them to management objectives for the site under study?

2. Can the candidate estimate site index and potential productivity based on site attributes and current stand conditions?

Evaluation:

Adequate [ ] **Inadequate [ ]**
Comments:

VII. Stand Objectives

1. Can the candidate explain why the species to be managed and stand structures identified are compatible with the anticipated successional development?

2. Can the candidate show that the target stand composition and structure are consistent with natural processes in the area? (Such as fire regime, insect and disease etc.)

3. Can the candidate explain how the target stand meets the full complement of resource objectives identified for the stand?

4. Can the candidate relate the target composition and structure identified to achieving resource objectives over time?

Evaluation:

Adequate [ ] **Inadequate [ ]**
Comments:

VIII. Alternative Treatments

1. Can the candidate develop sufficient and reasonable treatment alternatives related to the pertinent issues and resources?

2. Can the candidate relate current stand conditions, including growth, to target objectives?

3. Can the candidate evaluate the need for intermediate entries in the stand?

4. Can the candidate think ahead through a logical sequence of activities that would carry the stand through one rotation period (even-aged mgt.) or until structural targets are met (uneven-aged mgt.)?

5. Can the candidate show that the proposed alternative silvicultural system is feasible to implement on the site?

6. Can the candidate use correct terminology?

Evaluation:

Adequate [ ] **Inadequate [ ]**
Comments:

IX. Analysis of Alternatives

1. Can the candidate describe the levels of resource outputs over time for each alternative?

2. Has prediction of tree growth following treatment included appropriate use of growth and yield models?

3. Can the candidate demonstrate knowledge of tree survival and growth and environmental relationships such as respiration, photosynthesis and germination requirements?

4. Can the candidate show that the alternatives are consistent with the ecosystem processes that historically played a role on this site?

5. Can the candidate show if the alternatives contribute to forest regulation goals?

6. Can the candidate demonstrate an economic comparison of the alternatives?

7. Can the candidate explain how the various resource management objectives would be met through the alternative treatments?

8. Does the candidate recognize that Forest Plan Amendments may be necessary to implement any of the proposed alternatives?

9. Can the candidate demonstrate knowledge of the genetic implications that the various alternatives may have to the future of the forest stand?

Evaluation:

Adequate [ ] Inadequate [ ]
Comments:

X. The Prescribed Treatment

1. Can the candidate correctly specify implementation requirements such as: regeneration needs including site preparation, appropriate distribution of seed or shelterwood trees, regeneration type (natural vs. artificial) and species, appropriate stock type, care and handling, stocking rates, and probability of any other cultural needs including animal damage control; gene conservation, genetic diversity, and tree improvement; insects and diseases; site productivity; stocking level needs; windthrow and fire potential; and product type?

2. Did the candidate determine that the site can be regenerated within legally mandated time frames?

3. Can the candidate carry the prescription to a logical conclusion?

4. Does the candidate know if the proposed treatment can be implemented with current technology?

5. Can the candidate identify all the pertinent treatment and evaluation and monitoring actions?

6. Can the candidate defend the actions proposed, in terms of legal and policy mandates?

7. Can the candidate specify sufficient detail of timing, leave tree selection, etc., for implementation?

Evaluation:

Adequate [ ] **Inadequate [ ]**
Comments:

XI. Effects of the Treatment

1. Can the candidate describe the overall effects to the site resulting from the proposed treatment?

2. Does the candidate know the immediate and long-term effects this proposed treatment will have on the larger landscape?

3. Can the candidate demonstrate how this treatment sequence contributes to the desired condition identified for the landscape within which this stand is "nested"?

Evaluation:

Adequate [ ] **Inadequate [ ]**
Comments:

XII. Literature

1. Can the candidate apply the literature correctly?

2. Did the candidate miss any significant literature in the development of this prescription?

3. Is the prescription supported by the literature?

Evaluation:

Adequate [ ] **Inadequate [ ]**
Comments:

CHAPTER 8. ILLUSTRATIONS

Exhibit 1 – 53 IAM Chapter 9 Silviculture

Exhibit 2 – Silvicultural Practices, Vegetative Management Activity and Stand Structure

Exhibit 3 – Walk thru Survey

Exhibit 4 – Prescription Forms

Exhibit 5 – Marking Guidelines

Exhibit 6 – Prescription Example

Exhibit 7 – Recommendations on Becoming a Silviculturist

Exhibit 1

53 IAM Chapter 9
Silviculture

9.1 Purpose. This chapter documents the policies, standards, and responsibilities relevant to the application of silviculture on Indian forest lands (See 53 IAM 1).

9.2 Guidance. Handbooks, directives and other guides may be issued and revised as necessary (see 53 IAM 1.3; also see the *Indian Forest Management Handbook*, *Volume 9,* titled, *Silviculture*, for detailed process and procedural guidance). Regional directives may be issued as necessary to address local processes and procedures.

9.3 Scope. The directives contained in this chapter apply to all Federal agencies and programs participating in the management, accountability, or protection of Indian forest resources. Regardless of the means of program execution, the appropriate Federal Official shall assure that the standards prescribed herein are met.

9.4 Policy. All Indian forest lands shall have effective management and protection through the application of sound silvicultural principles.

A. Strategic. Silvicultural guidelines will be included in all Forest Management Plans (See 53 IAM 2.8, C.14.).

B. Operational. Forest treatments on Indian forest lands shall be consistent with sound silvicultural principles. Silvicultural prescriptions shall be required for all forest treatments that affect the present and/or long term character of a forest stand. Project level silvicultural decision-making should include the process of silvicultural examination, diagnosis of treatment, silvicultural prescriptions, and monitoring.

9.5 Silvicultural Examinations. The silvicultural examination is the process for obtaining data needed to identify existing conditions for stand diagnosis and prescription development. Various methods exist for gathering such data, ranging from informal surveys to formal Stand Exams (refer to 53 IAM 8.5.E.). The particular method used and the amount of information collected will vary with the complexity of the resource and detail needed to adequately prescribe treatment.

9.6 Silivicultural Prescription. A silvicultural prescription is usually stand specific but can encompass several stands, a cover type or forest type, where the desired treatment result is the same.

A. Diagnosis of Treatment Needs. Stand diagnosis follows silvicultural examination. Diagnosis includes collecting, recording, compiling, summarizing, and analyzing of Stand Exam data. The results of this diagnosis along with the data used shall be documented in the Silvicultural Prescription document.

B. Silvicultural Prescription Document. The prescription proposes a specific treatment that will meet management and resource objectives within existing constraints and desired time frames. The prescription document shall use standard terminology and definitions (See *The Dictionary of Forestry*, Society of American Foresters, September 1998). In order to reduce paperwork, a Forest Officer's Report or other project reports can also serve as the Silvicultural Prescription document, as long as the following minimum content is met:

General: Reservation/Property Preparer's name Date of preparation Method of field exam Stand designation number Silvicultural system to be applied. Cutting method/treatment this entry.
Stand Description
Special management constraints
Land owner desires as described in IRMP/FMP and other specific sources
Stand needs and treatment objectives
Spatial data such as a map or GIS theme
Description of prescribed treatment
Implementation Guide.
Monitoring needs
Appendix of supporting material
Signature page

9.7 Monitoring and Evaluation of Silivicultural Treatments. Appropriate monitoring plans will be included in the prescription to evaluate the results of the prescription and all silvicultural treatments that have been implemented. Monitoring may indicate the need for additional management action(s) to satisfy the objectives of the prescription.

9.8 Document Retention.

A. Short Term. The prescription with all supporting information should be retained throughout the duration of the project.

B. Long Term. The prescription and monitoring/evaluation results shall be retained indefinitely.

9.9 Responsibilities. In addition to the responsibilities identified in 53 IAM 1.7, the following are directly associated with silviculture.

A. Director, Bureau of Indian Affairs.

(1) Develop national silvicultural policies.

INDIAN AFFAIRS MANUAL

Part 53 Forestry
Chapter 9 Silviculture Page 3

(2) Provide assistance in the implementation of Regional silvicultural program direction, oversight and guidance.

B. Regional Director.

(1) Develop regional policies, standards and silvicultural guidelines for program implementation.

(2) Assure silvicultural standards and policies are met.

(3) Provide assistance in the implementation of Reservation silvicultural program direction, oversight and guidance.

C. Agency Superintendent.

(1) Plan and budget for silvicultural program needs.

(2) Prepares, organizes, and conducts silvicultural activities.

(3) Assure silvicultural quality control.

(4) Maintain silvicultural data and document archive for all Indian forest lands.

Exhibit 2

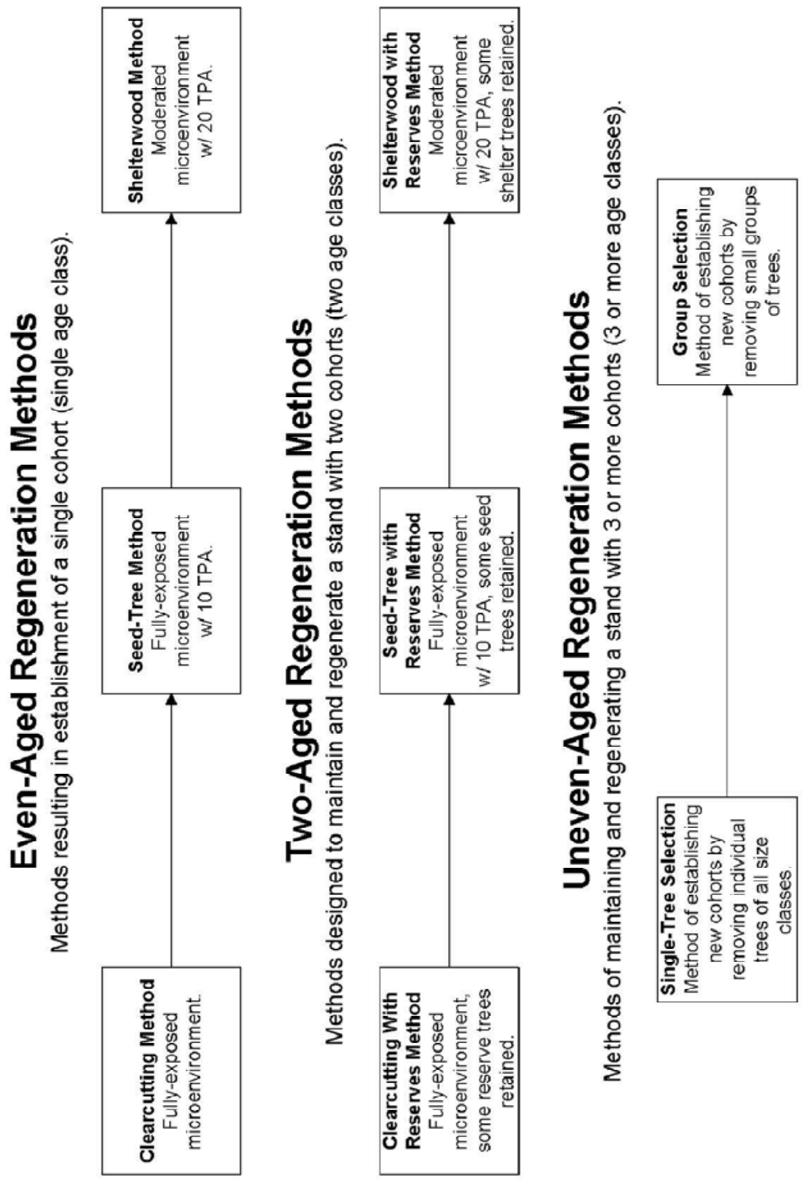
Silvicultural Practices, Vegetative Management Activity And Stand Structure

Regeneration Methods

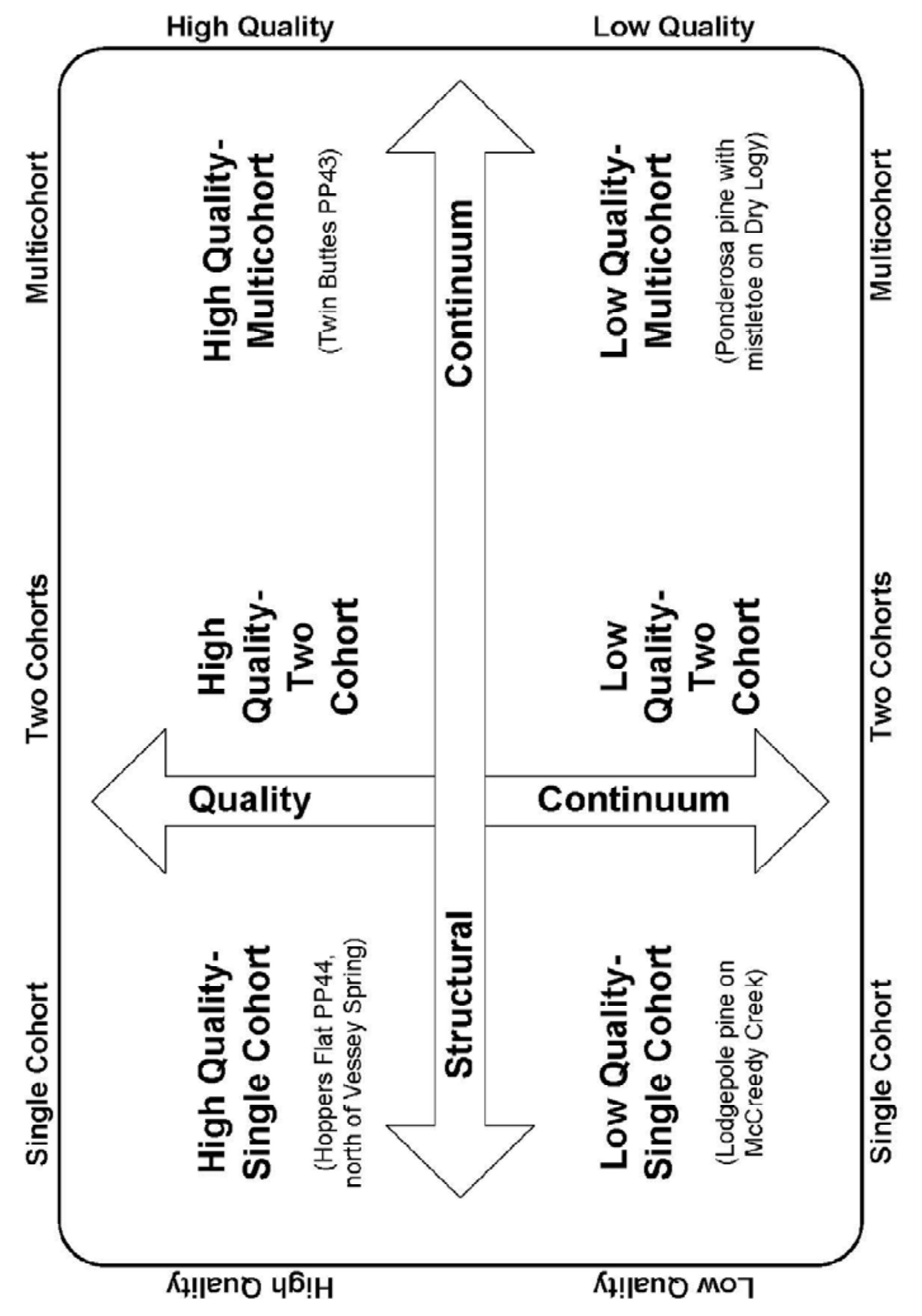
Desired Future Condition and Prescribed Treatments

Regeneration Methods and Intermediate Treatments. See glossary and/or chapter 3 for full description.

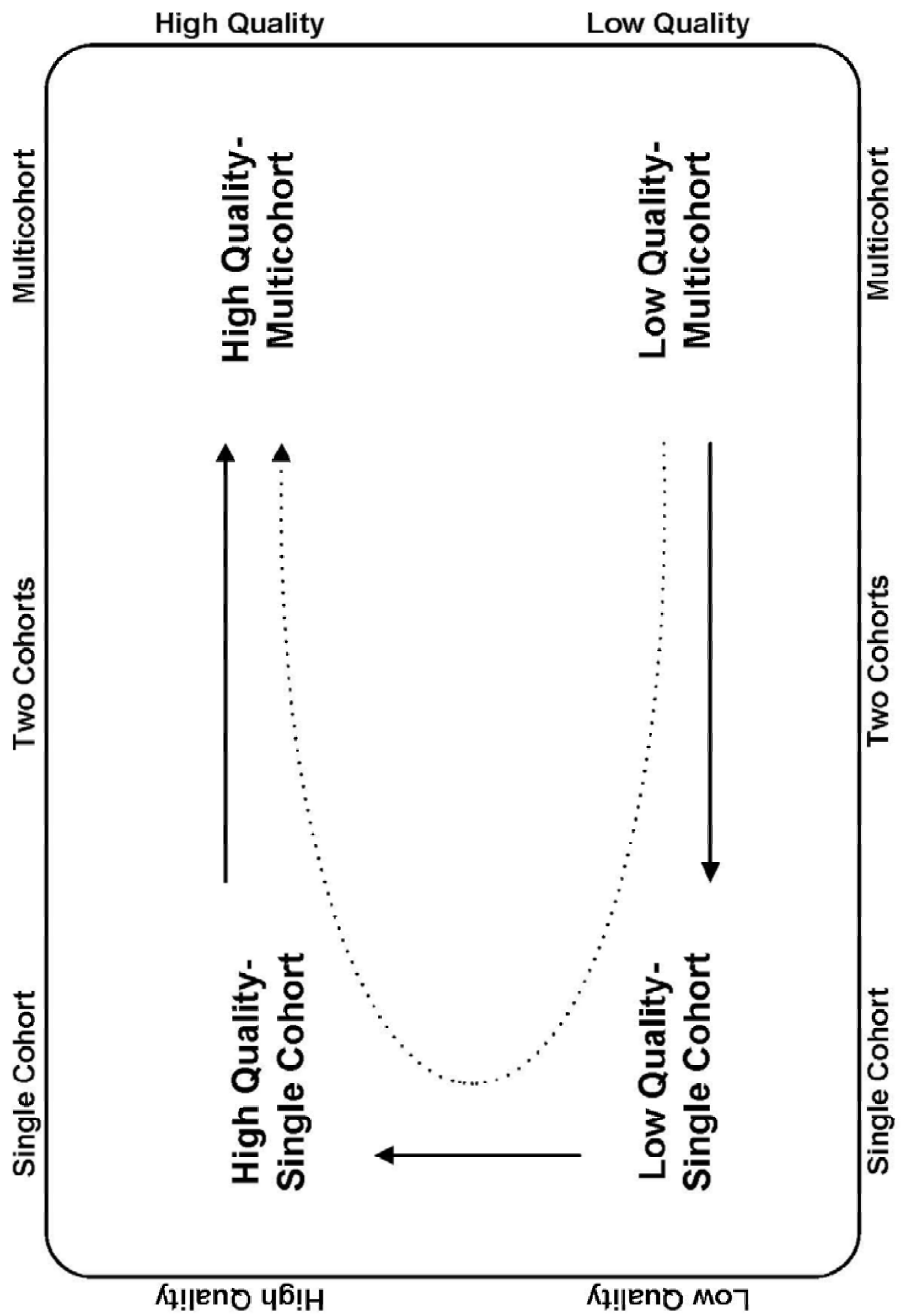
STAND STRUCTURE	**EVEN-AGED, SINGLE-STORIED STAND** One age class comprises at least 90% of total stand BA for most of the rotation. Age difference between oldest and youngest tree in a class is less than 20% of the rotation.				**TWO-AGED, TWO-STORIED STAND** Two age classes, each contributing >10% of BA for most of the rotation.	**UNEVEN-AGED MUTI-STORIED STAND** Three or more age classes with each age class contributing >10% of BA.		**ONE-, TWO-, OR MULTI-STORIED STAND**
Regeneration Method or Tending Treatment (last column)	**Coppice** Vegetative regeneration is from stump sprouts or root	**Clearcutting** No trees provide shelther	**Seed Tree** Small number of dispersed trees provide seed	**Shelterwood (SW)** Sufficient number of trees remain to provide shade	**With Reserves** Trees in upper story provide continuous cover	**Single Tree Selection** Continuous tree cover in stand	**Group Selection** Max width size typically <=2 times height of mature tree	**Intermediate Treatment** Stand enhancing: occurs after establishment and prior to final harvest
VEGETATIVE **MANAGEMENT** **ACTIVITY**	Coppice Cut Coppice w/Reserves	<= 5% tree cover post harvest: Patch Clearcut Strip Clearcut Stand Clearcut - - - - - - - - - - 6-10% tree cover post harvest: Patch Clearcut w/Reserves Strip Clearcut w/Reserves Stand Clearcut w/Reserves	Seed Tree Cut with removal (seed trees removed after regeneration) - - - - - - - - - - Removal Cut w/Reserves (some or all of seed trees are retained after regeneration)	1. Optional Preparatory Cut 2. Establishment Cut 3. Removal Cut - - OR - - 2. Group SW Establishment Cut 3. Group SW Removal Cut - - OR - - 2. Strip SW Establishment Cut 3. Strip SW Removal Cut - - OR for any - - 3. Removal Cut w/Reserves	Coppice w/Reserves Clearcut w/Reserves Seed Tree w/Reserves Seed Tree Cut Removal Cut Shelterwood w/Reserves Preparatory Cut Establishment Cut Removal Cut	Single Tree Selection Coppice Selection	Group Selection Group Selection w/Reserves	Improvement Cut Release Cleaning Liberation Weeding Salvage Cut Sanitation Cut Thinning Commercial & Noncommercial



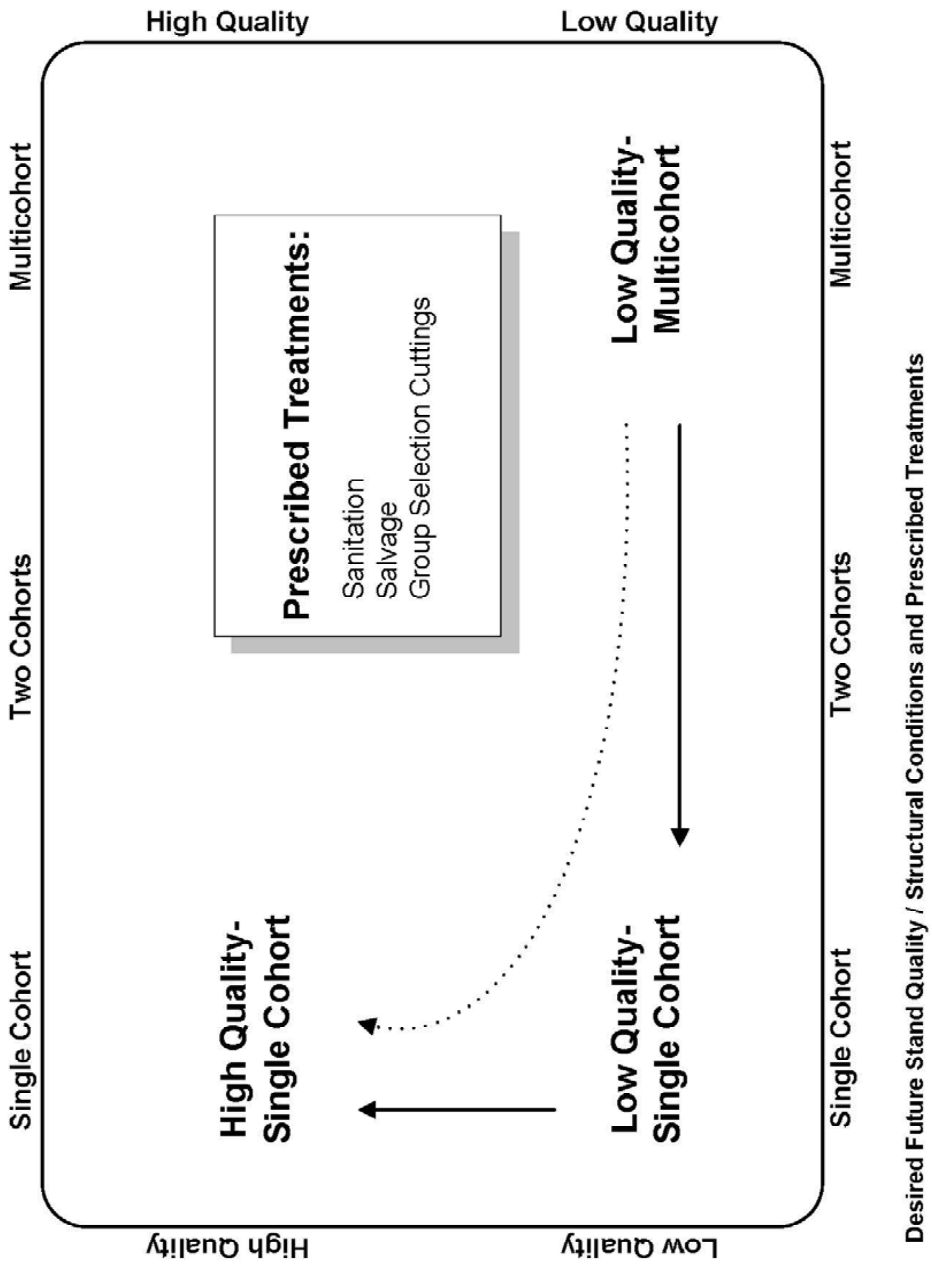
Regeneration Methods

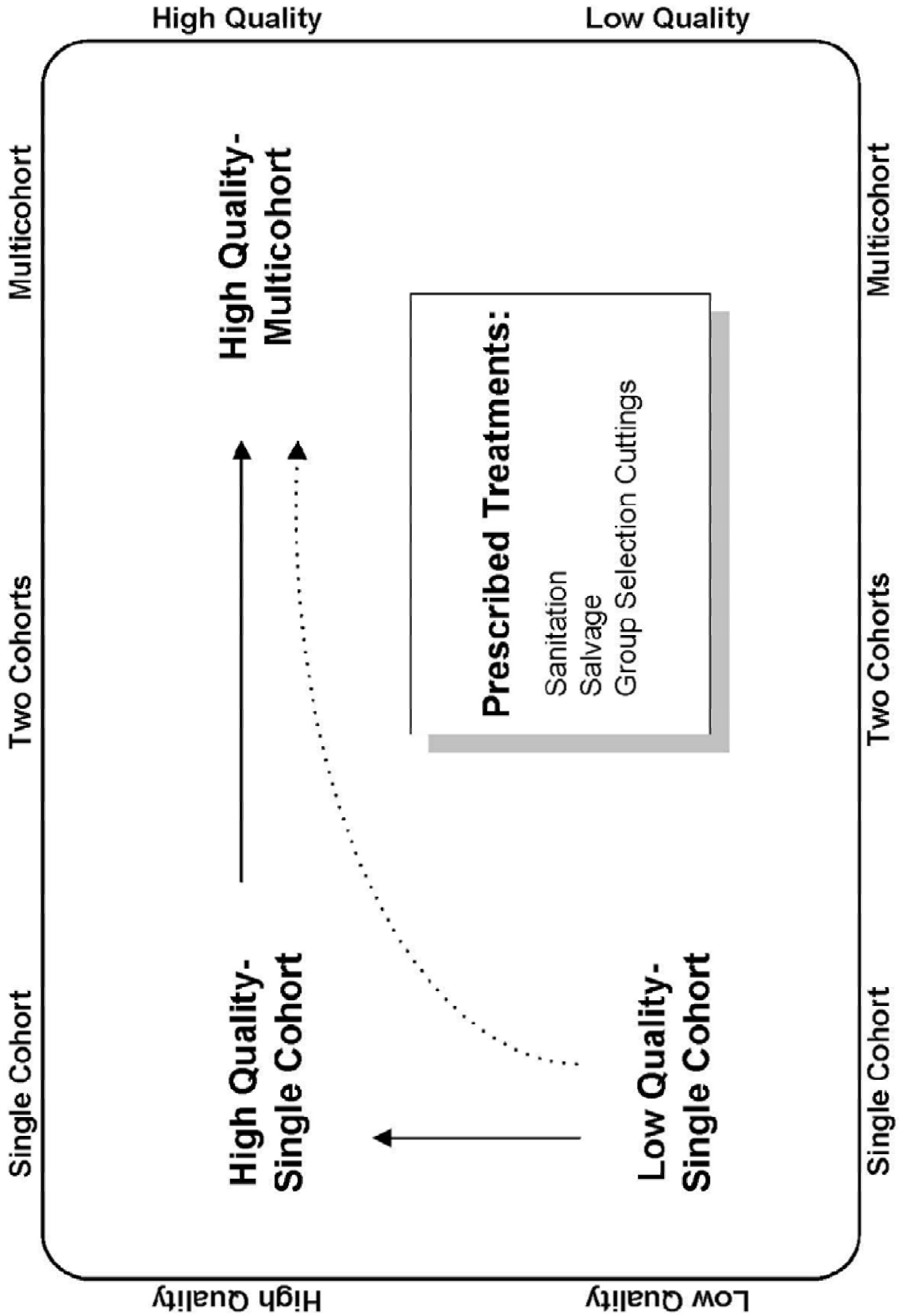


Stand Quality / Structural Matrix



Desired Future Stand Quality / Structural Conditions and Prescribed Treatments


High Quality
Low Quality
Multicohort
Two Cohorts
Single Cohort
Prescribed Treatments:
Sanitation
Salvage
Group Selection Cuttings
Low Quality-Multicohort
High Quality-Single Cohort
Low Quality-Single Cohort
Multicohort
Two Cohorts
Single Cohort
High Quality
Low Quality
Desired Future Stand Quality / Structural Conditions and Prescribed Treatments



Desired Future Stand Quality / Structural Conditions and Prescribed Treatments

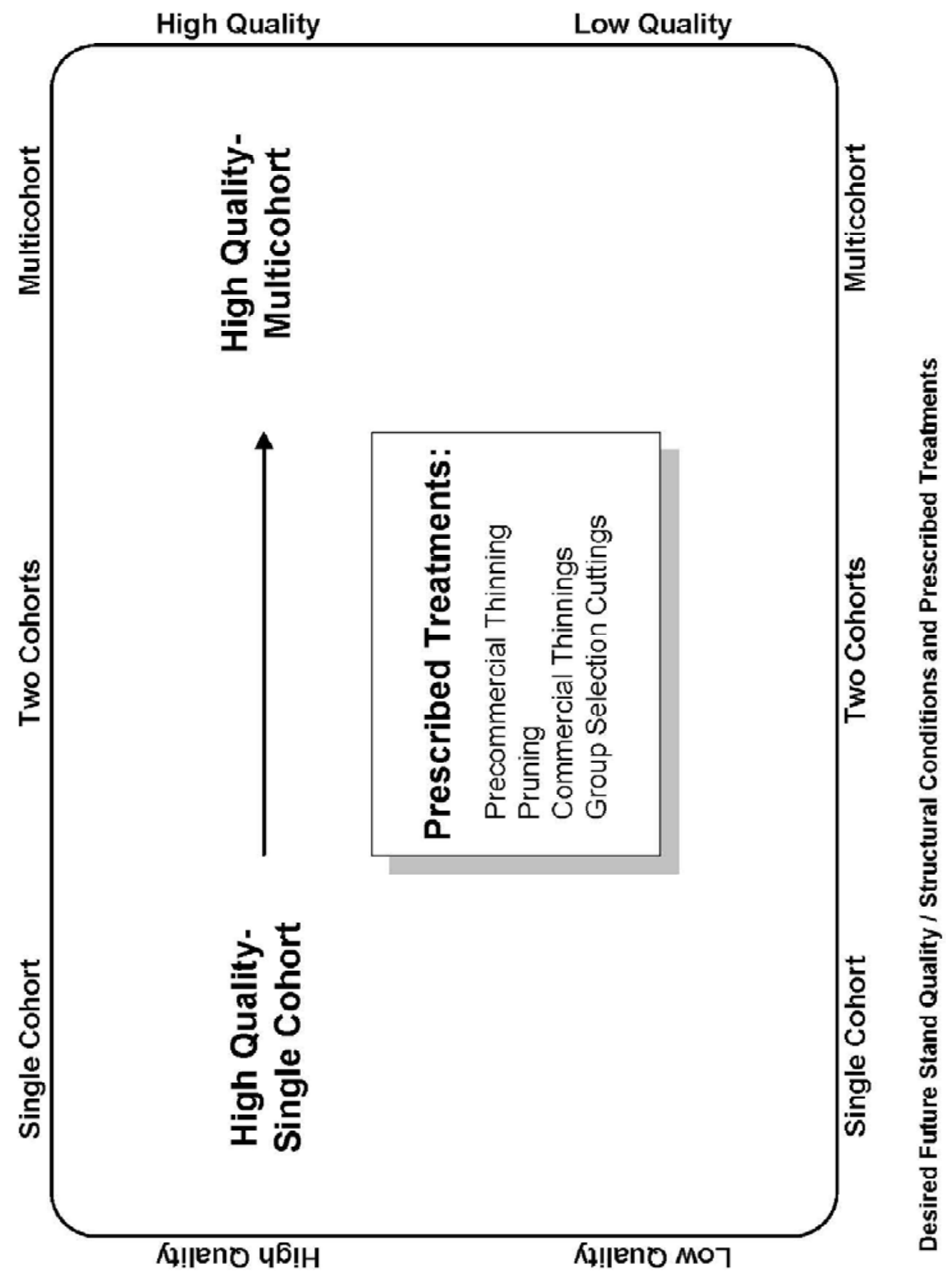

High Quality
Low Quality
Multicohort
Two Cohorts
Single Cohort
High Quality-
Multicohort
High Quality-
Single Cohort
Prescribed Treatments:
Precommercial Thinning
Pruning
Commercial Thinnings
Group Selection Cuttings
Multicohort
Two Cohorts
Single Cohort
High Quality
Low Quality
Desired Future Stand Quality / Structural Conditions and Prescribed Treatments

Exhibit 3

Walk thru Stand Exam Form

This form will be available on the BIA sharepoint for your use and adaptation.

SILVICULTURAL PRESCRIPTION
WALK-THROUGH SURVEY

Project Name: ________________________________ By: ____________________________

Stand Number: ________________________________ Date: ___________________________

Plant Association (Habitat Type): __________________________________

Stand Conditions:

Even / Uneven-aged: _________ Estimated Volume: _______________

Estimated Stocking Level: _________________________

Last Entry Date: _______________ Treatment: _____________________

Species:	______	______	______	______
%Composition:	______	______	______	______
Avg. Tot. Age:	______	______	______	______
Avg. DBH:	______	______	______	______
Rad. Inc. (20ths):	______	______	______	______
Damaging Agts:	______	______	______	______
and Severity:	______	______	______	______
General Vigor:	______	______	______	______

Resource Comments/Objectives

Wildlife/ Fish: ____

Site Problems: ____

Water: ____

Soil: ____

Accessibility: ____

Other: ____

Silvicultural Recommendations

Desired Future Condition / Treatment Objectives:

Treatment Alternatives:

Treatment Recommendation:

Preliminary Marking Guidelines:

Harvest Requirements:

Slash Disposal / Site Preparation:

Planting Recommendations:

Future Treatment Recommendations:

Miscellaneous Comments:

Exhibit 4

Prescription Form

The following “form” incorporates the minimum content of a Prescription as described in 53 IAM 9, Silviculture. This will be available on BIA sharepoint for your use and modification.

SILVICULTURAL PRESCRIPTION

Reservation
Sale Name

Prepared by: ____________________________ Date: ____________________

Approved by: ___________________________ Date: ____________________
Designated Silviculturist

- Stand Identification: *Location of the Stand / group of stands. Stand number or Sale block #.*
- Exam Type: *Method of Field Exam* / *Silvicultural Rx Survey: stand exam or walk through.*
- Silvicultural system to be applied: *Uneven-aged, even-aged, two-aged*
- Cutting method/treatment this entry: *Shelterwood, selection method, etc.*

Site Description: *Include site information such as % slope, aspect, elevation, habitat type, and number of acres.*

Site Data:

Acres: _______ Slope: _______ Aspect: _______ Elevation: _______

Plant Association: __________________________

Stand Description: *Describe the existing condition including stand structure (even-aged, uneven-aged, multi-storied); species composition; average age if even-aged or ages of both cohorts if two-aged; average DBH, stocking level (Basal area, volume, trees/acre, SDI); growth (Recorded in 1/20ths inch)*

Stand Description/Data:

Stand Structure: __________________________________

Species Composition: *Species (%)*

Average Age: _______ Average DBH: _______

Stocking Levels/Density: *Basal area, volume, trees/acre, SDI*

Growth: *Recorded in 1/20ths inch*

Special Management Constraints: *Tie to Forest Management Plan, indicate land management or management emphasis zone such as timber, wildlife, riparian. Describe any management constraints.*

<u>Diagnosis</u>: Discussion. What are the relevant stand attributes and dynamics, past history of the stand and surrounding area?

- Species composition/stocking
- Stand structure: density, quality and species by age grouping
- Insect and disease agents at work
- Past disturbances: Logging, thinning, fire (type), blowdown, etc.
- Understory shrub species

<u>Desired Condition (DC)</u>:

- Based on guidelines set by approved FMP and/or IRMP.
- Important to understand that current and historical disturbance patterns influenced stand development.
- Describe the desired condition in brief, measurable statements, including time period for completion.
- Primary attributes for target stand: Species composition, density, structure.
- Optional resource needs: Thermal cover, down woody material (fuels reduction), riparian habitat.
- Develop the pathway for the treatments to follow over the life of the stand.

<u>Prognosis and Alternative Development</u>:

- First: What is the management and silvicultural system? Even-aged, Two-aged (even-aged w/ reserves), uneven-aged, temporary even-aged?
- Predict: Can the existing stand be manipulated toward the target stand? Compare the existing condition to the DFC and describe the need or how the DFC will benefit resources at the stand and landscape level. What treatment alternatives, if any, are consistent with good biology and policy?
- Prescribe: What are consequences of the selected treatments and what will the stand look like in 20 – 40 years? Include tree species regeneration.
- Take into account insects and diseases

<u>Selected Silvicultural Prescription</u>:

- Describe the specific treatment, including intermediate treatments, if any, in chronological order.
- Density range and stand average for reserve stand.
- Structural considerations in UEA stands - assure all age-size classes are left.
- Harvest: Logging method, limitations, and site protection issues.
- Utilization standards.
- Slash disposal, need for fuels reduction.
- Site prep and % scarification.
- Reforestation needs: Tree species, density, micro-site info, planting/seeding suggestions
- Special considerations: snag retention, DWD
- Intermediate Treatments: Follow-up thinning
- Next planned harvest

<u>Other Alternative Treatments Considered</u>: *These are other viable options that were available.*

- No Treatment - Describe the impact of no treatment.

- Other Treatments – These are options for harvest other than the treatment selected.

<u>Comments</u>: *Additional considerations or mitigation for:*

- Threatened or Endangered Species
- Fences, Section corners
- Wildlife
- Water Quality
- Cultural Resources
- Soils, wet areas
- Decking / hauling
- Existing skid trails - utilize or not

<u>Monitoring Needs</u>:

Exhibit 5

Marking Guides

SALE NAME
Treatment and Block
MARKING GUIDELINES

Mark ________________ trees in ____________ paint
Leave/cut *color*

Objective:

Briefly state the objective for the treatment.

Spacing:

Describe the leave density in:

- Square feet of basal area per acre
- Spacing in feet between trees
- Trees per acre

Species (in order of preference):

List the tree species in order of preference.

Leave Tree Characteristics:

Describe the characteristics of the leave trees:

- Crown ratio
- Needle retention
- Disease free
- Cone production
- Tree form
- Superior genetics

Comments: *Example:*

Species Preference: (PP > SP > DF) > > (WF > WP)

Preferred species and desirable leave tree characteristics have priority over meeting spacing guidelines.

Leave at least two large snags (20+) per acre and two cull trees/acre for wildlife.

Note: Marking Guidelines for Uneven-aged Silvicultural Prescriptions may have more detail and cover more variable conditions.

Uneven-aged Prescription

Marking Guides

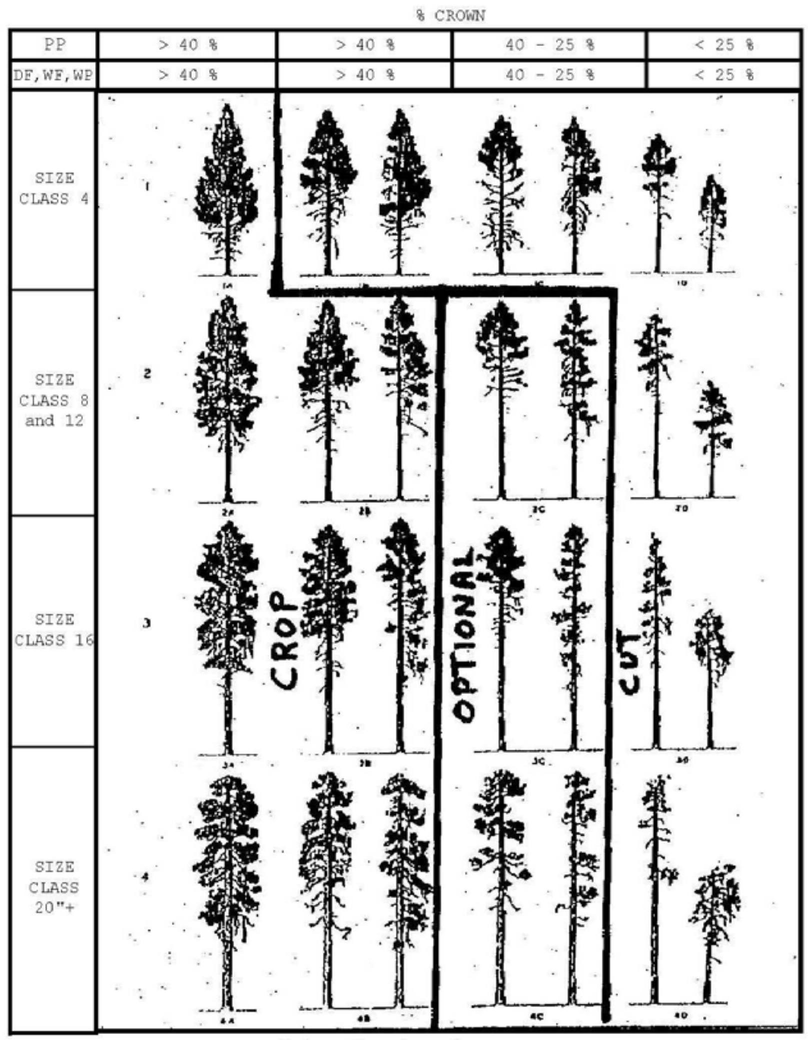
Uneven-aged Prescription
Supplement Marking Guidelines

STAND/MANAGEMENT STRATUM DESCRIPTION: SALE NAME,
ZONE, SPECIES, SITE, HARVEST METHOD, HABITAT TYPE,
ETC. SAMPLE ONLY

% CROWN SELECTION CRITERIA				
SIZE CLASS	SPECIES	CROP	OPT.	CUT
4	PP	>50	------	<50
	DF,WF,WP			
8	PP	50	32-40	<35
	DF,WF,WP			
12	PP	50	32-40	<35
	DF,WF,WP			
16	PP	40	25-40	<25
	DF,WF,WP			
20"+	PP	40	25-40	<25
	DF,WF,WP			
TOTALS				

SPECIES: PP "q" = 1.2	BASAL AREA/ACRE					
SIZE CLASS	PRE-TEATMENT		TARGET		POST-TREATMENT	
	TPA	BA	TPA	BA	TPA	BA
4	130	11.3	21.7	1.9	21	1.8
8	75	26.2	17.5	6.1	16	5.6
12	35	27.5	14.1	11.1	14	11.0
16	18	25.1	11.4	15.9	12	16.8
20	12	26.2	9.2	20.1	10	21.8
24+	5	15.7				
Total	275	132.0	73.9	55.1	73	57.0

OTHER CROP TREE STANDARDS: CROP TREES MUST BE FREE OF INSECT, DISEASE, OR ANY SEVERE DEFECTS. ONLY PP WILL BE MARKED TO CUT.



Note: Example only.

PRESCRIPTION/RECONNAISSANCE FORM

PREPARER:	JON SMITH
TIMBER SALE:	SALE #1
STAND/MANAGEMENT STRATUM DESCRIPTIO	BA=55 MAX DIA=20" Q=1.2 (4" SIZE CLASS)

AGE/SIZE CLASS	CROP TREES DOT COUNT	OPTIONAL TREES DOT COUNT	NON-CROP TREES DOT COUNT	TARGET STAND TPA	TARGET STAND BA	ACTUAL TPA
2 TO 6				22	1.9	
TOTALS:	BA/AC: TPA:	BA/AC: TPA:	BA/AC: TPA:			
6 TO 10				18	6.1	
TOTALS:	BA/AC: TPA:	BA/AC: TPA:	BA/AC: TPA:			
10 TO 14				14	11.1	
TOTALS:	BA/AC: TPA:	BA/AC: TPA:	BA/AC: TPA:			
14 to 18				11	15.9	
TOTALS:	BA/AC: TPA:	BA/AC: TPA:	BA/AC: TPA:			
18 to 22				9	20	
22+						
TOTALS:	BA/AC: TPA:	BA/AC: TPA:	BA/AC: TPA:	74		

LIVE CROWN RATIO CROP STANDARDS			
	PP > 50% 0-8"	PP > 40% 8-28"	PP <
	DF >	DF >	DF <
	WP >	WP >	WP <
	WF >	WF >	WF <

Q FACTOR: 1.2
ASPECT RANGE:
HABITAT TYPE: PIPO/FEAR 2

BAF	FIXED PLOT	NUMBER OF PLOTS	BEARINGS AND DISTANCES TO PLOT

OTHER CROP TREE CRITERIA: PP

*MAX DIAMETER = 20"

*INSECT AND DISEASE FREE

*NO FORKS, CROOK, SWEEP, DEAD TOPS

STAND DIAGNOSIS:

Markers Tally Aid – Uneven-aged Rx
Each row should fill up at the same time. This example for “q” = 1.44

MARKING TALLY FORM - RESIDUAL TREES / CROP & OPTIONAL

Q FACTOR = __1.44__ TARGET BA = ______ STAND ID:_________ Acres:_________

SIZE CLASS																									
____" DBH																									
TARGET																									
TPA:_____																									
LIVE CROWN:																									

SIZE CLASS																	
____" DBH																	
TARGET																	
BA:_____																	
TARGET																	
TPA:_____																	
LIVE CROWN:																	

SIZE CLASS												
____" DBH												
TARGET												
BA:_____												
TARGET												
TPA:_____												
LIVE CROWN:												

SIZE CLASS								
____" DBH								
TARGET								
BA:_____								
TARGET								
TPA:_____								
LIVE CROWN:								

Markers Tally Aid – Uneven-aged Rx cont.

Each row should fill up at about the same time. This example for “q” = 1.44

SIZE CLASS						
____" DBH						
TARGET						
BA:______						
TARGET						
TPA:______						
LIVE CROWN:						

SIZE CLASS				
____" DBH				
TARGET				
BA:______				
TARGET				
TPA:______				
LIVE CROWN:				

SIZE CLASS			
____" DBH			
TARGET			
BA:______			
TARGET			
TPA:______			
LIVE CROWN:			

ADDITIONAL MARKING GUIDELINES:

1
2
3
4
5
6
7
8
9
10

DISCLAIMER: THIS CHART USES A Q FACTOR OF 1.44, NUMBER OF BOXES PER SIZE CLASS WILL VARY WITH OTHER Q FACTORS

Exhibit 6

Prescription Example

BUREAU OF INDIAN AFFAIRS
SOUTHWEST REGION

SILVICULTURAL STAND PRESCRIPTION

Reservation/Logging Unit	Stand Number
Mescalero / Elk-Silver Logging Unit	Stratum
Silvicultural System	**Treatment this Entry**
Uneven-Aged	Unbalanced Single Tree Selection

I. Description of the Present Stand Condition

This stratum covers a total of 6,038 acres and is comprised of many disbursed stands. Aspects are variable but most stands have a north or northeast aspect. Slope ranges from slight to steep with the majority being 10 to 25 %. Stands are generally positioned from the toe of the slope to the upper slope with a few stands extending onto the ridge top. The predominant elevation range is between 7,800 and 8,300 feet. The most common plant associations are White fir / Maple (Rocky Mountain Maple or Bigtooth Maple) and White fir /Gambel oak and. Site quality is high with an average site index of 95 for Douglas-fir. Soils tend to be moderate to deep. Soil types vary greatly but generally are derived from limestone and are considered moderately productive for commercial timber.

This stratum is comprised of dense, healthy, high volume mixed conifer stands. Douglas-fir, white fir, ponderosa pine and southwestern white pine are all well represented. All size classes are well represented, although crop quality trees in the younger age classes are under represented. Therefore, these are unbalanced, unevenaged stands. Stand density is the main concern. There are 669 trees per acre, basal area is 122 sq. ft. / acre, and the stratum is at 50% of maximum Stand Density Index. Individual tree growth is shutting down especially in the smaller size classes, and some density related mortality is occurring.

Bark beetles are actively killing trees in all commercial species, especially in the steadily declining component of ponderosa pine. White pine blister rust is actively affecting growth and is killing small and large diameter southwestern white pine in this cool, moist stratum. Growth loss and mortality (especially in the small southwestern white pines) due to the blister rust will become more severe in the next decade. Spruce budworm is present but has not been a significant problem yet. However, given the present stand condition the budworm population could explode to epidemic proportions in just a few years. Root diseases are present but have not been a significant problem. Dwarf mistletoe is present in Douglas-fir and ponderosa pine but infection is light. Douglas-fir visible dwarf mistletoe infection rates average 3% on a trees per acre basis, and a 0.2 (out of a 6.0 Hawksworth Scale) Dwarf Mistletoe Rating. Ponderosa pine visible dwarf mistletoe infection rates average 6% on a trees per acre basis, and a 0.8 (out of a 6.0 Hawksworth Scale) Dwarf Mistletoe Rating. Quadratic mean diameter is 5.8 inches and 90% of the stocking (TPA) is represented in trees less than 10.7 inches dbh.

All stands within this stratum are considered important for wildlife species. Due to the structural diversity, many different wildlife species make use of the stands within this stratum for various activities. The main cultural concerns for this stratum are the desire to retain teepee pole stands and to retain several large trees per acre in as many separate locations as possible.

II. Stand Treatment Objectives

1. Improve forest health by reducing stratum density to 40-60 sq. ft of basal per acre through commercial harvest and Timber Stand Improvement (TSI) treatment within ten years.

2. Begin steering the stratum closer to a regulated uneven-aged condition.

3. Establish at least 33well-spaced, crop tree-quality seedlings per acre over a 20-year cutting cycle.

4. Increase radial growth increment to at least one inch per decade over a 20 year cutting cycle.

5. Retain at least two trees per acre > 20-inch dbh for large tree retention objectives.

III. Detailed Prescription

A. Description of Prescribed Treatment

Single tree selection is an uneven-aged cutting method whereby regulation of yield is based on volume rather than area (even-aged management). Stands will be selectively harvested such that individual crop trees of different size classes will be left based on a designated q-slope, maximum tree size, residual stocking level (usually measured in terms of basal area), cutting cycle length, and age class width. Due to the disparity in the current stand conditions and the target regulated condition, a designated q-slope will not be used to determine the number of crop trees to be retained in each different age/size class. Stands will be selectively harvested to maintain and promote age/size class diversity, remove high risk, poor vigor and/or mistletoe infected stems. Stocking will be improved to maximize growth and species composition.

The target residual growing stock level is 40-60 square feet of basal area per acre. This level should allow for the rapid growth of diameter increment on the existing commercial sized stems in the 8-12 inch size class, more moderate growth on the 16+ inch size class and retention of health and vigor on the scattered mature and over mature trees. In addition, ample growing space should be available to allow the continued growth of the seedling/sapling component. In most stands the release of the seedling component that is currently below knee high will serve to fill the need for establishment of a new cohort during this cutting cycle. Release of this component will occur after follow up TSI is completed. Based on current site conditions, it is anticipated that another new cohort will become established later during the current 20 year cutting cycle. Within and immediately adjacent to aspen patches, all commercial species except ponderosa pine, both crop and non crop quality will be cut with the objective of providing more available growing space for the aspen.

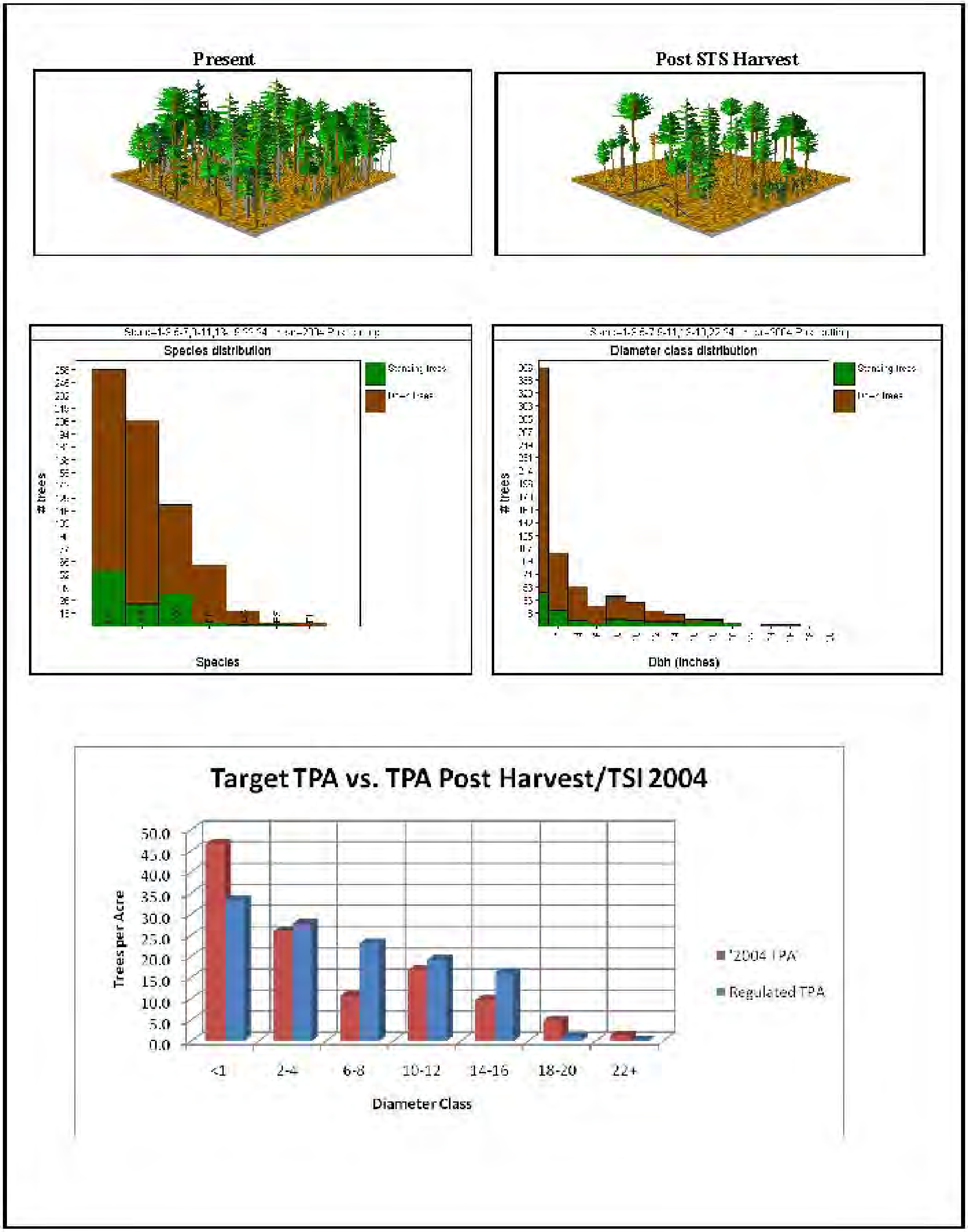
Forest health and fuel reduction treatment funding will be pursued for thinning the smaller diameter size classes. Prescribed burning is not specifically called for in this prescription but could be used on a stand specific basis if fuel loading conditions were light enough to minimize fire related mortality in the smaller size classes. The likelihood of using prescribed fire at the stratum level will increase in the future as the stands become closer to a regulated condition and slash loading is decreased.

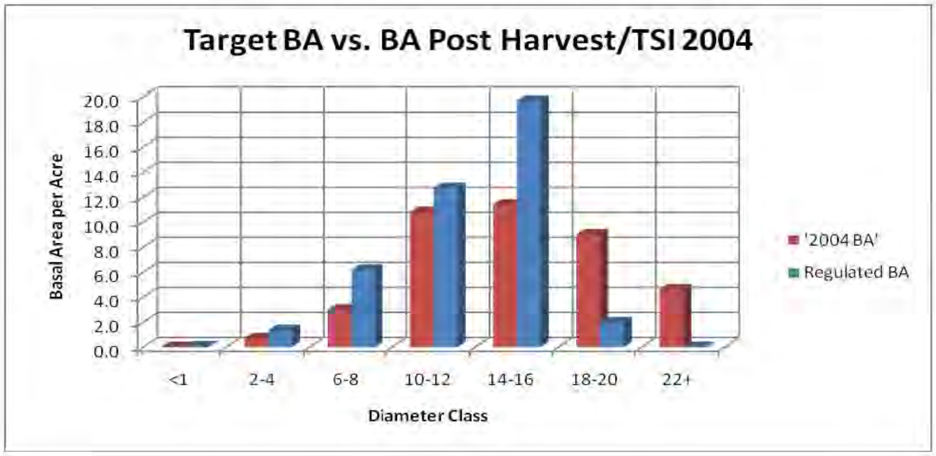
The desired future stand will have fast growing, healthy trees well represented in all age/size classes. It maintains forest health, perpetuates horizontal, vertical, and species diversity, promotes ponderosa pine, and provides a continuous supply of sawlogs every 20-25 years.

Current Stocking Commercial Species			
Dia. Class	TPA	BA	FVS D-class
0-0.9	356.0	0.1	<1
1-4.9	133.7	4.7	2-4
5-8.9	65.9	18.6	6-8
9-12.9	52.8	33.2	10-12
13-16.9	25.1	29.0	14-16
17-20.9	11.5	21.8	18-20
21+	4.1	12.8	22+
Total	649.1	120.2	

Target-Post-Harvest (Regulated)		
Dia. Class	TPA C. Sp.	BA C. Sp.
0-0.9	33.29	0.05
1-4.9	27.74	1.36
5-8.9	23.12	6.18
9-12.9	19.27	12.71
13-16.9	16.05	19.70
17-20.9	1.00	1.97
21+	0.00	0.00
Total	120.47	41.97

Actual Post-Harvest 2004		
Dia. Class	TPA C. Sp.	BA C. Sp.
0-0.9	46.6	0.0
1-4.9	25.9	0.7
5-8.9	10.7	3.0
9-12.9	16.7	10.8
13-16.9	9.7	11.4
17-20.9	4.8	9.0
21+	1.3	4.6
Total	115.70	39.50


Present
Post STS Harvest
Species distribution
Standing trees
trees
Species
Diameter class distribution
Standing trees
trees
Dbh (inches)
Target TPA vs. TPA Post Harvest/TSI 2004
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Trees per Acre
<1
2-4
6-8
10-12
14-16
18-20
22+
Diameter Class
'2004 TPA'
Regulated TPA



B. Harvesting Method and Restrictions

"Whole tree" harvesting of machine-felled timber is the preferred harvesting technique. This harvest technique will significantly reduce the amount of slash and fuel loading compared to conventional techniques and the skidding of the trees that are stacked in "bundles" will result in reduced damage to the residual stand. With the stated goal of retaining a component of crop tree quality trees in the smaller size classes, reducing damage to the residual stand is very important. All timber will be felled to the lead to reduce damage to the residual stand. Both rubber-tired and tractor skidders are permissible. Water bars will be required as needed on skid trails to prevent soil erosion. All landings and portion of the main skid trails will be seeded with a mixture of the native and non-native grasses. Noxious plants on landings and road shoulders will be treated with herbicide. Some new road construction will be required to log this stratum. Grade dips will be constructed, and all roads will be out sloped prior to sale closeout.

C. Reforestation/Timber Stand Improvement

No reforestation needs are anticipated for this stand. The objectives for the TSI follow-up are to remove all residual mistletoe infected PP and DF and to thin the healthy seedling/sapling/pole PP, DF and WP components. This thinning is designed to reduce stocking levels enough to significantly increase growth rates across all diameter classes and create enough available growing space to establish a new cohort. Stocking levels of crop tree quality regeneration in this stand were so variable that no attempt to balance distributions within these age/size classes was attempted for this entry. Stand level tracking of commercial and precommercial treatments is contained in the TSI database.

D. Slash Treatment

All slash generated from harvesting and thinning will be lopped to a height of 24 inches above ground within 150 feet of roads, and to a height of 36 inches elsewhere. This will help mitigate concerns about aesthetic quality and wildlife/ livestock movement.

E. Site Preparation

None

F. Schedule of Treatments

2006 - Unbalanced Single Tree Selection Harvest.
2008 - Post harvest timber stand improvement treatment in the precommercial size classes to reduce the total stocking level to 40 – 60 sqft. of basal area per acre.
2026 - Single Tree Selection Harvest.
2028 - Timber stand improvement treatment.
2035 - Prescribed burning if conditions and funding allow.

IV. Implementation Guide

Cutting Method/Treatment	**Marking Method**
Uneven-aged Regeneration Treatment- Single Tree Selection	Leave Tree for all species.
Marking Paint Color Green Leave Tree.	

The single tree selection cutting method will be implemented using a green paint leave-tree mark. Mark trees waist high and taller to an average spacing of 20 to 25 feet and a basal area of 40 to 60 sqft per acre.

Leave trees will generally be the biggest and the best-looking trees in each size class and must meet the following crop tree specifications: insect and disease free; good form and vigor; and have a live crown ratio greater than 25% for ponderosa pine and > 40% for all other species.

Species preference is ponderosa pine>>southwestern white pine>Douglas-fir>white fir. It is OK to leave lightly or non-visibly infected, crop quality southwestern white pine.

Use the 30-foot mistletoe rule for ponderosa pine and the 50-foot mistletoe rule for Douglas-fir. Do not worry if this results in places that have less than the target residual basal area.

Spacing width around leave tree overstory ponderosa pine should be 25-30 feet. Do not leave mark any trees within an aspen grove except ponderosa pine. Try to leave a component of crop tree quality trees in each size class from waist high to the largest trees in the stand. The stocking target for trees less than 9 inches dbh is 60-70 tpa with an emphasis on 3 to 8 inch dbh trees. All leave trees must meet crop tree standards.

Markers will periodically check the average residual basal area per acre by using prism sweeps at various locations throughout the stand. For all marking areas, it is important to have your maps at all times. Marking boundaries will be shown on the map but unit boundaries may not be flagged on the ground. The Timber Sale Officer or Layout Forester will advise the marking crew if boundaries are flagged or not. If boundaries are flagged, they will be in orange ribbon. Markers will watch out for any tepee pole areas, cultural sites, springs, wildlife trees calving and fawning areas etc. Red flagging will be carried to flag these sensitive areas for avoidance; also inform the Timber Sale Officer or Layout Forester about the location and reason these areas are to be avoided. Trees that are retained due to wildlife value should be marked with a green "W" on the bole and a stump mark. Use orange paint to cancel out all marking mistakes.

V. Monitoring Plan

Objectives as stated in the Rx:

Improve forest health by reducing stratum density to 40-60 sq. ft of basal per acre through commercial harvest and Timber Stand Improvement (TSI) treatment within ten years.

Begin steering the stratum closer to a regulated uneven-aged condition.

Establish at least 33well-spaced, crop tree-quality seedlings per acre over a 20-year cutting cycle.

Increase radial growth increment to at least one inch per decade over a 20 year cutting cycle.

Retain at least two trees per acre > 20-inch dbh for large tree retention objectives.

Implementation Monitoring:

As stated above, markers will periodically check themselves. A second set of eyes will check each marker and the timber sale as a whole to determine the average residual basal area per acre as well as adherence to crop tree quality specifications. Plot locations shall be well distributed, representative and unbiased.

Timber sale officer will inspect harvesting and report to the silviculture files acceptance of logging practices.

Post-treatment stocking surveys of the seedling, sapling and pole-sized component shall be done following TSI treatment to validate the establishment of a new cohort. Surveys will target the regeneration portions of the stand.

Effectiveness Monitoring:

During each CFI, growth in the plots falling within this stratum will be calculated and compared to growth before treatment. Additional stand exam data will also be analyzed at least every 10 years to determine if the radial growth objective has occurred. Stand tables will be generated and the structure (q and TPA per diameter class) will be analyzed to determine that the Rx is indeed steering the stand towards an uneven-aged structure, has at least 33well-spaced crop tree-quality seedlings per acre, and at least two trees per acre > 20-inch dbh. Data will include dwarf mistletoe rating.

VI. Signature Page

Prepared By: ______________________________ ______________
Name, Title Date

Reviewed By: ______________________________ ______________
Name. Agency Silviculturist Date

Reviewed By: ______________________________ ______________
Name, Forest Manager Date

Please note that while it is recommended that a designated silviculturist review and sign all silvicultural prescriptions, it is not required in the BIA. This form may be tailored to fit your needs.

Single Tree Selection

SUMMARY STATISTICS (PER ACRE OR STAND BASED ON TOTAL STAND AREA)

		START OF SIMULATION PERIOD									REMOVALS				AFTER TREATMENT					GROWTH THIS PERIOD			MAI		
YEAR	AGE	NO OF TREES	BA	SDI	CCF	TOP HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	TOP HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MERCH CU FT	FOR TYP	SS ZT
2004	0	669	122	278	132	73	5.8	2780	2394	9526	552	1804	1527	5834	40	81	42	60	8.0	10	41	0	0.0	201	13
2014	10	116	54	102	54	66	9.2	1386	1242	5550	0	0	0	0	54	102	54	66	9.2	10	49	1	0.0	201	14
2024	20	115	69	124	67	71	10.5	1865	1693	7876	0	0	0	0	69	124	67	71	10.5	0	0	0	0.0	201	14

Species: ALL Year: 2004 Mgmt Id: NONE Stand: 1-3,5-7,9-11,13-19,22,24..

	LIVE TREES						HARVESTED TREES						MORTALITY TREES					
DIAM. CLASS	TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT
2	455.2	4.2	1.7	16.9	0.0	0.0	389.6	4.1	1.6	16.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	51.7	24.1	4.0	49.7	0.0	0.0	44.8	24.2	3.4	41.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	27.7	39.8	5.5	86.6	57.9	0.0	26.3	40.1	5.2	82.0	54.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	39.8	42.8	13.8	227.4	191.8	0.0	30.1	43.4	10.7	176.4	149.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	32.5	48.1	17.6	317.2	239.5	686.8	24.3	47.4	13.1	233.3	175.6	503.4	0.0	0.0	0.0	0.0	0.0	0.0
12	21.6	57.2	16.2	338.5	281.9	1068.2	12.4	59.8	9.3	203.0	169.3	646.1	0.0	0.0	0.0	0.0	0.0	0.0
14	16.4	65.7	16.9	406.8	361.7	1564.9	10.6	63.4	11.0	255.8	227.4	974.8	0.0	0.0	0.0	0.0	0.0	0.0
16	8.7	70.7	12.1	311.9	286.9	1318.3	4.8	68.8	6.6	164.9	151.6	692.6	0.0	0.0	0.0	0.0	0.0	0.0
18	7.3	75.8	12.8	355.4	331.9	1603.6	4.0	73.3	6.9	187.0	174.9	845.7	0.0	0.0	0.0	0.0	0.0	0.0
20	4.2	77.8	9.0	252.1	237.9	1172.2	2.7	77.8	5.9	165.4	156.0	772.3	0.0	0.0	0.0	0.0	0.0	0.0
22	2.1	88.1	5.5	174.2	166.4	839.0	1.1	92.9	2.8	92.7	88.7	448.3	0.0	0.0	0.0	0.0	0.0	0.0
24	0.9	91.6	2.8	91.2	87.5	447.6	0.7	88.9	2.1	67.0	64.2	327.8	0.0	0.0	0.0	0.0	0.0	0.0
26	0.8	90.7	2.8	91.0	88.9	476.8	0.7	91.6	2.4	80.7	78.9	424.9	0.0	0.0	0.0	0.0	0.0	0.0
28	0.1	88.0	0.3	11.0	11.2	64.3	0.1	88.0	0.3	11.0	11.2	64.3	0.0	0.0	0.0	0.0	0.0	0.0
30	0.1	100.9	0.7	24.4	23.7	126.3	0.1	103.0	0.3	12.4	12.1	64.5	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.1	106.1	0.7	26.1	26.7	160.4	0.1	110.0	0.3	13.3	12.9	70.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	669.1	17.5	122.2	2780.3	2394.0	9528.3	552.2	15.7	81.8	1803.5	1526.7	5834.7	0.0	0.0	0.0	0.0	0.0	0.0

Species: DF Year: 2004 Mgmt Id: NONE Stand: 1-3,5-7,9-11,13-19,22,24..

	LIVE TREES						HARVESTED TREES						MORTALITY TREES					
DIAM. CLASS	TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT
2	162.1	2.8	0.4	4.8	0.0	0.0	134.5	2.8	0.4	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	31.0	23.8	2.3	31.0	0.0	0.0	24.1	23.7	1.7	23.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	7.6	36.7	1.4	20.4	11.7	0.0	6.2	37.3	1.0	15.8	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	14.2	42.9	4.8	79.1	65.0	0.0	9.5	46.6	3.4	60.0	50.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	17.7	50.1	9.7	177.4	130.5	563.9	12.7	49.5	6.9	125.4	91.0	254.9	0.0	0.0	0.0	0.0	0.0	0.0
12	11.8	57.1	8.6	177.7	146.6	500.1	6.5	62.5	4.8	108.4	90.1	310.9	0.0	0.0	0.0	0.0	0.0	0.0
14	5.4	68.2	5.5	134.0	119.1	478.6	4.0	65.5	4.1	96.7	85.9	346.5	0.0	0.0	0.0	0.0	0.0	0.0
16	3.7	69.5	5.2	127.8	117.5	520.8	2.0	69.0	2.8	67.9	62.4	276.1	0.0	0.0	0.0	0.0	0.0	0.0
18	1.4	71.7	2.4	61.5	57.5	270.5	0.4	70.9	0.7	17.1	15.9	74.0	0.0	0.0	0.0	0.0	0.0	0.0
20	2.3	76.9	4.8	131.8	124.6	606.9	1.3	73.5	2.8	72.0	68.0	331.4	0.0	0.0	0.0	0.0	0.0	0.0
22	1.6	86.9	4.1	127.5	121.8	612.4	0.5	94.2	1.4	46.0	44.1	221.7	0.0	0.0	0.0	0.0	0.0	0.0
24	0.4	96.4	1.4	46.9	45.1	231.0	0.2	92.9	0.7	22.7	21.8	111.3	0.0	0.0	0.0	0.0	0.0	0.0
26	0.2	76.4	0.7	18.5	17.7	92.6	0.1	67.0	0.3	8.1	7.8	40.8	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.1	100.9	0.7	24.4	23.7	126.3	0.1	103.0	0.3	12.4	12.1	64.5	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.1	110.0	0.3	13.3	12.9	70.0	0.1	110.0	0.3	13.3	12.9	70.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	259.5	18.3	52.3	1176.2	993.7	3873.2	202.2	16.2	31.7	693.8	571.2	2102.1	0.0	0.0	0.0	0.0	0.0	0.0

Species: WF Year: 2004 Mgmt Id: NONE Stand: 1-3,5-7,9-11,13-19,22,24..

	LIVE TREES						HARVESTED TREES						MORTALITY TREES					
DIAM. CLASS	TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT
2	148.3	5.0	0.8	10.0	0.0	0.0	141.4	5.1	0.8	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	10.3	24.0	0.7	7.2	0.0	0.0	10.3	24.0	0.7	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	10.2	40.3	2.1	32.4	20.8	0.0	10.2	40.3	2.1	32.4	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	14.2	43.9	4.8	81.0	66.7	0.0	11.0	43.4	3.8	62.8	52.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	4.4	54.2	2.4	49.7	37.5	135.9	2.6	51.0	1.4	27.3	20.5	74.4	0.0	0.0	0.0	0.0	0.0	0.0
12	4.9	59.0	3.8	83.4	70.3	284.7	2.3	59.0	1.7	38.1	32.1	130.0	0.0	0.0	0.0	0.0	0.0	0.0
14	5.1	67.5	5.2	129.9	115.7	503.8	3.1	66.8	3.1	77.1	68.6	298.8	0.0	0.0	0.0	0.0	0.0	0.0
16	2.5	69.8	3.4	89.4	82.3	380.7	1.0	71.8	1.4	36.8	33.9	155.9	0.0	0.0	0.0	0.0	0.0	0.0
18	3.4	80.0	5.9	173.6	162.8	778.6	1.8	77.7	3.1	89.3	83.7	400.7	0.0	0.0	0.0	0.0	0.0	0.0
20	1.6	77.4	3.5	98.8	93.4	460.0	1.1	80.5	2.4	71.9	68.0	335.6	0.0	0.0	0.0	0.0	0.0	0.0
22	0.4	93.1	1.0	35.5	33.9	170.1	0.4	93.1	1.0	35.5	33.9	170.1	0.0	0.0	0.0	0.0	0.0	0.0
24	0.4	86.7	1.4	44.3	42.4	216.5	0.4	86.7	1.4	44.3	42.4	216.5	0.0	0.0	0.0	0.0	0.0	0.0
26	0.3	101.6	1.0	38.7	37.3	193.5	0.3	101.6	1.0	38.7	37.3	193.5	0.0	0.0	0.0	0.0	0.0	0.0
Total	206.1	17.4	36.0	873.8	763.1	3123.9	185.8	14.8	23.9	571.5	493.2	1975.5	0.0	0.0	0.0	0.0	0.0	0.0

Species: PI Year: 2004 Mgmt Id: NONE Stand: 1-3,5-7,9-11,13-19,22,24..

DIAM. CLASS	LIVE TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	HARVESTED TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	MORTALITY TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT
2	3.4	4.0	0.0	0.0	0.0	0.0	3.4	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	3.4	4.0	0.0	0.0	0.0	0.0	3.4	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Species: PP Year: 2004 Mgmt Id: NONE Stand: 1-3,5-7,9-11,13-19,22,24..

DIAM. CLASS	LIVE TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	HARVESTED TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	MORTALITY TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT
2	41.4	3.3	0.0	0.0	0.0	0.0	41.4	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.6	32.0	0.3	4.1	3.2	0.0	1.6	32.0	0.3	4.1	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	3.1	38.0	1.0	14.4	12.5	0.0	3.1	38.0	1.0	14.4	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	3.2	41.3	1.7	26.4	19.3	73.6	3.2	41.3	1.7	26.4	19.3	73.6	0.0	0.0	0.0	0.0	0.0	0.0
12	4.0	53.9	3.1	61.5	51.3	233.6	3.2	53.6	2.4	47.5	39.4	178.7	0.0	0.0	0.0	0.0	0.0	0.0
14	3.6	61.2	3.8	85.1	74.4	358.4	1.9	56.7	2.1	43.2	37.5	179.7	0.0	0.0	0.0	0.0	0.0	0.0
16	1.0	77.8	1.4	39.0	35.3	176.2	0.5	72.0	0.7	18.1	16.3	81.2	0.0	0.0	0.0	0.0	0.0	0.0
18	1.2	73.6	2.1	55.7	50.8	255.3	0.4	63.5	0.7	16.0	14.4	71.8	0.0	0.0	0.0	0.0	0.0	0.0
20	0.3	85.7	0.7	21.5	19.9	105.3	0.3	85.7	0.7	21.5	19.9	105.3	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.2	95.0	0.7	23.7	24.2	137.5	0.2	95.0	0.7	23.7	24.2	137.5	0.0	0.0	0.0	0.0	0.0	0.0
28	0.1	88.0	0.3	11.0	11.2	64.3	0.1	88.0	0.3	11.0	11.2	64.3	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.1	102.0	0.3	12.8	13.8	90.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	59.7	18.4	15.5	355.3	315.9	1494.7	55.9	14.9	10.7	226.0	198.1	892.1	0.0	0.0	0.0	0.0	0.0	0.0

Species: WP Year: 2004 Mgmt Id: NONE Stand: 1-3,5-7,9-11,13-19,22,24..

DIAM. CLASS	LIVE TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	HARVESTED TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	MORTALITY TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT
2	93.1	5.0	0.3	2.1	0.0	0.0	62.1	4.2	0.2	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	3.4	40.0	0.5	7.2	0.0	0.0	3.4	40.0	0.5	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	6.8	44.4	1.4	23.9	17.8	0.0	6.8	44.4	1.4	23.9	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	5.7	46.2	2.1	36.9	32.3	0.0	4.8	44.6	1.7	29.7	25.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	5.9	44.3	3.1	51.9	40.4	113.5	5.3	44.3	2.8	46.1	35.9	100.5	0.0	0.0	0.0	0.0	0.0	0.0
12	0.9	61.8	0.7	15.8	13.8	49.8	0.5	69.0	0.3	9.0	7.7	26.5	0.0	0.0	0.0	0.0	0.0	0.0
14	2.0	58.9	2.1	46.1	41.9	176.2	1.6	59.6	1.7	38.8	35.4	149.9	0.0	0.0	0.0	0.0	0.0	0.0
16	1.3	64.9	1.7	42.1	39.0	179.3	1.3	64.9	1.7	42.1	39.0	179.3	0.0	0.0	0.0	0.0	0.0	0.0
18	1.4	71.1	2.4	64.6	60.9	299.2	1.4	71.1	2.4	64.6	60.9	299.2	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.1	87.0	0.3	11.2	10.7	56.4	0.1	87.0	0.3	11.2	10.7	56.4	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.1	78.0	0.3	10.1	9.6	53.2	0.1	78.0	0.3	10.1	9.6	53.2	0.0	0.0	0.0	0.0	0.0	0.0
Total	120.7	14.9	14.9	311.8	266.4	927.6	87.3	16.9	13.4	284.8	242.9	865.0	0.0	0.0	0.0	0.0	0.0	0.0

Species: JU Year: 2004 Mgmt Id: NONE Stand: 1-3,5-7,9-11,13-19,22,24..

DIAM. CLASS	LIVE TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	HARVESTED TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	MORTALITY TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.7	25.0	0.3	3.8	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.7	25.0	0.3	3.8	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Species: BS Year: 2004 Mgmt Id: NONE Stand: 1-3,5-7,9-11,13-19,22,24..

DIAM. CLASS	LIVE TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	HARVESTED TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	MORTALITY TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.4	40.0	0.3	5.0	4.5	0.0	1.4	40.0	0.3	5.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	1.0	39.0	0.3	5.5	4.7	0.0	1.0	39.0	0.3	5.5	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.4	85.0	0.3	11.7	10.6	47.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.2	99.0	0.3	13.6	12.8	61.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	3.0	49.7	1.4	36.7	32.6	109.0	2.4	39.6	0.7	11.3	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Species: CA Year: 2004 Mgmt Id: NONE Stand: 1-3,5-7,9-11,13-19,22,24..

DIAM. CLASS	LIVE TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	HARVESTED TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT	MORTALITY TREES: TREES PER ACRE	AVG HT	BASAL AREA	TOTAL CU FT	MERCH CU FT	MERCH BD FT
2	6.9	14.5	0.2	0.0	0.0	0.0	6.9	14.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	6.9	18.0	0.6	4.1	0.0	0.0	6.9	18.0	0.6	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	1.6	30.6	0.7	10.5	10.5	0.0	0.8	24.0	0.3	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.6	42.0	0.3	8.0	8.0	0.0	0.6	42.0	0.3	8.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	16.0																	

GLOSSARY

The following terms and definitions have been included to assist in working with this Handbook. Terminology should be used consistently at all locations to maintain clarity when planning projects and reporting accomplishments. Use of forestry slang and jargon is unacceptable in professional documents. Because forest management is a long-term endeavor, one of the main purposes of a silvicultural prescription is to document forestry activities so that future foresters may continue the schedule of planned treatments. It is imperative that silvicultural documents be prepared in a clear and concise manner, using standard terminology so that future foresters can understand the intent and purpose of past treatments.

The following definitions were taken primarily from *The Dictionary of Forestry* (Helms, Society of American Foresters 1998) and "Silviculture Terminology" (Silviculture Instructors Subgroup, Silviculture Working Group (D2) Society of American Foresters, 1994). Both are recognized sources for silvicultural terminology and definitions. Footnoted definitions were taken from either 25 CFR 163.1 or the BIA *Fuels Program Business Management Handbook*, February 2006. The silviculturist should be well aware of other terms worthy of definition in 25 CFR 163.1.

Adaptive Management
A dynamic approach to forest management in which the effects of treatments and decisions are continually monitored and used, along with research results, to modify management on a continuing basis to ensure that objectives are being met.

Advance Regeneration (Reproduction) – *synonym* Advance Growth
Seedlings or saplings that develop or are present in the understory.

Afforestation
Establishment of a forest or stand in an area where the preceding vegetation or land use was not forest.

Age Class (Cohort)
A distinct aggregation of trees originating from a single natural event or regeneration activity, or a grouping of trees, such as a 10-year age class, as used in inventory or management**.**

Artificial Regeneration (Reproduction)
A group or stand of young trees created by direct seeding or by planting seedlings or cuttings.

Basal Area
The area of the cross-section area of a single stem, including the bark, measured at breast height (4.5 feet above the ground).

Biodiversity
The variety and abundance of life forms, processes, functions, and structures of plants, animals, and other living organisms, including the relative complexity of species, communities, gene pools, and ecosystems at spatial scales that range from local through regional to global (*syn*. biological diversity, diversity).

Biological Diversity (see Biodiversity)

Breast Height
A standard height from ground level for recording diameter, girth, or basal area of a tree, generally 4.5 feet.

Burning, Prescribed
The application of fire, usually under existing stands and under specified conditions of weather and fuel moisture, in order to attain silvicultural or other management objectives.

Canopy
The foliar cover in a forest stand consisting of one or several layers.

Canopy Closure (see Crown Cover)

Cleaning
A release treatment made in an age class not past the sapling stage in order to free the favored trees from less desirable individuals of the same age class that overtop them or are likely to do so (see Improvement Cutting, Liberating, Weeding).

Clearcutting (see Regeneration Methods)

Codominant (see Crown Class)

Cohort (see Age Class)

Commercial Forest Land
Forest land that is producing or capable of producing crops of marketable forest products and is administratively available for intensive management and sustained production.[1]

Composition, Stand
The proportion of each tree species in a stand expressed as a percentage of the total number, basal area, or volume of all tree species in the stand.

Coppice (see Regeneration Methods)

Crop Tree
Any tree selected to become a component of a future commercial harvest.

Crown
The part of a tree or woody plant bearing live branches and foliage.

Crown Class
A category of tree based on its crown position relative to the crowns of adjacent trees.

> ***Emergent***
> A tree whose crown is completely above the general level of the main canopy, receiving full light from above and from all sides.
>
> ***Dominant***

[1] Definition taken from 25 CFR §163.1.

A tree whose crown extends above the general level of the main canopy of even-aged stands or, in uneven-aged stands, above the crowns of the tree's immediate neighbors, and receiving full light from above and partial light from the sides.

Codominant
A tree whose crown helps to form the general level of the main canopy in even-aged stands or, in uneven-aged stands, the main canopy of the tree's immediate neighbors, receiving full light from above and comparatively little from the sides.

Intermediate
A tree whose crown extends into the lower portion of the main canopy of even-aged stands or, in uneven-aged stands, into the lower portion of the canopy formed by the tree's immediate neighbors, but shorter in height than the codominants and receiving little direct light from above and none from the sides.

Overtopped (Suppressed)
A tree whose crown is completely overtopped by the crowns of one or more neighboring trees – *note* the vigor of overtopped trees varies from high to low depending on individual circumstances.

Crown Cover
The ground area covered by the crowns of trees or woody vegetation as delimited by the vertical projection of crown perimeters and commonly expressed as a percent of total ground area (*syn*. Canopy Cover).

Crown Density
The amount and compactness of foliage of the crowns of trees or shrubs.

Cutting Cycle
The planned interval between partial harvests in an uneven-aged stand (see Thinning Interval).

Density Management
The cutting or killing of trees to increase spacing and accelerate growth of remaining trees – *note* density management is used to improve forest health of stands, to open the forest canopy for selected trees, to maintain understory vegetation, to accelerate growth to maintain desired seral conditions, or to attain later-successional characteristics for biological diversity.

Dominant (see Crown Class)

Dysgenic
Being detrimental to the genetic qualities of future generations – *note* the term applies, especially to human-caused deterioration, such as losses resulting from high-grading a forest stand. Examples of dysgenic forest practices include (a) use of planting stock of unknown origin or maladapted to the planting site or (b) removal of the best trees when harvesting and leaving inferior trees to regenerate the area ("High grading").

Ecological Approach
A type of natural resource planning, management, or treatment that ensures consideration of the relationship between all biotic organisms (including humans) and their abiotic environment.

Ecological Classification
A multifactor approach to categorizing and delineating, at different levels of resolution, areas of land and

water having similar characteristic combinations of physical environment (such as topography, climate, geomorphic processes, geology, soil, and hydrology), biological communities (such as plants, animals, microorganisms, and potential natural communities), and human factors (such as social, economic, cultural, and infrastructure.

Ecoregion
A contiguous geographic area having a relatively uniform macroclimate, possibly with several vegetation types, and used as an ecological basis for management or planning.

Ecosystem
A spatially explicit, relatively homogeneous unit of the earth that includes all interacting organisms and components of the abiotic environment within its boundaries – note an ecosystem can be of any size, e.g., a log, pond, field, forest, or the earth's biosphere.

Ecosystem Management
Management guided by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on the best understanding of ecological interactions and processes necessary to sustain ecosystem composition, structure, and function over the long term – *note* the term was initially introduced by the USDA Forest Service.

Emergent (see Crown Class)

Even-aged Stand
A stand of trees composed of a single age class in which the range of tree ages is usually plus or minus 20 percent of rotation.

Even-aged System
A planned sequence of treatments designed to maintain and regenerate a stand with predominately one age class. The range of tree ages is usually less than 20 percent of the rotation. (see clearcutting, seed tree, shelterwood, and coppice regeneration methods).

Fire Condition Class
Depiction of the degree of departure from historical fire regimes, possibly resulting in alterations of key ecosystem components. These classes categorize and describe vegetation composition and structure conditions that currently exist inside the Fire Regime Groups. Based on coarse scale national data, they serve as generalized wildfire rankings. The risk of loss of key ecosystem components from wildfires increases from Condition Class 1 (lowest risk) to Condition Class 3 (highest risk). Condition Classes measure general wildfire risk as follows[2]:

> ***Condition Class 1 -*** For the most part, fire regimes in this Fire Condition Class are within historical ranges. Vegetation composition and structure are intact. Thus, the risk of losing key ecosystem components from the occurrence of fire remains relatively low.
>
> ***Condition Class 2 -*** Fire regimes on these lands have been moderately altered from their historical range by either increased or decreased fire frequency. A moderate risk of losing key ecosystem components has been identified on these lands.

[2] Definitions taken from the BIA *Fuels Management Business Rules Handbook*, July 2008.

***Condition Class 3* -** Fire regimes on these lands have been significantly altered from their historical return interval. The risk of losing key ecosystem components from fire is high. Fire frequencies have departed from historical ranges by multiple return intervals. Vegetation composition, structure and diversity have been significantly altered. Consequently, these lands verge on the greatest risk of ecological collapse.

Fire Regime
Description of the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects as well, in a given area or ecosystem. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval. Five combinations of fire frequency, expressed as fire return interval in fire severity, are defined[2]:

Groups I and II include fire return intervals in the 0 - 35 year range. Group 1 includes ponderosa pine, other long needle pine species, and dry site Douglas fir. Group II includes the drier grassland types, tall grass prairie, and some Pacific chaparral ecosystems.

Groups III and IV include fire return intervals in the 35-100+ year range. Group III includes the interior mixed fire regime including wet Douglas fir habitat types, woodlands, Bosque, and dry site shrub communities such as sagebrush and chaparral ecosystems. Group IV includes lodgepole pine and jack pine.

Group V is the long interval (infrequent), stand replacement fire regime and includes temperate rain forest, boreal forest, and high elevation conifer species.

Forest or Forest Land
An ecosystem at least one acre in size, including timberland and woodland, which: is characterized by a more or less dense and extensive tree cover; contains, or once contained, at least ten percent tree crown cover, and is not developed or planned for exclusive non-forest resource use.[1]

Forest Fertilization
The addition of nutrient elements to increase growth rate or overcome a nutrient deficiency in the soil.

Forest Health
The perceived condition of a forest derived from concerns about such factors as its age, structure, composition, function, vigor, presence of unusual levels of insects or disease, and resilience to disturbance – *note* perception and interpretation of forest health are influenced by individual and cultural viewpoints, land management objectives, spatial and temporal scales, the relative health of the stands that comprise the forest, and the appearance of the forest at a point in time.

Forest Management Plan
The principal document, approved by the Secretary, reflecting and consistent with an integrated resource management plan, which provides for the regulation of the detailed, multiple-use operation of Indian forest land by methods ensuring that such lands remain in a continuously productive state while meeting the objectives of the tribe and which shall include: standards setting forth the funding and staffing requirements necessary to carry out each management plan, with a report of current forestry funding and staffing levels; and standards providing quantitative criteria to evaluate performance against the objectives set forth in the plan.[1]

Forest Regulation
The technical (in contrast to the administrative and business) aspects of controlling stocking, harvests, growth, and yields to meet management objectives including sustained yield.

Fragmentation
The process by which a landscape is broken into small islands of forest within a mosaic of other forms of land use or ownership – *note* e.g., islands of a particular age class (e.g., old growth) that remain within areas of younger-aged forest – *note* fragmentation is a concern because of the effect of noncontiguous forest cover on connectivity and the movement and dispersal of animals in the landscape.

Genotype
An individual's heredity (genetic) constitution – *note* the genotype interacts with the environment to produce the phonotype.

Green Tree Retention (see Reserve Trees)

Growth and Yield (See yield table)

Group Selection (see Regeneration Methods)

Habitat
1. A unit area of environment. **2.** The place, natural or otherwise, (including climate, food, cover, and water) where an animal, plant, or population naturally or normally lives and develops.

Habitat Type
Ecology, silviculture: an aggregation of units of land capable of producing similar plant communities at climax – *synonym* potential vegetation.

Harvesting Method
A procedure by which a stand is logged; emphasis is on meeting logging requirements while concurrently attaining silvicultural objectives. (*see* regeneration method, variable retention harvest system)

Improvement Cutting
The removal of less desirable trees of any species in a stand of pole-sized or larger trees, primarily to improve composition and quality. (*see* Cleaning, Liberating, and Weeding)

Indian Forest Land
Indian land, including commercial, non-commercial, productive and non-productive timberland and woodland, that are considered chiefly valuable for the production of forest products or to maintain watershed or other land values enhanced by a forest cover, regardless of whether a formal inspection and land classification action has been taken.[1]

Indian Land
Land title which is held by: The United States in trust for an Indian, an individual of Indian or Alaska Native ancestry who is not a member of a federally-recognized Indian tribe, or an Indian tribe; or by an Indian, an individual of Indian or Alaska Native ancestry who is not a member of a federally recognized tribe, or an Indian tribe subject to a restriction by the United States against alienation. [1]

Ingrowth

The volume, basal area or number of those trees in a stand that were smaller than a prescribed minimum diameter or height limit at the beginning of any growth-determining period and that, during that period, attained the prescribed size.

Integrated Resource Management Plan
A document, approved by an Indian tribe and the Secretary, which provides coordination for the comprehensive management of the natural resources of such tribe's reservation. [1]

Intermediate (see Crown Class)

Intermediate Treatments (Tending)
Any treatment or tending designed to enhance growth, quality, vigor, and composition of the stand after establishment or regeneration and prior to final harvest. (*see* Stand Improvement)

Irregular *of a regeneration method (e.g., irregular shelterwood)*
Characterized by a variation in age structure (usually uneven-aged) or in spatial arrangement of trees.

Landscape
A spatial mosaic of several ecosystems, landforms, and plant communities across a defined area irrespective of ownership or other artificial boundaries and repeated in similar form throughout.

Liberation
A release treatment made in a stand not past the sapling stage in order to free the favored trees from competition with older, overtopping trees.

Management Objective
A concise, time-specific statement of measurable planned results that correspond to pre-established goals in achieving a desired outcome.

Monoculture
A stand of a single species, generally even-aged.

Monitoring
The collection of information over time, generally on a sample basis by measuring change in an indicator or variable, to determine the effects of resource management treatments in the long term.

Mycorrhizae
The usually symbiotic association between higher plant roots (host) and mycelia of specific fungi that aid plants in the uptake of water and certain nutrients and may offer protection against other soil-borne organisms.

Natural Regeneration
The establishment of a plant or a plant age class from natural seeding, sprouting, suckering, or layering.

Nurse Tree (Nurse Crop)
A tree, group, or crop of trees, shrubs or other plants, either naturally occurring or introduced, used to nurture, improve survival or improve the form of a more desirable tree or crop when young by protecting it from frost, insolation, wind, or insect attack.

Objective (see Management Objective)

Old-Growth Forest
The (usually) late successional stage of forest development – *note 1.* old-growth forests are defined in many ways; generally, structural characteristics used to describe old-growth forests include (a) live trees: number and minimum size of both seral and climax dominants, (b) canopy conditions: commonly including multilayering, (c) snags: minimum number of specific size, and (d) down logs and coarse woody debris: minimum tonnage and numbers of pieces of specific size. n*ote 6.* an old-growth forest is commonly perceived as an uncut, virgin forest with very little human-caused disturbance; some believe that the time taken for stands to develop old-growth structure can be shortened by silvicultural treatments aimed at producing the above characteristics. (Please see *The Dictionary of Forestry*, Society of American Foresters, 1998 for more definitions of this word).

Overstory Removal
The cutting of trees constituting an upper canopy layer in order to release trees or other vegetation in an understory. (see regeneration method)

Overtopped (see Crown Class)

Phenotype
The observed state, description, or degree of expression of a character or trait 2. the product of the interaction of the genes of an organism (genotype) with the environment.

Pole
A tree of a size between a sapling and a mature tree – *note* the size of a pole varies by region.

Potential Vegetation
Vegetation that would develop if all successional sequences were completed under present site conditions.

Precommercial Thinning (PCT)
The removal of trees not for immediate financial return but to reduce stocking to concentrate growth on the more desirable trees.

Productivity
Management: The relative capacity of an area to sustain a supply of goods or services in the long run – see **site quality**.

Reforestation
The reestablishment of forest cover either naturally (by natural seeding, coppice, or root suckers) or artificially (by direct seeding or planting) - *note* reforestation usually maintains the same forest type and is done promptly after the previous stand or forest was removed. (*syn*. Regeneration).

Regeneration
Silviculture - Seedlings or saplings existing in a stand; or the act of renewing tree cover by establishing young trees naturally or artificially (*syn*. Reforestation).

Regeneration (Reproduction) Method
A cutting procedure by which a new age class is created; the major methods are clearcutting, seed tree,

shelterwood, selection, and coppice. (see Harvesting Method)

COPPICE METHODS:
Methods of regenerating a stand in which the majority of regeneration is from stump sprouts or root suckers.

Coppice
A method of regenerating a stand in which all trees in the previous stand are cut and the majority of regeneration is from sprouts or root suckers.

Coppice with Reserves
A coppice method in which reserve trees are retained to attain goals other than regeneration. The method normally creates a two-aged stand.

EVEN-AGED METHODS:
Methods to regenerate and maintain a stand with a single age class.

Clearcutting
The cutting of essentially all trees, producing a fully exposed microclimate for the development of a new age class. Regeneration can be from natural seeding, direct seeding, planted seedlings, or advance reproduction. Cutting may be done in groups or patches (group or patch clearcuttings), or in strips (strip clearcutting). The management unit or stand in which regeneration, growth, and yield are regulated consists of the individual clearcut stand (see Group Selection). When the primary source of regeneration is advance reproduction, the preferred term is overstory removal.

Clearcutting with Reserves (see Two-aged Methods)

Seed Tree
The cutting of all trees except for a small number of widely dispersed trees retained for seed production and to produce a new age class in fully exposed microenvironment. Seed trees are usually removed after regeneration is established.

Seed Tree with Reserves (see Two-aged Methods)

Shelterwood
A method of regenerating an even-aged stand in which a new age class develops beneath the moderated microenvironment provided by the residual trees. The sequence of treatments can include three distinct types of cuttings: (1) an optional preparatory cut to enhance conditions for seed production; (2) an establishment cut to prepare the seed bed and to create a new age class; and (3) a removal cut to release established regeneration from competition with the overwood. Cutting may be done uniformly throughout the stand (Uniform Shelterwood), in groups or patches (Group Shelterwood), or in strips (Strip Shelterwood).

Shelterwood with Reserves (see Two-aged Methods)

TWO-AGED METHODS:
Methods designed to maintain and regenerate a stand with two age classes. The resulting stand may be two-aged or tend toward an uneven-aged condition as a consequence of both an extended period of regeneration establishment and the retention of reserve trees that may represent one or more age

classes.

Clearcutting with Reserves
A clearcutting in which varying numbers of reserve trees are not harvested to attain goals other than regeneration.

Seed Tree with Reserves
A seed tree method in which some or all of the seed trees are retained after regeneration has become established to attain goals other than regeneration.

Shelterwood with Reserves
A variant of the Shelterwood Method in which some or all of the shelter trees are retained after regeneration, well beyond the normal period of retention, to attain goals other than regeneration.

UNEVEN-AGED (SELECTION) METHODS:
Methods of regenerating and maintaining a multi-aged structure by removing some trees in all size classes either singly, in small groups, or in strips.

Group Selection
A method of regenerating uneven-aged stands in which trees are removed, and new age classes are established, in small groups. The maximum width of groups is approximately twice the height of the mature trees with smaller openings providing microenvironment suitable for tolerant regeneration and the larger openings providing conditions suitable for more intolerant regeneration. The management unit or stand in which regeneration, growth, and yield are regulated consists of an aggregation of groups. (See Clearcutting)

Group Selection with Reserves
A variant of the Group Selection Method in which some trees within the group are not cut to attain goals other than regeneration within the group.

Single Tree Selection
Individual trees of all size classes are removed more-or-less uniformly throughout the stand, to promote growth of remaining trees and to provide space for regeneration – *synonym* individual tree selection.

Regeneration (Reproduction) Period
The time between the initial regeneration cutting and the successful reestablishment of a new age class by natural means, planting, or direct seeding.

Regular Uneven-aged (Balanced) Stand
A stand in which three or more distinct age classes occupy approximately equal areas and provide a balanced distribution of diameter classes. (see irregular)

Relative Stand Density
The ratio, proportion, or percent of absolute stand density to a reference level defined by some standard level of competition.

Release (Release Operation)
A treatment designed to free young trees from undesirable, usually overtopping, competing vegetation.

Treatments include cleaning, liberating, and weeding. (see Stand Improvement)

Reserve Trees (Green Tree Retention)
A tree, pole-sized or larger, retained in either a dispersed or aggregated manner after the regeneration period under the clearcutting, seed tree, shelterwood, group selection, or coppice methods (*syn*. Standard, green tree retention).

Resiliency
The capacity of a (plant) community or ecosystem to maintain or regain normal function and development following disturbance.

Root Pruning
The cutting of seedling roots, with minimum disturbance, in a nursery bed to limit their vertical or lateral growth. (see Undercutting)

Rotation
In even-aged systems, the period between regeneration establishment and final cutting.

Salvage Cutting
The removal of dead trees or trees damaged or dying because of injurious agents other than competition, to recover value that would otherwise be lost.

Sanitation Cutting
The removal of trees to improve stand health by stopping or reducing the actual or anticipated spread of insects and disease. (see Stand Improvement)

Sapling
A tree, usually young, that is larger than a seedling but smaller than a pole. Size varies by region.

Scarification
Mechanical removal of competing vegetation and/or interfering debris, or disturbance of the soil surface, designed to enhance reforestation.

Seed Tree (see Regeneration Methods)

Shelterwood (see Regeneration Methods)

Silvics
The study of the life history and general characteristics of forest trees and stands, with particular reference to environmental factors, as a basis for the practice of silviculture.

Silvicultural System
A planned series of treatments for tending, harvesting, and reestablishing a stand. The system name is based on the number of age classes (coppice, even-aged, two-aged, uneven-aged), or the regeneration method (clearcutting, seed tree, shelterwood, selection, coppice, coppice with reserves) used.

Silviculture
The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

Silviculturist (note proper spelling - *not* "Silviculturalist")

Single Tree Selection (see Regeneration Method)

Site Class
A classification of site quality, usually expressed in terms of ranges of dominant tree height at a given age or potential mean annual increment at culmination.
Site Index
A species-specific measure of actual or potential forest productivity (site quality, usually for even-aged stands), expressed in terms of the average height of trees included in a specified stand component (defined as a certain number of dominants, co-dominants, or the largest and tallest trees per unit area) at a specified index or base age. Site index is an indicator of site quality.

Site Preparation
A hand or mechanized manipulation of a site designed to enhance the success of regeneration. Treatments may include bedding, burning, chemical spraying, chopping, disking, drainage, raking, and scarifying and are designed to modify the soil, litter, and vegetation and to create microclimate conditions conducive to the establishment and growth of desired species.

Site Quality (Productivity)
The productive capacity of a site, usually expressed as volume production of a given species - *syn*. site productivity.

Size Class
Tree size recognized by distinct ranges, usually of diameter or height.

Snag
A standing, generally un-merchantable dead tree from which the leaves and most of the branches have fallen.

Stand
A contiguous group of trees sufficiently uniform in age class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit (see Mixed, Pure, Even-aged, and Uneven-aged Stands).

All-aged Stand
A stand with trees of all or almost all age classes, including those of exploitable age. (i.e. That definition comes from the SAF *Dictionary of Forestry*. Smith, in *The Practice of Silviculture*, says this about all-aged stands:

> *The concept of the mixed, all-aged stand of stable climax vegetation with some ancient trees and no net gain or loss of materials is more of an abstraction than a reality. Diagrams depicting such forests are useful for conveying ideas succinctly, but the concept that they depict may be to forest ecology and silviculture what the perfect black body is to physics and engineering.*

Mixed Stand
A stand in which there is a mixture of species.

Multi-aged (Multi-cohort) Stand

A stand with two or more age classes or cohorts.

Pure Stand
A stand composed of essentially a single species.

Stratified Mixture
A stand in which different species occupy different strata of the total crown canopy.

Stand Density
A quantitative, absolute measure of tree occupancy per unit of land area in such terms as numbers of trees, basal area, or volume. (see relative stand density).

Stand Density Index (SDI)
A widely used measure developed by Reineke (1933) that expresses relative stand density in terms of the relationship of a number of trees to stand quadratic mean diameter. Any index that expresses relative stand density based on a comparison of measured stand values with some standard condition.

Stand Improvement
A term comprising all intermediate cuttings made to improve the composition, structure, condition, health, and growth of even- or uneven-aged stands.

Stand Development
Changes in forest stand structure over time.

Stand Structure
The horizontal and vertical distribution of components of a forest stand including the height, diameter, crown layers and stems of trees, shrubs, herbaceous understory, snags, and down woody debris.

Stewardship
The administration of land and associated resources in a manner that enables their passing on to future generations in a healthy condition.

Stocking
An indication of growing-space occupancy relative to a pre-established standard. Common indices of stocking are based on percent occupancy, basal area, relative density, stand density index, and crown competition factor.

Stratum *plural* strata
A distinct layer of vegetation within a forest community. *Syn.* Canopy layer. 2. A subdivision of a population, used in stratified sampling.

Succession
The gradual supplanting of one community of plants by another. The sequence of communities is called a sere, or seral stage. A series of dynamic changes by which organisms succeed one another through a series of plant community (seral) stages leading to potential natural community or climax.

Suppressed (see Crown Class)

Sustainability

The capacity of forests, ranging from stands to ecoregions, to maintain their health, productivity, diversity, and overall integrity, in the long run, in the context of human activity and use.

Sustained Yield
The yield of forest products that a forest can produce continuously at a given intensity of management. [1]

Tending (see Intermediate Treatments).

Thinning
A cultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or to recover potential mortality.

Crown Thinning (Thinning from Above, High Thinning)
The removal of trees from the dominant and co-dominant crown classes in order to favor the best trees of those same crown classes.

Free Thinning
The removal of trees to control stand spacing and favor desired trees using a combination of thinning criteria without regard to crown position.

Low Thinning (Thinning from Below)
The removal of trees from the lower crown classes to favor those in the upper crown classes.

Mechanical Thinning (Geometric Thinning)
The thinning of trees in either even- or uneven-aged stands involving removal of trees in rows, strips, or by using fixed spacing intervals.

Selection Thinning (Dominant Thinning)
The removal of trees in the dominant crown class in order to favor the lower crown classes.

Thinning Interval
The period of time between successive thinning entries, usually used in connection with even-aged stands. (see cutting cycle)

Tolerance, Shade
The capacity of trees to grow satisfactorily in the shade of, and in competition with, other trees. If intolerant of shade, they are termed light demanders; if tolerant, shade bearers.

Two-aged Stand
A stand with trees of two distinct age classes separated in age by more than 20 percent of rotation.

Two-aged System
A planned sequence of treatments designed to maintain and regenerate a stand with two age classes.

Undercutting
The root pruning of seedlings in a nursery bed to limit root depth extension. (see Root Pruning and wrenching)

Uneven-aged Stand
A stand of trees of three or more distinct age classes, either intimately mixed or in small groups.

Uneven-aged System
A planned sequence of treatments designed to maintain and regenerate a stand with three or more age classes. (see Single Tree Selection, Group Selection)

Variable Retention Harvest System
An approach to harvesting based on the retention of structural elements or biological legacies (trees, snags, logs, etc.) from the harvested stand for integration into the new stand to achieve various ecological objectives. The major variables in the variable retention harvest system are types, densities, and spatial arrangement of retained structures; aggregated retention is the retention of structures or biological legacies as (typically) small, intact forest patches within the harvest unit; dispersed retention is the retention of structures or biological legacies in a dispersed or uniform pattern.

Watershed
A region or land area drained by a single stream, river, or drainage network.

Weeding
A release treatment in stands not past the sapling stage that eliminates or suppresses undesirable vegetation regardless of crown position.

Wrenching
The disturbance of seedling roots in a nursery bed to stimulate the development of a fibrous root system. Usually done one or more times in a growing season, using a tilted blade drawn by a tractor at a prescribed depth.

Yield
Management: the amount of wood that may be harvested from a particular type of forest stand by species, site, stocking and management regime at various ages.

> **Growth-and-Yield Model**
> A set of relationships, usually expressed as equations and embodied in a computer program, that provide estimates of future stand development given initial stand conditions and a specified management regime. *Note* – growth-and-yield models are used to generate managed-stand yield tables, predict future stand conditions for management planning, update inventories, and compare predicted results of alternative possible management regimes.